

**TAMIL NADU GENERATION AND DISTRIBUTION
CORPORATION LTD**

**FLUE GAS DESULPHURISATION (FGD) SYSTEM
PACKAGE OF**

1 X 800 MW NCTPP STAGE-III, CHENNAI, TAMIL NADU

**TECHNICAL SPECIFICATION
FOR
AGITATORS OF FGD SLURRY TANKS**

SPECIFICATION NO.: PE- TS- 485- 571- 18000-A001



**BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA**

	Title: 1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO, Tamilnadu Technical Specification for Agitators of FGD Slurry Tanks	Specification No: PE-TS-485-571- 18000-A001	
		Contents -Section – I & II	
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INTENT OF SPECIFICATION

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1.0 SCOPE OF ENQUIRY/ INTENT OF SPECIFICATION

- 1.1 The specification covers Supply part, Services part and Mandatory spares 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, 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, assembly AND services part covers supervision services for erection & commissioning (Supervision by OEM), 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** including Operation & Maintenance, Troubleshooting etc., training of customer at manufacturer's works (3 persons for 2 days including lodging and boarding) & handover in flawless condition of the package to the customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order for Flue Gas Desulphurization (FGD) plant of **1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO, Tamilnadu.**

The following points may be noted.

- Agitators are part of various slurry tanks, details of which are given in Technical Information of Agitators.
 - Bidder shall assume full unit responsibility for the entire equipment assembly and make all possible efforts to comply strictly with the requirements of this specification and other specifications/attachments to inquiry/order.
 - The Bidder shall offer only proven design which meets the Provenness /Pre-qualification requirement of TANGEDCO. If bidder doesn't meet the specified provenness criteria, their offer will be rejected.
- 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 **Agitators for FGD Slurry Tanks.**
- 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

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of drawings and specifications and shall be entitled to reject any work or material which in his 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 -III); 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

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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 The equipment covered under this specification shall not be dispatched unless the same have been finally inspected, accepted and dispatch release issued by BHEL/Customer.
- 1.13 BHEL's Customer's representative shall be given full access to the shop in which the equipment's are being manufactured or tested and all test records shall be made available to him.
- 1.14 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. The bidder will also arrange for BHEL a copy of the standards in ENGLISH language. The cost of such service will be deemed to have been included by the bidder in the total cost of the package. BHEL will not entertain any additional cost on account of the same.
- 1.15 All text/ numeric in the document / drawings to be generated by the successful bidder will be in English language only.
- 1.16 The bidder's offer shall not carry any sections like clarification, interpretations and /or assumptions.

Note:

- a) Bidder to note that BHEL reserves the right for drawing/document submission through web-based Document Management System. Bidder would be provided access to the DMS for drawing/document approval and adequate training for the same. Detailed methodology would be finalized during the kick-off meeting. Bidder to ensure following at their end.
 - Internet explorer version – Minimum Internet Explorer 7.
 - Internet speed – 2 MBPS (Minimum preferred).
 - Pop ups from our external DMS IP (124.124.36.198) should not be blocked.
 - Vendor's internal proxy setting should not block DMS application's link (<http://dmsserver.bhelpem.com/Wrench%20Web%20Access/Login.aspx>).

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PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA

**ANNEX - 1.1**
PROJECT INFORMATION

1.0	General		
1.1	Project Title	:	1 x 800 MW North Chennai Coal Based Super Critical Thermal Power Project Stage III.
1.2	Plant capacity	:	800 MW
1.3	Type of project	:	Brown field
1.4	Owner	:	Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO)
1.5	Plant site location	:	In the premises of North Chennai Thermal Power Station (NCTPS)
1.6	Location co-ordinates	:	80° 19' E to 80° 20' E Longitude 13° 13' N to 13° 18' N Latitude
1.7	Nearest Village	:	Ennore & Puzhuthivakkam Village
1.8	Nearest Town & City	:	Chennai (35 Km)
1.9	State Capital	:	Chennai (35 Km)
1.1	Nearest Railway Station	:	Athipattu Pudunagar (~ 5 Km) on Chennai – Vijayawada Line
1.11	Nearest Airport	:	Chennai (~ 60 Km)
1.12	Nearest Seaport	:	Ennore (~ 3 Km)
1.13	Nearest Road access	:	All weather road from Pattamandri on the Thiruvottiyur – Ponneri highway
2.0	Meteorological Condition		
2.1	Climate	:	Tropical, very dry and hot summer, dry and cold winter and good rain-fall in monsoon accompanied with strong wind
2.2	Site Elevation	:	(+) 10.0 Meter above Mean Sea Level
2.3	Ambient Temperature		
a.	Annual Maximum Mean Temperature	:	45 °C
b.	Annual Minimum Mean Temperature	:	15 °C
c.	Design ambient temperature	:	30 °C
2.4	Relative Humidity		
a.	Maximum	:	90%
b.	Minimum	:	36%
c.	Design	:	75%
2.5	Annual Rainfall		



	Maximum	:	2540 mm
	Average	:	1600 mm
	Minimum	:	1175 mm
2.6	Basic Design Wind Pressure	:	As per IS: 875 (Latest Edition)
2.7	Wind Speed	:	11.8 kmph (Avg), 50 m/s (max)
2.7	Seismic zone	:	Zone: III as defined in IS:1893-2002
2.8	Design ambient temperature for Electrical equipment	:	50 °C

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SPECIFIC TECHNICAL REQUIREMENT- MECHANICAL

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1.0. APPLICABLE CODES & REGULATIONS

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

Bidder 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 shall assist BHEL to obtain approval against the equipment, documents and drawings by Indian authorities.

2.0. PROVENNESS CRITERIA / PRE-QUALIFICATION REQUIREMENT

The Bidders are required to meet the Qualification Requirement (PQR) for Agitators as per provenness criteria & shall submit the credentials as called in 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 agitators refer “Agitator Schedule” in Section-II, Annexure-8 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	CS with Rubber Lining (min 6 mm thick Chloro/bromo butyl Rubber)

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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) with Flange	Not applicable (in BHEL scope)	Not applicable (in BHEL scope)
viii.	Flush pipe for Startup with flange (BHEL SCOPE)	Not applicable (in BHEL scope)	Not applicable (in BHEL scope)
ix.	Tank nozzle with flange (for Flush Pipe)	Not applicable (in BHEL scope)	Not applicable (in BHEL scope)
x.	Agitator Support Leg	Carbon Steel	Not applicable

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3.3 POWER SUPPLY DETAILS:

1.	POWER SUPPLY	
	The following voltage levels shall apply:	
	3 phase, 6.6 kV AC ,50 Hz	Voltage for motors rated 175 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 175 (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 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.	

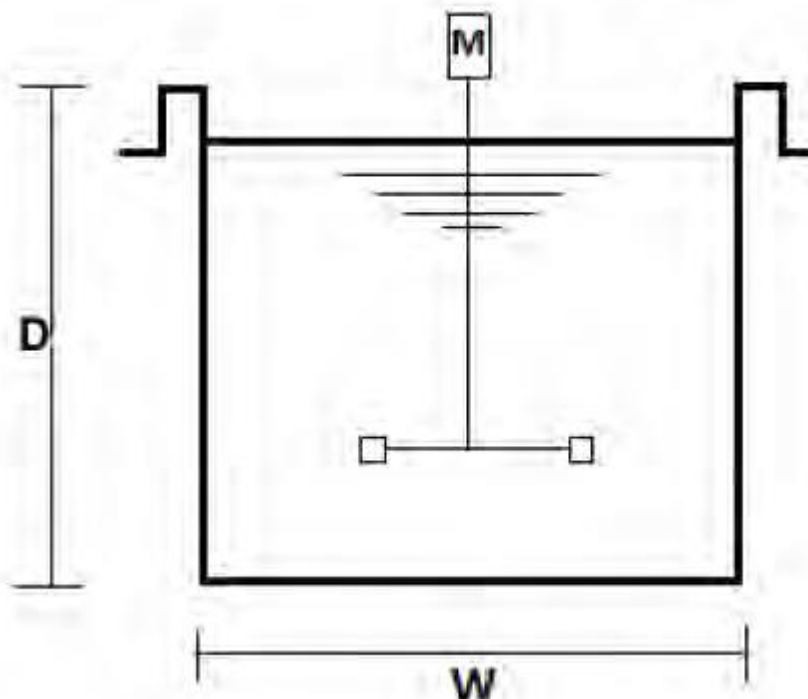
3.4 AGITATOR ARRANGEMENT

For arrangement of Agitators please refer “SIZING CALCULATION, SELECTION PARAMETER FOR ALL TANKS” under Annexure-III, 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.

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Drain Pit Tank Agitators:



For details of Drain Pits please refer “AGITATOR SCHEDULE” Section-II, Annexure-8 of the specification. These Agitators will operate continuously for FGD system operation.

4 SCOPE OF SUPPLY & SERVICES

The bidder 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/TANGEDCO shall not relieve the Bidder in any way of his obligation to maintain an adequate test, inspection, and documentation program of his own, and shall not relieve the Bidder 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's obligation to correct the condition when it is discovered, or of any other obligation under this specification.

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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's responsibility to ensure that the complete delivery complies with all relevant codes, standards and specifications.

The Bidder 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 bidders shall include Design, Manufacturing, Supply, and Supervision of Erection & Commissioning by **OEM**.

Design: Broadly includes basic engineering, detail engineering, preparation and submission of engineering drawings/calculations/datasheets/quality assurance documents/field quality 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.
- Mandatory spares as defined as Section-I, Sub-Section-D, Annexure-II.
- 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:

- Detailed Erection and commissioning procedure shall be submitted by successful bidder for carrying out the erection and commissioning at site by BHEL.
- Supervision for Erection & Commissioning, trial run at site by **OEM**.
- 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)

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- Visits shall be planned by BHEL site team and prior intimation shall be sent to supplier for visit to site for supervision services. Bidder shall be informed at least 10 days in advance for the requirement of visit at site. Visiting team shall consist of one or two expert of bidder (**OEM**) as deemed necessary by them.
- Bidder shall prepare the model of all Agitators under scope in an integrated & intelligent 3D software solution using rule-based, data centric 3D Design software with equipment drawings, data sheets, BOQ, schematics and logic diagrams etc. in the aforesaid 3D model. After the completion of engineering the corresponding complete 3D review model shall be handed over to BHEL.

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
	x. Supporting arrangement including tie rods, gusset plates etc. of Side Entry Agitator on the tank Wall. Vessel Nozzle and mating flange for supporting on the tank wall, gaskets and fasteners.
	xi. VOID.

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Sl. No	Scope
	xii. Foundation plate with foundation bolts
	xiii. Painting and Rust Prevention during shipment and construction
	xiv. Packing and transportation
	xv. Supervision of Erection & commissioning at site by OEM.
	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

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Sl. No	Scope
	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. Supervision of Erection & commissioning at site by OEM.
	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.

The quantity, location of the agitators has been included in the agitator schedule (Section-II, Annexure-8).

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.

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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 material for the shaft (which is continuously in contact with slurry) and agitator blades of the Auxiliary Absorbent Tank Agitators shall be made with Alloy 926 or better material. For Agitators in other tanks, agitator blades shall be made with Alloy 926 or better material and shaft can be rubber lined (minimum 6 mm thick Chloro-butyl Rubber). This does not release the bidder 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	-VOID-
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 bidders.
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.
XI	All exposed moving parts shall be covered by guards.

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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'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.

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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 "SECTION-II Annexure-8". 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 "SECTION-II Annexure-11 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 account frequency variation.
XXI	The agitator shall be suitably designed for mounting and operation in purchaser's tank whose details are given under sizing calculation of tanks, annexed with the enquiry specification (SECTION-I, SUB-SECTION-D, Annexure-III). The bidder shall review and seek clarifications, if any on Tank sizing document.
XXII	In case Bidder 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.

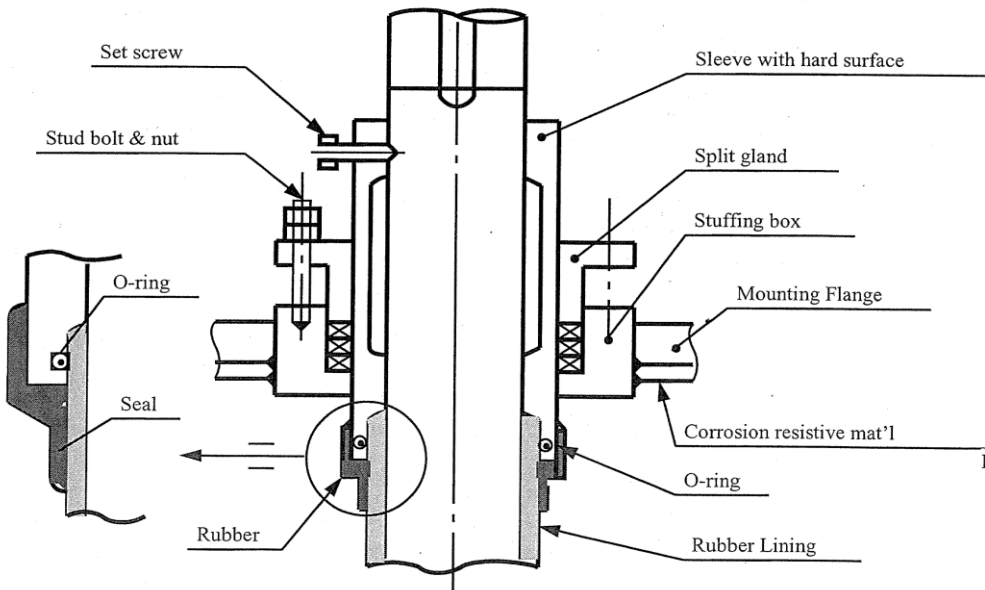
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XXIII	Unless otherwise specified, for small diameter impeller, it shall be possible to remove complete agitator assembly without dismantling through the opening provided on the tank/sump, and for large diameter impeller, the blade shall be of removable construction for ease of removal. Bidder shall also provide the headroom required for taking out the agitator as above.
XXIV	Any instruments provided shall be Profibus Compatible.
XXV	Bidder shall provide the design and arrangement of baffle plates in circular tanks/rectangular sump. Baffle plates are in BHEL scope.
XXVI	Bidder shall provide proper dowelling between motor and base plate, gear box and mounting tool/base plate, for ease of assembly of agitator unit. Tapered dowell 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)	The blades of the agitators shall be of Alloy 926 or better material.
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 bidders.

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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.
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.

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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.
XII	The sub-vendor of the seal shall be approved by customer during contract execution.
2	<u>Vertical Agitators for Other Slurry Tanks & Drain Pit Tanks</u>
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: 

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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, the mechanical seal should be as per ISO-21049 / API 682.
C)	SHAFT
I.	MOC of Shaft shall be as per Clause no.3.2 & “Agitator Schedule”, Section-II, Annexure-8. 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.

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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 designated as “Full Compliance Material” shall meet the requirements of the industry specification as listed for the material in the table as well as in the specification in the respective section.
II	A detail quality plan is to be submitted along with offer for all items marked “Full Compliance Material”.
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, 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

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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 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.

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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 than Motor and Gear Box shall be able to run independently at no-load condition by detaching the respective coupling.
VI.	It is desirable that for servicing of seal, coupling half should not be removed. Coupling should be dynamically balanced to Gr: G6.3, ISO-1940. Any deviation to this requirement is subject to customer approval during detailed engineering based on applicable codes and standards to be furnished by the bidders.
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

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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, 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 be of Alloy 926 or better material 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.

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II.	The Material of Construction (MOC) of Agitators shall be Alloy 926 or better material as per Cl. No. 3.2 & “Agitator Schedule”, Section-II, Annexure-8.
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 shall inform the required nozzle size. Further the mating flange shall be in the scope of the bidder.
V.	The Bidder to consider Gypsum Sedimentation during stoppage of Agitator.
VI.	The following information to be provided along with the bid: a) Impeller Diameter b) Impeller Speed c) Agitator Pumping Capacity (m ³ /min) d) Volume per Agitator:
L)	GENERAL REQUIREMENT OF TOP ENTRY AGITATORS IN OTHER SLURRY TANKS & DRAIN PITS:
I.	All Agitators shall be designed for continuous operation.
II.	The Material of Construction (MOC) of Agitators: Agitator blades shall be made with Alloy 926 or better material & Agitator shaft can be rubber lined as per Clause No.3.2 & “Agitator Schedule”, Section-II, Annexure-8.
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.

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V.	Nozzle size, on which Agitator shall be mounted, shall have enough opening to Insert rotating assembly from top. Bidder shall inform the required nozzle size. Further the mating flange shall be in the scope of the bidder.								
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 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 (as per the below table) above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variation: <table> <tr> <td>Agitator Rated BKW</td><td>Motor Margin</td></tr> <tr> <td><22KW</td><td>125% of Agitator Rated BKW</td></tr> <tr> <td>22KW-55KW</td><td>115% of Agitator Rated BKW</td></tr> <tr> <td>>55KW</td><td>110% of Agitator Rated BKW</td></tr> </table>	Agitator Rated BKW	Motor Margin	<22KW	125% of Agitator Rated BKW	22KW-55KW	115% of Agitator Rated BKW	>55KW	110% of Agitator Rated BKW
Agitator Rated BKW	Motor Margin								
<22KW	125% of Agitator Rated BKW								
22KW-55KW	115% of Agitator Rated BKW								
>55KW	110% of Agitator Rated BKW								
2	It should meet the electrical specification (SECTION-I, SUBSECTION-C3).								

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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.
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.

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12	Rotation arrows shall be cast in or attached with stainless steel plate on each item of rotation equipment at a readily visible location.
13	Unless otherwise specified, all equipment items where the weight exceeds 15 kg shall be provided with suitable lifting lugs, ears or ring bolts or tapped holes for lifting rings. Minimum shock factor for lifting lugs shall be minimum 2.0. The position of lifting lugs and reference dimension shall be shown on GA and/or outline drawings. NDT shall be conducted for lifting lugs. When any spreader bars are required for lifting and laydown, the bidder shall provide spreader bar with equipment.
14	Skid Mount/Transportation: Equipment shall be fabricated as skid mount design as much as practical to minimize erection at the site.
15	If the driver/driven equipment train is in the resonance condition or any vibration problems occur, the bidder shall solve the problems in a timely manner.
16	Bidder shall provide the necessary gaskets.
17	All the surfaces of the carbon steel should be rust prevented before shipment for the period of at least 12 months for storage and construction.
18	Bidder to provide capacity of hoist required for material handling and the details of heaviest component to be handled. Bidder 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 along with offer to be submitted.
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 and shall be inclusive in Bidder quoted price.
21	Material of construction for all equipment/components shall be subject to customer/ BHEL approval during detail engineering. Accordingly, bidder 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.

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22	Bidder to provide sub vendor list and Bidder shall strictly adhere to customer approved vendor list (reference list is included in SUB-SECTION-D, Annexure-I). In case bidder proposes an additional vendor for an item or vendor approval is required for any new item, acceptance shall be subject to approval by customer/ BHEL before placing order and bidder shall submit relevant documents to take up with customer for approval. Bidder shall submit relevant documents as per Sub-Supplier Questionnaire provided in referred Annexure.		
23	It shall be the complete responsibility of the successful bidder 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. If any of the sub vendors does not have the approval of customer/ BHEL, the same may be replaced with another customer/BHEL approved sub-vendor only, without any price implications to BHEL.		
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 shall follow the procedures of inspection as per the approved QAP. Bidder has to submit the following documents along with inspection call and if any other documents required as per approved QAP. - Raw material inspection certificate - Internal test reports - Statutory certificates as required. - All inspection & testing shall be carried out based on the following documents: a. Relevant Standards b. Specifications c. Approved drawings d. Data Sheets e. Calibration certificate for all the measuring instruments		
25	During detail engineering, bidder to strictly adhere to BHEL/customer drawing formats, document numbering, quality plan & FQP formats		
26	The identification and numbering of equipment, systems, items, etc. of supply, as well as of all documents and drawings shall be in accordance with reference Designation System for Power Plants - KKS system.		

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27	Complete detail engineering drawings, calculations, selection of components etc. shall be reviewed & subject to approval of BHEL/Customer during detail engineering
28	Bidder shall furnish necessary inputs & drawings of all equipment in editable Auto CAD/ MS-Word /Excel format.
29	During detail engineering, successful bidder shall ensure flow of drawings/documents as per schedule. Any comments from BHEL/Customer should be addressed timely by the bidder.
30	Bidder to note above mentioned points not exhaustive and any work /items required for completing the smooth operation and ensuring satisfactory running of the machines till final hand over to the end user shall also be in the scope of the bidder.
31	Bidder shall provide design support to assist the Purchaser in efficiently integrating the furnished equipment. Design support specifically includes: a) Bidder 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. Further the packing shall be done in line with requirements mentioned in point no. 2 to 20 of this section. Imported Supply: All imported supply should be packed as per Sea worthy packing standards as per Sub-Section D, Annexure-V. 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.

