

2 x 660 MW KORADI TPS UNITS - 11 & 12
(FOR MISCELLANEOUS TANKS- SITE FABRICATED AND AGITATORS)

AND

2 x 660 MW TALCHER TPP STAGE-III
(FOR AGITATORS)

TECHNICAL SPECIFICATION
FOR
MISCELLANEOUS TANKS- SITE FABRICATED AND AGITATORS

SPECIFICATION NO.: PE-TS-497/527-167-A001



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA



TECHNICAL SPECIFICATIONS FOR
MISC. TANKS (SITE FABRICATED) AND
AGITATORS

SPECIFICATION No:PE-TS-497/527-167-A001

SECTION

DATE

Aug. 26

SHEET : 1 OF 2

CONTENTS

SECTION - I

SUB- SECTIONS	TITLE			Page No.	
Sub-Section-A	INTENT OF SPECIFICATION			4	
Sub-Section-B	PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA			8	
Sub-Section-C	TECHNICAL SPECIFICATIONS				
	Sub Section-C1	SPECIFIC TECHNICAL REQUIREMENT– MECHANICAL			
		C1-A	SPECIFIC TECHNICAL REQUIREMENT-TANKS		12
		C1-B	SPECIFIC TECHNICAL REQUIREMENT-AGITATOR		23
		C1-C	SPECIFIC TECHNICAL REQUIREMENT-RUBBER LINING		48
		C1-D	SPECIFIC TECHNICAL REQUIREMENT-GLASS FLAKE LINING		53
	Sub Section-C2	CUSTOMER SPECIFICATION			
		C2 - A	PROJECT SPECIFIC REQUIREMENT		62
		C2 - B	GENERAL TECHNICAL REQUIREMENT, QUALITY ASSURANCE		107
		C2 - C	PAINTING SPECIFICATION		173
		Sub Section-C3	ELECTRICAL SPECIFICATION		174
Sub Section-D	ANNEXURE-I	LIST OF MAKES OF SUB-VENDOR ITEMS		248	
	ANNEXURE-II	REFERENCE QUALITY PLANS		254	
	ANNEXURE-III	TANK SCHEDULE		289	
	ANNEXURE-IV	MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION		296	
	ANNEXURE-V	GA DRAWINGS OF MISC. TANKS (CST(s) and FGD(s))		302	
	ANNEXURE-VI	TYPICAL DETAILS OF AGITATOR HANDLING ARRANGEMENT ABOVE TANK BRIDGE		326	
	ANNEXURE-VII	AGITATOR SCHEDULE FOR KORADI PROJECT		327	
	ANNEXURE-VIII	TYPICAL DETAILS OF DRAIN SUMPS		329	
	ANNEXURE-IX	MATERIAL OF CONSTRUCTION FOR TANKS		331	
	ANNEXURE-X	VOID		-	
	ANNEXURE-XI	GUARANTEE POWER CONSUMPTION FORMAT FOR KORADI PROJECT		333	



TECHNICAL SPECIFICATIONS FOR
MISC. TANKS (SITE FABRICATED) AND
AGITATORS

SPECIFICATION No:PE-TS-497/527-167-A001

SECTION

DATE Aug. 26

SHEET : 2 OF 2

SECTION – II

SUB SECTIONS	TITLE	Page No.
Sub-Section-A	STANDARD TANK SPECIFICATIONS	337
Sub-Section-B	GUIDANCE FOR DESIGNING AND FABRICATION OF STEEL CONSTRUCTIONS FOR RUBBER LINING	346
Sub-Section-C	FORMAT FOR OPERATION AND MANITENANCE	356
Sub-Section-D	SITE STORAGE AND PRESERVATION GUIDELINES	360
Sub-Section-E	PACKING PROCEDURE	376

SECTION – III

SUB SECTIONS	TITLE	Page No.
Annexure-1	LIST OF DOCUMENTS TO BE SUBMITTED WITH BID	461
Annexure-2	COMPLIANCE CUM CONFIRMATION CERTIFICATE	462
Annexure-3	PRE-BID CLARIFICATION SCHEDULE	464
Annexure-4	DEVIATION SHEET WITH COST OF WITHDRAWAL	465
Annexure-5	LIST OF MAKES OF SUB VENDOR ITEMS	466
Annexure-6	LIST OF TOOLS & TACKLES	467
Annexure-7	LIST OF COMMISSIONING SPARES	468
Annexure-8	ELECTRICAL LOAD DATA FILLED UP BY THE BIDDER	469
Annexure-9	TECHNICLA PRE-QUALIFICATION REQUIREMENT	470 – 478.

**SECTION-I,
SUB-SECTION-A**

INTENT OF SPECIFICATION

1.0 **INTENT OF SPECIFICATION**

- 1.1 (a) The specification covers Supply part, Services part, Engineering charges and Mandatory spares for Miscellaneous FGD Tanks and Agitators package, comprising of design (i.e. Preparation and submission of drawing /documents including “As Built” drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, erection & maintenance tools & tackles, fill of lubricants & consumables till handing over, mandatory spares along with spares for erection, start-up and commissioning, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in-site transportation, erection & commissioning, trial run at site and carrying out Performance guarantee tests at site, training of customer/ client O&M staff covering all aspects of the Agitator & lining- Operation & Maintenance, Troubleshooting etc., handover in flawless condition of the package to the End customer, complete with all accessories cover under scope of work. The scope shall also include
- (i) Supervision by Agitator OEM personnel at site during agitator erection and commissioning, performance testing and training to End customer.
 - (ii) Erection & commissioning of lining (rubber lining & glass flake) and performance test at site in tanks and drain sump shall be by lining OEM only.

The above scope shall be as per BHEL NIT & tender technical specification, amendment & agreements till placement of order of the **MISCELLANEOUS TANKS - SITE FABRICATED AND AGITATORS PACAKGE for 2 x 660 MW KORADI TPS UNITS - 11 & 12.**

(b) The specification also covers Supply part, Services part, Engineering charges and Mandatory spares for Agitators package, comprising of design (i.e. Preparation and submission of drawing /documents including “As Built” drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, erection & maintenance tools & tackles, fill of lubricants & consumables till handing over, mandatory spares along with spares for erection, start-up and commissioning, forwarding, proper packing, shipment and delivery at site, unloading, handling up to BHEL store for safely handover.

Services part covers supervision by agitator OEM along with package supplier at site during the reconciliation of supplied material, assembly, erection & commissioning, trial run at site and carrying out Performance guarantee tests at site, training of customer/ client O&M staff covering all aspects of the Agitator - Operation & Maintenance, Troubleshooting etc. & handover in flawless condition of the package to the customer, complete with all accessories cover under scope of work as per BHEL NIT & tender technical specification, amendment & agreements till placement of order of the **AGITATORS PACAKGE for 2 x 660 MW TALCHER TPP STAGE-III.**

- 1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve them of the responsibility of providing such facilities to complete the supply, erection and commissioning, performance and guarantee/demonstration testing of MISCELLANEOUS FGD TANKS - SITE FABRICATED AND AGITATORS PAKCAGE (Agitator package, both for Koradi Project and Talcher Stage-III project).

- 1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment / system shall conform in all respects to high standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in Customers judgement is not in full accordance herewith.
- 1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing. Similarly, the extent of supply also includes all items required for completion of the system for its safe, efficient, reliable and trouble-free operation.
- 1.5 Items though not specifically mentioned but needed to make the system complete as stipulated under these specifications are also to be furnished unless otherwise specifically excluded.
- 1.6 The general terms and conditions, instructions to tenderer and other attachment referred to elsewhere are hereby made part of the tender specifications. The equipment / material and works covered by this specification is subject to compliance to all the attachments referred in the specification. The tenderer shall be responsible for adherence to all requirements stipulated herein.
- 1.7 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under Sec.-III of the specification **within 10 days of receipt of tender documents**. In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser/Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.
- 1.8 Deviations, if any, should be very clearly brought out clause by clause along with cost of withdrawal in the enclosed schedule (in Section -II); otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification. If no cost of withdrawal is given against the deviation, it will be presumed that deviation can be withdrawn without any cost to BHEL/it's customer.
- 1.9 In the event of any conflict between the requirements of two clauses of this specification & requirements of different codes/standards and between respective clauses of sub-section C & sub-section D, more stringent clause as per the interpretation of the owner shall apply.

- 1.10 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.
- 1.11 Unless specified otherwise, all through the specification, the word contractor shall have same meaning as successful bidder/vendor and Customer/Purchaser/Employer will mean BHEL and/or Customer as interpreted by BHEL in the relevant context. Please refer GCC/SCC for better clarity.
- 1.12 Various codes and standards to be used shall be as indicated in various parts of the specification. In case bidder uses any standard other than those indicated in the specification, the onus of establishing equivalence of the same with the specified standards will rest with the bidder and acceptance of the same shall be sole prerogative of customer.
- 1.13 All text/ numeric in the document / drawings to be generated by the successful bidder will be in English language only.
- 1.14 The bidder's offer shall not carry any sections like clarification, interpretations and /or assumptions.

PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA

 TECHNICAL SPECIFICATION MISC. TANKS (SITE FABRICATED) AND AGITATORS		SPECIFICATION No:PE-TS-497/527-167-A001 Rev. No. 00 Date: AUG. 2026
PROJECT INFORMATION 2x660 MW MAHAGENCO Koradi		
S. No.	DESCRIPTION	DETAILS
1	CUSTOMER	MAHARASHTRA STATE POWER GENERATION CO. LTD.
1.1	CONSULTANT	STEAG
2	LOCATION	At Koradi Thermal Power Station, near Koradi village, which is situated at about 11Km from Nagpur city, in Maharashtra state, India.
3	METEOROLOGICAL DATA	
3.1	SUMMER OUTSIDE DBT	50 deg C
3.2	SUMMER OUTSIDE WBT	27 deg C
3.3	MONSOON OUTSIDE DBT	29.4 deg C
3.4	MONSOON OUTSIDE WBT	27.2 deg C
3.5	WINTER OUTSIDE DBT	15.6 deg C
3.6	WINTER OUTSIDE WBT	11.1 deg C
3.7		RH - 61% IN DRY SEASON & 85% IN MONSOON SEASON
3.8	PEAK GROUND HORIZONTAL ACCELERATION (MCE),	0.1*g
3.9	BASIC WIND SPEED	44 m/s
3.10	HEIGHT ABOVE MSL	304.75 m
4	ELECTRICAL DATA	
4.1	AMBIENT TEMPERATURE FOR DESIGN OF ELECTRICAL EQUIPMENT	50 deg C
4.2	RATED FREQUENCY	50Hz
4.3	FREQUENCY VARIATION	(+)3% to (-)5%
4.4	AC VOLTAGE	415V, 3 Phase
4.5	AC VOLTAGE VARIATION	+/-10%
4.6	SYSTEM FAULT LEVEL AT RATED VOLTAGE	50KA for 1.0 sec
4.7	SHORT TIME RATING FOR TERMINAL BOXES	50KA for 0.25 sec
5	ANALYSIS OF EQUIPMENT COOLING WATER	
	CHARACTARISTICS	VALUE
i)	SILICA (Max.)	0.01 ppm as SiO2
ii)	IRON as Fe	NIL
iii)	TOTAL HARDNESS	NIL
iv)	pH VALUE	8.5 to 9.5
v)	CONDUCTIVITY	Not more than 0.1 micro mho/cm at 25 DegC.
5.1	DESIGN DMCW INLET TEMP. TO VARIOUS COOLERS	38 deg C

	TECHNICAL SPECIFICATION MISC. TANKS (SITE FABRICATED) AND AGITATORS	PE-TS-497/527-167-A001
		Rev. No. 00
		Date : AUG. 26