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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's responsibility to investigate these limitations and to provide suitable packaging and shipping to permit transportation to site.
6	Packing (tare) shall be part of the equipment cost and shall not be subject to return. The packing should ensure integrity and cohesiveness of each delivery batch of equipment during transportation. In case of equipment assemblies and unit's delivery in the packing of glass, plastics or paper the specification of packing with the material and weight characteristics are to be indicated.
7	Each package should have the following inscriptions and signs stenciled with an indelible ink, legibly and clearly; a. Destination b. Package Number c. Gross and Net Weight d. Dimensions e. Lifting places f. Handling marks and the following delivery marking
8	Each package or shipping units shall be clearly marked or stenciled on at least two sides as per the dispatch instruction givens during the contract. In addition, each package or shipping unit shall have the symbol painted in red on at least two sides of the package, covering one fourth of the area of the side.

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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 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.

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16	Prior to transport from manufacturer's work to destination, components of the unit shall be completely cleaned to remove any foreign particles. Flange faces and other machined surfaces shall be protected by an easily removable rust preventive coating followed by suitable wrapping.
17	All necessary painting, corrosion protection & preservation measures shall be taken as specified in painting schedule. Supplier shall consider the coastal environment zone which is defined as "very severe" during final finishing/shipping.
18	Successful bidder shall furnish the detail packing /shipment box details with information like packing box size, type of packing, weight of each consignment, sequence no. of dispatch, no. of consignment for each deliverable item against each billing break up units/ billable blocks. Without these details the BBU shall not be approved during detail engineering.
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	SUPERVISION OF ERECTION, TESTING AND COMMISSIONING
1	The erection of Agitators will be done by owner as per Erection Manual and check List to be provided by the bidder during detail engineering. However, the bidder shall make visit as per enquiry/PO for the supervision of erection, pre-commissioning & post- commissioning check-up, start-up, testing and trial runs of all the items covered under the scope of supply & Services.
2	The bidder will be informed well in advance for the visit.
3	-VOID-
4	Price comparison for evaluating the lowest bid will be considered for all main supply, supervision of E&C charges and mandatory spares price all together along with the loading on account of guarantee power consumption (as applicable).

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5	Scope of Supervision by OEM for Erection & commissioning: Tentatively following visits shall be planned by site team which shall be as follows: - - Three visits (for all agitators) of 20 days each for supervision of erection, pre-commissioning & post- commissioning check-up, start-up, testing and trial runs of all the items covered under the scope of supply & Services. - Two visits of 10 days each (for all agitators) for performance demonstrations and handing over of system. - Any additional visit as per requirement of BHEL site office during erection of equipment.
6	Any other service required for making the installation complete in all respect within battery limits and for satisfactory erection & commissioning of the system shall be in bidder's scope.
8	EXCLUSION
	The following work associated with the Agitators will be by others: - Access, Walkways, platforms and ladders - Handling equipment (hoist) along with the handling arrangement. However, bidder shall provide the details of the same to BHEL. - Baffle plates - Installation, however, supervision of erection and commissioning shall be in bidder's scope
9	INSPECTION AND TESTING
1	The General inspection requirements to be considered are as below:
2	Bidder 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 shall furnish performance test procedure along with standard. The test procedure will be reviewed and approved by the BHEL/customer.
4	Since there is no standard for "Acceptance Test Procedure" for Agitator, Agitator manufacturer is to submit a test procedure and Quality Plan, clearly indicating that equipment will meet the desired parameter.

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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.		
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		

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	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 bidder's work, bidder 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. Please also 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, vendor 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.

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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 bidders
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.
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’s works before dispatch or where the test facilities are available.
17	The Bidder shall conduct performance test for the remaining Agitators and submit the reports.

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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 should furnish performance guarantee as per applicable standard guarantee for the design, manufacture, material and safe operation of the equipment's.
21	Bidder to arrange all calibrated gauges, Instruments during inspection.
22	Mechanical running and the performance test shall be carried out. Bidder 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-C, SUB-SECTION-C2-B).
2	Rust preventive paint after inspection at shop floor before dispatch shall be in bidder's scope.
3	Corrosion protection, coating and galvanizing, painting shall be taken care by the bidder. Bidder shall 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 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 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 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-II Annexure-7).

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11.1	START UP & COMMISSIONING SPARES
	Start-up & Commissioning Spares shall be part of the main supply of the Agitators. Start-up & commissioning spares are those spares which may be required during the start- up and commissioning of the equipment/system. All spares required for successful operation till commissioning of Agitator shall come under this category. Bidder shall provide an adequate stock of such start up and commissioning spares to be brought by him to the site for the equipment erection and commissioning. The spares must be available at site before the equipment's are energized. The List of such spares to be provided during bidding stage (SECTION-II Annexure-9).
11.2	RECOMMENDED SPARES
	Bidders shall also furnish the recommended spares list along with the offer required for 3 years of normal operation of the plant and should be independent of the list of the mandatory spares. Prices of recommended spares will not be used for evaluation of the bids. The price of these spares will remain valid up to 6 months after placement of Notification of Award for the main equipment.
11.3	MANDATORY SPARES:
	a) Bidder to quote for the mandatory spares as per the Mandatory Spare list (SECTION-I, SUB-SECTION-D Annexure-II). b) Bidder shall quote for the "Mandatory Spares Part List", and it will be considered for L1 evaluation. Mandatory spare parts items shall be handed over separately and shall not be mixed with the supply of the main equipment parts. Spares shall be sent in pre-decided lots in containers/secure boxes. All boxes/containers are to be distinctly marked in red color with boldly written "S" mark on each face of the containers. Spares shall not be dispatched before dispatch of corresponding main equipment's. Each item shall be labelled in English and be packed against damage and sealed to prevent deterioration from corrosion. The protection shall be sufficient for a minimum of 10 years' storage in a dry weatherproof building. 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

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I	Bidder'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 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 shall list at least three equivalent lubricants manufactured by alternative companies.
13	BID EVALUATION CRITERIA FOR POWER CONSUMPTION:
1.	POWER GUARANTEE Bidder 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 11 of Section-II.
14	LIQUIDATED DAMAGES FOR POWER CONSUMPTION
	Refer Annexure 11 of Section-II.

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15	PERFORMANCE GUARANTEE
	a) All performance tests for Agitators shall be carried out in accordance with any latest international codes/standards. b) Bidder shall furnish Performance guarantee for the design, manufacture, material, safe and trouble-free operation of the Agitators and its accessories c) The Bidder shall ensure a design of the equipment to achieve an average target availability of 98% for 120 days and average target availability of 95% for 1 year. 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 which shall be submitted for BHEL/ end customer approval. h) In the event that the performance test is unsuccessful, bidder shall take necessary remedial action at his cost and the performance test shall be repeated. For additional details of performance guarantee please refer ‘functional guarantee’ under Sub-section C2-A, Section-I.
16	DOCUMENTATION
A	DOCUMENTS TO BE SUBMITTED ALONG WITH THE OFFER
	The Bidder shall submit all documents, drawings, diagrams and all such information, which are necessary to fully understand the offer for techno – commercial Offer. Vendors are requested to comply with above in all respect. List of such documents have been indicated in (SECTION-II Annexure-1).
B	DOCUMENTS TO BE SUBMITTED AFTER AWARD OF CONTRACT

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	a) The Successful bidder shall submit necessary data, documents and drawings for review, approval as specified in this specification. Drawings that are reviewed by the end customer/ BHEL, will be returned to bidder with a transmittal letter with any comments and / or questions marked on the drawings or noted in the letter. All comments and questions must be resolved before a resubmission of drawings / documents. If the design has not developed enough to resolve some of the comments or questions, bidder shall place a “hold” on those items or areas of design. End customer/ BHEL reserves the right to return drawings unprocessed to bidder if there exists any evidence that bidder has not acknowledged all comments and questions. 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 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. Bidder to ensure submission of hard copies as per end customer requirement for all engineering drg/doc and for all subsequent revisions along with a soft copy through email to concerned project team. d) The list of such drawing/documents have been indicated in (SECTION-I, SUB-SECTION-D Annexure-IV).
17	LIST OF REFERENCE DRAWINGS BY BHEL
I	The document specified in Annexure-III, Sub-Section-D of Section-I are being provided along with the tender specification for estimation and calculation purpose of the bidder.

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CUSTOMER SPECIFICATION: PROJECT SPECIFIC GENERAL REQUIREMENTS



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PROJECT SPECIFIC GENERAL REQUIREMENTS GENERAL TECHNICAL REQUIREMENTS



VOLUME II
SUB-SECTION – 2.1
FLUE GAS DESULPHURIZATION SYSTEM

1.0.0 GENERAL

This section covers minimum requirements for design, engineering, fabrication, manufacture & assembly, inspection, erection, testing and commissioning of complete Flue Gas Desulphurization System and the auxiliaries.

2.0.0 CODES AND STANDARDS

The equipment to be provided shall specifically conform to the latest editions of the following codes, standards, specifications and regulations. Also the system design shall conform to the requirements of applicable codes as specified in the General Technical Specification.

IS 5120 / API 610 / HIS/

IS:8034 : Centrifugal Pumps

IS 1710 / ANSI / HI : Vertical Pumps

ASME B 31.1 : Power Cycle Piping

ISO 4427/4437/IS: 4984/

ASTM D3350 : HDPE Pipes

ANSI B 16.5 : Flanges (Upto 600 NB)

AWWA C 207 : Flanges (Above 600 NB)

ISO 7919 / ISO 10816 : Vibration

IS 9222 Part 1 : Chemical Handling Devices

OSHA : Occ. Safety Health Admin.

ISO 1996 : Noise Level

IS 7938 : Air Receivers for Compressed Air Installation

IS 4503 : Specification for small and tube type heat exchangers

TEMA : Standards of the Tubular Exchanger Manufacturers

Association IS 2825 Code for Unfired Pressure Vessels

PTC 9 : Compressor, vacuum pump and Blower

PTC 10 : Compressors and exhausters.

PTC 40 : Performance Testing for FGD

3.0.0 SYSTEM DESCRIPTION

The Flue Gas Desulphurisation (FGD) System shall be based on Wet Limestone Forced Oxidation process. The FGD system shall be installed downstream of the existing Induced Draft (ID) fans. The flue gas shall be drawn from air preheater outlets of the balanced draft, pulverised coal fired Steam Generator and guided through adequately sized duct work into the specified number of independent gas streams of Electrostatic Precipitator. The flue gas after the Electrostatic Precipitator shall be led to the suction of the ID fans.



During the normal operation the flue gas temperature at ID fan outlet shall be in the range of 130-140 deg C .The flue gas temperature may approach the economiser outlet temperature of about 300°C in case the regenerative air preheaters fails to operate. The Contractor shall take this aspect into account while designing the Flue Gas Desulphurisation (FGD) System.

3.1.0 Service Conditions

The existing Steam Generator is designed to burn pulverised coal having properties as indicated in Annexure-1.1, Vol.II Section 1 of General Technical Specifications. Also HFO/ HSD shall be used during startup and at low loads for warm up and flame stabilisation. Further, the frequency and duration for startup and low loads operation may be quite long during the first year of unit commissioning and operation..

The Steam Generator has been designed for cyclic/two shift operation. Expected numbers of Steam Generator start-ups during 25 years of design life are as follows:

S.No	Type of Starts	Number of Starts
1	Hot start (after 8 hours of unit shut down)	4000
2	Warm start (after 36 hours of unit shut down)	1000
3	Cold start (after 72 hours of unit shut down)	150

The Contractor shall take into account the entire characteristics of expected combination of fuels to be fired and the expected numbers of Steam Generator startups while designing the FGD system.

4.0.0 DESIGN CRITERIA

The Flue Gas Desulphurisation (FGD) System shall be designed to meet all the conditions specified above. Flue gas analysis for the expected coal are given in the General Technical Specification. The values indicated for FGD sizing in the technical specification shall be considered as minimum design criteria. These shall be modified to more conservative values if, Contractor experience warrants the same. However, no credit shall be given to the Bidder for this during evaluation of the bids. Utilization of these values in no way relieves the Bidder of his responsibility to meet all the guarantee requirements. The Bidder shall also furnish along with his offer the detailed calculations and data along with his Bid to establish as to how the Bidder will meet the efficiency requirements both at design and guarantee point as specified in FGD sizing criteria. The FGD system shall also be capable of operating with partial bypass of flue gas. Bidder shall submit with the offer a write-up highlighting the capability of operation of FGD system with partial bypass of flue gas and the range for operating in partial bypass mode.

The wet absorber system shall be designed to maintain the required SO₂ removal.

In order to be compatible to all possible modes of operation, the design of the FGD plant shall enable short start-up times, compatible with load changes in the Steam Generator and shall ensure reliable mode of continuous operation.

The flue gas desulphurization plant (FGD) shall be designed to be operated with limestone as specified in Section-1, Annex 1.4 of the General Technical Specification.

The FGD and the ancillary facilities shall be suitable for unlimited operation with all transients and at any load point between the minimum and maximum load point of the Steam Generator. Further, the FGD plant shall be suitable for an unlimited operation at any pollutant



concentrations between minimum and maximum without exceeding the emission values of SO₂ emission of less than 100 mg/Nm³ (6% O₂ dry).

In case of failure of the SG and ancillary equipment, the FGD plant shall be brought automatically to the off-load operation without restriction by the current load case by suitable measures.

In case of a power failure all items of equipment (minimum one agitator in absorber and limestone slurry tank, process water pump & lube oil system of booster fan & ball mill) which may cause irreversible damage to the FGD System shall be connected to the emergency power supply system to be provided by the Contractor. Bidder shall furnish a list of all of all such Auxiliaries in their bid proposal.

In case of shutdown and outage periods, draining and flushing of limestone slurry and gypsum slurry pipe work, tanks and all other items being in contact with limestone slurry or gypsum slurry shall be possible without restriction and without necessity of extensive or unusual preparation and activity. Draining and flushing which are required even during short time outages or an emergency shutdown shall be started automatically and by remote control from the Control Room.

All items or equipment which are subject to wear, abrasion or failure (e.g. nozzles, pumps, pipe work, etc.) shall be designed and installed for easy replacement, repair and maintenance.

The design and the construction shall be performed so as to avoid stress corrosion cracking, galvanic or other types of corrosion. Especially when using two different alloys, appropriate measures shall be taken to avoid corrosion. This is subject to approval by the Employer.

All items of equipment including flue gas ducts, expansion joints, etc. shall be designed considering thermal and mechanical strength as a function of the maximum temperature which might occur in case of a failure of any upstream equipment.

Waste water which might be generated during flushing and cleaning procedures of the equipment (e.g. lime slurry bins, pipes, trucks, etc.) shall be collected in sump and shall possibly be reused in the wet absorber.

In case distance from Limestone Grinding system/ Gypsum Dewatering and Absorber is more than 500M, Bidder shall provide the following:-

Flushing system at intermittent locations for the lime stone slurry pipeline which shall contain tank and pumps. Intermittent location distance of flushing system shall be based on their proven practice

4.1.0 Justification of Proposed Design

All the design procedures, systems, and components proposed shall have already been adequately developed and have demonstrated good reliability under similar or more arduous conditions elsewhere.

Booster Fans, Slurry Recirculation Pumps, Oxidation Blowers, Wet Limestone Grinding Mills, Slurry Pumps, Agitators, Vacuum Belt Filters, Gas to Gas Heat exchanger (GGH) & Booster Fan Motor for the Wet Limestone based Flue Gas Desulphurisation (FGD) System offered by the Bidder shall be only from such manufacturer(s) who has previous experience of manufacturing and supplying the respective equipment(s) and have been in successful operation in at least one (1) plant for a period not less than one(1) year prior to the date of Techno-Commercial bid opening



The Bidder shall submit with the offer, comprehensive information on how the L/G ratio, mass balance, spray nozzle cone angle, spray nozzle arrangement; limestone consumption etc. of the proposed design has been arrived at. The Bidder shall also submit along with the offer, a detailed write up on the proposed design features with recent design modifications, if any, and their specific advantages over the previous designs.

4.2.0 Statutory Approval

The engineering, design, supply and installation of FGD system and the associated auxiliaries shall comply with the applicable safety code and regulation of the locality where the system is being installed.

4.3.0 Location & Layout Requirements

The Bidder shall offer the best design to accommodate the Flue Gas Desulphurisation (FGD) System and Lime stone & Gypsum handling & storage system within the confines of the space available.

Approach road to every entity, facility, building etc. shall be provided by the contractor. Sufficient maintenance space to be ensured for FGD auxiliary by the contractor.

Fouling of the FGD structure with functioning of existing auxiliaries/structure shall be avoided.

The layout of FGD System have been indicated in the tender drawings No. FCE-1116127-GE-DWG-LAY-3000-001. The layout indicated is only for the purpose of the tender, Bidder shall consider necessary facilities required for the system in the available area allocated for the FGD, any interface with the existing shall be taken care by the Contractor without affecting the existing systems. Any relocation of the existing system (if required) shall be discussed and based on which a proposal shall be submitted and take the necessary approval from the Owner before execution of such changes.

Capital Overhaul of FGD System

Employer envisages to carryout the capital overhaul of units once in three (3) years. The design and materials for various equipment/auxiliaries etc. shall be selected by the Contractor keeping in view the above requirement of the Employer, such that no major repairs/replacements, requiring shutdown of the unit, are needed in between the capital overhauls.

4.4.0 Approach & Handling Facilities

Proper approach shall be provided for access to all equipment during normal operation and maintenance. Unless otherwise specified, platforms, staircase and ladders shall follow the stipulations specified elsewhere in this specification.

Equipment requiring monitoring during regular operation shall be approachable from the ground floor through staircase. Staircase with minimum width of 1200 mm shall be provided for approach to elevated structures at 5m height from the nearest platform. Below this height a vertical ladder with minimum clear width of 600 mm may also be acceptable.

Platform with a minimum clear width of 1000 mm shall be provided all around the lowest absorber spray levels and mist eliminators. Similar platforms shall be provided at subsequent elevations if they are more than 3000 mm apart from each other. An adequately sized manhole with platform (min. 2 sq. m) shall be provided above each spray level. Ladders/staircase shall be provided for the access to the platform.



The absorber slurry recirculation pumps, gypsum bleed pumps and limestone feed pumps shall be mounted on the ground level. Suitable approach and platforms shall be provided for all the valves required during regular operation.

A 1500 mm space shall be provided around all pumps, except absorber recirculation pumps, where a 2000 mm space shall be provided.

Platform with a minimum width of 1500 mm shall be provided all around the pulverizers and feeders. Approach along with suitable platforms shall be provided for ball loading hoppers. A 1000 mm wide platform with suitable approach shall be provided around each hydro-cyclone.

A 2000 mm wide floor/platform shall be provided all around each belt filter.

The regular basement floor is not acceptable in FGD area. Further local Pits/trenches shall be avoided as far as possible.

Handling arrangement of milling system, Booster fans, Slurry recirculation pumps, oxidation blower, belt feeder system etc. complete with crane/monorail along with removal space for maintenance shall be provided by the Contractor.

Approach for removal of equipment for maintenance shall be provided.

All other safety requirements as per the Factories Act, National Electricity code shall be complied with while developing Layout.

Cable trenches/slits, if unavoidable, shall be provided with adequate cushioning of sand and the same shall be covered with PCC.

Each Equipment room shall be provided with alternate exits in case of fire/accidents as per requirements of Factories Act and Statutory bodies/insurance companies.

Minimum Headroom (free height) under all floors, ducts, walkways and stairs shall be 2.50 M.

Inter-connecting pipes/cables between various facilities of FGD plant shall be routed on the steel trestles to be provided by the Contractor. The clear head room for the same shall be minimum 8 M.

4.5.0 Maintenance

The Contractor shall provide adequate handling facilities & approach as for carrying out on-line and off-line maintenance of the FGD system and its auxiliaries. In order to carry out on-line maintenance, it shall be possible to readily disassemble, repair and reassemble the equipment supplied in the shortest period.

4.6.0 Noise level

The equivalent weighted average of sound level measured at a distance of 1.5 m above floor level in each elevation and one meter horizontally from the base of any equipment furnished and installed under these specifications, expressed in decibel shall not exceed 85 dB(A).

5.0.0 FGD PLANT EQUIPMENT SPECIFICATION

Specified hereafter are the minimum acceptable functional requirements of the Employer, and all components, equipment and systems for the Flue Gas Desulphurisation System shall be designed to cater to these requirements. Compliance to various stipulations of the Technical Specifications, functional requirements of Employer and utilization of various parameters and their values in the specification by the Bidder shall in no way relieve the Bidder of his



responsibilities to meet all guarantee requirements or of providing completely safe and reliable operating equipment/systems.

The complete FGD system and the associated auxiliaries shall be designed by the standard industrial practices. The FGD system shall be designed to achieve the required SO₂ capture without the use of oxalic acid or any other additives. Only field proven materials for similar application shall be used for the system. The complete installation of liners shall be made under the supervision of the liner supplier as per their guidelines. In the execution of the welds contractor must ensure that welding material has same corrosion resistance as the actual plate surface.

Alloy to carbon steel welds must either be hidden behind a covering strip of alloy material, and be executed by a special welding procedure ensuring the same quality at the weld surface as the alloy lining. All welding which shall be in the contact with process fluids shall be executed under the supervision of the designer/manufacture. The Flue Gas desulphurization shall be limestone based. The FGD shall be sized for 100 % of the Flue gas flow. The efficiency of SO₂ removal shall be minimum 95.0%.

The inlet duct shall be tapped from the outlet ducts of ID fans and transferred to a common duct. The flue gas shall be passed through the Absorber. The absorber inlet duct shall be made of Carbon steel of minimum 7 mm thickness.

The flue gas desulphurization system shall be designed for the process data furnished at Annex 1.2 of Section 1 and Annex 2.1.1 of this section.

5.1.0 Absorber

The Bidder may offer either a spray type absorber, with single or multiple levels of spray, or an absorber with gas bubbling through the slurry, as per his proven practice. Only proven system in successful operation in previous installations supplied by the Bidder shall be offered.

A Spray System (if offered)

- i) The Bidder shall provide spray system and minimum spray levels required to meet the stipulated guarantee and design requirement. The spray system (including slurry recirculation pump & nozzles) shall be sized to achieve a desired L/G ratio required to meet the guaranteed SO₂ removal efficiency, with redundancies specified under this clause.
- ii) In case the Bidder offers an absorber with multiple levels of spray nozzles, each spray level shall be provided with independent 2x100% pumps. Alternatively, the Bidder may offer a spare spray level with each spray level served by an independent 100% capacity pump. In case the Bidder offers a single level of spray, one number of standby pump of the same capacity & head as the working slurry recirculation pumps shall be provided. The Bidder shall provide spray system / spray levels only as per his proven practice, which should be in successful operation elsewhere.
- iii) The slurry recirculation pumps shall have a minimum margin of 10% of flow and head, over the actual requirement for meeting the guarantee and design point conditions.
- iv) The slurry recirculation pumps shall be wear-resistant and equipped with flushing devices to prevent sedimentation and shall be designed and installed in a manner to allow easy replacements, repair and maintenance. The slurry recirculation pumps shall be equipped with oil level indication, coupling guard and collecting equipment for leakage, made of resistant material. Single mechanical seals with automatic flushing with a connection for additional manual flushing shall be provided.



The slurry recirculation pumps shall have motor driven knife gate valve at pump suction and discharge side. In order to optimise power consumption of FGD system at part load operation, Bidder to provide atleast one slurry recirculation pump preferably lower level with Variable Frequency Drive (VFD).

- v) The slurry pumps shall comply with the requirements stipulated in this section.
- vi) Sufficient redundancy, as per the proven practice of the Bidder, shall be provided in the spray nozzles. Minimum 10% spare nozzles shall be provided at each level. Bidder to furnish the calculation and drawing supporting the provided 10% spare nozzle during detailed engineering, for Owner/Consultant's approval.
- vii) The Absorber shall have suitable access /inspection doors and shall have suitable approach to access all the internals.
- viii) The complete absorber vessel (absorber oxidation tank, absorber tower & absorber outlet duct up to absorber outlet flange including sump) shall be made of clad sheet of C276/Alloy 59 (minimum 2 mm thick) by explosion bonding or hot rolling, having minimum 7 mm thick carbon steel as base material.
- ix) The lining material shall be guaranteed for an uninterrupted minimum life of 25 years.
- x) All internal members shall be with minimum 2mm Alloy 59/C276. All metallic fasteners provided inside the absorber/ absorber wet-dry interface ducting shall be of Alloy 59/C276.
- xi) The absorber wet-dry interface shall be of solid Alloy 59 or C276 of minimum 6 mm thickness.
- xii) The other bridges/supports shall be lined with minimum 2 mm Alloy 59/C276.
- xiii) Centrifugal/ Screw type slurry re-circulation pumps shall be provided for circulating the slurry to the Absorber. The Pumps shall have 10 % margin on Capacity and Head. The pumps shall be provided with suction strainer and flushing arrangement with high pressure fresh water for cleaning purpose.
- xiv) Compressors/Blowers shall be provided for the oxidation of the calcium sulphite salt to gypsum. Necessary sparger, injectors, nozzles, piping and valves etc as required for the complete operation of the system shall be envisaged.
- xv) The absorber shall provide with adequate (1Working+1 Standby) compressors/Blowers. This shall be designed to load based on demand with 2.5 times and 4.5 times the theoretical requirement for spray type and jet bubbling type respectively. Oxidation nozzles / spargers shall have a minimum redundancy of 10% or as per the contractor's proven practice whichever is maximum.
- xvi) Absorber unit shall have (1W+1S) centrifugal/Screw type bleed pumps.
- xvii) Process water tank with a capacity of 24 hrs requirement of FGD system shall be provided. The tank level shall be controlled by control valve with isolation valves.
- xviii) 2 x 100 % process water transfer pumps shall be envisaged for the preparation of the lime slurry. The Pump House shall have adequate material handling facility, maintenance space.



This pump shall take the suction from the Process water tank and pump the water to the limestone slurry preparation tank. The slurry preparation tank shall be IS 2062 construction with replaceable chlorobutyl/bromobutyl rubber lining of minimum 4 mm thickness

- xix) An emergency cooling system for automatic spray of quenching water for a sufficient time (minimum 15 min) at the inlet to the absorber, in case the gas temperature exceeds the design temperature due to failure of upstream equipment's shall be provided to protect the FGD and all other sensitive downstream equipment against high flue gas temperatures. The water shall be supplied from an elevated tank (emergency water tank) installed near to the absorber. The tank volume and the injection lances/nozzles shall be designed to protect the inlet duct and the lining of the absorber. The inlet duct shall be sloped towards the absorber
- xx) Provision shall be made for facilitating operation of unit with FGD bypass. This shall also facilitate the online maintenance of absorber system and associated equipment.
- xxi) Sufficient number of agitators, as per the proven practice of the contractor, shall be provided for thorough mixing of the re-circulating slurry. The contractor shall offer and demonstrate mixing arrangement such that n-1 number of agitators is sufficient to avoid the slurry settlement in the absorber tank in case of one agitator under breakdown (n-total no. of working agitators). In case vertical agitators in Absorber are offered, one complete mechanical assembly of agitator shall be supplied as warehouse spare for Absorber.
- xxii) The absorber oxidation tank shall be provided with an over flow line complete with sealing pot, over flow and drain line. The absorber over flow shall be taken to a sump in the absorber region, from where the slurry shall be pumped back to the absorber and Emergency slurry tank by a sump pump
- xxiii) It should be possible to build platforms inside the absorber for access to all parts of the absorber during maintenance. In case the contractor offers a multiple spray level design, minimum distance of 1.5 m shall be maintained between individual spray levels. Arrangement shall be properly designed to facilitate access for maintenance and replacement of spray nozzles.

B Bubbling Type Absorber

- i) In case the Bidder offers a bubbling type absorber, the gas distribution system shall be sized with sufficient margin for choking of nozzles/holes.
- ii) In case the bidder offers an absorber with gas bubbling through the slurry, the complete gas distribution system to the slurry shall be in bidder's scope. No recirculating pump and spray header and nozzles shall be required in such case.
- iii) However, 2x 100% Cooling Pumps instead of Slurry Recirculation shall be provided.
- iv) The spray headers & piping for cooling pump discharge shall be made of Alloy 59 or C276 and nozzles shall be made of Silicon Carbide or ceramic or equivalent having a minimum guaranteed life of 20,000 hrs. The Cooling Pumps shall be installed inside a building.
- v) The sparger and gas riser tubes shall be made proven material which shall have a minimum life of 5 years.



Minimum 10% redundancy, shall be provided in the Sparger Tubes.

- In case of Spray Tower System, Suction In case of Spray Tower System, screens shall be installed inside Absorber vessel to protect the recirculation pumps. In case Bubbling type suction strainers shall be installed at the suction line side of Gas Cooling Pumps. The Screens shall be made of Alloy 59 /C276 or abrasion resistant FRP/Polypropylene (in case Contractor/Collaborator has proven experience). For the agitators a flushing system for startups shall be provided.

C Design

The design and arrangement of the absorber shall be field proven for successful long-term operation in conjunction with a coal fired power plant.

The design of flue gas ducts and inlet and outlet hoods of the FGD as well as guide vanes and baffle plates shall ensure a homogeneous flue gas flow with respect to the distributions of:

- (i) temperature
- (ii) velocity
- (iii) dust content
- (iv) slurry injection and distribution.

The above shall be proven by two phase Computational Fluid Dynamics simulations (liquid and gas). The scope of modelling shall include flue gas path inside the absorber vessel including inlet and outlet duct. Homogeneity shall be ensured, if the deviation from average is less than, +/- 10%. Further, in the Absorber outlet hood no internals such as guide vanes and baffle plates shall be allowed.

The fabrication of the absorber vessel shall follow common practice as there shall be no longitudinal seams located behind any attachment or obstruction which would prevent inspection of the welds. Nozzles, access ways, and their reinforcements shall not be located in or on any seam. Inaccessible gaps or hollow beams shall be avoided.

The absorber shell shall be designed for pressure loads, piping forces and moments, wind and seismic loads and all other loads imposed on the absorber. Bracing and reinforcement shall be adequate to prevent deflection and vibration. Internal supports for mist eliminator sections, etc. shall be designed to withstand the flooded weight of the supported section. The absorber and its structural supports shall be designed for the maximum operating loads including design positive & negative internal pressure, static head, external attachment loads (such as exerted by piping) wind load using the allowable stresses permitted by the applied standards.

It shall be possible to reach the SO₂ emission guarantees, at Guarantee point condition, with at least one spray level continuously out of service (in case the absorber is equipped with several spray levels) or one spare pump continuously out of service.

Three stage chevron type Mist Eliminators (ME) made of polysulf one or stainless steel shall be provided at the exit of the absorber. Provision shall be made for continuous washing of both ends of the first & second stage and the front section of the third stage of mist eliminators. Wash water arrangement shall also be provided at the back end of the second stage of mist eliminator. If the mist eliminator washing system is designed for cyclic washing of different sections, all the valves required for cycling shall be motorized or pneumatically operated. The automatic valve for the spray system shall be easily accessible on a platforms close to the mist eliminator. Entrained slurry shall be collected by mist eliminators downstream of the slurry spray system to avoid carry-over of slurry to the stack.



The ME system shall be equipped with washing and drain provisions, where drains are directed into the absorber. Washing provisions shall include external and internal piping systems with replaceable nozzles, water pressure booster pumps (if required) complete with all piping, valves, instrumentation and controls. The mist eliminator wash piping/header shall be constructed of rubber lined carbon steel or glass fiber reinforced plastics. Polypropylene or PVC is also acceptable for mist eliminator wash headers provided Contractor or its Collaborator has proven experience for the same. Ease of replace ability and placement of the mist eliminator on maintenance platforms is an important requirement. The ME shall be designed to allow for efficient cleaning in process. Test ports shall be provided downstream of the mist eliminator to enable performance testing.

The mist eliminator system shall be capable of withstanding high velocity spray water jets typically employed during manual cleanings. The ME shall be constructed in individual cells. The design shall safely avoid ME vibration and/or humming. The individual cells shall be sized so that no more than two maintenance personnel are needed to handle them manually when they are fully scaled or plugged, and the cells shall be capable of passing through the access doors for the mist elimination section. Easy access for placement and replacement of the mist eliminator shall be incorporated in the design of the mist eliminator arrangement and the absorber vessel.

Walkways shall be arranged and also measures shall be taken as appropriate to permit the internal components to be disassembled and reassembled during repairs without the necessity for time-consuming preparatory work. The headroom shall have a height of more than 2200 mm. The mist eliminator support beams shall be designed to act as maintenance walkways approximately 300 mm wide and shall allow for a minimum 500 Kg/m² load. The support beam/walkways shall provide personnel access to all mist eliminator modules, wash headers and wash nozzles.

Adequate number of viewing ports with flushing devices connected to automatically operating washing system shall be delivered at following locations:

- (i) upstream of 1st stage
- (ii) between 1st and 2nd stage
- (iii) downstream of 2nd stage.
- (iv) downstream of 3rd stage

The regular flushing shall be done in a defined time sequence.

A washing spary system along with pump and accessories shall be provided to wash down the mist eleminator element surfaces and therby prevent any deposit buit up on them.

The absorber oxidation tank shall be provided with an over flow line (for spray tower process) complete with sealing pot, over flow and drain line. The absorber over flow shall be taken to a sump in the absorber region, from where the slurry shall be pumped back to the absorber by a sump pump.

Materials used shall be suitable for the chemistry of the absorber process and resist abrasion from any particulate contained in the incoming flue gas and from the particulate of desulphurization process.

All equipment located in the gas path or connected to such equipment shall be designed to withstand the maximum inlet gas temperature fluctuations. There shall be no damage whatsoever to any equipment as a result of these fluctuations.

The raw gas inlet duct of the absorber shall be equipped with a flushing device of the side walls and the ground, which shall operate continuously as well as intermittently. The complete absorber vessel (absorber oxidation tank, sump tank, absorber tower & absorber outlet duct upto absorber outlet flange) shall be made of clad sheet of C276 / Alloy 59 (minimum 2 mm



thickness) by explosion bonding or hot rolling, having minimum 7 mm thick carbon steel as base material.

The material of process equipments of flue gas desulphurization system shall be appropriate for the chloride content and pH level at which the process is to operate.

All internal members shall be lined with minimum 2 mm Alloy 59/ C276. All metallic fasteners which are provided inside the absorber/absorber wet-dry interface ducting shall be of Alloy 59/ C276.

The absorber wet-dry interface shall be made of solid Alloy 59 or C276 of minimum 6 mm thickness.

The other bridges (supports) shall be lined with minimum 2 mm Alloy 59/ C276.

Lining material and technical application requirements shall be furnished by manufacturer experienced with similar FGD plants. Proof of such experience shall be provided by the Contractor.

The spray headers (if provided) and air supply headers shall be made of FRP or Carbon Steel with rubber lining (minimum 10 mm natural rubber lining), corrosions and erosion resistant in the inner and outer side (Silicon Carbide coating on metal/FRP surface exposed to slurry). Optionally ceramic coating is also acceptable provided bidder/Collaborator has proven experience for the same. The slurry spraying system shall be made of material resistant to erosion and corrosion. During the lifetime of the plant, only the nozzles shall be replaced. The distribution system of the slurry shall be hydraulically optimized. The spray nozzles shall be of silicon carbide or ceramic or equivalent having a minimum guaranteed life of 20,000 hrs. The design of the spray nozzles shall be such that rapid wear, encrustation and plugging are avoided. Nozzle pipes and slurry spray nozzles shall be with bolted flanged connections. Nozzle pipes shall be installed easily to be removed partially through absorber modules.

In case the absorber is equipped with several spray levels they shall be designed as follows:

- (i) For spray type Absorber, the last spray level upstream the mist eliminator shall be operated only in counter-flow.
- (ii) Depositions at downstream spray level and mist eliminator by co-flow injection of slurry shall be avoided.
- (iii) The spray lances shall be equipped with bars for installation of scaffolding without any offset. The spray levels shall be designed for a load of min. 500 kg/m².
- (iv) A flushing device of the spray levels with water shall be installed. Flushing shall take place if spray levels are out of operation.

The absorber shall be self-supported from the bottom to suit site conditions. Absorbers which are externally supported from the structure are also acceptable provided Bidder or its Technology Collaborator has proven experience of supplying such Absorbers which are operating for more than 5 years. The absorber shall have adequate stiffening arrangement on the external side. Internal stiffeners shall be used only where it is not possible to provide proper external stiffening with approval of employer.

It should be possible to build platforms inside the absorber for access to all parts of the absorber during maintenance. In case the contractor offers a multiple spray level design, minimum distance of 1.5 m shall be maintained between individual spray levels. Arrangement shall be properly designed to facilitate access for maintenance and replacement of spray nozzles.



The spray piping, mist eliminators and its supporting structure shall be designed to carry sufficient load during maintenance.

The bottom of the absorber sump shall be designed so that there will be an easy entrance for a man with a wheelbarrow. Therefore the arrangement and dimensions of the inspection door of the absorber at ground level shall be designed to allow for this. The bottom of the absorber sump shall be designed in such a way that complete drainage of the absorption liquid/slurry is possible and is accessible without damage of lining.

In case of Spray Tower System, Suction screens shall be installed inside the Absorber vessel to protect the Slurry recirculation pumps. In case Bubbling type, suction strainers shall be installed at the suction line side of Gas Cooling Pumps. The Screens shall be made of Alloy 59 /C276 or abrasion resistant FRP/Polypropylene (in case Contractor/Collaborator has proven experience). For the agitators a flushing system for start ups shall be provided.

It should be possible to discharge the absorber sump into the Emergency slurry tank within 2 hours.

At the head of the absorber two manholes shall be provided to reduce the draught of the stack during outage.

Equipment's required for internal & external inspection shall be furnished by the contractor in brand new condition. List of all such items shall be furnished along with the Bid. The formation of agglomeration, deposition & caking shall be avoided. For areas, where this might occur, (e.g. mist eliminators, spray levels) the Contractor shall submit a cleaning procedure including the required safety measures as part of the inspection concept.

5.2.0 Gas to Gas Heat Exchangers

5.2.1 Type

The GGH shall be vertical shaft Rotary Regenerative with rotating matrix, with carrier fluid circulated by natural circulation or by circulation pump, if it is the bidder's standard practice.

The Bidder shall supply the system which is already proven and shall be in satisfactory operation in Power Plants of similar capacity.

As a minimum requirement GGH shall have the following :

- Two (2x100%) peripheral AC drive connected to drive GGH along with automatic clutching/declutching arrangement
- One (1x100%) Independent air motor drive along with automatic clutching/declutching arrangement.
- Air receiver with storage capacity which can facilitate not less than 10 minutes continuous operation of air motors.
- Piping and fittings, air filters, regulators including suitable solenoid valves for automatically admitting air for starting air motors in case of power failure, pressure transmitters on airline to air motor(s) etc.
- GGH stand still sensing device with necessary logic components, accessories and indicating lights, housed in the enclosure. The motions to be precluded at appropriate location of the rotor shaft.
- Permanent fire-fighting equipment on both gas as well as airsides and also on both cold as well as hot end sides including, spray nozzles, valves and pipe work connected to firewater system.



- Thermocouple type fire sensing devices complete with accessories.
- Dust hoppers with bracing, stiffeners, supporting structure, baffles, access door, matching flanges, expansion joints, RF type ash level switches (for high & low level) etc., and suitable approach platform for each hopper & ash level switches.
- Oil carry over probe for detection of oil during oil firing for GGH.
- Off load water-washing facility alongwith water supply pipe work (water to be tapped from service water system) & drainage piping to connect drains from air heater to the nearest station drains.
- Adequate number of thermocouples or platinum resistance temperature detectors (RTD) for measuring cold and hot end bearing metal temperature for interlock, protection and monitoring shall be provided..
- Forced lubrication system for bearing of each air heater shall be provided and shall include two (2) x 100% capacity oil pumps with motor, two (2) x 100% oil coolers, two (2) x 100% oil filters etc.
- Any other equipment/accessories/instrument etc., to make the system complete for reliable and safe operation.

5.2.2 Design Requirements

There shall be one (1 no.) Gas Heater at the inlet to the absorber.

The GGH shall be sized to achieve a minimum cold gas exit (stack inlet) temperature of 100° C under the Guarantee Point conditions.

The sizing the Gas-Gas Heater shall be sufficient to maintain a stack Inlet Temperature of 80° C even at 50% TMCR with the range of coals specified without considering any leakage through the GGH.

The above temperatures shall be uncorrected i.e., without considering any leakage through the GGH.

The design of the GGH shall ensure that leakage through the seals does not exceed 1.5% of the hot gas inlet flow from 50% TMCR to 100% BMCR. For this purpose, On line Automatic leakage control system shall be provided.

Seal air fans shall be provided to minimize the leakage across the seals. 2x100% seal air fans with motorized isolation gates at the discharge of each fan shall be provided. The above leakage shall be guaranteed by the bidder and demonstrated after 3000hrs of operation. No shut down or internal adjustment of the seals shall be permitted during the above period.

The gas tight rotor housing and all internal equipment shall be designed and constructed, as a minimum, for the defined life and conditions, including the effects of corrosion and erosion. The design shall minimise leakages and pressure drops and shall avoid ledges, pockets and crevices. Thermal expansion under all operating conditions shall not result in adverse distortion, fouling or tilting.

5.2.3 Heat Transfer Surfaces

Rotary Gas Heater shall be of rotary regenerative type with bisector arrangement and vertical axis of rotation. The bisector modular rotary gas heater shall be with easy maintenance & replacement provision. The material of construction of the internals of the Rotary Gas Heater shall be selected to meet the corrosion and temperature resistant properties required during operation & shutdown conditions. The elements are to be coated with enamel to withstand the operating conditions of the GGH.