PROJECT INFORMATION
NTPC TALCHER-III 2x660 MW EPC

SL. NO	DESCRIPTION	UOM	DETAILS
1	CUSTOMER	-	NTPC LTD.
1.1	CUSTOMER CONSULTANT	-	NTPC LTD.
2	LOCATION	-	The proposed site is located near Talcher town in Angul district of Orissa having latitude and longitude as 20°55' N and longitude 85°25' E respectively. The site is approachable from Banarpal–Talcher section of National Highway No. 23 at a distance of about 1 km from Anand Bazar. Nearest railway station is at Talcher on Talcher-Cuttack section of North Eastern Railway at about 4 Kms. The nearest commercial airport is Bhubaneswar at about 90 km.
3	METEOROLOGICAL DATA		
3.1	MAXIMUM TEMPERATURE	°C	47.2
3.2	MINIMUM TEMPERATURE	°C	5.5
3.3	MAXIMUM RELATIVE HUMIDITY	%	83
3.4	MINIMUM RELATIVE HUMIDITY	%	35
3.5	AVERAGE ANNUAL RAINFALL	mm	108.3
3.6	HEIGHT ABOVE MSL	m	139
3.7	THE BASIC WIND SPEED “Vb” AT TEN METER ABOVE THE MEAN GROUND LEVEL (AS PER IS: 875 (Part-3))	m/s	50
3.8	The risk coefficient “K1”		1.08
3.9	Category of terrain		Category-2
4	ELECTRICAL DATA		
4.1	AMBIENT TEMPERATURE FOR DESIGN OF ELECTRICAL EQUIPMENT	°C	50
4.2	RATED FREQUENCY	Hz	50
4.3	FREQUENCY VARIATION	%	(+) 3 to (-) 5
4.4	AC VOLTAGE	V	415/3300
4.5	AC VOLTAGE VARIATION	%	415 V/240 V: +/-10; 3.3KV: +/- 6%
4.6	DC VOLTAGE	V	-
4.7	DC VOLTAGE VARIATION	%	-
4.8	FAULT LEVEL	KA/sec	Refer Electrical DataSheet

**SECTION-I,
SUB-SECTION-C1**

**SPECIFIC TECHNICAL REQUIREMENT –
MECHANICAL**



TECHNICAL SPECIFICATIONS FOR
MISC. TANKS (SITE FABRICATED) AND
AGITATORS

SPECIFICATION NO. PE-TS-497/527-167-A001

SECTION –I, SUB SECTION –C1A

REVISION 00

DATE: AUG. 26

SUB SECTION-C1A

SPECIFIC TECHNICAL REQUIREMENTS - TANKS

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS	SPECIFICATION NO. PE-TS-497/527-167-A001	
		SECTION –I, SUB SECTION –C1A	
		REVISION 00	DATE: AUG. 26

1.0 **SCOPE**

(a) The scope includes Supply part, Services part, Engineering charges and Mandatory spares for Miscellaneous FGD Tanks and Agitators package, comprising of design (i.e. Preparation and submission of drawing /documents including “As Built” drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, erection & maintenance tools & tackles, fill of lubricants & consumables till handing over, mandatory spares along with spares for erection, start-up and commissioning, forwarding, proper packing, shipment and delivery at site, transportation & storage at site, unloading, handling, in-site transportation, fabrication and erection & commissioning of tanks, lining and agitators, trial run at site and carrying out Performance guarantee tests at site, training of customer/ client O&M staff covering all aspects of the Agitator & lining - Operation & Maintenance, Troubleshooting etc., handover in flawless condition of the package to the End customer, complete with all accessories cover under scope of work. The scope shall also include

- (i) Supervision by Agitator OEM personnel at site during agitator erection and commissioning, performance testing and training to End customer.
- (ii) Erection & commissioning of lining (rubber lining & glass flake) and performance test at site in tanks and drain sump shall be by lining OEM only under the supervision of bidder.

The above scope shall be as per BHEL NIT & tender technical specification, amendment & agreements till placement of order of the **MISCELLANEOUS TANKS - SITE FABRICATED AND AGITATORS PACAKGE for 2 x 660 MW KORADI TPS UNITS - 11 & 12.**

(b) The scope includes Supply part, Services part, Engineering charges and Mandatory spares for Agitators package, comprising of design (i.e. Preparation and submission of drawing /documents including “As Built” drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, erection & maintenance tools & tackles, fill of lubricants & consumables till handing over, mandatory spares along with spares for erection, start-up and commissioning, forwarding, proper packing, shipment and delivery at site, unloading, handling up to BHEL store for safely handover.

Services part covers supervision by agitator OEM along with package supplier at site during the reconciliation of supplied material, assembly, erection & commissioning, trial run at site and carrying out Performance guarantee tests at site, training of customer/ client O&M staff covering all aspects of the Agitator - Operation & Maintenance, Troubleshooting etc. & handover in flawless condition of the package to the customer, complete with all accessories cover under scope of work as per BHEL NIT & tender technical specification, amendment & agreements till placement of order of the **AGITATORS PACAKGE for 2 x 660 MW TALCHER TPP STAGE-III.**

2.0(A) **SCOPE OF SUPPLY FOR KORADI PROJECT**

- 2.1 Supply of steel plates and structure for fabrication and erection of Condensate Storage Tanks and FGD Tanks, as specified under this specification. Refer ANNEXURE-V: GA DRAWINGS OF MISC. TANKS for details.
- 2.2 Supply of agitators (Vertical Agitators and Horizontal Agitators) comprising of complete Agitator Assembly, Gearbox/ V-belt drive with Motor, all couplings- Motor to Gearbox and Gearbox to shaft, Motor Canopy, Agitator base plate, Mechanical Seal, Support structure for horizontal agitators, Mounting nozzle with flanges & counter flanges with necessary fasteners and gasket for horizontal agitators. Also, including lining work of vertical agitator shaft flanges at site (as applicable), structure for fabrication and erection of agitator bridge & agitator handling structure for vertically mounted

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS	SPECIFICATION NO. PE-TS-497/527-167-A001	
		SECTION –I, SUB SECTION –C1A	
		REVISION 00	DATE: AUG. 26

agitators as specified under this specification. For details refer ANNEXURE-V: GA DRAWINGS OF MISC. TANKS and ANNEXURE-C1B: SPECIFIC TECHNICAL REQUIREMENT-AGITATOR.

- 2.3 Supply of lining (Bromo butyl rubber lining/ Vinyl ester-based flake glass lining) material including adhesives as per OEM recommendation, inside FGD tanks including the lining for structure, baffle plate, nozzles etc., at site, as specified under this specification. For details refer ANNEXURE-V: GA DRAWINGS OF MISC. TANKS, ANNEXURE-C1C: SPECIFIC TECHNICAL REQUIREMENT-RUBBER LINING and ANNEXURE-C1D: SPECIFIC TECHNICAL REQUIREMENT-GLASS FLAKE LINING.
- 2.4 The pipe, pipe fittings including pipe support structure inside the Condensate Storage Tank shall be supplied by the bidder including the above material for overflow, drain and NaOH breather & Seal pot. All inlet piping shall be extended up to the bottom of the tank and the clearance between the bottom of the tank and the edge of the inlet piping shall be kept as 500 mm (maximum).
The pipe & pipe fitting for FGD tanks is excluded from bidder scope of supply. Successful bidder shall provide the BOQ for pipe & piping fitting running inside tanks, overflow and drain, during detail engineering. However, the pipe supporting structure for these FGD tanks shall be in bidder scope of supply.
- 2.5 Tank nozzles with flanges shall be in bidder's scope. Counter flanges along with gasket, nuts and bolts shall be provided by bidder for Condensate Storage Tank. However, the counter flanges along with gasket, nuts and bolts for FGD tanks are excluded from bidder scope of supply. Successful bidder shall provide the BOQ for the same during detail engineering
- 2.6 All the material as specified under the table "Material Specification" in the respective Tank G.A. is in the scope of supply of bidder. Refer ANNEXURE-V: GA DRAWINGS OF MISC. TANKS for details.
- 2.7 NaOH Breather and Seal pot along with the first fill chemical and other accessories as shown in the Tank G.A. is in bidder scope of supply. Refer ANNEXURE-V: GA DRAWINGS OF MISC. TANKS for details.
- 2.8 Vent with screen, anchor bolts etc. for CST and FGD tanks is in bidder scope of supply.
- 2.8 Weir plates of adequate thickness (minimum 8 mm) shall be provided for all inlet piping.
- 2.9 The manhole (both shell and roof manhole) shall be of hinged and bolted type with nuts, bolts and gaskets in bidder's scope of supply. The size of the manhole shall be minimum 800 mm. Further, for FGD tanks, the size of the shell manhole, shall be provided considering the ease of entry/removal of the Agitator hub and shaft assembly.
- 2.10 Level Indicator (Float & Board Type) and Valves (as per GA dwg.) for Condensate Storage Tanks is in bidder scope of supply.
- 2.11 The scope of works shall also include supply and installation of special accessories including Agitators, agitator supporting arrangements, agitator bridge, agitator handling arrangement, baffle plates etc. as indicated in GA drwg of Tanks, Refer ANNEXURE-V: GA DRAWINGS OF MISC. TANKS for details. The necessary fixtures and other accessories for mounting these special accessories shall be included in the scope of work of the bidder. Supply of cable tray for power cable for agitators from 5M of the tanks. BHEL shall free issue power cable up to agitator motor, however, cable lugs and glands at motor end shall be supplied by bidder.

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS	SPECIFICATION NO. PE-TS-497/527-167-A001	
		SECTION –I, SUB SECTION –C1A	
		REVISION 00	DATE: AUG. 26

- 2.12 The minimum number of anchor bolts along with the minimum sizes and the minimum number of nozzles along with the minimum sizes is indicated in the respective tank GA dwg. However, any additional anchor bolts and nozzle requirement including higher size anchor bolt and nozzle, if found applicable during detailed Engineering shall be provided by bidder without any commercial implication and delivery implication to BHEL.
- 2.13 Painting of the tanks is included in bidder's scope of work. Painting specifications of storage tanks are given under Painting schedule in respective GA drwg of tanks. Painting requirements specified are minimum requirement. Any modification in painting requirement found applicable during detained engineering, shall be under bidder's scope without any commercial implication and delivery implication to BHEL.
- 2.14 Commissioning spares, tools and tackles for agitators, etc. as required for commissioning of the tanks are in bidder's scope.
- 2.15 Platforms, inter-connecting platforms, platforms for agitator maintenance, monkey ladder inside tank, staircase, hand railing, knee guard and toe guard (in stair case, agitator platform and all along the periphery of roof of the tank), as per the relevant design code / good engineering practice shall be included in bidder's scope of work. All staircase treads and platforms shall be 32 mm steel fabricated gratings. Gratings shall be galvanized as per latest code/standard. Width of staircase shall be 1200 mm.
- 2.16 Mandatory spares as specified.
- 2.17 Any other item required for making the installation complete in all respect and for satisfactory operation of the tank and items mounted thereon, meet layout and accessibility & operability requirements for the scope within the terminal points useless specifically mentioned under EXCLUSION.

2.0(B) SCOPE OF SUPPLY FOR TALCHER PROJECT

- 2.1 Supply of agitators (Vertical Agitators and Horizontal Agitators) comprising of complete Agitator Assembly, Gearbox/ V-belt drive with Motor, all couplings- Motor to Gearbox and Gearbox to shaft, Motor Canopy, Agitator base plate, Mechanical Seal, Support structure for horizontal agitators, Mounting nozzle with flanges & counter flanges with necessary fasteners and gasket for horizontal agitators. Also, including lining work of vertical agitator shaft flanges at site (as applicable) as specified under this specification. For details refer ANNEXURE-C1B: SPECIFIC TECHNICAL REQUIREMENT-AGITATOR.
- 2.2 Commissioning spares, tools and tackles for agitators, etc. as required for commissioning of the tanks are in bidder's scope.
- 2.3.1 Mandatory spares as specified.