The corrosion allowance shall be suitably selected for the gas composition provided for desirable corrosion life. Cold end elements shall be easily replaceable without disturbing other convection heating surfaces. Supplier shall incorporate full details of the measures proposed for mitigating corrosion of heating elements along with anticipated life of heating elements, which shall in any case not be less than 50,000 operating hrs. All element sections shall be basketed with heating elements, which shall be removable in groups and serviceable. Baskets should be reversible type. The necessary element removal gear shall be provided. The typical speed of the heat transfer rotor shall be 3-4 rpm. However, it will be finalized based on the vendor recommendation to minimize the leakage of Gas. The pressure drop across the heat transfer surface shall be within 150 to 200 mmwc. The sealing system for limiting the untreated gas to treated gas leakage shall be of proven design and type. Sootblower(s) shall be provided to permit thorough cleaning with the rotary gas heater remaining on-line.

5.2.4 Cleaning system

GGH cleaning shall be possible with water , air and steam . The cleaning air shall be from the compressed air package and the source of cleaning water shall be from process water. Soot blowers shall be provided to clean the Rotary Gas Heater on line & off line, Soot blowers should be capable of cleaning entire cross section of baskets.

The low pressure steam is available as indicated in the terminal point The minimum continuous period of operation without manual cleaning or any other maintenance shall be 12,000 hrs.

The heat transfer elements shall be arranged so that fouling and increased pressure drop do not occur during routine soot blowing. They shall also be self-draining and suitable for water washing.

A bottom hopper along with a drain line shall be provided for this purpose. The flow rate for the water washing lances shall be controlled by equipment supplied by others. The auxiliary driver(s) shall be fitted with facilities for remote and automatic operation in the event of failure of the main driver. All bearings shall have adequate arrangements for lubrication and shall be dust proof.

The wash water from GGH shall be collected in settling pond and pumped to the existing coal settling pond.

5.2.5 Shaft and Bearing Assembly

The rotor shaft shall be mounted on oil cooled and lubricated bearings suitable for radial and thrust loads. The bearing system is to operate under forced lube oil system. Under continuous operating condition of the rotor, supporting the rotor should be trouble free. The vibration levels is to be within normal limits as per standards. The system should permit easy dismantling & assembly of shaft & bearings. The rotor arrangement sketch along with rotor mounting & heat transfer surfaces fixing details is to be furnished. The lube oil system should be easy to access and maintain

5.2.6 Seals

The design and construction of the seals shall be such that seals can be easily replaced. The seals shall be made of special wear resistant material so as to avoid frequent seal replacement.

The design shall also incorporate arrangements for external adjustment of seal clearance.

**5.2.7 Accessories**

The Rotary gas heater shall be equipped with air-operated motor. This provision shall be required during power failure & rotating during maintenance. However, this aspect shall be finalized during the finalization of the equipment. In case of air operated motor requirement, standalone air receiver tank, volume of which shall be equivalent to 10 minutes of operation of rotary gas heater is required. The arrangement provided with air motor drive shall facilitate inching operation of rotating parts/ motor to enable carrying out maintenance works, adjustment of seals and replacement of heating elements. The supplier will make arrangement for supply of compressed air to the air motors. A hand operated crank shall be supplied to turn the rotor slowly without electric or air drive in the event of failure of both devices. Required quantity & quality of air shall be taken from the proposed Compressed air package.

The gas heater shall comprise of ducting, actuators; primary sensing devices; local instruments and all accessories required for a complete unit for safe operation.

The supplier's equipment must comply with the Noise & Vibration requirements in the Data Sheet(s). External insulation, the fixings and cladding are all in the supply of others. Unless otherwise stated, all equipment shall be supplied finish painted in accordance with the specification standards.

5.2.8 Piping

The General Piping requirements to be considered are as below:

All tubing, valves, piping and pipefittings forming an integral part of the rotary gas heater shall be provided. All integral piping shall be of carbon steel as per ASTM specification A 106 Grade B.

All flanges shall be of forged steel as per ASTM specification ASTM A 105. Dimensions, facing and drilling shall be as per ANSI B 16.5. Raised face flanges with serration shall be provided. Butt weld fittings shall conform to ANSI B 16. 9, for NB 50 and above. Socket weld fittings shall conform to ANSI B 16.11 for 40 NB and below. Carbon steel fittings shall be of forged type as per ASTM specification A105.

5.3.0 Flue Gas System

The entire flue gas system including flue gas ducts, absorber etc. shall be designed to meet the following conditions:

1. Design internal pressure at 67% yield strength (mm wc) $\pm$ 660 and – 150 mmwc or maximum conceivable head of Booster Fan, whichever is higher
2. Design Inlet Gas Temperature (deg.C) : 150
3. Inlet Dust Burden in Gas (mg/Nm³) : 200
4. Maximum flue gas velocity through the Absorber (M/sec) : Not more than 4.0 m/s at Design Point Conditions
5. Short temp excursion temperature of inlet gas (for approx. fifteen (15) minutes at a time) (deg. C) : 300
6. Recirculation Slurry pH : Not less than 5.5 under all operating Conditions



An adequate number of interconnecting, isolating and control dampers with drives shall be provided on all seal air and flue gas ducting before and after equipment on these systems to permit proper operations. All dampers shall be fitted with means for local manual operation with a graduated indicator limit switches for open and close position and designed to be retained in any position. All dampers required for control during start-up, normal operation and shutdown and for the sequential interlocking of fans and flue gas supply shall be electro actuated, and shall be arranged for remote operation and for manual operation.

Wherever necessary a series of sampling, measuring and test points shall be arranged in the flue and ducts in approved positions. Means shall be provided for measuring the total flow rate.

Expansion joints shall be provided with internal plates to prevent turbulence or deposition of dust in the joints. Gas flues ducts shall be welded construction of plates, suitably stiffened by means of angles, tees or flats secured to the outside.

Wherever required, expansion joints of proven design shall be provided in the ducts to take care of differential expansion in the system. The material chosen for expansion joints shall be suitable for the duty conditions and the corrosive atmosphere of the FGD system and shall be field proven for similar applications. The expansion joints shall be guaranteed for faultless material and workmanship, for a minimum guaranteed life of not less than 20000 hrs. of operation. During Guarantee period any defects noticed in the expansion-joints due to faulty material and workmanship shall be rectified by the Contractor free of cost.

The duct work is free to expand, but are rigid against wind and seismic disturbances.

The duct layout shall ensure that there is no accumulation of acid mist on the duct floor. The absorber outlet duct shall not have any horizontal section for this purpose. Adequate provision is made for all expected expansions or contractions.

All ducts shall be designed to minimize resistance to gas flow and to give good distribution of flow particularly to Absorber.

All necessary inspection access, observation and cleaning doors shall be provided. These doors shall be perfectly gas tight under all working conditions. Each inspection door has to be equipped with observation flaps which can be opened and closed without any tool. The inspection doors have to be provided for inspection of each heating surface at flue gas inlet and outlet.

All ducts with operating temperature above 60 °C shall be insulated.

In general, flue gas ducts shall be interconnected by welding. Only in places where maintenance or repair is required (dampers, expansion joints, fans, etc.), flanged connections may be provided.

The gas duct from Gas-Gas Heater (GGH) outlet to Absorber shall be made of Carbon steel of minimum 7mm thickness Lined with 4 mm thick Alloy C276 / Alloy 59.

Lining shall be attached properly to the base to ensure that the base material does not come into contact with the corrosive gases under any circumstance. Sufficient overlap of the lining material shall be provided under the supervision of designer/manufacturer.

All guide vanes & internal trusses (if provided) shall be made of 317 LMN or appropriate material which offers similar or better corrosion resistance properties as of duct plates.

Duct design shall take into account following all occurring together.

i) Wind Load



- ii) Dead weight including weight of insulation, lining, wash water and vertical live load.
- iii) Horizontal flue gas ducts shall be designed additionally for minimum 245 kg/m fly ash loading on the surface or for one fourth of duct full of ash or for maximum possible accumulation of ash in the duct work, under all normal, upset or abnormal operating conditions, whichever is higher. The ash density for the purpose of loading shall be at least 1300 kg/m³.
- iv) The following minimum load factor shall be applied to the design loads.

Temperature (Deg.C)	27	38	93	149	205	260	316	321
Load Factor	1.00	1.02	1.12	1.19	1.25	1.29	1.34	1.45

- v) Expansion joint reaction.
- vi) All interconnecting gas ducts shall have a minimum slope of 45 deg. With respect to horizontal so that any chance of accumulation of ash particles in the duct can be avoided under all operating conditions.
- vii) The ducts shall be of rectangular cross-section and shall be of all welded construction. Circular ducts shall not be acceptable.

Duct stiffening shall be made of rolled sections. No internal stiffeners

- i) shall be used for ducts from Absorber outlet to chimney inlet.
- ii) Necessary insulation and cladding shall be provided on these ducts.

All ducts shall have a sufficient slope with respect to horizontal so that any chance of accumulation of ash particles or water in the duct can be avoided under all normal/abnormal operating conditions. The inlet duct shall be sloped towards the absorber.

5.4.0 Specific Requirements

- a) The stiffeners provided on the ducts walls shall be of such a design and layout that no rainwater can accumulate on the duct surfaces.
- b) The flanges at the bolted joints shall have adequate stiffeners to avoid damages to the flanges.
- c) All necessary wall boxes and floor collars shall be provided where the ductwork pass through walls, floor and roof.
- d) The floor collars shall be fitted 'With a high combing to prevent water and dust falling through the hole.
- e) The ductwork shall be fitted 'With a steel hood to cover the opening.
- f) Weatherproof flashing shall also be provided wherever necessary.
- g) The configuration and design of ducts shall be coordinated 'With the pulveriser parts removal requirement.



- h) Air and gas ducts shall not counter internal bracings, which cause excessive pressure drop.
- i) Duct plates shall be designed for one-way beam action over stiffeners and considered fully continuous over all supports.
- j) Bidder to ensure proper draining facilities for the complete system including proper drainage of acidic fluids from the ducts so as to avoid any accumulation of acidic fluids.
- k) The deflection of the plate, assumed continuous, shall be less than one-half the plate thickness.

5.5.0 Duct Work Structure

- a) Ductwork sections between expansion joints shall be investigated 'With regard to their ability to transmit loads to supports. Care shall be exercised to identify uplift condition.
- b) Internal stiffeners:
 - (i) Duct shape shall be maintained by providing internal stiffening elements at or near supports. However, these internal stiffeners shall be used, if and only if, it is not possible to provide external stiffeners.
 - (ii) Internal stiffening elements shall consist of trusses, preferably comprised of extra-strong steel pipes (min. dia. 76.2 mm) acting in conjunction 'With external stiffeners. Such internal stiffeners for the flue gas duty between boiler and ESP shall be provided 'With erosion protection shields.
 - (iii) The number of internal trusses shall be limited to the minimum required for structural integrity and shaped so as to offer least resistance to gas flow and to minimize the accumulation of fly ash in the bottom of duct.
 - (iv) Conceptual data of internal stiffeners of the ducting shall be furnished along with the offer.
 - (v) All the detailed design data shall be furnished to the Employer before the duct support column foundation data submission.
- c) Corner angles shall be used on all inside comers of all ducts to provide adequate continuity.
- d) Inside welds of comer angles to duct plate shall be continuous and seal welded. Where inside surface of ducts will be coated, welds shall be full throat.
- e) Field welding and all connections of bracing (stiffening elements) to stiffeners shall be well designed in order to develop full strength of the members. The gusset plates shall be of 10 mm minimum thickness.
- f) The duct, plates, trusses, stiffeners, bracings and ductwork shall be designed as structures in accordance with relevant Indian Standards.
- g) All openings in ducts shall be reinforced for all design loads.
- h) Ductwork supports may be hangers or sliding bearing, guides and anchorages. A coefficient of sliding friction of 10% can be used With self-lubricated plates such as "LUBRITE" or "MECHANITE", a coefficient of sliding friction of not less than 35% shall be used for steel-on-steel contact. The allowable bearing stress for self-lubricated plates shall be 70 Kg/sq.cm.



5.6.0 Fabrication Requirements

- a) Fabrication shall be as per IS specification for Design, fabrication and erection of Structural Steel for Building.
- b) Welding shall be in accordance with Section IX of ASME code.
- c) Ducts shall be strength welded and seal welded to produce a gas tight duct. Alignment holes shall be provided in mating flange sections.
- d) Ducting shall be detailed and fabricated in a few pieces as practical, taking into account, shipping and erection considerations.
- e) Materials improperly detailed or fabricated necessitating extra work during erection on field, shall be the responsibility of the Contractor.

5.7.0 Gates & Dampers

The arrangement of the flue gas system shall allow complete isolation of the absorber from the gas side, with the unit in operation. A gas tight, motor operated Guillotine gate type damper shall be provided before the suction of each Booster fan and at outlet of each booster fan. A motor operated multi louver damper with seal air arrangement shall also be provided in the clean gas duct after GGH.

All gates/dampers shall be designed to withstand the operating flue gas temperature without distortion.

There shall not be any backlash, play, etc. with linkage mechanism, actuator and final control element.

Thermal expansion of ducting shall not produce stress in louvers, linkage arrangement etc.

Outlet dampers of seal air fans shall be pneumatically operated, suitable for remote manual operation.

All pneumatically operated interlocked dampers actuators shall be provided with solenoid valves

A quick acting biplane damper shall be provided by the Contractor in the bypass duct (flue gas duct connecting the existing chimney) for quick opening to allow bypass to come into operation in case of emergency. The damper shall be capable of quick opening during emergency conditions within a time of 10-20 secs. Bidder should indicate the required opening time for bypass damper for emergency operating condition.

5.7.1 Damper gas tightness

Damper gas tightness for the guillotine dampers shall be guaranteed for a gas tightness efficiency of 99.95% without sealing air and 100% with use of sealing air.

Damper gas tightness for the multi louver damper shall be guaranteed for a gas tightness efficiency of 99.5 % without use of sealing air.

The gas tightness shall be demonstrated at shop for minimum one type of damper of each type and size.

All dampers shall be designed to withstand the operating flue gas temperature without distortion.



The multi louver damper shall be capable of effectively stopping the flow when in closed position and while in full open position shall cause minimum pressure drop. The isolating damper design shall provide positive shutoff when closed.

All regulation dampers, vanes, blade pitch controls coming under auto regulation shall be able to provide the desired relationship between percentage opening and the flow.

The auto regulating dampers shall be capable of being operated between 20% to 85% opening as per the optimal requirements of control systems to achieve stable, steady and smooth automatic control of the plant and processes under all operating conditions.

There shall not be any backlash, play etc. with linkage mechanism, actuator and final control element.

Thermal expansion of ducting shall not produce stress in louvers, linkage arrangement etc.

All motor operated interlocked dampers actuators shall be provided with solenoid valves.

5.7.2 Pressurisation (Seal) fans

- a) All type of dampers shall be provided with 2x100% pressurization fans to achieve 100% sealing efficiency.
- b) The location and scheme for pressurization system shall be to Owner's approval.

5.7.3 Guillotine dampers

All guillotine dampers shall be motor operated, located in horizontal duct to avoid fly ash build up when in closed position and shall be of top entry type.

5.7.4 Multi louver dampers

- a) The damper shall be of heavy duty construction and shall operate without bind or fluttering under operating conditions.
- b) The damper louver shaft shall be rigidly constructed to prevent bending and shall be suitably insulated to protect from overheating.
- c) The spindles shall be adequately sized and bearings suitably insulated to protect overheating.
- d) The shaft bearings shall be mounted outside the damper box channel and arranged for convenient inspection.
- e) Stuffing boxes shall be provided on all damper blade shafts.
- f) The shaft shall be horizontal wherever possible.
- g) For preventing hot gases from escaping around damper shaft, double gland type stuffing boxes with graphite impregnated packing material shall be provided on all damper blade shafts.
- h) The dampers in flue gas paths shall be so located that the build-up of grit behind the damper blades is reduced to a minimum.

5.7.5 Bypass dampers

- a) Bypass dampers shall be quick acting biplane damper single flap/double flap construction with flexible duplex seals mounted on the flap itself. The seals shall have minimum life of 3 years. The seal material shall be high nickel alloy equivalent or better than hastelloy C-276 (ASTM B575, UNS 10276) or Inconel 625.



- b) The diverter damper shall ensure sealing efficiency of minimum 99.95% on flue gas flow without seal air. To provide man safe isolation for on-line maintenance, 2x100% seal air fans per damper shall also be provided to attain 100% gas tightness.
- c) The diverter flap shall be totally out of flue gas flow path in order to avoid any erosion from ash.
- d) The damper design shall prevent ash accumulation when in closed position.

The damper shall be capable of quick opening during emergency conditions within a time of 10-20 sees. Bidder should indicate the required opening time for bypass damper for emergency operating condition.

Weather hood to prevent rain water entry and accumulation shall be provided at damper top.

If grease lubrication is required, grease connection shall be accessible and suitable platforms etc. shall be provided.

The blades and frames of the dampers provided at the Inlet/outlet of Booster fan in the untreated gas path shall be made of carbon steel. The bypass damper and damper in the FGD outlet treated gas path, the frame of the damper shall be made of Carbon steel of minimum 7mm thickness clad with 2mm (thickness) Alloy C 276/Alloy 59. The blades shall be made of SS317LMN or better material and the seals shall be made of Alloy C-276 or better material.

5.7.6 Dampers operation

The dampers shall be pneumatically operated and controlled from the control room. Provision shall be made for giving signal automatic bypass controls of the absorber in case of failure of the absorber spray system.

- a) All dampers shall be arranged to facilitate local manual operation also from a gallery or floor level. Open and closed positions shall be clearly marked on the dampers
- b) The force required to operate the damper manually shall be limited to 35 kgs (maximum) at the rim of the hand wheel.
- c) The operating gear shall be fitted with a graduated indicator and shall be designed such that the damper may be retained in any position. The isolating dampers shall additionally be fitted with locking devices to permit locking in the fully open and shut positions.
- d) All powered dampers shall also have provision for manual operation during emergency and maintenance along with graduated local position indicator.
- e) Suitable all-around approach and platform shall be provided for manual operation of dampers and for carrying out maintenance on damper.
- f) All bearings for spindles for damper operating gear shall, be arranged for efficient grease lubrication. Grease lines of copper/ steel shall run from all greasing points on each damper to a convenient and easily accessible location adjacent to the respective damper and terminated with suitable clamps and grease nipples on a steel frame to facilitate easy lubrication.

5.7.7 Expansion Joints

Expansion Joints shall be provided wherever required to take care of the differential expansion in the system. The Material shall be suitable for the duty conditions. The expansion joint shall have a minimum guaranteed life of not less than 20,000 hrs of operation. During Guarantee period any defects noticed in the expansion-joints due to faulty material and workmanship shall be rectified by the Contractor free of cost.

The material chosen for expansion joints shall suitable for the duty conditions and the corrosive atmosphere of the FGD system and shall be field proven for similar applications



5.8.0 Booster Fans

The Booster Fans shall be located downstream of the ID Fans (Induced Draft Fans) in the inlet duct to Absorber shall be capable of handling the pressure drop in the FGD system & ducting upto the inlet of existing stack of 275 m height over the entire load range with any one or both Booster fans in operation in conjunction with one or both ID fan in operation while firing the specified range of fuels

Fans shall be provided in accordance with the following requirements:

Fans shall be Axial. Suitable control mechanism has to be provided for the control of the fans.

All the equipment shall be of the high efficiency aerodynamic design silent in operation, vibration-free and must guarantee complete safety in service. The fan rotors are over speed tested to at least 10% above the maximum operating speed and are dynamically balanced to VDI 2060 code. The forged shaft shall be designed to have its first critical speed well above the maximum running speed. The impeller shall be statically and dynamically balanced before shipment. Overhung runners are not acceptable.

The fan control system shall be designed to achieve stable and satisfactory operation with flow control and pressure controls. Fan flow control shall be by blade pitch control. The final control element shall be actuated operated and shall not have a backlash or play etc. The regulating dampers for pressure control shall operate in the range of 20% to 85%. The booster fan drive motors shall be VFD controlled. The system shall be capable of working on automatic mode for all regimes of operation in a steady and stable manner.

- Special features
 - i) The layout of Booster fans shall ensure interchangeability of impellers. Similar fans shall have same direction of rotation.
 - ii) The contractor shall submit detailed calculations for Owner's approval to confirm compliance with the sizing requirements specified elsewhere in the specification.
 - iii) Pulsation shall be avoided by suitable design of fan and connecting ductwork.
 - iv) Booster fan shall have a minimum stall margin of 20% over the Design duty points
 - v) Fan components along with servo/blade pitch control mechanism shall be designed to withstand and continuously operate with the maximum flue gas temperature that these fans will be required to handle.
 - vi) Bidder shall consider the margin over pressure requirement as 44% over the calculated head value excluding the static head. Margin on Static head shall be taken as 10%. For bubbling type Absorber, Bidder shall consider choking/blockage of 10% sparger tubes while calculating the head requirements of fan.
 - vii) Although employer envisages highly efficient electrostatic precipitator to control particulate emission, however. Bidder shall select the Booster fan components such as blades, hubs, casing etc. to encounter the high dust burden of the order of 200 mg/Nm³. The minimum wear life of Booster fan components shall not be less than 25000 hours of operation from the date of commissioning.
 - viii) Both fans shall operate with highest possible efficiency which shall be nearly equal at the Guarantee point flow and test block points.