3.0(A) SCOPE OF SERVICES FOR KORADI PROJECT

Services shall include but not be limited to the followings:

- 3.1 The scope under Services part comprising of unloading, handling, transportation & storage at site, in-site transportation, fabrication and erection & commissioning of tanks, lining and agitators, trial

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS	SPECIFICATION NO. PE-TS-497/527-167-A001	
		SECTION –I, SUB SECTION –C1A	
		REVISION 00	DATE: AUG. 26

run at site and carrying out Performance guarantee tests at site, training of customer/ client O&M staff covering all aspects of the Agitator & lining - Operation & Maintenance, Troubleshooting etc., handover in flawless condition of the package to the End customer, complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendment & agreements till placement of order. (Break-up as per Annexure-I(ii)). The scope shall also include

(i) Supervision by Agitator OEM personnel at site during agitator erection and commissioning, performance testing and training to End customer.

(ii) Erection & commissioning of lining (rubber lining & glass flake) and performance test at site in tanks and drain sump shall be by lining OEM only under the supervision of bidder.

- 3.2 Design, engineering, preparation of detailed GA dwgs, fabrication drawings, design calculation, STAAD calculation of Roof structure & Agitator platform Structure, FEA analysis of Slurry Tanks, bill of material, tag and piece numbers, welding procedures etc. Stiffeners and other structural framing for supporting the tank shall be designed by the fabricator and properly shown in the fabrication drawings. Also, including design engineering documents for Agitators, Quality plans, Erection procedures, O&M Manual etc.
- 3.3 Fabrication, Erection & Commissioning of Tanks. All machinery required for fabrication, erection, commissioning, testing etc. for tanks shall be arrange by bidder at its end.
- 3.4 Erection and commissioning of Agitators by bidder. This shall also include supervision by Agitator OEM experienced personnel at project site during erection and commissioning, performance testing and training to End customer. Laying/ erection of cable tray for power cable for agitators from 5M of the tanks is in bidder scope.
- 3.5 Storage (meeting the requirement of lining OEM recommendation without compromising the shelf life of lining & its adhesive), surface preparation & application, testing post application of rubber/glass flake lining in Tanks and Drain Sumps. Surface preparation of prior to lining shall be as per lining OEM recommendation. Application & testing of lining (rubber lining & glass flake) in tanks and drain sump shall be by lining OEM only under the supervision of bidder.
- 3.6 Erection of the Agitator Bridge, including the agitator handling arrangement for vertical agitators and support legs for horizontal agitators, shall be in the bidder's scope. Erection of the Electric Hoist/Chain Pulley Block (free issue item), to be transported by the bidder from BHEL's store to the erection location, is also included in the bidder's scope. Any damage to the free issue item after its handover to the bidder and during transportation, handling, erection, or installation shall be the sole responsibility of the bidder.
- 3.7 Post tank erection and/ or lining work completion until handover of tanks, modifications required, if any, due to change in piping layout, agitator details change etc. shall be in the scope of bidder.
- 3.8 Erection of all foundation bolts / anchor bolts etc. as required for any equipment/ foundation /concrete.
- 3.9 Inspection & testing at OEM works and at Site (as applicable), and carrying out demonstration test of tanks materials, Agitators and lining (rubber and glass flake) at site.
- 3.10 Surface preparation and painting of tank and other equipment within the battery limit.

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS	SPECIFICATION NO. PE-TS-497/527-167-A001	
		SECTION –I, SUB SECTION –C1A	
		REVISION 00	DATE: AUG. 26

- 3.11 Scaffolding required for tank erection, surface preparation, rubber lining, painting, agitator erection, inspection, testing, and all other associated activities shall be arranged, erected, maintained, modified, shifted, and dismantled by the Bidder at its own cost. Since these activities are carried out at different stages of the project, the Bidder shall ensure timely availability of scaffolding at each stage without waiting for separate instructions from BHEL. Any delay in providing or modifying the required scaffolding resulting in delay of erection, lining, painting, inspection, testing, or commissioning activities shall be entirely to the Bidder's account and shall not be considered as a valid ground for extension of time or any additional claim on BHEL.

Also, the Bidder shall coordinate with the rubber lining vendor and its site execution team to ensure that scaffolding is erected, relocated, modified, and made available in line with the execution requirements so that no activity is delayed due to non-availability of scaffolding. The bidder shall remain solely responsible for timely provision of scaffolding, irrespective of whether the scaffolding for rubber lining is arranged directly by the Bidder or through the rubber lining vendor. If considered appropriate by the Bidder, the scope of scaffolding required for rubber lining may be included in the scope of the rubber lining vendor; however, such an arrangement shall not relieve the bidder of its overall responsibility for timely execution and completion of the work.

- 3.12 Relevant scope of services as per GTR, GCC, SCC & ECC.
- 3.13 Any other service required for making the installation complete in all respect within battery limits and for satisfactory erection & commissioning of the system unless specifically mentioned under EXCLUSION.

3.0(B) SCOPE OF SERVICES FOR TALCHER PROJECT

Services shall include but not be limited to the followings:

- 3.1 Design, engineering, preparation of engineering documents for Agitators, Quality plans, Erection procedures, O&M Manual etc.
- 3.2 Supervision of erection and commissioning of Agitators by Agitator OEM experienced personnel at project site including supervision during performance testing and training to End customer.
- 3.4 Inspection & testing of Agitators at OEM work's and carrying out demonstration test of Agitators at project site.
- 3.5 Relevant scope of services as per GTR, GCC, SCC & ECC.
- 3.6 Any other service required for making the installation complete in all respect within battery limits and for satisfactory erection & commissioning of the system unless specifically mentioned under EXCLUSION.

4.0 DESIGN CONSIDERATIONS

- 4.1 The successful bidder shall furnish design calculations to BHEL during detailed engineering stage for approval along with relevant pages of authentic supporting literature e.g. Code, Hand book, National / international Standards etc. Calculation shall be necessarily done in **SI UNITS** only for the followings:
- a) Tanks shall be designed as per IS – 803 / API – 650 / AWWA – D 100 / IS –2825 / BS – 2594 / Good engineering practice as applicable and referred code shall be of latest edition.

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS	SPECIFICATION NO. PE-TS-497/527-167-A001	
		SECTION –I, SUB SECTION –C1A	
		REVISION 00	DATE: AUG. 26

- b) Weight calculation of plates, appurtenances, platforms & structures separately shall be included in the Design calculation.
- c) Design of roof and roof structures for vertical storage tanks along with agitators & agitator platforms shall be designed based on guidelines given in the book titled “Process equipment design” by Brownell and Young. Further, roof structure shall preferably be constructed on external side of roof.
- d) Tank stability calculation (wind load / seismic / overturning stability) considering static and dynamic loads of Agitator and its platforms and supporting arrangement shall be done as per API – 650/IS-803, latest edition. However, factors / coefficients as required for the design of tank shall be obtained from BHEL by the bidder after placement of order.
- e) Vent sizing calculation shall be done as per API – 2000, latest edition
- 4.2 The successful bidder shall indicate references of all the clauses indicating their page number from respective standard in the design calculation during detail engineering stage. All steps including formulas and abbreviations shall be clearly shown in the calculation. All inputs / assumptions shall be indicated in the first sheet of the calculation.
- 4.3 The thickness and sizes of plates shall be as per the respective tank GA drawing attached with the specification. For details refer ANNEXURE-V: GA DRAWINGS OF MISC. TANKS
- 4.4 Tank shall be suitably constructed for safe, proper and continuous operation under all conditions that can be expected in a plant life without undue strain, corrosion or other operating difficulties.
- 4.5 For cylindrical tanks, the plates shall be cold rolled through plate bending machine by several number of passes to true curvature.
- 4.6 Vessels seams shall be so positioned that they do not pass through vessel connections. For cylindrical vessels consisting of more than two sections longitudinal seams shall be offset.
- 4.7 Wherever possible, the inside seam weld shall be ground smooth, suitable for application of corrosion resistant primer.
- 4.8 The joint efficiency factor shall be considered as 0.85. Required radiography test shall be carried at Site.
- 4.9 All roofs and supporting structures shall be designed to support dead load plus a uniform live load of not less than 150 kg/m² of projected area. Further, the static and dynamic loads of the agitator assembly along with the agitator platform & support structure for Agitator handling equipment shall be considered over and above the uniform live load.
- 4.10 Code conformance for flanges / counter flanges shall be ANSI B 16.5. Code conformance for bolts and nuts shall be SA 193 & 194 respectively. Further, all fasteners used in wetted condition must be of Alloy 926 or better material so that even if it comes in contact with liquid by swelling of rubber lining, thread remains unaffected. Raw material of fastener must undergo Inter-Granular Corrosion test as per ISO-3651, Part-1 for Nitric Acid test.

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS	SPECIFICATION NO. PE-TS-497/527-167-A001	
		SECTION –I, SUB SECTION –C1A	
		REVISION 00	DATE: AUG. 26

- 4.11 The number & size of nozzles (including flanges, counter flanges and inside piping) indicated in the tank schedule are tentative and bidder guidance purpose only and the same may undergo change during detail engineering stage for which no commercial and delivery implication shall be entertained by BHEL.
- 4.12 Bidder shall furnish the STADD calculation for following:
- Roof Structure calculations for checking the stability of roof.
 - Agitator Bridge along with Agitator handling structure above roof of tank. Agitator handling structure is supported from Agitator bridge. Refer Tank GA dwrgs.
 - Shell buckling under Roof and other Shell Appurtenances loading.
- 4.13 Bidder to note that surface cleaning shall be of Blast clean type. However, Grit blasting shall be decided during detail engineering for which no commercial implication shall be entertained by BHEL. Further, the surface cleaning of the tanks shall be in line with the requirements specified in the specification for rubber/glass flake lining (Section-I, Sub Section-C1C).
- 4.14 Bidder to note that foundation drawing along with loading data & anchor bolt details shall be provided by bidder within two weeks' time from the LOI. However, Bidder to provide minimum anchor bolts for the Miscellaneous FGD tanks, as specified in Tank schedule.
- 4.15 A corrosion allowance of 3.0 mm shall be considered for designing the tanks.
- 4.16 Water Tanks shall be provided with Roof Structural Support in the form of Rafters and a Center Column.
- 4.17 Bidder will need to use appropriate Software for addressing the Agitator Dynamic load in the tank design calculation. In this regard, the Stress analysis(FEA) including analysis of Agitator mounting, nozzle, platform etc., shall be carried out by the bidder using the latest version of software accepted internationally for FEA. All relevant backups such as load calculations, flow charts, computer data etc. shall be furnished. Computer outputs shall be clear and in easily understandable format.

5.0 WELDING

- 5.1 Welding shall be in accordance with the requirement of IS: 803, 816, 817 and 823 or equivalent and as specified in the specification for lining (Section-I, Sub-Section-C1C).
- 5.2 Welding sequence shall be adopted in such a way so as to minimize the distortion due to welding shrinkage. Contractor shall indicate in his drawing the sequence of welding proposed by him, which should meet prior approval of the Engineer.
- 5.3 All welders shall be BHEL / customer / consultant qualified as per the approved quality plan / field quality plan which will be submitted by the successful bidder during detail engineering stage. WPS and PQR shall be submitted by the successful bidder to BHEL / customer / consultant for review and approval.

6.0 TEST AND INSPECTION

- 6.1 The particulars of the proposed tests and the procedure for the tests shall be submitted to the Owner / Engineer for approval before conducting the tests. The successful bidder shall submit FQP (field quality plan) and demonstration test procedure for BHEL / customer / consultant's approval during detail engineering stage. In the event of any change in the field quality plan and demonstration test

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS	SPECIFICATION NO. PE-TS-497/527-167-A001	
		SECTION –I, SUB SECTION –C1A	
		REVISION 00	DATE: AUG. 26

procedure, the same shall be incorporated by the bidder in the document and approved document shall be adhered by the bidder without any commercial implication.