- ix) Fan components along with servo/blade pitch control mechanism shall be designed to withstand and continuously operate with the maximum air or flue gas temperature that these fans will be required to handle. Fan component shall also be designed to withstand the excursions in flue gas temperature up to 300 degree Celsius, which may persist for about 30 minute duration. Such temperature excursion will not inhibit the safe and smooth operation of fans or cause any damage or increased maintenance.
- x) The fan rotational speed shall be maximum 745 rpm.
- Fan bearings:
 - i) The rotor assembly shall be supported over a oil lubricated bearing assembly consisting of antifriction/sleeve bearing adequately sized to take care of radial thrust loads.
 - ii) Bearing housings shall be provided with vibration pad and sensors for remote monitoring, interlock and protection.
 - iii) In case of oil lubricated bearing, the design shall be such that bearing are lubricated by external force oil lubricating system in which oil is cooled by external cooler. In addition, sump lubrication shall also be provided.
 - iv) One number duplex RTD and temperature indicators shall be provided for local and remote monitoring of the bearing metal temperature of fans for each bearing.
 - Fans shall be provided with its own forced lubrication oil system, including 2x100 % Lube. Oil coolers, Lube. Oil tank with heater, 2 x 100 duplex Lube Oil filters and 2 x 100% oil pumps. The lube oil pressure shall be higher than cooling water pressure. Each bearing shall be provided with an oil level indicator and screwed drain plug.
 - Silencers shall be provided to limit the noise level to the specified values.
 - Fan vibration monitoring pads shall be provided.
 - Fan housing shall be designed for ease of maintenance and access to the fan wheel or impeller. The casing shall be split type to provide easy removal of the fan wheel or impeller for replacement and repairs. Access doors shall be provided in each suction chambers, casing. The casing section shall have gasketed joints to ensure air-tight sealing. Drain connections shall be provided at the bottom most point of fan housing.
 - Fan casing shall be properly stiffened to minimize vibrations and distortions during operation.
 - Suitable cover arrangement to prevent rain water entry to fan motor and lube oil system

5.9.0 Flow measurements

- Flow measuring devices shall be provided at inlet for total flow measurement and control.
- Independent tapping points with necessary isolating valves shall be provided for control, measurement and performance test.
- Location, type and design of flow measuring devices shall be subject to Owner's approval.
- Necessary temperature element points for temperature compensation in the flow measurement shall also be provided.

**5.9.1 Existing ID fan**

The details regarding the existing ID fan is attached in Vol 2 Section 8.0.

6.0.0 CONSTRUCTION FEATURES**6.1.0 Fans**

The construction of fans shall comply with the following requirements:

Description	Booster Fan
Type of fan	Axial type type
Type of fan blade	Stream line, aero foil shaped section
Fan critical speed	Not less than 125% of fan maximum operating speed
Fan component design	To withstand torsional stresses three times the normal full load motor torque at all speeds
Fan housing design pressure	Shut off head of the fan

6.1.1 Fan Balancing

- The fans shall be statically and dynamically balanced before dispatch to site. Balancing of each fan shall be checked and adjusted at site, if necessary.
- Natural frequency of fan components shall be established by vibration testing to ensure that no part of the wheel is adversely excited by any force generated at operating speeds.
- For axial fan cantilever, variable pitch blade shall be subjected to natural frequency. The other components of fan wheels need not be subjected to natural frequency test if supplier can prove that these components are very rigid and have very high natural frequency compared to the operating frequency of respective fans giving justification.
- For centrifugal fans the rotating part shall be subjected to natural frequency test.

6.1.2 Operational Requirements

- Fans shall meet the following operational requirements:

Description	Booster fan
Fan Control	Capable of operating in automatic mode for all regimes of operation in a steady and stable manner.
	The final control element shall not have any backlash, plays etc., and shall operate in the range of 20% to 80% depending upon generating loads upto Boiler MCR
Vibration monitoring system	Suitable pads matching with vibration pickup shall be provided on fan bearing housings.
Bearing metal temperature monitoring	Shall be possible from remote as well as locally using adequate nos. of duplex platinum RTDs per bearing.

- The fans shall be suitable for parallel operation and sharing the load capacity over the entire range of operation without hunting. Pulsation shall be avoided by suitable design of fans and connected ductwork.



6.1.3 Flow measuring devices

- The draft plant shall include aero foil type flow elements in the system for total flow measurements and control, each with three pairs of tapping points.
- Two nos. duplex temperature element with thermos-wells for temperature compensation shall be provided.

6.1.4 Fan casing

- The fan casing shall be of split type to facilitate easy removal of the fan wheel or impeller for replacement and repairs.
- Access doors shall be provided in each suction chamber casing and diffuser.
- The sections shall have gasketed joint to ensure air tight sealing.

6.1.5 Fan Layout

- The layout of fans shall ensure interchangeability of the impellers. Similar fans shall have same direction of rotation.

6.1.6 Drain connections

- Drain connections shall be provided at bottom most point of the fan housing. The drain point shall be let to the nearest plant drain.

6.1.7 Fan suction

- For fans operating with flue gas, measures shall be taken to reduce the fans wear because of dust and fly ash to a minimum. Suitable design of shaft sealing shall be provided to leakage.

All platforms shall be provided to all components of the fan and motor subject of maintenance. Bearings with forced lubrication shall be provided. The lubricating system, consisting of oil receiver, oil heater, double capacity oil pumps, double oil coolers shall be dimensioned to incorporate the lubrication of the fan motor, too. One complete lubrication unit shall be attributed to each fan.

Inlet and/or outlet silencers shall be provided in order not to exceed the specified noise level. The silencers shall be of the element type so that it will be possible to change the individual silencer elements. The filling elements shall consist of non-combustible, heat-resistant damp-proof material.

Fans, of smaller capacity (shaft power less than 150 kW) may be provided with roller bearings.

6.2.0 Pumps

Pump Types

Centrifugal pumps shall be used wherever possible.

Positive displacement pumps of rotary type, Screw Pumps will be acceptable when handling viscous liquids.

Design and Construction

All pumps shall be designed to withstand 1.5 times the pump shut off pressure, under maximum suction pressure conditions.



Pumps shall be designed for 110% of nominal flow and shall be capable of at least 10% head increase at rated condition by installing new impeller. Best efficiency point for rated impeller diameter shall be on the right side of the rated capacity.

All pumps shafts shall be of ample size to transmit the full output from their drivers. The drivers shall be rated for the maximum power requirement of the pumps. For motor driven pumps, the rated flow and head shall be achieved with a variation of $\pm 10\%$ in voltage and $\pm 5\%$ in frequency of the power supply.

Impellers shall be fitted to the shaft in a suitable manner which will permit the transmission of the maximum torque developed under any operating conditions and removal without damage to either impeller or shaft.

Renewable wear rings shall be fitted to the casing and impeller.

All pumps shall be constructed of materials specifically designed for the conditions and nature of the pumped fluid and to resist cavitation's, erosion and corrosion.

Centrifugal pumps shall be preferably of horizontal shaft type unless specified otherwise. Each horizontal pump shall be mounted with its driving motor on a combined bed plate of rigid construction. The bed plate shall be complete with drip tray fitted with a drain plug. Bed plate material of construction shall be mild steel.

Sump Pumps shall be vertical centrifugal type, and submersible type for portable pumps.

The pump shall deliver the rated flow at rated head with margins as specified in the respective clauses. The pump shall be capable of pumping of filtrate water with solid concentration upto 10% & particle lumps of 6-7mm. Sump pumps handling slurry shall be designed with a maximum concentration of 30% solid by weight.

Centrifugal pumps shall be of rigid shaft design and shall be designed such that the first critical speed of the pump, when coupled to its driver, is at least 10% higher than the maximum operating speed. The shaft diameter and distance between two consecutive bearings must include a sufficient margin to satisfy this condition. The entire rotor assembly shall be statically balanced and dynamic balancing of the impeller is required if either of the following applies:

- i. Pump speed exceeds 1800 rpm, and impeller diameter exceeds 150 mm.
- ii. Pump speed exceed 1800 rpm for pumps having 2 or more stages.

Pumps shall operate smoothly throughout the speed range in reaching their operating speed.

Where necessary the pumps are to be fitted with devices to ensure a minimum through flow.

In case of pump with rubber lined casing the casing shall be radially split to allow easy removal of impeller.

Mechanical seals shall be considered for all pumps.

The material and thickness of the liners in pumps shall ensure a minimum service life of 2 years before replacement. All the wear parts of the pump shall be guaranteed for a minimum wear life of not less than 14000 hrs.

Fittings

All pumps shall be installed with isolating valves, a discharge non return valve and discharge pressure gauges unless otherwise stated. All positive displacement pumps shall be fitted with a discharge relief valve. Pulsation dampers shall be provided on the discharge piping.



All couplings and any intermediate shafting shall be supplied with removable type coupling guards. Couplings must have a rated capacity of atleast 110% of maximum power transmission requirement.

Coupling halves shall be matched to ensure accurate alignment. Horizontal shaft pumps shall be driven by the motor through an approved type of flexible coupling. Pin type flexible couplings shall not be used. Vertical shaft and in line pumps may be driven directly by the motor through a solid coupling.

Air release valves shall be fitted to all pumps at suitable points on the pump casing unless the pump is self-venting due to the arrangement of the suction and discharge nozzles. Drainage facilities shall be provided on the pump casing or adjacent piping to facilitate the dismantling of pumps.

All the slurry pumps shall be provided with motorized suction and discharge valves. In addition, flushing water lines with motorized/pneumatic valves shall be provided for each pump for automatic flushing of the pump after each shut down. The flushing water for the pumps shall be taken from the process water supply.

Water discharged from air cocks, drains and glands or seals shall be piped via tundish to the nearest convenient drain trench.

Bearings

All bearings shall be of ample surface area and for large pumps shall be of the automatic oil lubricated sleeve type. On pumps utilising ball or roller bearings the inner race shall be fitted directly on to the shaft and positively located by a shaller on the shaft.

Bearings on vertical shaft pumps shall be spaced to prevent vibration under any mode of operation.

Bearing housing on horizontal shaft pumps shall be designed to enable the bearings to be replaced without removing the pump or motor from its mounting. Outboard bearing shall be double roll ball bearing and inboard shall be roller bearing.

Bearing housing on horizontal shaft pumps shall be effectively protected against the ingress of water, pumped fluid and dust with suitable nonferrous deflectors.

All bearing oil wells shall be fitted with visual oil level indicators. Non pressure oil lubricated bearings shall be equipped with constant level oilers. Means of draining bearing housings shall be provided.

6.3.0 Blowers

Blowers shall be equipped with air filter; safety valve; solenoid valve to open the drain when the blower is out of operation; and silencers on the intake and delivery sides. The output and discharge head of the air blowers shall be determined by the bidder. Anti-vibration mountings and cork insulation as well as flexible pipe joints on the suction and discharge sides and surge vessels etc. shall be provided as necessary. Suitable discharge pipes shall be provided for stuffing box leakage and shall be connected to a drainage system.

6.4.0 Emergency Cooling water Tank

In case of abnormal situation, due to electrical blackout, failure of recirculation pump etc., the internals will be protected by emergency cooling system, One Emergency cooling system shall be provided in absorber to meet the emergency requirements.

**6.5.0 Wet/dry Interface washing pipes**

The absorber tower shall be equipped with interface washing pipes. This interface washing pipes shall supply water directly to the inlet walls of the absorber to clean off any build up slurry.

6.6.0 Thermal Insulation

6.6.1 Thermal Insulation along with aluminum cladding shall be provided for all the equipments/surfaces having skin temperature more than 60 degree Celsius except for absorber. Further, Thermal insulation of min 70 mm shall be provided for absorber outlet flue gas duct irrespective of skin temperature. The specification of the insulation including type, density, thickness, heat conductivity and finish shall be designed based on criteria specified below. The insulation thickness shall be designed based on following criteria.

Criteria	Design Conditions
(i) Ambient Temperature	45 °C
(ii) Surface wind velocity	0.25 m/sec.
(iii) Emissivity of Aluminium	0.2
(iv) Cladding surface temperature	60 °C (max.)
(v) Thermal conductivity of insulation material	Not less than the Maximum values as per IS:8183
(vi) Pipe/Equipment wall temperature	Maximum fluid design temperature
(vii) Overall heat transfer coefficient and insulation thickness	To be calculated as per ASTM c 680-89

However, the minimum insulation thickness, however, shall not be less than 75 mm.

6.6.2 Material and application of insulation material, protective cladding, wire mesh etc. shall be conforming to latest edition of following codes:

- (a) IS:8183
- (b) IS:3677
- (c) IS:3144
- (d) IS:14164
- (e) IS:280
- (f) ASTM-B 209

6.6.3 Insulation material for all equipments, ducting, etc. shall conform to following requirements:

Parameters	Requirement
(i) Material	(a) Lightly resin bonded mineral wool of best grade conforming to IS:8183. (Handmade mattresses is not acceptable). Material shall be rock wool only. Slag wool or slag wool inclusion shall not be accepted.



(b) Lightly resin bonded glass wool mattress, having density 64 Kg/m³ (min.), self-stitched in shop can also be accepted for temperature less than 400 °C.

(ii) Bulk density of lightly resin bonded mineral rock wool mattresses

(a) For use upto 400 °C 100 Kg/m³

(b) For use above 400 °C 150 Kg/m³

(iii) Physical requirements -

Following shall be met by testing as per relevant clauses of IS:3144.

(a) Shot content 5% by weight (maxm.), size of any shot not to exceed 5 mm in diameter

(b) Bulk density To comply with 16.03.00(i) & (ii) above.

(c) Weight gain by moisture absorption 2% (max.)

(d) Sulphur Content Not exceeding 0.6%

(e) Alkalinity as percentage of Na₂O Not exceeding 0.6%

(f) Maximum oil content Not exceeding 0.3% by weight

(g) Total carbon content Not exceeding 0.3% by weight

(h) Settlement Nil (When tested as per Cl. 21.1 & 21.2 of 18:3144)

(i) Handability Fully handable, without any lump formation and disintegration of material

(k) Loss of weight after combustibility test Not exceeding 5% by weight

6.6.4 The Insulation mattress shall be rated incombustible when tested by the method prescribed in clause 15 of 18:3144 and shall meet the requirement of the Mercantile Marine department, Uoyd's Register of shipping, underwriter, fire hazards codes and other International standards.

6.6.5 In addition to requirements as mentioned above, insulation material (and protective covering) shall:

(a) Be fresh, incombustible, rust proof, non-hygroscopic,

(b) Be capable of withstanding continuously and without deterioration the maximum temperature to which they will be subjected.

(c) Not react chemically, either to itself or with other components.

(d) Not sustain any fungi, or vermin and must not pose health hazards.



- 6.6.6 The Mineral wool shall:
- (a) Pass standard combustibility test both immediately after application and after subjected to maximum operating temperature for not less than 100 hrs.
 - (b) Not suffer permanent deterioration as a result of contact with moisture due to condensation and shall be free from objectionable odor.
 - (c) Not cause corrosion of the surface being insulated or of cladding on it under normal site conditions.
- 6.6.7 The use of insulation of finishing materials containing asbestos in any form is not permitted.
- 6.6.8 Insulation mattress/section shall be supplied in thickness of 25,40,50 and 75 mm. Insulation of higher thickness shall be made up in multiple layers using mattress/slabs of thickness specified above. However, if the required thickness is such that by using above mattress/slabs the calculated thickness is not achieved, the mattress/slabs in increment of 5 mm shall be acceptable for outer layers. The min. thickness however, shall not be less than 25 mm and number of layers shall be minimum and innermost layer shall be thickest.
- 6.6.9 Sheathing Material
- Sheathing material for all insulated surfaces, equipments, piping etc. confirming to ASTM B-209-1060 temper H-14 or IS:737 Gr 19000/H2, shall be provided. The thickness of aluminium sheathing to be used shall be 22 SWG (0.71mm).
- 6.6.10 Binding and lacing wires shall be 20 SWG Galvanised Steel wire
- 6.6.11 All Straps and bands shall be Galvanized Steel. Bands shall be 20 mm wide and 0.6 mm thick. For securing Aluminum sheathing material, stainless steel or anodized aluminum bends shall be used.
- 6.6.11.1 Screws shall be of galvanized steel, check headed, self tapping type. Above 400 degree Celsius temperature, screws shall be stainless steel.
- 6.6.12 Hexagonal wire mesh netting shall be 10-13 mm aperture and atleast 0.56mm diameter conforming to following Galvanized Steel wire.
- 6.6.12.1 Non metallic components like 3 mm thick mill board, aluminum pigment sealant, white glass cloth, insulating cement, neoprene washer shall be provided.
- 6.6.13 **Application of Insulation**
- 6.6.13.1 **General**
- (a) All surfaces to be insulated shall be cleaned of all foreign materials such as dirt, grease, rust etc. and shall be dry before the application of insulation.
 - (b) Before applying the insulation the contractor shall check that all instrument tapping, dampers, lugs and other connections on the surface to be insulated have been properly installed as per the relevant erection drawing.
 - (c) All flanged joints shall be insulated only after the final tightening and testing.
 - (d) The insulation shall be applied to all surfaces when they are at ambient temp. Ample provision shall be made for the maximum possible thermal movement and the insulation shall be applied so as to avoid breaking/telescoping due to alternate periods of expansion and contraction.



- (e) All cracks voids and depressions shall be filled with finishing cement, suitable for the equipment operating temp. so as to form a smooth base for the application of cladding.

6.6.13.2 All the refractory and insulation materials required for complete field application of insulation, cladding etc. covered under these documents and specifications shall be furnished with the equipment. They shall conform to the requirements of the various relevant ISI standards or other approved equivalents. All items such as insulating cement, sealing material, insulation material, screws, washers, etc., needed to complete the work in the course of the application of insulation and refractory shall be furnished. All insulating materials shall be chemically inert in both the dry and wet state and shall withstand the full working temperature conditions to which they are exposed without any deterioration. The gas ducts shall be insulated with mineral wool block or mineral wool blanket and all other equipment operating at elevated temp. shall be insulated with calcium silicate blocks, mineral wool blocks or mineral wool blanket insulation.

6.6.13.3 Application on Piping

- (a) All vertical pipes shall be provided with the suitable insulation supports to prevent collapsing/crushing of insulation due to its self-weight. Support rings shall be provided on all vertical piping with a difference in elevation of 4 meter or above, and there shall not be more than 3 m straight length between support rings.
- (b) Longitudinal joints of insulation mattress sections of horizontal piping shall be on the bottom or at the sides of the pipe.
- (c) When more than one layer of insulation mattress/section is required on piping the circumferential joints on adjacent layers shall be staggered by at least 150 mm and longitudinal joints shall be staggered by at least 50 mm.
- (d) The mattress type insulation shall be formed to fit the pipe and applied with the mattress edges drawn together at the longitudinal joints and secured by lacing wire. Pipe section insulation shall be fitted on pipe using binding wires.
- (e) Where insulation is applied in two or more layers each layer of mattress shall be backed with hexagonal wire mesh. For the first layer of insulation and in case of single layer insulation, hexagonal wire mesh shall be provided on both the surface of the mattress. For pipe sections, the sections shall be held in place by binding wires without any wire mesh.
- (f) The ends of all wire loops shall be firmly twisted together with pliers, bent over and carefully pressed into the surface of the insulation. Any gap in the insulation shall be filled with loose mineral wool or finishing cement.
- (g) Insulation mattress/section ends shall be terminated at a sufficient distance from the flanges to facilitate removal of bolts.
- (h) The insulation shall be held in place by fastening over with binding wire for insulation surface with diameter upto and including 550 mm and with metal bends for insulation surfaces with diameter over 550 mm. The fastening shall be done at intervals of 250 mm except where specified otherwise. The ends of the binding wires shall be hooked and embedded in the insulation. The straps shall be mechanically stretched and fastened with metallic clamping seals of the same materials as the strap.
- (i) Insulation for application on bends and elbows shall be cut into mitred segments, sufficiently short to form a reasonably smooth internal surface. After the application of insulation material place, insulating cement shall be applied as required to obtain a smooth surface.



- (j) Weather hoods shall be provided for insulated piping passing through floors/walls.
- (k) All pipe attachments coming on horizontal pipes, inclined pipes and bends shall be insulated along with pipe such that there will be no insulation applied to hanger rod and the component connecting hanger rod to pipe attachment. All pipe attachments exposed to weather shall be provided with weather proof covering.
- (l) Upstream of all drain lines and the lines connected to steam traps, shall be insulated upto and including first isolating valve for heat conservation. Rest of such lines such as downstream of the drain valves, traps etc. and other lines such as safety valve discharges, vents, etc. shall be insulated for personnel protection.