- 6.2 DPT / MPI on all welds (100%).
- 6.3 All cross / Tee joints and butt welds to be Radio graphed in line with the joint efficiency as specified.
- 6.4 For the offered tanks, Hydro fill test shall be carried out for at least 24 hours. Atmospheric storage tanks on inside surface shall be leak tested before painting/ rubber or glass flake lining.
- 6.5 All quality plans / checklists for various items shall be furnished during detail engineering stage for BHEL / customer's approval and any changes required by BHEL / customer shall be incorporated in the documents and adhered without any price implication. However, minimum requirement of MQP as indicated in the technical specification shall be followed. All necessary items as required for inspection and testing of the tank including instruments shall be arranged by the bidder.
- 6.7 Minimum tests shall be conducted as specified in the reference quality plan attached along with the specification for various equipment/ items. All quality plans are subjected to approval from end customer. Any cost implication shall not be sort by successful bidder incase of additional test requirements/ inspection witness by BHEL/ End customer.
- 6.7 Specific tests for Agitators
- a.) Lining of the agitator shall be tested for hardness and spark test etc. as per applicable standard.
 - b.) Impellers shall be tested for dimensional and balancing check. All impeller welds shall be tested by PT / MT.
 - c.) Gear Boxes, motors shall be tested for run test as per standard practice.
 - d.) Assembled agitators shall be subjected to run test at the manufacturer's works.
- 6.8 Other quality/ inspection requirements for agitators
- (a) Since agitators comes under Sub-QR Category, hence inspection at vendor works is applicable by BHEL/ BHEL TPI and End Customer as per End Customer approved Quality plan.
 - (b) Supplier shall submit the MQP in given format (Sample QP attached herewith) for End Customer approval. Please note that attached QP is indicative and minimum requirement only. Stage inspection and Quantum of check may vary during final approval by End customer.
 - (c) In case of agitator's supplier happens to be foreign supplier, bidder has to finalize inspection agency, duly approved by BHEL & End Customer, at their own cost and carry out inspection as per the approved Quality plan. Further, the list of third-party inspection agencies (as applicable) shall be provided by BHEL during detail engineering. Bidder has to furnish BHEL the inspection reports and other documents required as per approved Quality plan duly signed by the Inspection Agency after their witness for BHEL's and End Customer review and acceptance.
- 6.9 Painting: Painting details in the specification are minimum requirement. Painting shall be as per approved schedule which will be submitted by successful bidder during detail engg.

7.0 **MANDATORY SPARES:**

Mandatory Spares shall be supplied as per Annexure-X, Sub-Section-D, Section-I.

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS	SPECIFICATION NO. PE-TS-497/527-167-A001	
		SECTION –I, SUB SECTION –C1A	
		REVISION 00	DATE: AUG. 26

8.0 LIST OF COMMISSIONING SPARES:

The items required for successful commissioning of the Tanks, Agitators and Rubber/Glass Flake lining shall be specified by bidder under 'List of commissioning Spares' given under Section-III of specification.

9.0 TERMINAL POINTS

- Matching counter flanges for all nozzles mounted on the tanks. However, counter flanges for all nozzles of Condensate storage tanks shall be provided by the bidder.
- Flushing pipe for horizontal agitators shall be provided 5m from the tank.

10.0 EXCLUSIONS

- 1) Tank foundation & associated civil works, all instruments like level gauges (except for Condensate storage tanks), Level Transmitters, analyzers, etc. are excluded from bidder's scope of work. However, required no. of nozzles for the same shall be in bidder's scope of work.
- 2) The civil works for drain sumps indicated in the **Tank schedule** is excluded from bidder's scope of work.
- 3) Valves (except for condensate storage tank, refer GA dwg for CST) are excluded from bidder's scope of work.
- 4) Piping downstream from the nozzle flanges, outside of the tanks, except for overflow, drain and NaOH and Seal pot piping for Condensate storage tanks, is excluded from bidder's scope of work.
- 5) Piping for FGD tanks (except for termination of flushing pipe for horizontal agitators) is excluded from bidder's scope of work.
- 6) Chain pulley blocks/electric hoist required for the handling of Agitators (except handling arrangement above the roof of the tank) is excluded from the scope of bidder.

11.0 DRAWINGS AND DOCUMENTS TO BE SUBMITTED WITH THE BID

The bidder must submit the drawings / documents as mentioned under "LIST OF DOCUMENTS TO BE SUBMITTED WITH BID" (In Section-III, Annexure-1) along with their bid. In absence of any of these documents, BHEL reserves right not to evaluate the offer of the concerned bidder.

12.0 DRAWINGS/ DOCUMENTS REQUIRED DURING DETAIL ENGINEERING

The successful bidder shall submit the drawing / documents as mentioned under SECTION-I, Sub-Section-D, Annexure-IV during detail engineering for approval / information / reference (as the case may be).

13.0 OTHER TECHNICAL REQUIREMENTS

- a) 15 days' time is required by BHEL to offer their comments on the drawings and documents being submitted by the bidder (during detailed engineering stage in the event of L.O.I being placed) from the date of receipt.
- b) Bidder to depute competent designer (s) at BHEL's office during detailed engineering stage to discuss drawings and other technical documents as and when required by BHEL.

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS	SPECIFICATION NO. PE-TS-497/527-167-A001	
		SECTION –I, SUB SECTION –C1A	
		REVISION 00	DATE: AUG. 26

- c) Bidder to assess the capability of their sub-vendors in terms of preparation of drawings, calculations, documents, quality assurance, supply of material etc. as per project schedule before placing the order on them. No deviations shall be entertained.
- d) Size of hand rails on stairway and tank roof / top shall be minimum 32 NB and shall conform to IS 1239 (M). Handrails shall be galvanized as per relevant code/standard.
- e) Type of roof for vertical cylindrical storage tanks shall be supported cone roof as per latest edition of relevant design code.
- f) Commissioning of tanks will consist of installation of all accessories of tanks as per approved drawing/specification, charging of tank, water-fill test (for minimum 24 hours after complete filling of tank), satisfactory functioning of all accessories, emptying of tank, subsequent painting of complete tanks and changing of gaskets as per specification requirement.
- g) Bidder to furnish prices and unit price of each item of proposed tanks as per BHEL's price format only along with the final price bid.
- h) Bidder shall check that specifications of all the items are available in the NIT specification. However, in the event of absence of specification for any item, bidder will approach BHEL to furnish the specification of missing items and new specification will be adhered by the bidder for which no commercial implication shall be entertained by BHEL.
- i) All tools and plants including welding machines, crane, hydra, etc. and instruments as required for construction, erection and commissioning, trial run and functional demonstration test at site shall be arranged by the bidder.
- j) Bidder to furnish list of sub-vendors based on sub-vendor list enclosed with the specification during detail engineering stage for BHEL's / Customer review and approval and items shall be procured from the approved suppliers only. No commercial and delivery implication on account of any sub-vendor rejection by BHEL/ End Customer shall be provided by BHEL.
- k) Dealers are not acceptable for any item of the package. Bidder shall procure all items including plates, structural, flanges, counter flanges etc. from BHEL approved sub vendor only. No argument on this account shall be entertained.

**SECTION-I,
SUB-SECTION-C1B**

**SPECIFIC TECHNICAL REQUIREMENT –
AGITATOR**



TECHNICAL SPECIFICATIONS FOR
MISC. TANKS (SITE FABRICATED) AND
AGITATORS

SPECIFICATION No: PE-TS-497/527-167-A001

SECTION-C, SUB-SECTION-C1B

REV. 00

DATE: AUG. 26

SHEET: 1 OF 24

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.

Bidder/ its Sub-vendor shall supply the equipment in accordance with relevant regulations, codes and standards specified in the specification. If required by relevant regulations, codes and standards specified in the specification, Successful Bidder/ its Sub-vendor shall assist BHEL to obtain approval against the equipment, documents and drawings by Indian authorities.

2.0. PROVENNESS CRITERIA / PRE-QUALIFICATION REQUIREMENT

The Bidder/ its Sub-vendors are required to meet the Qualification Requirement (PQR) for Agitators as per provenness criteria & shall submit the credentials as called in the tender document. Only OEMs qualifying as per the qualification requirement shall be considered for placement of order.

3.0. TECHNICAL INFORMATION

3.1 AGITATOR DETAILS:

For details of Agitators Refer "Agitator Schedule" in Sub-Section-D, Section-I, Annexure-VII of the specification.

3.2 MATERIAL OF CONSTRUCTION

Sl. No.	Material of construction	Horizontal agitators (side entry)	Vertical Agitators (Top entry)
i.	Impeller blade	Alloy 926 or better material	Alloy 926 or better material
ii.	Impeller Hub	Alloy 926 or better material	Alloy 926 or better material
iii.	Shaft	Alloy 926 or better material (Duplex SS is also acceptable only for Koradi TPS)	CS with Rubber Lining (min 6 mm thick Chloro/bromo butyl Rubber)
iv.	Fasteners in wetted parts	Alloy 926 or better material	Alloy 926 or better material
v.	Fasteners in Non-Wetted	GI fastener (40 μ plated) / SS	GI fastener (40 μ plated) / SS
vi.	Mounting base	Alloy 926 or better material (Wetted parts)	Carbon Steel
vii.	Tank Nozzle (for inserting agitator)	CS + RL For Koradi – By Bidder	CS + RL For Koradi – By Bidder

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS		SPECIFICATION No: PE-TS-497/527-167-A001	
			SECTION-C, SUB-SECTION-C1B	
			REV. 00	DATE: AUG. 26
			SHEET: 2 OF 24	

	with Flange	For Talcher – By Bidder	For Talcher – By BHEL
viii.	Flush pipe for Startup with flange	CS + RL For Koradi – By Bidder For Talcher – By BHEL	CS + RL For Koradi – By Bidder (as per Agitator OEM recommendation) For Talcher – By BHEL
ix.	Tank nozzle with flange (for Flush Pipe)	CS + RL For Koradi – By Bidder For Talcher – By BHEL	CS + RL For Koradi – By Bidder (as per Agitator OEM recommendation) For Talcher – By BHEL
x.	Agitator Support (Legs/ Bridge)	Agitator support legs Carbon Steel For Koradi – By Bidder For Talcher – By Bidder	Agitator mounting bridge Carbon Steel For Koradi – By Bidder For Talcher – By BHEL

3.3 POWER SUPPLY DETAILS:

1.	POWER SUPPLY	
	The following voltage levels shall apply:	
	3 phase, 11 kV AC ,50 Hz	Voltage for motors rated above 1500 kW and for power distribution within the plant.
	3 phase, 3.3 kV AC ,50 Hz	Voltage for motors rated 200 kW and up to 1500 kW 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 up to 200 kW.
	1 phase 240V AC / 3 phase 415 V AC, 50 Hz	Standard voltage for power supplies to electric power consumers and motors Up to 0.2 kW.
	1. All equipments at 415V voltage level shall be suitable for voltage variation of $\pm 10\%$ and rated frequency of 50 Hz with a variation of + 3% to -5%, and 10 % (absolute sum) combined variation of voltage and frequency unless specifically brought out in the specification. 2. Bidder/ its Sub-vendor shall design and supply the equipment suitable for satisfactory operation under above mentioned power supply condition. 3. For further details refer electrical specification under Section-I, Sub-Section-C3.	

3.4 AGITATOR ARRANGEMENT

For arrangement of Agitators please refer “GA DRAWING OF SLURRY TANKS” under Annexure-V, Sub-Section-D, Section-I.

Auxiliary Absorber Tank Agitators will operate continuously when Limestone / Gypsum Slurry is evacuated from Absorber for any Absorber maintenance work. Other Slurry Tanks and sumps Agitators will operate continuously for FGD system operation.



TECHNICAL SPECIFICATIONS FOR
MISC. TANKS (SITE FABRICATED) AND
AGITATORS

SPECIFICATION No: PE-TS-497/527-167-A001

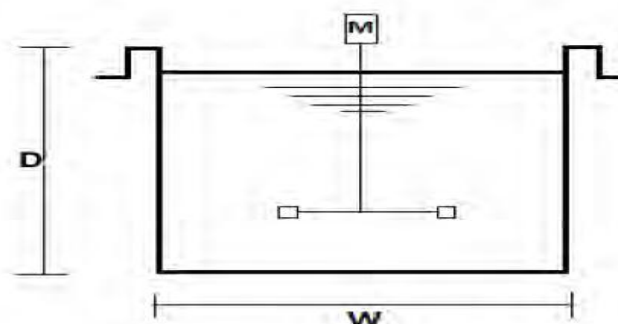
SECTION-C, SUB-SECTION-C1B

REV. 00

DATE: AUG. 26

SHEET: 3 OF 24

Drain Pit Tank Agitators:



For details of Drain Pits please refer "AGITATOR SCHEDULE" under Annexure-VII/A & B, Sub-Section-D, Section-I of the specification. These Agitators will operate continuously for FGD system operation.

4 SCOPE OF SUPPLY & SERVICES FOR AGITATORS

The Bidder/ its Sub-vendor shall assume sole responsibility for the design, fabrication, testing, surface preparation, painting, packing, transportation and performance of the specified equipment with accessories, and shall ensure that the equipment with accessories are in conformance with this specification, as well as other documents which form part of the Purchase Order/Contract.

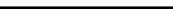
Various inspections by the BHEL/End Customer shall not relieve the Bidder/ its Sub-vendor in any way of his obligation to maintain an adequate test, inspection, and documentation program of his own, and shall not relieve the Bidder/ its Sub-vendor of any other obligation under this specification. Furthermore, any inadvertent overlook of deviations from some requirements of this specification by the buyer shall not constitute a waiver of these requirements, or of the Bidder/ its Sub-vendor's obligation to correct the condition when it is discovered, or of any other obligation under this specification.

This specification only states the lowest technical requirement, neither specifying all technical details, nor referring the pertaining code and standard fully. It is the Bidder/ its Sub-vendor's responsibility to ensure that the complete delivery complies with all relevant codes, standards and specifications.

The Bidder/ its Sub-vendor is obliged to supply relevant drawings and documentation to the buyer. All to be in English language and metric system, if not otherwise agreed in writing.

Scope for the Bidder/ its Sub-vendors shall include Design, Manufacturing, Supply, and Erection & Commissioning.

Design: Broadly includes basic engineering, detail engineering, preparation and submission of engineering drawings/calculations/datasheets/quality assurance documents/field quality

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS		SPECIFICATION No: PE-TS-497/527-167-A001	
			SECTION-C, SUB-SECTION-C1B	
			REV. 00	DATE: AUG. 26
			SHEET: 4 OF 24	

plans, storage instructions, commissioning procedures, Erection & assembly Drawings, operation & maintenance manuals, performance guarantee test procedures and assisting BHEL in obtaining time bound approval from customer.

Supply: The scope includes the following:

- Includes manufacturing/fabrication, shop floor testing, stage inspections, final inspections, painting & packing and supply.
- Mandatory spares as defined as Section-I, Sub-Section-D, Annexure-X.
- Recommended spare parts list to be furnished (is not part of scope of supply)
- Any special tools & tackles required for the entire equipment to disassemble assemble or maintain the units.
- Start-up & Commissioning Spares
- First fill of consumables

Services: Services to be provided by the Bidder/ its Sub-vendor:

- Erection & Commissioning, trial run at site.
- Performance guarantee tests at site & handover in flawless condition of the package to the customer
- Training of customer/ client O&M staff covering all aspects of the Agitators - Operation & Maintenance, Trouble-shooting etc. at site
- Training of customer at manufacturer's works (3 persons for 2 days including lodging and boarding)

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

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 arrangement



TECHNICAL SPECIFICATIONS FOR
MISC. TANKS (SITE FABRICATED) AND
AGITATORS

SPECIFICATION No: PE-TS-497/527-167-A001

SECTION-C, SUB-SECTION-C1B

REV. 00

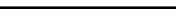
DATE: AUG. 26

SHEET: 5 OF 24

Sl. No	Scope
	x. Supporting arrangement including tie rods, gusset plates etc. of Side Entry Agitator on the tank Wall. Nozzle and mating flange for supporting on the tank wall, gaskets and fasteners.
	xi. VOID.
	xii. Foundation plate with foundation bolts
	xiii. Painting and Rust Prevention during shipment and construction
	xiv. Packing and transportation
	xv. VOID.
	xvi. Special tools & tackles as applicable
	xvii. Start-up spares, Spare parts for commissioning & erection, Mandatory Spares: As per Project Specific Requirement
	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
1.	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 arrangement
	x. Mating Flange for Supporting on Slurry Tank Roof
	xi. Shims
	xii. Painting and Rust Prevention during shipment and construction
	xiii. Packing and transportation
	xiv. VOID.
	xv. Special tools & tackles as applicable
	xvi. Start-up spares, Spare parts for commissioning & erection, Mandatory Spares: As per Project Specific Requirement
	xvii. Installation, operation and maintenance manuals
	xviii. Any other items required for completeness of the equipment except the items covered in the exclusions.

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS		SPECIFICATION No: PE-TS-497/527-167-A001	
			SECTION-C, SUB-SECTION-C1B	
			REV. 00	DATE: AUG. 26
			SHEET: 6 OF 24	

The quantity, location of the Agitators has been included in the **AGITATOR SCHEDULE** (Sub-Section-D, Section-I, Annexure-VII).

4.1	TECHNICAL REQUIREMENTS
I	Agitators shall be supplied in tanks and vessels to prevent caking and settlement of particles out of the slurry, e.g. in the limestone slurry tank, Auxiliary Absorbent tank, and sumps etc.
II	All agitators shall be designed for continuous operation unless otherwise specified. The design of the agitators shall be of proven type.
III	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. Size gearbox with service factor ≥ 1.5 .
IV	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.
V	The MOC for Agitators shall be generally as per this Specification, however, this does not release the Bidder/ its Sub-vendor of the responsibility for selecting the correct materials.
VI	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 side mounted agitators without having to drain completely the slurry inside the tank.
VII	Agitator design calculations for Reynolds number, Power number, Power Number vs Reynolds Number curve for the specific impeller type, Torque, Shaft Critical Speed, Mixing Time Correlation (Turbulent), Pumping Capacity (Flow Number), Just-Suspended Speed (Zwietering's Correlation), Motor Sizing with Safety Factor, Shaft Diameter — Torsional Stress, bending moment, side entry nozzle thickness calculation, flange thickness calculations, nozzle support details, etc. shall also be submitted for BHEL approval.
VIII	Lifting lugs and eyes and other special tackle shall be provided as necessary to permit easy handling of the agitators and their components.
IX	Static and dynamic (as far as applicable) balancing of all agitators shall be carried out after assembly. Any deviation to this requirement is subject to customer approval during detailed engineering based on applicable codes and standards to be furnished by the Bidder/ its Sub-vendors.
X	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.

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS		SPECIFICATION No: PE-TS-497/527-167-A001	
			SECTION-C, SUB-SECTION-C1B	
			REV. 00	DATE: AUG. 26
			SHEET: 7 OF 24	

XI	All exposed moving parts shall be covered by guards.
XII	The shape of the impeller blades of side entry agitator's/top 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 slurry specified in the specification. In order to avoid excessive wear impeller tip speeds must not exceed 12 m/s.
XIII	Belt drives (if applied for side entry agitators) shall be properly designed to provide a minimum lifetime of 2 years under design conditions
XIV	It shall be noted that all Agitators are meant for keeping the solid particles in suspended mode in liquid with "Full Off-Bottom Suspension" of solid particles to 98% of liquid column to virtually "Uniform Solid Concentration". No chemical reaction will take place.
XV	Maintaining a uniform concentration over the 95% of liquid column. Absolute sweeping of solid particle from tank bottom is a must for all Agitators. If speed is required to be increased to guarantee the above requirements; the same can be increased by vendor. Bidder/ its Sub-vendor's machines that consume less power will be in an advantageous position.
XVI	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 "Inefficiency of the Agitator".
XVII	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 parameters.
XVIII	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 that vibration at test stand can only be taken as "for information".
XIX	Every Tank will have a pump whose suction line shall be connected to tank. These pumps are to operate continuously at the lowest operating level which is decided by Process requirement. Hence, the minimum operating level of liquid in every tank for every Agitator is a must to assess the combined operation of Agitator as well as that of pump alone. The Tank water level is indicated in "GA drwgs of Tanks". Any minor change in liquid level required by Agitator supplier will be accommodated only if it is acceptable to the pump supplier.
XX	Agitator must have low-pitch propeller with low solidity ratio and Power Number. The Maximum Input Power at motor terminal shall be considered as a guaranteed parameter under "Schedule of Guaranteed Power consumption format" in " SUB-SECTION-D, SECTION-I, ANNEXURE-XI " 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 10% margin at maximum liquid level, taking in to

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS		SPECIFICATION No: PE-TS-497/527-167-A001	
			SECTION-C, SUB-SECTION-C1B	
	REV. 00		DATE: AUG. 26	
			SHEET: 8 OF 24	

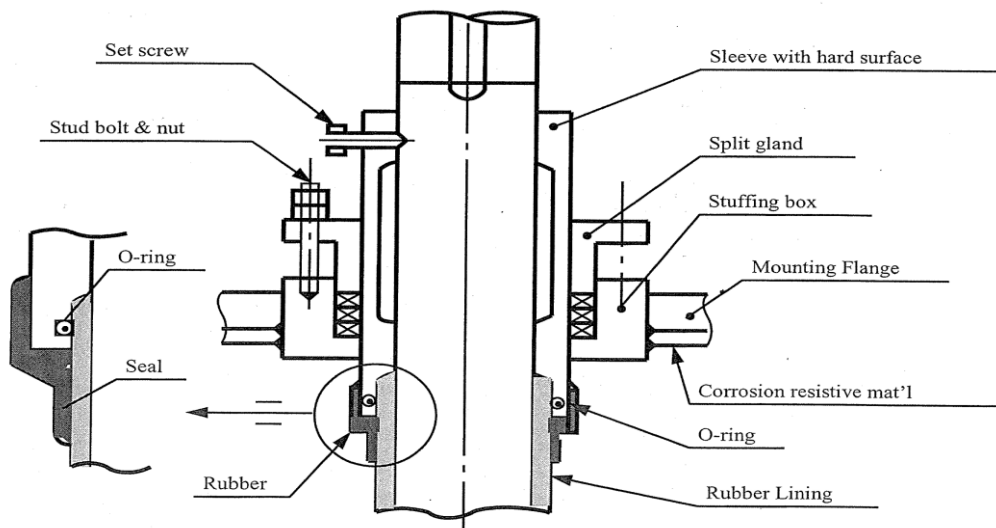
	account frequency variation.
XXI	The agitator shall be suitably designed for mounting and operation in purchaser's tank whose details are given under GA drawings of Tank(s) & Sumps , annexed with the enquiry specification. The Bidder/ its Sub-vendor shall review and seek clarifications, if any, on Tank & Sump GA Drawings.
XXII	In case Bidder/ its Sub-vendor provides a Vertical Agitator with hub design, the same has to be of Alloy 926 or better material. Impeller hub material has to be Alloy 926 or better material. Type of impeller and its power number to be clearly mentioned in the technical document submitted by vendor for BHEL approval.
XXIII	Unless otherwise specified, for small diameter impeller, it shall be possible to remove complete agitator assembly without dismantling through the opening provided on the tank/sump, and for large diameter impeller, the blade shall be of removable construction for ease of removal. Bidder/ its Sub-vendor shall also provide the headroom required for taking out the agitator as above.
XXIV	VOID
XXV	Bidder/ its Sub-vendor shall provide the design and arrangement of baffle plates in circular tanks.
XXVI	Bidder/ its Sub-vendor shall provide proper dowelling between motor and base plate, gear box and mounting tool/base plate, for ease of assembly of agitator unit. Tapered dowel shall be provided.
XXVII	Vendor shall provide suitable arrangement for supporting the agitator shaft with impellers during removal of gear-box for maintenance and details of such arrangements shall be furnished.
4.2	CONSTRUCTIONAL FEATURES
A)	BLADE AND HUB OF PROPELLER
I)	VOID.
II)	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.
III)	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. Any deviation to this requirement is subject to customer approval during detailed engineering based on applicable codes and standards to be furnished by the Bidder/ its Sub-vendors.
IV)	Impeller should be dynamically balanced to Gr: G16: ISO-1940 after rubber lining of shaft.
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.