6.6.13.4 Application on Valves and Fittings

- (a) All valves fittings and specialties shall be insulated with the same type and thickness of insulation as specified for the connected piping with the special provisions and or exceptions as given below.
- (b) All valves and flanges shall be provided with removable box type of insulation covered with box fabricated from aluminium sheets of thickness same as the connected pipe cladding. Adjoining pipe insulation shall be bevelled back to permit removal bolts and nuts or bands. The portion of the valve which can not be covered by box type insulation shall be filled by loose insulating material of packing density at least equal to that of the insulating material of adjoining pipe. The insulation for valves/flanges shall be applied after the finishing has been applied over the connected piping. The cladding shall be applied in such a manner that the bonnet flange can be exposed easily without disturbing the complete insulation and cladding.
- (c) Flanges on lines having temperature upto and including 150 deg.C shall not be insulated.
- (d) Union shall not be insulated.
- (e) Expansion joints, metallic or rubber, shall not be insulated unless otherwise specifically indicated.
- (f) Safety valves shall be insulated.

6.6.14 While applying mineral wool blanket insulation:

- (a) Provide expanded metal or hexagonal wire mesh on both sides for single layer mattress and on first layer in case of multilayer insulation. Subsequent layers of multilayer insulation to have only one side wire netting.
- (b) The edges of adjacent blankets to be leased together, by appropriate lacing wire as per Clause 16.08.00.
- (c) Any gap between joints between insulation layers shall be filled by loose mineral wool confirming to IS:3677.
- (d) All insulation to be secured by 1.63 mm dia wire netting over blankets with ends of wire tightly twisted, and pressed in to insulation surface.
- (e) Impelling pins shall be placed on centers not exceeding 300 mm.

6.6.15 Flue Gas ducts with external stiffeners shall have first layer of insulation between the stiffeners and a second layer of insulation over stiffeners so that stiffeners are also insulated and a level surface is achieved.



6.6.16 Application of Metal Cladding

All insulated surfaces of the FGD shall be provided with metal cladding in accordance with the following requirements.

- (a) All insulation procedure of metal cladding shall have prior approval of the Owner.
- (b) All insulated surfaces of FGD shall be covered with aluminium cladding.
- (c) Cladding for FGD components are to be finished with plain aluminium sheeting of thickness not less than the values specified. Wherever an inner casing plate is necessary to effect a gas tight enclosure, the plate shall be of mild steel of required thickness, but not less than four (4) mm suitably stiffened and supported.
- (d) Cladding on straight surfaces shall be finished with aluminium sheeting of at least 20 SWG thicknesses suitably pressed along diagonals to form diamond shape or otherwise formed.
- (e) Cladding for insulated circular surfaces will be constructed from aluminium sheets of thickness not less than 20 SWG.
- (f) Weather proof flashings shall be installed where the panels intersect with columns and at other similar joints.

6.6.17 Application

All metal cladding shall be fabricated and installed to ensure a neat appearance and no open ended sections of cladding shall be left uncovered. The following provisions shall also be complied with:

- (a) All closures, flashings and seals required shall be provided and installed.
- (b) An asphalt and craft paper moisture barrier shall be provided to the aluminium cladding for all out door applications. Such moisture barriers shall be fixed to the inner surface of the cladding or shall be cemented to the outside surface of the insulation before application of cladding.
- (c) All the used in the outdoor cladding shall be provided with Neoprene washers.
- (d) All openings and joints in outdoor cladding for piping connections, supports or access shall be suitably flashed and weather-proofed. Where such flashings or weather-proofing cannot effectively control the entry of moisture, then such openings and joints shall be weather-proofed by application of aluminium pigmented sealer.
- (e) Cladding on the top surfaces of the FGD, duct work and equipment shall be suitably reinforced to prevent damage by personnel walking thereon.

6.6.18 Protection of Equipment during insulation application

All equipment and structure shall be suitably protected from damage while applying insulation. After completion all equipment and structures shall be thoroughly cleaned of insulating materials which might have fallen on them.

6.7.0 Sump pumps

- 6.7.1 Contractor shall provide sumps of adequate capacity in the each absorber area, limestone grinding area and gypsum dewatering area for containing the over flow from the respective



systems. Acid resistant tiles or other suitable material of standard thickness as per bidders proven practice shall be provided as liner. Contractor shall make arrangements for pumping the drainage water back to the respective system with vertical sump pumps. Agitators shall also be provided to avoid settling of solids in the sump. Adequate redundancy in line with the standard practice adopted by the bidder shall be provided. This Clause covers the design, manufacture and erection of all vertical sump pumps for the FGD system.

- 6.7.2 The contractor shall offer only proven design in successful operation in similar application at previous installations. The design, manufacture, installation and testing of the pumps shall follow the latest applicable Indian I International (ASME I EN I Japanese) Standards.
- 6.7.3 The pumps shall be designed for continuous operation. The pump shall be single stage centrifugal type with semi open or open impeller. The pump impeller shall be cantilever type and shall not be supported below the base plate for easy withdrawal.
- 6.7.4 The pump shall deliver the rated flow at rated head with margins as specified in the respective clauses. The pump shall be capable of pumping of filtrate water with solid concentration upto 10% & particle lumps of 6-7mm. Sump pumps handling slurry shall be designed with a maximum concentration of 30% solid by weight.
- 6.7.5 The material chosen for the pump components shall be suitable for the fluid handled and shall be proven in similar application.
- 6.7.6 The pumps shall not be supported below the base plate level for easy withdrawal without entering the sump.

6.8.0 Agitator

- 6.8.1 Agitators shall be supplied in tanks and vessels to prevent caking and settlement of particles out of the slurry, e.g. in the absorber vessel, limestone mill recycle tanks, limestone slurry tank, Auxiliary Absorbent tank, and sumps etc.
- 6.8.2 All agitators shall be designed for continuous operation unless otherwise specified. Horizontal agitators shall be used for Absorber. Vertical agitators can also be used for Absorber, if it is only the standard & proven practice of the Contractor for the offered Absorber design. In other vessels and tanks vertical agitators are also acceptable if they are of proven make and the Bidders standard practice which can be proven by means of suitable references. The design of the agitators shall be of proven type.
- 6.8.3 Standard type agitators with suitable characteristics shall be used wherever practical. The agitators shall be complete with motor, gearbox, agitator shaft, coupling, safety guards, mechanical seal (for side entry agitators), impeller, support legs, agitator mounting flange including bolts nuts and gasket etc.
- 6.8.4 All agitator parts and accessories in contact with the stirred fluid shall be constructed of materials specifically designed for the conditions and nature of the stirred fluid and be resistant to erosion and corrosion.
- 6.8.5 The material for the shaft (which is continuously in contact with slurry) and agitator blades of the Absorber Agitators shall be made with Alloy 926 or better material. For Agitators in other tanks, agitator blades shall be made with Alloy 926 or better material & shaft can be rubber lined. This does not release the Contractor of the responsibility for selecting the correct materials.
- 6.8.6 Each agitator and its associated equipment shall be arranged in such a manner as to permit easy access for operation, maintenance and agitator removal without interrupting plant operation. It shall be possible to remove the sealing devices of the Agitators of the absorber vessel without having to drain completely the absorber.



- 6.8.7 To prevent mechanical blocking load start-up after standstill of pumps, piping and agitators for slurries shall be applied with C-hose connection.
- 6.8.8 Lifting lugs and eyes and other special tackle shall be provided as necessary to permit easy handling of the agitators and their components.
- 6.8.9 Static and dynamic (as far as applicable) balancing of all agitators shall be carried out after assembly.
- 6.8.10 All agitator parts and components shall be designed and calculated for fatigue life, considering maximum bending loads, induced by fluctuating hydraulic forces and torsional loads, based on the installed motor power. For side entry agitators the alternating bending moment resulting from impeller and shaft weight has to be considered additionally.
- 6.8.11 All exposed moving parts shall be covered by guards. Side entry agitator shall be flange mounted.
- 6.8.12 The shape of the impeller blades of side entry agitators shall be designed to avoid wear on the impellers which will affect the agitator performance as specified for a minimum period of 2 years of continuous operation under design conditions for the range of coal & limestone specified in the specification. In order to avoid excessive wear impeller tip speeds must not exceed 12 m/s



ANNEX – 2.1.1

SPECIFIED DESIGN DATA - FLUE GAS DESULPHURIZATION SYSTEM

Sl.No.	Description	Unit	Data
A)	FGD PROCESS DATA		800 MW unit
1	SO ₂ burden at ID fan outlet	mg/Nm ³	2000
2	SO ₂ removal efficiency	%	Not less than 95%, (to meet the SO ₂ emission guarantee at FGD outlet of 100 mg/Nm ³)
3	Inlet Dust Burden in Gas (max)	mg/Nm ³	200
B)	BOOSTER FANS		
1	Type of fan		Axial type type
2	Numbers		2x60% (sized for 60% BMCR flue gas flow) for absorber.
3	Mode of Operation		Two fan
4	Fan sizing criteria with all the following conditions occurring together		Booster Fan to be sized for one (1) Booster Fan stream in operation taking into account following factors occurring together
4.1	Flue Gas Flow through fan		862 m ³ /sec
4.2	Power supply frequency		47.5 Hz
4.3	Pressure at Terminal Point before Booster Fan suction		0 mmWc
4.4	Gas temperature (degree Celsius)		150
4.5	Pressure required at chimney inlet with FGD bypass damper closed	mmWC	10
5.0	The fans shall also fulfill following sizing criteria in addition to those mentioned at clause 4.0 above		Each fan to be sized with following conditions occurring together.
5.1	No. of fans in operation		2
5.2	Flue gas flow through each fan		783 m ³ /sec
5.3	Margin over flow		20%
5.4	Margin over pressure requirement		Bidder shall consider the margin over pressure requirement as 44% over the calculated head value excluding the static head. Margin on Static head shall be taken as 10%. For bubbling type Absorber, Bidder shall consider choking/blockage of 10% sparger tubes while calculating the head requirements of fan.
5.5	Power supply frequency		50 Hz
5.6	Pressure at Booster Fan suction		0 mmWc
5.7	Gas temperature (degree Celsius)		150
5.8	Flue gas control		Blade pitch control
5.9	Pressure required at chimney inlet with FGD bypass damper closed		10



Sl.No.	Description	Unit	Data
6	Blade material		Nodular Cast Iron or High Wear Resistant Steel with or without Hard coating as per the proven practice of the fan manufacturer
7	Fan critical speed		Not less than 125% of fan maximum operating speed
8	Fan component design		To withstand torsional stresses three times the normal full load motor torque at all speeds
9	Fan casing material and plate thickness		Abrasion and wear resistant, high BHN steel having minimum 8.0 mm thickness or 12mm mild steel with liner of thickness 10mm (min.)
9	Fan housing design pressure		Shut off head of the fan
10	Fan rotational speed		745 rpm (max.) (axial type)
11	Fan control		Blade pitch control
12	Minimum life		Booster fan components shall not be less than 25000 hours of operation from the date of commissioning
			Note : Booster fan shall have a minimum stall margin of 10% over the Design duty points.
C)	ABSORBER/SCRUBBER		
1.	MOC of the Absorber		The complete absorber vessel (absorber oxidation tank, absorber tower & absorber outlet duct up to absorber outlet flange) shall be made of clad sheet of C276/Alloy 59 (minimum 2 mm thick) by explosion bonding or hot rolling, having minimum 7 mm thick carbon steel as base material. The lining material shall be guaranteed for an uninterrupted minimum life of 25 years. All internal members shall be with minimum 2mm Alloy 59/C276. All metallic fasteners provided inside the absorber/ absorber wet-dry interface ducting shall be of Alloy 59/C276. The absorber wet-dry interface shall be of solid Alloy 59 or C276 of minimum 6 mm thickness. The other bridges/supports shall be lined with minimum 2 mm Alloy 59/C276. Refer cl.5.1.0 for lining details.
2.	Velocity of the Gas in the Absorber	m/s	Maximum 4.0



Sl.No.	Description	Unit	Data
3.	Air Temperature Drop in Absorber	°C	Temperature in Chimney to be maintained as mentioned.
4.	Number of Spray header in Absorber		By Bidder with a provision of Future addition .
5.	Spacing between Spray header		Minimum 1.8m.
6.	MOC of Spray Header		MOC of absorber spray header/pipes to be minimum of 10 mm thick. MSRL upto 150 mm, and pipes less than 150mm to be of FRP for external. Complete piping shall be FRP inside absorber Silicon Carbide/ Ceramic Spray nozzles with guaranteed life of 20,000 hours.
7.	MOC of Mist Eliminator		Chevron type -FRP
8.	Number of layers Mist Eliminators at FGD outlet		Minimum 3 layers.
9.	Facility of Mist eliminator washing		To be provided, Online facility
10.	MOC of the Slurry tank		MS with 1.5mm corrosion allowance with inside glass flake lining/ ceramic acid resistant tile lining. The life of lining shall be guaranteed for the entire plant life (25 to 30 years)
11.	Concentration of Lime in Slurry tank		10-20 %
12.	pH of Slurry		> 5.5
13.	Slurry Specific gravity		1.0-1.15
14.	Provision of Online pH meter, Density meter, Level, Temperature in the Slurry Sump		To be Provided
15.	Retention Time	Minutes	As per supplier's design.
D)	AIR INJECTION SYSTEM		
1.	Air Injection system		To be Provided- with Blowers / Compressor
2.	Quantity		2 x 100 % electric motor driven
3.	Type		Single stage, integrally geared, single or dual vane centrifugal type oxidation blowers complete with integral gearbox, lube oil system, instrumentation and accessories. The blowers will be used for supplying a variable volume of air to the absorber reaction tank
4.	Capacity		2.5 times for spray & 4 times the actual/ Theoretical air requirement for bubbling type.
	Head		For Spray Type process actual requirement considering choking/ blockage of minimum 10% of the oxidation nozzles / sprayers or minimum 8500 mmwc whichever is higher.



Sl.No.	Description	Unit	Data
			For Bubbling Type process actual requirement considering choking/blockage of minimum 10% of the oxidation nozzles / sprayers or minimum 3500 mmwc whichever is higher.
	Margin of head		10% under above conditions
E)	AGITATOR (FOR ABSORBER)		
1.	Agitator MOC		Duplex Stainless Steel
2.	Number of standby agitator	Nos	1
F)	GAS TO GAS HEAT EXCHANGER		
	Type of Heat Exchanger		Rotary regenerative with vertical axis rotation
	Seal Leakage		< 1.5 % of the Hot gas inlet flow at 50 % to 100 % BMCR.
	MOC of Heating elements		Corten steel, minimum 1.2 mm thickness with coating
	On load cleaning medium		Steam
	Off load cleaning medium		Water / Air/ Steam
	Bearing		Forced lubricated and oil cooled
G)	DUCT SIZING		
1.	Design Inlet Gas Temperature	°C	150
2.	MOC of the Flue gas Duct		(a) wet-dry interface shall be made of The absorber wet-dry interface shall be of solid Alloy 59 or C276 of minimum 6 mm thickness. (b) Absorber outlet duct to Wet Chimney shall be made of Carbon steel of minimum 7 mm thickness clad with 2 mm (thickness) Alloy C 276/Alloy 59, to handle the wet saturated gas with condensate.
3.	Corrosion Allowance	mm	1.5
4.	Dampers at the Inlet Duct to booster fan and outlet Duct of Booster fan		Guillotine type (Motor Operated)
5.	Dampers at the Outlet Duct of FGD		Multi louver damper (Motor Operated)
6.	Bypass Damper in the Main Duct		Pneumatic operated Quick operation (typical - 5 to 10 secs*) Bi-plane damper to be Provided. * Bidder to interface with BTG supplier for quick opening time requirements.
7.	Velocity of the Gas in the Duct	m/s	12-15
8.	Sealing Air		To be Provided for all Dampers at outlet of booster fan to achieve 100%



Sl.No.	Description	Unit	Data
			sealing efficiency.
9.	Sealing Air fans		1W + 1S (each damper)
10.	Insulation		All ducts with operating temperature above 60°C shall be insulated
11	Duct MOC from Terminal up to absorber		Carbon steel (minimum 7mm) provided the duct stresses remain in the normal range.
H)	Emergency cooling System Tank		
1	Hold up volume- Time period to be considered	Minutes	15 (minimum)
2	No. of tank		1 No. for absorber
I)	Slurry Recirculation Pumps		
1.	Type		Screw / Rotary
2.	Design		For 1.5 times the shutoff head at Max. suction pressure. 110% flow at rated conditions with 10% in pressure
3.	Drive		Motor driven. Designed for +/-10% Voltage and +/- 5% Frequency variations.
4.	Seal		Mechanical
5.	Shaft	MOC	SS 316
6.	Casing & Impeller	MOC	Silicon carbide (SiC)/hi-chrome impeller and SiC lining for casing
7.	Quantity (Min)		Shall be decided based on the number of levels of spray offered by the bidder (1 W+1 S for each level)



VOLUME- II
SUB-SECTION - 2.2
LIMESTONE CONVEYING SYSTEM

1.0.0 GENERAL

This section covers minimum requirements for design, engineering, fabrication, manufacture & assembly, inspection, erection, testing and commissioning of complete Limestone Unloading and Storage System.

2.0.0 CODES AND STANDARDS

The equipment to be provided shall specifically conform to the latest editions of the following codes, standards, specifications and regulations. Also the system design shall conform to the requirements of applicable codes as specified in the General Technical Specification

IS 3938	:	Hoist
IS 3177	:	Crane
IS 3832	:	Manual Hoist
IS 11592	:	Belt Conveyor
IS 7938	:	Air Receivers for Compressed Air Installation
ANSI B 16.5	:	Flanges (Upto 600 NB)
AWWA C 207	:	Flanges (Above 600 NB)
ISO 7919 / ISO 10816	:	Vibration
OSHA	:	Occ. Safety Health Admin.
ISO 1996	:	Noise Level
PTC 10	:	Compressors and exhausters.
IS 7167	:	Code for selection and use of bucket elevators
IS 6833	:	Specification for bucket Elevator
IS 6834	:	Specification for conveyor chains, chain wheels and attachments.
CEMA	:	Conveying Equipment Manufacturer's association – Belt conveyors for bulk materials
IS: 1891 – 1994	:	Conveyor and Elevator Textile Belting - Specification - Part 1 General Purpose Belting
IS:14386 -1996	:	Belt conveyors-Traveling Tripper- Motorised for belt widths 650mm to 1600 mm- Dimensions
IS:8531-1986	:	Specification for Pulleys for Belt conveyors
IS:8598 - 1987	:	Specification for Idlers and idlers set for belt conveyors
IS 9295 - 1983	:	Steel tubes for Idlers for Belt conveyors
ISO 5049/1 or IS 800	:	Code of construction of structural works.
IS 16143 (Par 2&4)/ ASTM C50/ ASTM 02013	:	Lime stone Sampling System
IS:2062 - 2011	:	Steel for general structural purposes.
IS:1239 2004 part 1	:	Spec for mild steel tubes tubular and other wrought steel
IS:3589 : 2001	:	Steel pipes for water and sewage (168.3 to 2540mm outside diameter)
IS 7155 (part 3): 1990	:	Code of Recommended Practice for Conveyor Safety
"American Conference of Governmental Industrial Hygienists"(ACGIH)	:	Calculation of dust extraction capacity
IS 325	:	Three phase induction motors.
IS:4894	:	Specification of centrifugal fan
ASHRAE :2007	:	HVAC applications



3.0.0 SYSTEM DESCRIPTION

The Limestone handling system shall comprise of the following:

- i) Limestone storage shed
 - ii) Reclaiming underground hoppers with grizzly bars
 - iii) Rod gate, Rack and pinion gate
 - iv) Vibrating feeder
 - v) Conveyors and its technological structures
 - vi) Belt feeders
 - vii) Chutes and hoods, skirt boards
 - viii) Bucket elevators
 - ix) Crushers (primary & secondary)
 - x) Screens
 - xi) Bulk limestone silo
 - xii) Day lime stone silo
 - xiii) Sump Pumps
 - xiv) Electrical/ Manual Hoists
1. Trucks/dumpers shall transport limestone to the Power Plant via Road. The limestone shall be unloaded manually in the limestone storage shed. Clear access either side of stockpile shall be provided for movement of pay loader/bulldozer/truck/dumper in the shed. Direct unloading limestone to the reclaim underground hopper shall also be considered, accordingly necessary space for truck/dumper movement shall be provided in reclaim underground hopper area. The unloading trucks/trippers shall have a gross load capacity of 60 Ton with a payload of 40 Ton. The unloading truck/dumper will be weighed both in loaded and unloaded condition on the existing weigh bridge near Ash silo. The supply of 1 No. Pay loader & 1 No. Dozer is in bidder's scope. Grizzly over reclaim underground hopper shall be designed to take load of the truck / pay loader / bulldozer in case it moves over it.
 2. Vibrating feeder shall be provided under each reclaim underground hopper for extracting limestone and feed on the belt feeder BF-1A & BF-1B. The belt feeder shall discharge lime on to Bucket Elevator BE- 1A & BE-1B.
 3. Belt feeder BF-1A/1B shall transfer limestone to crusher house through bucket elevator. Suspended magnets (EMS) shall be provided on Belt feeder BF1A/1B for removal of metallic tramp. Two numbers Belt Scales shall also be provided on Belt feeder BF-1A/1B for measurement of limestone flow rate.
 4. In Lime stone Crusher house, limestone from bucket elevator BE1 shall be fed to primary crusher. Similarly, limestone from bucket elevator BE2 shall be fed to another primary crusher. Simultaneous operation of two streams shall be considered by bidder.
 5. Each of the two stage crusher shall crush lime to (-) 20 mm size with screen. The crushed lime shall be discharged on to dedicated set of belt feeder (BF-2A & BF-2B) placed below the crusher floor. The Belt feeders BF-2A & BF-2B shall discharge lime on to Bucket Elevator BE- 2A & BE-2B.
 6. Bucket Elevator BE-2A & BE-2B shall discharge lime to the bulk crushed lime storage silo.
 7. From crushed bulk Lime storage silo, Belt feeders BF-3A & BF-3B shall discharge lime on to Conveyor BC-1A & BC-1B. Conveyor 1A & 1B shall convey the lime to the Conveyor 2A & 2B. Conveyor 2A & 2B shall convey the lime to the day silo.



8. Limestone sampling unit shall be provided to sample the limestone from either stream in crusher house.
9. A passenger cum goods elevator shall be provided in limestone crusher house.

4.0.0 DESIGN CAPACITY AND MARGIN

S No	Equipment	Duty Requirement	Design Capacity as %age of duty requirement
1	Vibrating feeders	2x100% for each stream	110%
2	Bucket elevators (Raw & Crushed Limestone)	2x100%	110%
3	Crushers (Primary & Secondary)	2x100%	110%
4	Screens	2x100%	110%
5	Belt feeders	2x100%	110%

5.0.0 DESIGN CRITERIA

- The limestone delivered to power station shall be of size 250 mm and below. However, occasionally 1-2% limestone of 400 mm lump size may also be encountered.
- Occasionally, metal pieces like broken shovel teeth, brake shoe, wires, shale & sand stone as high as 20% etc. may also come along with Limestone.
- The limestone 'as received' shall contain varying percentage of fines. This may form adhesive lumps particularly during monsoon when surface moisture is at its maximum value. The sizing and selection of all equipment shall take care of above.
- For volumetric computations of limestone handling system the bulk density of limestone shall be taken as 1400 kg/m³. However for torque & drive requirements the density of lime stone shall be taken as 1700 kg/m³.
- For gypsum handling system, the bulk density shall be taken as 900 kg/m³ for volumetric computation and 1250 kg/m³ for torque and drive requirements.
- Reclaimed limestone shall be crushed to the required size by crushers. Two stage crushing shall be provided considering limestone receipt in lumps of 250mm.
- Design capacity of the conveyor system shall be considered for the selection of bucket size, belt (with cleats) width, belt speed and the continuous motor rating at 50 deg C Ambient.
- Lump size of (-) 250mm can be handled by bucket elevator designed to handle the specified limestone.
- Belt conveyor system shall be designed as per the latest edition of CEMA or Equivalent International Standard.
- Bulk Limestone silo shall be stored in RCC Silo. Silo shall be sized to meet the Seven (7) days requirement of the unit for 100 % Gas Treatment at design efficiency. The bidder shall arrive at the effective Capacity of Silo accordingly.



- Day Limestone silo shall be stored in 10 mm thick carbon steel with 4 mm thick SS304 lining in the complete cones. Silo shall be designed to meet the 24 hours requirement of the unit for 100 % Gas Treatment. The bidder shall arrive at the effective capacity of Silo accordingly.
- Bulk Limestone Silo / Day Limestone Silo shall have the following accessories minimum.
 - Bag type vent filter (Pulsating jet type) with fan on the vent line at the top of storage silo to meet statutory Norms. Pressure relief vent on the top of silo to safeguard the silo from getting pressurized.
 - Unloading spout with all accessories such drive equipment, rotary feeder, limit switches, dust suppression unit etc for unloading limestone into conveyors.
 - Silo level indicator with all accessories.
 - Day Limestone Silo shall be provided with minimum 3 nos. of air canons at the necessary location, capable of removing/clogging/blockage in the silo.
 - Necessary fluidizing pad & liner shall be provided for bulk lime stone silo. Based flow study of limestone in bulk storage silo, required air canon shall be provided.
 - One number motorized shut-off gate shall be provided at Day Limestone silo discharge chute to conveyor and Gravimetric Belt feeder. One number shut-off gate shall be provided at Day Limestone silo discharge chute to conveyor and Gravimetric Belt feeder.
 - One number emergency discharge chute with isolation valve shall be provided for Bulk Limestone Silo / Day Limestone Silo. The level of the chute shall be such that limestone can be discharged in to a truck directly. Layout shall permit the truck access near silo.
 - For day limestone silo facilities shall be provided for unloading the silo, through feeder, to a truck at ground level, along with all necessary chutes and diversion chutes.
 - One (1) lot of maintenance/operating floor for silo unloading, staircase to approach upto top of silo, handling arrangement at top of silo, hand railings, rung ladder to approach inside silo etc.
 - One (1) outlet connection with blind flanges & valves
 - Silos shall have a manhole in the shell and also in the roof. The number of manholes shall be decided based on the diameter of the silo.
 - Self-cleaning Bag filters shall be provided on the storage silos. The Bidders should provide exhaust fans to assist venting. Bag filters and fans shall be installed under cover, and the protected from all potential adverse weather conditions. The dust loading from the outlet of the bag filters shall not exceed 30 mg per Nm³ under any operating condition with 10 per cent bags plugged.
 - Facility shall be provided to open/close the day limestone silo outlet gate, through actuator, from remote as well as local.
 - All other items required to make the system complete in all respects.
 - 2 nos. vibrating feeders/belt feeders shall be provided for smooth material flow from silo.
 - PLC shall be provided for limestone handling system.
 - The design of Day Limestone Silo shall confirm to IS 9178 (Part 1 to 3).



- Gravimetric feeders shall be provided for proper weighing of limestone. Lime stone from Silo shall be transferred to the Wet Ball mill for size reduction. Two (1W+1S) wet ball mill and associated system shall be provided. Mills shall have provision of service water tapping in addition to the mill circuit.
- All mechanical, electrical, civil and structural system design shall consider:
 - a. Simultaneous running of both conveyors at rated capacity.
 - b. Starting of one stream with other stream in standstill condition.
 - c. Starting of one stream with other stream in operation at rated capacity.
 - d. Round the clock operation of Limestone & Gypsum handling plant

6.0.0 DRIVE EQUIPMENT RATING

Continuous Motor Rating (Name Plate Rating) at 50 Degree Centigrade Ambient temperature for Electric Motors

a) For conveyors of belt conveyor	*120% of actual power at drive motor systems output shaft at specified design capacity
b) Crushers, monorail hoists (travel and hoisting), elevators, rack and pinion gates, all the drives in sampling units, various pumps of DS/DE systems, service water systems, cooling water system, potable water system and sump pumps, Ventilation Fans.	*110% of actual power requirement at drive motor output shaft at guaranteed (rated) capacity.

*The actual power at drive motor output shaft shall be calculated after considering all the losses of down the line equipment's of the drive train.

Gear Box Rating:

- a) For belt conveyor systems @Service factor X {1.2 times the actual power requirement at drive pulley shaft at design capacity}

In any case, gear box rating shall not be less than motor nameplate rating.

- b) For other equipment@ Service factor X {1.2 times the actual power requirement of the driven equipment}.

@ Service factor shall include all the components considered by the supplier and should be clearly indicated in manufacturer's gear box selection catalogues

Coupling:

Not less than motor nameplate rating.

7.0.0 CONSTRUCTION REQUIREMENTS

- a) Limestone storage shed

Lime stone shall be stored in the storage shed. The limestone fed in to the reclaim underground hopper by truck / pay loader / bull dozer to feed the belt feeder through vibrating feeder. Limestone storage shed of 7 days storage shall be considered. Shed shall be provided with side protection. Adequate space inside shed for truck movement shall be provided.



b) Reclaim Underground Hopper

Four (4) nos. (2x100% for each stream) of Reclaim underground hopper shall be provided. The reclaim underground hopper shall be of RCC construction. The capacity of reclaim underground hopper shall be minimum 30 m³ for each hopper. The minimum valley angle of the hopper will be considered as 60°. The grizzly bar arrangement shall be provided at top of the reclaim underground hopper.

c) Belt Conveyor & Belt feeder

- i. Slopes of conveyors, wherever applicable, shall not exceed 14 deg. depending on the lump size, and other governing factors.
- ii. All conveyors shall be designed for 110% of rated capacity.
- iii. Belt conveyor system shall be designed as per the latest edition of 'Belt Conveyors for Bulk Materials' published by Conveyor Equipment Manufacturer's Association' or equivalent International Standard. A value for idlers shall be considered 2.8 (min.) for the purpose of conveyor calculation.
- iv. Angle of surcharge of all conveyors shall be considered as 20°. Trough angle of conveyor shall be 35°.

- v. Steel cord belt shall be provided with rip protection.

vi. Idlers

- Idlers shall be three roll, 35 degrees troughing angle (with 2 deg forward tilt) for carrying side and impact idler at loading point for all belt conveyors.
- The side brackets for all idlers shall be of pressed 'C' type. Conveyor idlers, below the magnetic separators shall be of non-magnetic material (stainless steel).
- Carrying idlers shall be placed at 0.6m of the normal distances of placed on the conveyors at the convex curve area.
- Impact idlers shall be placed at 400 mm distance at the feeding zone.
- Wobble tolerance idlers with +/-0.2mm shall be provided below the belt weigher for better weighing accuracy.
- Roller used in idlers shall be made from ERW steel tube. Wall thickness shall be minimum 4 mm without any negative tolerance.
- The rollers shall be mounted on EN-8 or equivalent material spindles by means of ball bearings of either deep groove
- The return idlers for all conveyors shall be single roll type. For conveyors longer than 400m, two roll return idlers with 10 deg. troughing angle shall be provided.
- Idler rollers shall be waterproof, dust proof and weather proof against a high velocity water jet. All idlers shall be provided with minimum double labyrinth dust seal.

- vii. Suitable crossover in the gallery shall be provided at an interval of 100 m.



viii. Pulley

- The following minimum parameters shall be followed:
 - Maximum allowable deflection of shaft at hubs : 5 Minutes
 - End disc plate thickness : 12 mm (min.)
 - Shell plate thickness : 12 mm (min.)
 - Diameter:
 - (i) All drive pulleys : 630 dia (min)
 - (ii) All balance pulleys : 500 dia (min)
- Maximum type of pulleys permitted based on pulley diameter and shaft diameter shall be limited to three (3) nos. These shall comprise of two (2) nos. drive pulleys & one (1) no. for all balance pulleys excluding tripper & SS pulleys.
- All pulleys shall be of welded construction, MS construction with rubber lined and statically balanced.
- Thickness of rubber lagging shall be 12 mm grooved in diamond pattern with grooved 6 mm wide x 6 mm deep for drive and 12 mm plain type for non-drive pulleys with shore hardness shall be of 55 to 65 durometer (Shore A). The face width of the pulleys shall be considered belt width + 100mm for conveyors.
- The shafts of pulleys shall be of Forged Steel shaft EN-8 or equivalent material.
- Single snub with wrap angle 210° shall be considered for design of conveyors.
- The pulleys below inline magnetic separators shall have shell of nonmagnetic SS-304. The bearings shall be heavy duty roller type, horizontal split type, dust tight with double labyrinth seals. Lubrication shall be of greasing arrangement with conical head shape nipples.
- For selection of pulley shaft dia of all the pulleys, a margin of atleast 20% shall be considered on the maximum tension at designed Conveyor capacity.

ix. Belting

The belting shall be of Synthetic Fabric of Nylon-Nylon. Number of plies shall be minimum 3. The minimum cover thickness shall be 5 mm at the top and 2 mm at the bottom. Factor of safety shall be considered as minimum 10.

Maximum belt sag shall be 2% between idlers.

Belt ratings shall be selected in such a way that there are only three (3) ratings of belting. This however excludes and belting of belt feeders. Belting shall be completely interchangeable among same rating of belt.

x. Brake

All inclined conveyors shall be provided with hold back integral with the gearbox and electro-hydraulic thruster brakes.

Electro-hydraulic thruster brakes shall also be provided for conveyors where the coasting time is required to be adjusted.



xi. Scrapper

One sprung blade type (Tungsten carbide tip) and one torsion arm type (with poly urethane blade) belt scrapers at discharge pulleys and one no. V-plough type (with poly urethane blade) internal scraper shall be provided for each conveyor. Diagonal plough type scraper shall be provided for the reversible type conveyor/feeder at both head and tail ends.

xii. Take Up

Take up arrangement sand pit, safety guards etc. shall be as per relevant Indian standards. The belt conveyors shall be equipped with suitable tensioning devices. The devices shall have sufficient travel to allow the easy removal and replacement of the belt pulleys. If dead weight tensioning units are employed they shall have slide rails on each side. The total weight should be made up of individual weights of not more than 15 kg each.

Conveyors/belt feeders shall be provided with either screw type (for conveyor length up to 40 m) or automatic gravity take-up (Horizontal / Vertical) (for conveyor length more than 40 m) as applicable.

The gravity take up shall be provided with a minimum travel of 2.5% of length of conveyor plus one splicing length for N-N belt wherever possible. Wire mesh guard of 2.5m height above ground level / maintenance platform level around take up will be provided.

The gravity take up counter weight box shall not be more than 1500mm from ground level at its Lowest position.

Take up arrangement shall suit all operating conditions or (2.5% for synthetic belt and 0.5% for steel/cord belt) of conveyor center to center length whichever is larger. Further the initial location of take-up shall be decided in such a way that it is possible to carryout min. two (2) nos. Vulcanizing Joints without adding any external belt.

xiii. Conveyor Gallery & Walk Ways

All conveyors shall be provided with hood. The hood shall have inspection door at every 15M. For two conveyor, 1100 mm clear walk width at center and 800mm on either side of gallery. Walkways shall be covered with chequered plate and protected from rain.

xiv. Rack & Pinion Gates

Rotary actuator operated rack and pinion gate shall be provided. Gate shall be mounted such that lime load does not act vertically on the gate.

Suitable manually operated rod gates shall be provided over rack and pinion gates for their easy operation and maintenance.

The rack and pinion gates shall be guided properly and suitable rollers with bearings sealed for life and dust proof shall be provided.

The rack and pinion gates shall be mild steel construction with liner plate of 10 mm thick.

The gates shall be operated by means of double rack and pinion. The material of rack & pinion wheel shall be cast steel and shaft be EN-8.



xv. Chutes

- 10mm thick MS mother plate
- Liner plate: 20 mm TISCRA/LSLAS07 on sliding surface and adjacent side
- Minimum chute inclination: 60 deg for limestone
- Minimum chute inclination: 70 deg for gypsum
- Complete chute work above the drive floor for conveyors provided with 'In-line belt magnetic separators' shall be of 10 mm thick SS - 304 in the zone of magnetic field.
- Hinged inspection doors (generously sized) of leak proof construction shall be provided for access/ maintenance purpose, at approachable heights, of the chutes.
- Bolted flange joints shall be of dust tight construction and necessary sealing material shall be provided in all the flange connections for adequate sealing.
- Long chutes guiding flow from considerable height shall be provided with impact plates wherever change in direction of flow takes place.
- For sealing of inspection doors labyrinth type arrangement to be provided. In addition to positive locking arrangement, mounting bolts, to tighten the door further against rubber shall also be provided.
- Approach/maintenance platforms complete with chequered plate floor, hand railings, ladder etc. shall be provided for all gates.

xvi. Magnetic separator

- Inline Suspended Magnetic Separators shall be provided for continuous and automatic extraction and discharge of tramp magnetic pieces from limestone being discharged from conveyors as specified. The sets shall be complete in all respects with drives, magnets, inline belts, hoppers, chutes, tramp-iron boxes and all electrical ancillaries like control panels etc.
- Magnet core material shall be pure annealed iron or equivalent high permeability magnetic material. The coil shall be of aluminum wire with class 'H' insulation, to limit the absolute temperature of the winding to 140 deg. centigrade. The oil used for cooling the ILMS and SM shall be silicon based.
- The 'Force Index' i.e. the product of flux density in gauss and rate of change of flux density w.r.t. distance, at the bottom of falling material trajectory shall be 100,000 (gauss x gauss/inch) minimum in hot condition for mounting height of 400mm. However, the strength of the magnet shall not be less than 1000 gauss in hot running condition at distance of 400 mm. The minimum strength of the magnet shall be 1000 gauss at the specified mounting height at the center of Belt width.
- Mounting height of 400 mm shall be taken between top of conveyor belt or bottom of falling material trajectory and the surface of magnetic separator belt. Characteristic curve of magnet with the value of flux density varying between 50 mm to face of conveyor belt shall be provided. The cross section of magnet shall be suitably designed to provide sufficient area for magnetising the coil



effectively covering full cross section of the discharge material. The magnetic separator shall be located such that it picks-up tramp iron from Lime trajectory after it has been discharged from head pulley.

- The tramp magnetic pieces buried under Lime picked up by the magnetic separator shall be discharged suitably to ensure that it falls into the tramp iron chute, which shall be provided up to ground level. All conveyors with magnetic separator at head end shall have non-magnetic SS pulleys. Head pulleys of all conveyors with in line magnetic separator at head end shall be provided with SS shell and end disc.
- Suitable arrangements shall be provided in the magnet for keeping the coil of the magnet dry from atmospheric condensation when the magnetic separator is not in use.

xvii. Safety Switches

- Pull cord switches : First at 4 m and subsequent at 25 m interval on both the sides.
- Belt sway switches : First at 15 m and subsequent at 50 m interval on both side
- Zero speed switches : One for each conveyor at non drive pulley

xviii. Hoods over the conveyor head pulleys shall be made of suitably stiffened minimum 4 mm M.S. Plates and shall be provided with hinged and gasketed inspection doors with suitable access to them. Further, serrated rubber seal shall also be provided at the very inlet of head chute to minimize dust nuisance.

d) Bucket elevators

- i. Bucket elevators shall be double chain bucket type and shall be manufacturer's standard size and design, modified only as required and suitable for duty
- ii. Bucket elevators shall be designed with a bucket filling rate of 60% by volume at normal operating flow rate and using the minimum density of material. Elevator power calculation shall be based on buckets filled to 100% of the theoretical capacity with minimum density material allowing adequate provision for digging load.
- iii. Factor of safety for chain shall be minimum 10.
- iv. The elevator casing shall be fabricated of steel plate, adequately braced and stiffened so as to be completely self-supporting. Minimum thickness shall be 6 mm.
- v. Suitable chain tensioning device shall be provided.
- vi. Maximum operating speed of the elevators as per IS 7167.
- vii. The bucket elevators shall be equipped with a holdback. The holdback shall be mounted on the side opposite to the drive side.
- viii. Holdbacks shall be readily accessible for regular inspection, maintenance and replacement.
- ix. Holdback selection shall be rated for two times of the motor full load torque.
- x. Drive train, including shaft bearing pillow blocks, shall have a separate support independent of the casing. The support shall be designed such that all drive loads are transferred to the main building structure. For this purpose, shafts shall be



extended to allow for shaft mounting of gear reducer and holdback (on opposite side).

- xi. The gear reducers shall be separate units with a torque arm fixed to a common, heavy duty, base with the motor.
- xii. Casing design shall be self-supported, dust-tight and weatherproof. Dust-tight inspection and repair doors shall be provided as required for proper inspection and maintenance.
- xiii. Zero speed switches shall be provided at non drive end.
- xiv. Sprocket shall have replaceable teeth.
- e) Lime stone crusher (primary & secondary)
 - i) The crusher shall be of hammer mill type and shall be designed on following clauses and the data sheet.
 - ii) The crusher design should be such the crushing action is accompanied by the minimum of attrition.
 - iii) Uniform crushing impact shall be assured.
 - iv) The crusher shall be capable of delivering the normal rated output even when handling damp limestone having maximum moisture content. No clogging or building up of material on the crushing element shall be develop.
 - v) Temperature sensing devices shall be installed on both bearings of each of the crusher to trip the crusher incase temperature goes beyond allowable limit.
 - vi) Crusher shall be provided with vibration monitoring (VMS) system.
 - vii) Zero speed limited switch shall be provided for protection against any un-crushable material.

7.1.0 Flap Gates

The motor operated 2 position flap gates shall be provided in transfer chutes and shall be complete with electrically operated actuators. The gates shall be of robust construction and suitable for trouble free operation. The face of the flap gate shall be made out of 20 mm thick TISCRAI or equivalent material.

The material of shaft shall be EN-8 or equivalent. The diameter of the shaft shall be suitable for motor stalled condition and associated twisting

Provision for alternative manual operation shall also be made using declutchable hand wheel. Manual effort required to operation the flap gate shall not exceed 25 kg.