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS	SPECIFICATION No: PE-TS-497/527-167-A001	
		SECTION-C, SUB-SECTION-C1B	
		REV. 00	DATE: AUG. 26
		SHEET: 9 OF 24	

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.	-VOID-
VII.	Requirement of flushing water, its quantity, and pressure to be indicated in data sheet.
VIII.	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.
IX.	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.
X	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
XI	Seal life has to be guaranteed, taking into consideration all its components for 25000 hrs. If the seals fail before the completion of guaranteed period, the same should be replaced free of cost by the Bidder/ its Sub-vendor. Bidder shall obtain the guarantee on OEM's letter head.
XII	The sub-vendor of the seal shall be approved by customer during contract execution.

2 **Vertical Agitators for Other Slurry Tanks & Drain Pit Tanks**

I Agitator shall be supplied with stuffing box or any proven equivalent or superior sealing type. Construction of Gland Packing shaft seal system shall be as per the below fig:



		TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS		SPECIFICATION No: PE-TS-497/527-167-A001	
				SECTION-C, SUB-SECTION-C1B	
				REV. 00	DATE: AUG. 26
				SHEET: 10 OF 24	
II	Agitator shall be supplied with stuffing box or any proven equivalent or superior sealing type. For type of sealing to be provided for various Agitators please refer Agitator schedule. 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/ its Sub-vendor, the mechanical seal should be as per ISO-21049 / API 682.				
C)		SHAFT			
I.	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 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.				
D)		BEARING & BEARING HOUSING IN GEAR BOX			
I	Bearing shall be of rolling type radial and thrust bearing (FAG/SKF/Timken make only) as required. Thrust bearing shall be sized for continuous operation under all specified condition.				
II	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 considered 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) .				
III	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 through RTD.				
IV	If bearing housing requires cooling water, volume and pressure of cooling water is to be indicated in Technical Data Sheet.				
V	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			
I	Agitator components 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.				
II	A detail quality plan is to be submitted along with offer for all item.				
III	Final acceptance of the quality plan will be approved by ultimate user during detailed engineering without any commercial implication. QAP should be as per the best practice followed internationally to avoid any conflict of interest.				
F)		DRIVER (MOTOR)			
I	Driver shall be sized to meet all specified operating conditions including bearing housing,				

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS		SPECIFICATION No: PE-TS-497/527-167-A001	
			SECTION-C, SUB-SECTION-C1B	
			REV. 00	DATE: AUG. 26
			SHEET: 11 OF 24	

	seal, external gear box and coupling loss (if any).
II	Motor shall be able to accelerate to speed at reduced voltage and frequency as specified in "Site Power Supply Condition" as per Clause: 3.3.
III	It should meet the electrical specification (SECTION-I, SUBSECTION-C3).
G)	GEAR BOX
I.	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. An auxiliary slow drive provision shall be provided in the Gear Box so that slurry is always kept in dynamic condition to avoid settling of slurry at bottom, in the event of Agitator is not operating at its rated speed. Rating of Gear box shall be at least 1.5 times the rated torque of Agitator. Gear box details are subject to customer approval during detailed engineering without any commercial implications.
II.	The reduction unit shall be procured from a reputed manufacturer and shall confirm to BS: 721 (latest edition)/AGMA/Equivalent specifications. The sub-vendor of the gear-box shall be approved by customer during contract execution.
III.	Gear drives shall have splash type oil lubrication. If oil pumps are used, they shall be removable for maintenance without disturbing the motor or drive housing.
IV.	The gear reduction unit shall always be provided with an oil drain, a breather and oil level gauge. The lubrication to be designed keeping in view that the temperature within the bearing should not exceed 85 Deg. C.
V.	-VOID-
VI.	The Bidder/ its Sub-vendor shall provide an easily accessible oil level gauge and a dipstick that will indicate oil level under standstill and operating conditions.
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, if applicable, shall be Spacer-type flexible coupling, made of Cast Iron. Spacer shall be of sufficient length so that 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. Any deviation to this requirement is subject to customer approval during detailed engineering based on applicable codes and standards to be furnished by the Bidder/ its Sub-vendors.

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS		SPECIFICATION No: PE-TS-497/527-167-A001	
			SECTION-C, SUB-SECTION-C1B	
			REV. 00	DATE: AUG. 26
			SHEET: 12 OF 24	

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. Nozzle is not in the scope of supply of Agitator manufacturer. It should be noted that Nozzle 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.	Base plate with desired number of holes shall be provided by the Bidder/ its Sub-vendor, will be machined on one side. Base 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
I	All fasteners used in wetted condition must comply to the material given in this specification so that even if it comes in contact with liquid by swelling of rubber, thread remains unaffected. Raw material of fastener must undergo Inter-granular Corrosion test as per ISO-3651, Part-1 for Nitric Acid test.
II	Mounting flange dimensions shall be as per ASME B16.5 up to 600 Nb, ASME B 16.47 for more than 600 NB.
III	Rubber Lining (As Applicable) a) Rubber lined surfaces shall utilize 6 mm nominal thickness chlorobutyl rubber. b) Areas of high wear (e.g. leading edges on impeller blades) shall have an additional 6 mm of rubber for abrasion protection. c) No field-applied linings are permitted except for file patch kits.
K)	GENERAL REQUIREMENT OF SIDE ENTRY AGITATORS:
I.	All Agitators shall be designed for continuous operation.
II.	VOID.
III.	It should be of Flange mounted type
IV.	Nozzle size, on which Agitator shall be mounted, shall have enough opening to Insert rotating assembly from side. Bidder/ its Sub-vendor shall inform the required nozzle size. Further the mating flange shall be in the scope of the Bidder/ its Sub-vendor.
V.	The Bidder/ its Sub-vendor to consider Gypsum Sedimentation during stoppage of Agitator.
VI	VOID

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS	SPECIFICATION No: PE-TS-497/527-167-A001	
		SECTION-C, SUB-SECTION-C1B	
		REV. 00	DATE: AUG. 26
		SHEET: 13 OF 24	

L)	GENERAL REQUIREMENT OF TOP ENTRY AGITATORS IN OTHER SLURRY TANKS & DRAIN PITS:
I.	All Agitators shall be designed for continuous operation.
II.	VOID.
III.	It should be roof mounted.
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 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.	Nozzle size, on which Agitator shall be mounted, shall have enough opening to Insert rotating assembly from top. Bidder/ its Sub-vendor shall inform the required nozzle size. Further the mating flange shall be in the scope of the Bidder/ its Sub-vendor.
VI.	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.
VII.	Impeller should be dynamically balanced to Gr: G16: ISO-1940 after rubber lining of shaft.
VIII	In case Bidder/ its Sub-vendor provides a Vertical Agitator with hub design the same has to be of Alloy 926 or better material
IX	Operation speed of the Agitator motor shall be at least 25% below the first critical speed.
X	-VOID-
XI	-VOID-
4.3	MOTOR
1	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 selected with minimum margin above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variation. Refer Electrical specification for motor margins.
2	It should meet the electrical specification (SECTION-I, SUBSECTION-C3).
5	GENERAL REQUIREMENTS
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/cm2(G). For instance, the pressure gauges should have dual unit's indication.
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.

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS	SPECIFICATION No: PE-TS-497/527-167-A001	
		SECTION-C, SUB-SECTION-C1B	
		REV. 00	DATE: AUG. 26
		SHEET: 14 OF 24	
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. Carbon steel shaft shall have a corrosion allowance of 6mm on its diameter. On other non-pressure carbon steel parts, a corrosion of 3mm shall be considered on each surface.		
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/ its Sub-vendor 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/ its Sub-vendor shall solve the problems in a timely manner.		
16	Bidder/ its Sub-vendor 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/ its Sub-vendor to provide capacity of hoist required for material handling and the details of heaviest component to be handled. Bidder/ its Sub-vendor shall provide a typical arrangement/drawing of the handling arrangement.		
19	The list of all Bought out items with makes and country of origin to be mentioned during detailed engineering and shall be subjected to BHEL/end customer approval.		
20	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/ its Sub-vendor and shall be inclusive in Bidder/ its Sub-vendor quoted price.		

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS	SPECIFICATION No: PE-TS-497/527-167-A001	
		SECTION-C, SUB-SECTION-C1B	
		REV. 00	DATE: AUG. 26
		SHEET: 15 OF 24	
21	Material of construction for all equipment/components shall be subject to customer/ BHEL approval during detail engineering. Accordingly, Bidder/ its Sub-vendor shall consider MOC for all equipment/component (complying tender specifications), as per best engineering practice, global standard and global references, in case no MOC is available in specs.		
22	Bidder/ its Sub-vendor to provide sub vendor list and Bidder/ its Sub-vendor shall strictly adhere to customer approved vendor list (reference list is included in SUB-SECTION-D, Annexure-I). In case Bidder/ its Sub-vendor proposes an additional vendor for an item or vendor approval is required for any new item, acceptance shall be subject to approval by customer/ BHEL before placing order and Bidder/ its Sub-vendor shall submit relevant documents to take up with customer for approval. BBidder/ its Sub-vendor shall submit relevant documents as per Sub-Supplier Questionnaire provided in referred Annexure.		
23	It shall be the complete responsibility of the successful Bidder/ its Sub-vendor to obtain “Sub Vendor Approval” from BHEL / customer for all equipment’s & components. Any delay in sub vendor’s approval should not affect the project schedule.		
24	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/ its Sub-vendor shall follow the procedures of inspection as per the approved QAP. Bidder/ its Sub-vendor has to submit the following documents along with inspection call and 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: a. Relevant Standards b. Specifications c. Approved drawings d. Data Sheets e. Calibration certificate for all the measuring instruments		
25	During detail engineering, Bidder/ its Sub-vendor to strictly adhere to BHEL/customer drawing formats, document numbering, quality plan & FQP formats		
26	VOID.		
27	Complete detail engineering drawings, calculations, selection of components etc. shall be reviewed & subject to approval of BHEL/Customer during detail engineering		
28	Bidder/ its Sub-vendor shall furnish necessary inputs & drawings of all equipment in editable Auto CAD/ MS-Word /Excel format.		
29	During detail engineering, successful Bidder/ its Sub-vendor shall ensure flow of drawings/documents as per schedule. Any comments from BHEL/Customer should be addressed timely by the Bidder/ its Sub-vendor.		
30	Bidder/ its Sub-vendor to note above mentioned points not exhaustive and any work /items required for completing the smooth operation and ensuring satisfactory running of		

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS		SPECIFICATION No: PE-TS-497/527-167-A001	
			SECTION-C, SUB-SECTION-C1B	
			REV. 00	DATE: AUG. 26
			SHEET: 16 OF 24	

	the machines till final hand over to the end user shall also be in the scope of the Bidder/ its Sub-vendor.
31	Bidder/ its Sub-vendor shall provide design support to assist the Purchaser in efficiently integrating the furnished equipment. Design support specifically includes: a) Bidder/ its Sub-vendor shall verify/ validate the number and location of agitators to keep material in suspension. b) Static and dynamic loading information and requirements for Agitator support design (applicable for top & side type)
32	Any other item required to meet the stipulations mentioned in GTR, GCC and SCC and relevant to Agitator package unless specifically excluded from scope of supply.
6	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 as per Sub-Section D, Section-II. 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 end customer.
5	Packaging or shipping units shall be designed within the limitations of the unloading facilities of the receiving ports and the ship which will be used. It shall be the Bidder/ its Sub-vendor'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

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS	SPECIFICATION No: PE-TS-497/527-167-A001	
		SECTION-C, SUB-SECTION-C1B	
		REV. 00	DATE: AUG. 26
		SHEET: 17 OF 24	

	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 cases 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 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

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS		SPECIFICATION No: PE-TS-497/527-167-A001	
			SECTION-C, SUB-SECTION-C1B	
			REV. 00	DATE: AUG. 26
			SHEET: 18 OF 24	

	the delivery site, Name and Address of the Sender, Serial Number of Agitator, and 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/ its Sub-vendor 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.
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.
7	ERECTION, TESTING AND COMMISSIONING
1	The erection and commissioning of Agitators shall be done as per Erection Manual and check List to be provided by the Bidder/ its Sub-vendor during detail engineering.
8	EXCLUSION
	NIL.
9	INSPECTION AND TESTING
1	The General inspection requirements to be considered are as below:
2	Bidder/ its Sub-vendor shall furnish written copies of shop production, fabrication and quality test procedures and drawings to be used on the Agitators for review by BHEL/end customer prior to manufacture.
3	The Bidder/ its Sub-vendor shall furnish performance test procedure along with standard. The test procedure will be reviewed and approved by the BHEL/customer.
4	Agitator manufacturer is to submit a test procedure and Quality Plan, clearly indicating that equipment will meet the desired parameter.
5	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.

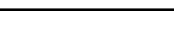
		TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS		SPECIFICATION No: PE-TS-497/527-167-A001	
				SECTION-C, SUB-SECTION-C1B	
				REV. 00	DATE: AUG. 26
				SHEET: 19 OF 24	
6	No liquid should enter the tube through any flange joint. “O”-ring used in the flange joint will deteriorate 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 hour to check sweating of any flange. Hydrostatic test is meant in part for a check of equipment joint at new condition only. It cannot be considered as a guarantee of functional objective of rubber used.				
7	Mechanical Run Test (in air) Each Agitator unit shall be given a 4-hour mechanical run test in air at vendor's shop. Agitator unit shall be mounted in the same manner as it will operate in the field. During this test the record shall be made of: a) Shaft run out at free end. b) Dynamic shaft deflection adjacent to the mechanical seal/packing/vapor seal. c) Gearbox oil temperature and temperature of bearing housing in stool. The temperature of the gear box oil shall not exceed ambient plus 40 Deg. C and that of bearing housing shall not exceed from room temperature plus 20 Deg. C after temperatures have stabilized. d) Bearing Housing vibration checks shall be carried out. Maximum acceptable vibration velocity shall be 6 mm/sec. e) Noise level shall be checked and shall be within the specified limits mentioned in the specification. f) Agitator shaft RPM and motor RPM. g) Check of satisfactory operation of shut off and retracting arrangement. Please also refer serial no. 9 below.				
8	Mechanical Run Test (in water) Each agitator unit shall be given a load test in water at the vendor's shop. The duration of this test shall be 4 hours unless agreed otherwise between the Purchaser and the vendor. The following parameters shall be recorded during the test: a) Dynamic shaft deflection adjacent to the mechanical seal/packing/vapor seal. b) Gear box bearing oil temperature and temperature of bearing housing in stool. The temperature of gear box oil shall not exceed ambient plus 40°C and that of bearing housing shall not exceed room temperature plus 20°C after the temperatures have stabilized. c) Bearing housing vibrations. Maximum acceptable vibration velocity is 6 mm/sec. d) Noise levels shall be checked and shall be within the specified limits mentioned in the specification. e) Electrical power input to the motor. f) Agitator shaft RPM and motor RPM. g) Check of satisfactory operation of shut off and retracting arrangement. As a part of the Quality Assurance Plan, where possible as per facility available at				

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS	SPECIFICATION No: PE-TS-497/527-167-A001	
		SECTION-C, SUB-SECTION-C1B	
		REV. 00	DATE: AUG. 26
		SHEET: 20 OF 24	
	Bidder/ its Sub-vendor's work, Bidder/ its Sub-vendor may demonstrate the power consumption also of each agitator at shop with the available fluid along with relevant calculation to establish the correlation with the slurry used for the project, apart from necessarily demonstrating power requirement at site. Also, Please refer sl. no 9 below.		
9	In case of any constraints in carrying out shop tests indicated at S No. 7 & 8 above, the Mechanical run tests for agitators shall be carried out with air/water at shop along with other test requirement in line with the QAP to be approved by customer during detail engineering.		
9A	Acceptance Test (at Site) After the Agitator has been installed at site and is ready for test, Agitator supplier shall depute his representative to supervise the site acceptance test.		
10	DYNAMICS		
10.1	CRITICAL SPEED		
10.1.1	Operation speed of the Agitator motor shall be at least 25% below the first critical speed		
10.1.2	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 there is a separation margin of minimum 20% between the torsional critical speed (dry/wet) and any operating speed.		
10.2	VIBRATION SEVERITY		
10.2.1	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.		
10.2.2	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 and 1.5-2.3mm/sec even if Motor rating falls below 15kw. Any deviation to this requirement is subject to customer approval during detailed engineering based on applicable codes and standards to be furnished by the Bidder/ its Sub-vendors		
10.2.3	Vibration measurements of bearing housing shall be made in root mean square (RMS) velocity.		
10.2.4	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.		
11	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.		
12	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.		
13	Test certificates shall be issued for each lot of raw material used in the coating, corresponding to specific weight and traction resistance.		

 TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS		SPECIFICATION No: PE-TS-497/527-167-A001	
		SECTION-C, SUB-SECTION-C1B	
		REV. 00	DATE: AUG. 26
		SHEET: 21 OF 24	

14	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.
15	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.
16	Out of all Agitators One Number of each type will be inspected at the Bidder/ its Sub-vendor’s works before dispatch or where the test facilities are available.
17	The Bidder/ its Sub-vendor shall conduct performance test for the remaining Agitators and submit the reports.
18	Contract shaft mechanical seals shall be used during shop tests, unless the seal design is unsuitable for the shop-test condition, if applicable.
19	Agitators shall not be released for shipment, until shop tests data and performance tests curves have been approved by Owner.
20	Bidder/ its Sub-vendor should furnish performance guarantee as per applicable standard guarantee for the design, manufacture, material and safe operation of the equipment’s.
21	Bidder/ its Sub-vendor to arrange all calibrated gauges, Instruments during inspection.
22	Mechanical running and the performance test shall be carried out. Bidder/ its Sub-vendor to arrange Motor of same / higher rating for the shop test and inspection.
23	All testing requirement/certificates shall be in line with QAP to be approved by customer during detailed engineering.
10	PAINTING
1	Painting details for agitator support: - Please refer painting specification (SECTION-I, SUB-SECTION-C2C).
2	Rust preventive paint after inspection at shop floor before dispatch shall be in Bidder/ its Sub-vendor’s scope.
3	Corrosion protection, coating and galvanizing, painting shall be taken care by the Bidder/ its Sub-vendor. Bidder/ its Sub-vendor shall submit the painting scheme during detail engineering. in line with the specification and shall be subject to approval of BHEL / End Customer.
11	SPARES, TOOLS & TACKLES
1	Bidder/ its Sub-vendor shall supply a set of special tools and tackles required either for erection or operation or maintenance of the agitator units. A list of such tools shall be submitted by Bidder/ its Sub-vendor along with the offer.
2	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/ its Sub-vendor 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 (SECTION-III, Annexure-6).
11.1	START UP & COMMISSIONING SPARES

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS	SPECIFICATION No: PE-TS-497/527-167-A001	
		SECTION-C, SUB-SECTION-C1B	
		REV. 00	DATE: AUG. 26
		SHEET: 22 OF 24	
	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/ its Sub-vendor 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 energized. The List of such spares to be provided during bidding stage (SECTION-III Annexure-7).		
11.2	Void		
11.3	MANDATORY SPARES:		
	a) Bidder/ its Sub-vendor to quote for the mandatory spares as per the Mandatory Spare list (SECTION-I, SUB-SECTION-D Annexure-X). b) 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. c) All spares supplied under this contract shall be strictly inter-changeable with the parts for which they are intended for replacements. All the mandatory spares shall be manufactured along with the main equipment components as a continuous operation as per same specification and quality plan.		
12	FIRST FILL OF CONSUMABLES		
I	Bidder/ its Sub-vendor's scope shall include supply and filling of all chemicals, lubricants, grease, filters and consumable items for operation up to commissioning including top up requirements. 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.		
II	Bidder/ its Sub-vendor shall also supply a quantity not less than 10% of the full charge of each variety of lubricants, servo fluids, gases, chemicals etc. (as applicable) used which is expected to be utilized during the first year of operation. This additional quantity shall be supplied in separate containers.		
III	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 chemicals, 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/ its Sub-vendor shall list at least three equivalent lubricants manufactured by alternative companies.		

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS	SPECIFICATION No: PE-TS-497/527-167-A001	
		SECTION-C, SUB-SECTION-C1B	
		REV. 00	DATE: AUG. 26
		SHEET: 23 OF 24	

13	BID EVALUATION CRITERIA FOR POWER CONSUMPTION:
1.	POWER GUARANTEE Bidder/ its Sub-vendor to specify the total guaranteed power per Agitators operating at the rated capacity in their offer.
2.	BID EVALUATION CRITERIA FOR POWER CONSUMPTION: Refer Annexure XI, Sub Section D, Section-I.
14	LIQUIDATED DAMAGES FOR POWER CONSUMPTION
	Refer Annexure XI, Sub Section D, Section-I.
15	PERFORMANCE GUARANTEE
	a) All performance tests for Agitators shall be carried out in accordance with any latest international codes/standards. b) Bidder/ its Sub-vendor shall furnish Performance guarantee for the design, manufacture, material, safe and trouble-free operation of the Agitators and its accessories c) The Bidder/ its Sub-vendor 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. d) Noise level ≤ 85 dB (A) at 1m horizontal distance from equipment/enclosures and 1.5m above operating floor is to be guaranteed. 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) Life of Agitator components/parts from the date of commissioning for continuous operation shall be guaranteed for 24 months. g) Acceptance tests to be carried out as per the procedure defined by the Bidder/ its Sub-vendor which shall be submitted for BHEL/ end customer approval. h) In the event that the performance test is unsuccessful, Bidder/ its Sub-vendor shall take necessary remedial action at his cost and the performance test shall be repeated. For additional details of performance guarantee please refer 'functional guarantee' under Sub-section C2-B, Section-I.
16	DOCUMENTATION
A	DOCUMENTS TO BE SUBMITTED ALONG WITH THE OFFER
	The Bidder/ its Sub-vendor 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. List of such documents have been indicated in (SECTION-II Annexure-1).
B	DOCUMENTS TO BE SUBMITTED AFTER AWARD OF CONTRACT
	a) The Successful Bidder/ its Sub-vendor shall submit necessary data, documents and drawings for review, approval as specified in this specification. Drawings that are

	TECHNICAL SPECIFICATIONS FOR MISC. TANKS (SITE FABRICATED) AND AGITATORS		SPECIFICATION No: PE-TS-497/527-167-A001	
			SECTION-C, SUB-SECTION-C1B	
			REV. 00	DATE: AUG. 26
			SHEET: 24 OF 24	

	reviewed by the end customer/ BHEL, will be returned to Bidder/ its Sub-vendor 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/ its Sub-vendor shall place a “hold” on those items or areas of design. End customer/ BHEL reserves the right to return drawings unprocessed to Bidder/ its Sub-vendor if there exists any evidence that Bidder/ its Sub-vendor has not acknowledged all comments and questions.
	b) 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/ its Sub-vendor in soft and hard copy forms. For all document’s 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. c) All documents in hard and soft form 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. d) The list of such drawing/documents have been indicated in SECTION-I, SUB-SECTION-D Annexure-IV.
17	LIST OF DRAWINGS AND SCHEDULES BY BHEL
I	The document specified in Sub-Section-D of Section-I are being provided for estimation and calculation purpose of the Bidder/ its Sub-vendor.



TECHNICAL SPECIFICATIONS FOR
MISC. TANKS (SITE FABRICATED) AND AGITATORS

SPECIFICATION NO. PE-TS-497/527-167-A001	
SECTION –I, SUB SECTION –C1C	
REVISION 00	DATE: AUG. 26

SUB SECTION-C1C
SPECIFIC TECHNICAL REQUIREMENTS – RUBBER LINING



TECHNICAL SPECIFICATIONS FOR
MISC. TANKS (SITE FABRICATED) AND AGITATORS

SPECIFICATION NO. PE-TS-497/527-167-A001

SECTION –I, SUB SECTION –C1C

REVISION 00

DATE: AUG. 26

1.0 SCOPE OF WORKS

- 1.1 Design, manufacture, testing and supply of rubber lining material for the duty condition for FGD Tanks as specified in Annexure- III (Tank schedule), Sub Section-D, Section-I.
- 1.2 Erection and Commission of Rubber lining, delivery of material at site, surface preparation for lining surfaces, lining the surface to the satisfaction of the customer shall be in lining OEM scope, cost for Erection and Commission shall be included in the offer.
- 1.3 Bidder shall be required to follow all the conditions specified by lining OEM for safe storage and application of lining, without any commercial and delivery implication to BHEL, even though not specified explicitly in this specification.

2.0 SURFACE PREPARATION

- 2.1 The Tanks surface to be lined should be blasted to a bright grey metal finish (Sa 2½ requirement), free from rust, weld marks, oil and any other foreign matter. The blasting is carried out with the help of dry grit (copper sludge)/Sand under dry air pressure of 7 kg/cm² by Compressor. Surface roughness shall be 50-60 Microns.
- 2.2 After blast cleaning, blasted surface will be applied by surface protecting primer to prevent the corrosion. After 100% blasting of the particular Tank is completed, the surface is cleaned by appropriate solvent, so as to see that all the small dust particles are removed. Sharp corner shall be suitable rounded off. Surface should not have any sharp notch.
- 2.3 After this procedure suitable bonding agent and 3 to 4 coating of the specially formulated rubber adhesive should be applied for proper bonding of the Rubber Sheets to be lined.
- 2.4 Compressor and any other facilities required for grit/shot blasting shall be arranged by Bidder/ Its Sub-Vendor. Any hoses provided in the compressed air line shall be tested with air before commencement of grit blasting job.
- 2.5 The grit/shot blasting machine shall be provided with safety valve (safe trip) as a protection against over pressure.
- 2.6 Scaffolding shall be done by the Bidder/ Its Sub-Vendor. Any scaffolding provided by the Bidder/ Its Sub-Vendor shall be of steel only.

3.0 GUIDELINES FOR DESIGNING AND FABRICATION OF STEEL CONSTRUCTIONS FOR RUBBER LINING:

Please refer Section-II, Sub-Section-A

4.0 RUBBER LINING

- 4.1 The lining shall completely cover the roof, sides and internals of Slurry Tanks, support angle, insert plates, openings, Man Hole / Inspection / Flange openings. etc.,
- 4.2 After Rubber sheet applied on the surface, rubber sheets should be systematically pressed to the metal surface by the help of mechanical tools like Rubber Rollers and metal thin rollers to remove the air between metal and rubber sheet. All rubber joints are properly overlapped by



TECHNICAL SPECIFICATIONS FOR
MISC. TANKS (SITE FABRICATED) AND AGITATORS

SPECIFICATION NO. PE-TS-497/527-167-A001

SECTION –I, SUB SECTION –C1C

REVISION 00

DATE: AUG. 26

25 to 35 mm wide tapered cut rubber sheet. All the joints will be covered by 75 mm X 1.5 - 1.7 mm thick rubber strip.

4.3 Bidder/ Its Sub-Vendor shall specify the shelf life of the rubber material being supplied and shall furnish the storage methods to be followed at site to ensure that the rubber material shall not be spoilt during storage.

4.4 Bidder/ Its Sub-Vendor shall submit the surface preparation and lining procedure to the purchaser for approval. The lining work shall start only after obtaining approval from Purchaser.

4.5 ATMOSPHERIC CONDITION REQUIREMENTS

This section deals with the atmospheric condition requirement to be checked while undertaking the rubber lining at site.

1. Blasting or Coating shall not be applied if following conditions prevail.
 - When temperature of the surface to be coated is less than 3°C above the dew point, or the relative humidity is higher than 85%.
 - When the base metal temperature is greater than 60°C.
 - When the atmospheric temperature is below 4°C.
 - When there is, in the opinion of lining Contractor, the likely hood of an unfavourable change in the weather condition within 2 hours after coating.
 - When there is deposition of moisture in the form of rain or condensation.
2. Humidity shall be calculated by lining OEM using whirling hygrometer whose thermometers are calibrated.
3. Surface temperature shall be measured using suitable temperature gauge and calibration certificate of the same shall be provided by Bidder/ its Sub-Vendor.
4. Record will be maintained throughout the execution period. Readings shall be taken once in every 4 hours up to the time work is in progress. The frequency of reading should be increased during adverse weather conditions.
5. While working in unfavourable weather conditions (like monsoons or winters or if provided for in the contract or in large confined spaces where blasting and priming of the entire surface cannot be completed in one day operation, use of dehumidifier shall be resorted to. The dehumidification equipment will have to be maintained in such a way that the humidity is around 65% -75% inside the sump/tank at all times during the work. No flash rusting of the blast surface should take place till the time it receives a primer coat.
6. Where dehumidification equipment is to be used, the humidity readings are to be taken inside and outside the equipments to be coated.
7. Dehumidification equipment may not be necessary for contained space working if work is done at near ideal atmospheric conditions as described above.



TECHNICAL SPECIFICATIONS FOR
MISC. TANKS (SITE FABRICATED) AND AGITATORS

SPECIFICATION NO. PE-TS-497/527-167-A001

SECTION –I, SUB SECTION –C1C

REVISION 00

DATE: AUG. 26

8. In cases where dehumidification is not possible, alternate methods of warming up the work front like use of halogen lights, room heaters are to be adopted.

9. Humidity is to be taken at the location where the blasting coating operations taking place.

5.0 INSPECTION AND TESTING OF RUBBER LINING

- 1 Ageing Test : 70°C for 24 hrs. (IS: 3400 Pt.4)
Change in Tensile Strength: $\pm 5\%$
Elongation at break: $\pm 10\%$
- 2 Abrasion Test : Wt. loss – Max. 25%
- 3 Tensile Strength : 35 kg/cm² (min) for Bromo Butyl and
40 kg/cm²(min) for Chloro Butyl Rubber
- 4 Elongation at break : $\geq 300\%$ minimum for 4mm thk rubber specimen
- 5 Peeling strength : ≥ 3 N/mm
- 6 Hardness : 55 $\pm$ 5° Shore A
- 7 Spark Test : 1.5 KV/ mm
- 8 Lining shall be visually inspected to ensure free from poorly weed out fibers, entrapped air and exposed fires. Defects are to be repaired by sanding a generous area around the defected portion and applying a layer of rubber material.
- 9 Spark test shall be carried out at appropriate areas in the presence of Purchaser. Bidder/ Its Sub-Vendor should conduct test as per relevant standards.
- 10 After installation, the Rubber lining shall be subjected to testing at site as per relevant standards. If the performance is found not to meet the requirements as specified, the Rubber lining shall be rectified or replaced by the Bidder/ Its Sub-Vendor without any extra cost to the Purchaser.

6.0 FINISHING & INTERNAL TESTING

- 6.1 Rubber surface of all flanges and manhole of Equipment will be finished by the mechanical tools to get leakage free surface during commissioning.
- 6.2 After above finishing, 100% testing will be carried out for continuity by high frequency high voltage spark tester. If there is any puncture, they are checked and rectified as per the standard procedure of repair (Clause 6.1) as mentioned in procedure.

7.0 REPAIRING PROCEDURE

- 7.1 Faulty spots on the rubber lining are cut off down to be substrate and the seams of the remaining rubber are beveled.
- 7.2 Rubber sheet with a broad bevel cut is glued on the substrate laid bare.
- 7.3 On spots to be repaired of a diameter < 300 mm, a second layer of Rubber sheet is glued covering the seams of the first layer.
- 7.4 Several spots to be repaired in a small area are jointly covered with a second layer of Rubber sheet.

8.0 PERFORMANCE GUARANTEE

The lining material shall be guaranteed for **an uninterrupted minimum life of 25000 hrs.** Performance parameters to be guaranteed by the lining OEM and tolerances permitted shall be as indicated in the data sheet. Rubber lining or any portion thereof is liable for rejection, if it fails



TECHNICAL SPECIFICATIONS FOR
MISC. TANKS (SITE FABRICATED) AND AGITATORS

SPECIFICATION NO. PE-TS-497/527-167-A001

SECTION –I, SUB SECTION –C1C

REVISION 00

DATE: AUG. 26

to give any of the guaranteed performance parameters. The lining should be guaranteed for faultless material and workmanship. During Guarantee period any defects noticed due to faulty material and workmanship, shall be rectified by Bidder/ Its Sub-Vendor free of cost. Bidder shall obtain the above guarantee from lining OEM on its letter head.

9.0 PACKING

9.1 The part items of the Rubber lining should be identified by Tag numbers and should be packed as to minimize the possibility of damage during storage or transit. The packing should be suitable for tropical conditions.

9.2 Please refer Sub Section- E, SECTION – II for Packing Procedure.

10. DOCUMENTATION

DATA TO BE FURNISHED BY THE BIDDER/ ITS SUB-VENDOR AFTER RECEIPT OF PURCHASE ORDER:

- 10.1 List of Drawing and documents to be submitted for review, approval and information with submission dates.
- 10.2 Quality Assurance Plan to be submitted for approval.
- 10.3 Detailed dimensional General Arrangement drawing of the lining surfaces.
- 10.4 Document containing all the design data and information about the material, scope of work and weight of the material supply, Packing procedure etc.
- 10.5 Installation, operation and maintenance manual.
- 10.6 Surface preparation procedures.

The above data to be clubbed and aligned with the document mentioned in the Master Drawing list.



TECHNICAL SPECIFICATIONS FOR
MISC. TANKS (SITE FABRICATED) AND AGITATORS

SPECIFICATION NO. PE-TS-497/527-167-A001	
SECTION –I, SUB SECTION –C1D	
REVISION 00	DATE: AUG. 26

SUB SECTION-C1-D
SPECIFIC TECHNICAL REQUIREMENTS – GLASS FLAKE LINING