Flap gate actuator shall be supported from floor/platform, not from the chute body.

All parts of the gate in contact with limestone shall be of stainless steel construction.

7.2.0 Dust Control System

Contractor shall provide adequately sized and fool proof dust control system, the performance of which should be guaranteed by the Contractor as required in the Technical specifications.



Dust Suppression System (Dry fog type)

Operation : Water & air sprayed by Fogging nozzle.
Location of spray : At all Limestone discharge & receipt point on all transfer points
Capacity & Pressure : 0.5Kg/cm² for water (min.)/at spray head 5kg/cm² for air (min.)

Dust Suppression System (Plain water)

Plain water dust suppression system shall be provided for Limestone storage shed in order to suppress the dust.

7.3.0 Ventilation System

Mechanical Ventilation System

- i) Underground Areas : Minimum 15 supply air changes and minimum 7 exhaust air changes per hour.
- ii) Other Areas : Minimum 10 supply air changes

Pressurized Ventilation System : Minimum 15 supply air changes

7.4.0 Dust extraction system

Type : Venturi scrubber type
Capacity : As per American Conference Governmental Industrial Hygienists (ACGIH)
Location :
• Reclaim hopper shed
• Belt feeder after crusher
• Feeder at crusher house
• Gypsum storage shed

7.5.0 Service Water System

Service water connections are to be provided in conveyor galleries at 50 meter interval and one (1) no. on each floor of transfer points, toilets and minimum two (2) nos. on each floor of crusher house.

- i. Flow at each valve : 5 cub.m/hr
- ii. Minimum discharge Pressure at tap point : 2 kg/sq.cm
- iii. No. of valves operated simultaneously : 6 nos.

7.6.0 Cranes and Hoists

The equipment to be covered shall include (but not limit to) all conveyor drive units, all pulleys, in line magnetic separators, sampling units, various DSS/service water/potable water pumps, gravity take up units, suspended magnet, Belt drum at transfer houses /Silo floors etc.

7.7.0 Sump Pumps

The pumps shall be of wet pit types, vertical shaft and impeller shall be specially designed to pass large solids or unscreened liquids. The construction and material shall be suitable for pumping Lime/dust contaminated water with a minimum of maintenance. All bearings of the pump shall be located above the water level.



ANNEX – 2.2.1

SPECIFIED DESIGN DATA

Sl. No.	Description	Unit	Data
A	LIME STONE UNLOADING SYSTEM		
1.	Reclaim Underground Hopper Capacity		Number of reclaim underground hopper required is 4 nos. (2x100% in each stream), RCC construction, 30 m ³ (minimum) storage capacity for each hopper
2.	System capacity		To be sized for single shift operation of 4 hours for 24 hours limestone requirement for 100 % flue gas treatment or 60 tph of limestone requirement for 4 hours operation whichever is maximum. This is applicable for all equipment's/component downstream of unloading limestone hopper and upto day silo.
3.	Crusher, Screens and Feeder		To be sized for single shift operation of 4 hours for 24 hours limestone requirement for 100 % flue gas treatment or 60 tph of limestone requirement for 4 hours operation whichever is maximum. This is applicable for all the equipment's downstream of hopper.
4.	Bucket Elevator (Raw limestone)		
	a) Nos.		Two (1W+1S)
	b) Rated Capacity	T/h	To be sized for single shift operation of 4 hours for 24 hours limestone requirement for 100 % flue gas treatment or 60 tph of limestone requirement for 4 hours operation whichever is maximum.
5.	Bucket Elevator (Crushed Limestone)		
	c) Nos.		Two (1W+1S)
	d) Rated Capacity	T/h	To be sized for single shift operation of 4 hours for 24 hours limestone requirement for 100 % flue gas treatment or 60 tph of limestone requirement for 4 hours operation whichever is maximum.
6.	MOC of Limestone Silo		RCC (Bulk storage)/ MS lined (Day Silo)
7.	Capacity of Limestone Silo		Bulk limestone silo requirement of 7 days. Day (24 hours) Requirement of Limestone for 100 % Flue Gas Treatment
8.	Limestone Particle size	mm	250 (maximum) at Reclaim Underground Hopper



Sl. No.	Description	Unit	Data
B	BELT CONVEYORS		
1.	Type of belt		Synthetic Fabric of Nylon / Nylon
2.	Limestone Conveyor		
a.	Capacity (Rated)		To be sized for single shift operation of 4 hours for 24 hours limestone requirement for 100 % flue gas treatment or 60 tph of limestone requirement for 4 hours operation whichever is maximum.
b.	Capacity (Design)	T/h	110% of rated (guaranteed) capacity for all conveyors
3.	Gypsum Conveyor		
a.	Capacity (Rated)		To be sized for single shift operation of 4 hours for 24 hours gypsum generation for 100 % flue gas treatment or 55 tph of gypsum generation for 4 hours operation whichever is maximum.
b.	Capacity (Design)	T/h	110% of rated (guaranteed) capacity for all conveyors
4.	Maximum slope		14 deg
5.	Max. belt Sag between idlers		2%
6.	Minimum Radius		
	(i) Concave curve		250 m (In case of travelling trippers, the requirement of minimum radius shall be decided based on the space availability)
	(ii) Convex Curve		50 m
7.	Belt Width	mm	Shall not be less than 800mm upto crusher and after that minimum 650mm belt width upto day limestone silo For gypsum handling system the belt width shall be 650 mm throughout.
8.	Belt Speed	m/s	Shall not be more than 2 m/s
9.	Cover Grade		a) Flame test : Conforming to ISO:340 b) Drum Friction and Electrical Surface Resistance Test: Conforming to Canadian standard association CAN / CSA M-422- M87 Grade - C.
10.	Cover Thickness (without – ve tolerances).		
	(a) Face		5.0 mm (min.)
	(b) Bottom		2.0 mm (min.)
11.	No of Plies	Nos	Minimum 3
12.	Drive Arrangement		Snub drive
13.	Factor of safety		10 min. for N-N belt
14.	Normal Working tension at design capacity		Less than 80% of max. allowable working tension



Sl. No.	Description	Unit	Data
15.	Pulley		Heavy duty type.
	Pulley shaft diameter		Margin of minimum 20% shall be Considered on maximum tension at design capacity for arriving at the shaft dia.
	Drive Pulleys		
	Lagging		Hot lagged with vulcanized natural rubber Diamond groove for the head and tail pulleys of bidirectional conveyors.
	Lagging thickness		12 mm thick grooved in diamond pattern with grooves 6 mm wide x 6 mm deep
	Minimum angle of wrap		210° degrees
	Maximum Out of roundness		0.5% of nominal diameter
	Other pulleys		
	Lagging		Hot lagged with vulcanized natural rubber
	Lagging thickness		12 mm thick plain
	Bearings		
	Bearing life (minimum)	h	30,000
	Bearings		Double row self-aligning spherical roller bearing
16.	Idlers		
	Type		
	Carrying		Three roll, 35 degree troughing, 2 degree forward tilt
	Return		Single Roll, For conveyors upto 400 m c/c length. Two roll with 10 degree angle for conveyors more than 400 m c/c length
	Loading point		Impact type
	Spacing		
	Carrying idlers		1.2 m (0.6 m for convex curves).
	Return idlers		3.0 m (for convex curves not more than 1.5 m.)
	Loading point		Minimum six (6) with 400 mm spacing.
	Self-aligning troughing idlers		At 10 m distance from head & Tail pulleys with intermediate spacing 15m
	Self-aligning return idlers		At 10 m distance from Head & Tail pulleys with intermediate spacing 20m. (Not required for conveyors more than 400m c/c long where 2 roll return idlers are provided).
	Bearings		
	(a) Carrying		Ball Bearings of deep groove type or seize resistance type of min. 30 mm size, lubricated for life.
	(b) Return		Ball Bearings of deep groove type or seize resistance type of min. 20 mm size,



Sl. No.	Description	Unit	Data
			lubricated for life.
	Material		
	(a) Roller		ERW Steel tube min. wall thickness 4.0 mm
	(b) Spindle		EN- 8 or equivalent.
	Testing of rollers		Free rotation, friction, Dust & water tests
	Lubrication		Life lubricated (Factory lubricated & sealed for life)
17.	Technological structures		
a)	Stringers/Short supports		Min. stringer size shall be ISMC 100 Short post shall be provided with sufficient cross bracing and knee bracing wherever required.
b)	Deck plate		Min. 3.15 mm shall be provided at feeding point and discharge point.
c)	Seal plate		Min. 3.15mm shall be provided road/rail way crossing.
18.	Accessories		
a)	No. of belt cleaners		External: Two (2) nos. two shall be at head end Internal : one at tail end (internal)
b)	Belt Cleaners		
	External		Spring loaded scraper type cleaner with modular, segmented and replaceable PU blades with separate main-cleaner & precleaner etc.
	Internal		V-Plough type, mild steel flats with hard rubber strips.
19.	Skirt board		
a)	Length		Entire feeding chute shall be extended minimum 3 m ahead of front edge of chute & 500 mm beyond rear edge of chute.
b)	Width		Width: 2/3rd of the belt width Skirt board shall be designed in such a way avoiding spillage if the conveyor is having multiple feeding points
c)	Height		Not less than 750 mm
d)	Side plate		10mm(min.) TISCRAKMS/Equivalent
e)	Liner		Liner :min 5 mm thick TISCRA/ SAILHARD
f)	Thickness of skirt rubber		Min 25 mm for side skirt and 32 mmm for rear skirt.
g)	Hardness		55 (+/-) 5 shore A
h)	Chute blockage switch		Required
i)	Conveyor life		7000 hrs (min)



Sl. No.	Description	Unit	Data
20.	Magnetic Separator/ Suspended magnets		
a)	Location		Over Discharge Pulley
b)	Force Index		Minimum 100,000
c)	Strength of magnet at the specified mounting height		1000 gauss
d)	Drive unit		Adequately sized with 20% margin
e)	Belting		Suitable to withstand high temperature & impact of tramp iron
f)	Discharge		Into tramp iron chute
21.	Belt Scale		
a)	Type		Electronic load cell type
b)	Operation		Microprocessor based fully automatic
c)	No. of floating idlers		Minimum four (4)
d)	Load Cells		
e)	Type		Strain gauge type hermetically sealed
f)	Minimum Nos.		Four (4)
g)	Overload protection		100 % of rated belt scale capacity
h)	Structural capacity		250 % of rated belt scale capacity
i)	Flow Rate Indicator		Electronic Digital Display Minimum 4 digits
j)	Flow totalizer		8 digit display with reset facility.
k)	Accuracy		For entire range of 20% to 120% of rated capacity with an accuracy of atleast ($\pm$) 0.25% throughout its range.
l)	Calibration		
	Automatic		Zero & span calibration
	Manual		With test load chain
	(a) Test load chain length		Two idler spaces more than weighing lengths
	(b) Chain reel equipment		Complete with weight adding facility.
22.	Drive Motors		
a)	Type		Three Phase Squirrel Cage Induction Motors
b)	Mounting (for conveyors)		Base mounted
c)	Continuous motor rating (Name plate rating) at 50 °C Ambient		120% of actual power requirement at motor output shaft at design capacity.
23.	Conveyor Bridges		
a)	Walkways		
	(a) Construction		Chequered plate with antiskid arrangement.



Sl. No.	Description	Unit	Data
			Chequered plate steps shall be provided where conveyor slope exceeds 10 degrees. (Totally sealed so that no water falls down while washing.)
	(b) Central walkway width		1100 mm
	(c) Side walkway width		800 mm
b)	Side Windows		
	(a) Spacing (Center to center)		25.0 m on each side (in staggered fashion)
	(b) Size		1.2 m x 1.5 m
24.	Trestles		
a)	Spacing of monkey ladders on trestles		
	(a) Where height of conveyor gallery (walkway level) is 10m or more.		On every trestle
	(b) Where height of conveyor trestle gallery (Walkway level) is less than 10m.		On alternate trestle
C	BRAKES AND CLAMPS		
1.	General		
a.	Brakes		(i) For decelerating of conveyors & rotating equipment's. (ii) Brakes are mandatory for H.T. drives involving scoop type coupling.
b.	Rail Clamps		For various mobile equipment travelling on rails
2.	Design & Construction Requirement		
a.	Brakes		
i.	Type		Electro Hydraulic Thruster brakes A.C. operated or Disc brakes.
ii.	Braking Torque		Adjustable from 0 to 100% of rated braking torque.
iii.	Brake Shoes		Operated directly by spring
iv.	Shoe lining		Asbestos with interwoven brass wires.
v.	Max. Temperature for shoe lining		200 degree C.
vi.	Thruster		Class-B insulation, IP-65 protection.
b.	Clamps		
i.	Rail Clamp support		Independent from the rails.
ii.	Limit Switches		ENGAGED & "DISENGAGED" signals.
iii.	Clearance between Rail damp face & Rail surface		Minimum 50 mm
iv.	Material for Rail clamp Mechanism		Forged steel
v.	Thruster		Class-B insulation, IP-65 Protection



Sl. No.	Description	Unit	Data
vi.	Type		Electro hydraulic thruster, manual
D	METAL DETECTOR		
a.	General		
	Type		Coil type
b.	Design & Construction		
i.	Sensitivity		25 mm aluminum sphere below limestone for synthetic belting
ii.	Enclosure		Fiber glass
lii.	Control		Through local control panel.
iv.	Calibration		Provision for automatic static calibration with adjustable sensitivity.
E	LIMESTONE SAMPLING UNIT		
a.	General		
	Type		Automatic
b.	Design & Construction		
i.	Codes & Standard		ASTM C-50
ii.	Uncrushed feed limestone size		(-) 250 mm
lii.	Crushed feed limestone size		(-) 20 mm
F	LIMESTONE CRUSHER (PRIMARY/ SECONDARY)		
1.	Type		Hammer mill type crusher
2.	Stages		2 stage crushing (Primary and secondary)
3.	Nos.		1W+1S
4.	Design Capacity of crusher		To be sized for single shift operation of 4 hours for 24 hours limestone requirement for 100 % flue gas treatment or 60 tph of limestone requirement for 4 hours operation whichever is maximum.
5.	Material to handle		Limestone
6.	Feed size		-250 mm, occasionally 1-2% of 400mm size
7.	Product size		-20 mm, 90 % (min.)
8.	Vibration Limit		As per ISO 10816
9.	Drive arrangement		Electric motor with belt drive
10.	Rotor Balancing		Static
11.	Type of sealing		Labyrinth, dust tight arrangement
12.	Type of bearings		Spherical roller
13.	Tramp collection		Required
14.	Output size adjustment facility		Required



Sl. No.	Description	Unit	Data
15.	Top cover of crushers		Hydraulically operated
16.	Lubrication		Manual through grease gun OR with recommended grade of oil in which case the Plummer block shall be designed with oil filling, oil draining and visual oil checking facilities
17.	Material of construction		
a)	Rotor shaft		Forged steel
b)	Hammer head		Wear resistant cast alloy steel/Mn Steel IS276 Gr.3
c)	Hammers arm		Carbon steel
d)	Housing / frame		Steel, IS:2062
e)	Breaking blocks		Cast steel / MS fabricated
f)	Liners		
	Material		Suitable for duty required
	Thickness		As required.
18	Vibration Monitoring System		
a)	Number & type of vibration		One (1), Microprocessor based, monitoring system able to distinguish between high frequency vibration caused by bearing trouble and low frequency vibration caused by imbalance.
b)	Number of channels		16 (Rack mounted in cabinet)
c)	Transducer		a) Velocity pick-up or a peizo-electric accelerometer. Type shall be decided during detail engineering based on the details of equipment to be monitored. b) Light weight stud mounting. c) Frequency response 1 Hz -10kHz.
d)	Connecting cable		Low noise fire proof coaxial cable to be laid in flexible conduit.
e)	Monitors (to be located in FGD control room)		Dual channel monitor for each location along with: a) Buffered signal output and software for vibration analysis through FGD control desk HMI. b) Recorder signal output
f)	Display		Analogue and digital
g)	Alarm		0-100% full scale adjustable.
h)	Trip		0-100% full scale adjustable.
i)	Test		Functional checking from front inhibiting alarm & trip
j)	Relays		0.25 A at 220 Volts DC or 5 Amp at 240V AC. Independent potential free contacts for alarm & trip purpose.



Sl. No.	Description	Unit	Data
k)	Signal Conditioner		individual 4-20 mA DC analogue output.
l)	Power Supply		240 V $\pm 10\%$ AC, 50 Hz $\pm 3\%$, -5%
G	CHUTES & HOPPERS		
a)	Sliding zones & adjacent sides		Minimum 20 mm thk. TISCRAAL / equivalent
b)	No striking/ Non sliding zones		Minimum 10 mm thk MS
c)	Chute with valley angle 60 degree and above (for limestone)		All four sides of 20 mm thk. TISCRAAL/equivalent material
d)	Chute with valley angle 70 degree and above (for gypsum)		All four sides of 20 mm thk. TISCRAAL/equivalent material
e)	In the zone of magnetic field of ILMS (chute above floor over which ILMS is suspended)		SS-304 10 mm thk.
f)	In the zone of flap gates		20 thk TISCRAAL/ equivalent material
g)	Discharge Hoods overhead pulleys		4 mm thk M.S. with rubber curtain
h)	Inspection Doors		Hinged & leak proof construction (min. size 350 x 450 mm)
	Flap Gate		
a)	Type		Linear actuator operated, 2 position
b)	Travel		60 to 70 deg. (with limit switches on both sides).
c)	Drive		Dust tight motor driven with suitable linkages
d)	Shaft		EN8
H	DRIVE EQUIPMENT		
a.	General		
	Continuous Motor Rating (Name Plate Rating) at 50 Degree Centigrade Ambient temp. for Electric Motors		
	a) For conveyors of belt conveyor systems		*120% of actual power at drive motor output shaft at specified design capacity
	b) Mobile trippers travel drive, mono-rail hoists (travel and hoisting), various pumps of DS - systems, service water systems, cooling water system, potable water system and Ventilation Fans		*110% of actual power requirement at drive motor output shaft at guaranteed (rated) capacity.
	*The actual power at drive motor output shaft shall be calculated after considering all the losses of down the line equipment's of the drive train.		
	Single LT drive motors shall be used for conveyor drive ratings up to 200 KW. For conveyor drive rating beyond 200 KW, single HT drive shall be used for conveyors.		
b.	Design & Construction Requirement		
i.	Gear Box		Type
	(a) Below 40 kW		Helical, worm, bevel as per requirement without cooling coil



Sl. No.	Description	Unit	Data
	(b) Equal to and Above 40 kW		Helical / bevel helical without cooling coil
	Service Factor		As per accepted engineering practice / manufacturer's recommendations .
	Ambient temperature for Thermal rating		50°C Minimum
	Mounting		On Machined/Ground Surfaces
	Output Rating		a) For belt conveyor systems @ Service factor X {1.2 times the actual power requirement at drive pulley shaft at design capacity}
			b) For other equipment @ Service factor X {1.2 times the actual power requirement of the driven equipment }
	@ Service factor shall include all the components considered by the supplier and should be clearly indicated in manufacturer's gear box selection catalogues.		
	Duty		24 Hrs. Continuous
	Rating		Not less than motor name plate rating
	Thermal Rating		Corresponding to 50 Deg ambient Temp and in any case shall not be less than motor rating.
ii.	Flexible Couplings		
	Type		Geared coupling.
	Rating		Not less than motor rating.
iii.	Fluid Couplings		For all motors having rating more than 40 kW.
	Type		
	(a) L.T. Motors		Traction type
	(b) H.T. Motors		Scoop tube type
	Rating		Not less than motor nameplate rating
	In lieu of fluid coupling & gearbox bidder may also offer permanent magnet coupling/adjustable speed drive with permanent magnet coupling for motor upto 200kW rating		
I	MISCELLANEOUS SYSTEMS		Service water system, Potable water system, Sump pump and DSS system pumps
1.	Service Water System		
a)	Pumps		2x100% for water
b)	Water connections		
	(a) Conveyor Galleries		every 50 m
	(b) Junction tower		Min. 1 no. at every floor
	(c) Limestone storage shed		To be provided
	(d) Crusher house		Min. 1 no. at every floor
c)	Connection details		32 NB plug valve
d)	Hose pipes with hose reel		One in each building of 25 mtr. Length with nozzle



Sl. No.	Description	Unit	Data
2.	Potable Water System		
a)	Pumps		2 X 100% electric motor driven
b)	Water connections		
	a) Limestone storage shed		To be provided
	b) Crusher house		Minimum one (1) no. at each floor
	c) Junction tower		Minimum one (1) no. at each floor
3.	Dust Suppression System (Plain water)		
a)	Pumps		2 X 100% electric motor driven
b)	Water connections		
	a) Limestone storage shed		To be provided
4.	Water Supply Pumps for SW/PW/DSS		
a)	Casing		Axial or radially split with drain & vent connection
b)	Impeller		One piece, keyed to shaft along with locking device
c)	Shaft		Critical speed atleast 20% away from operating speed
d)	Shaft sleeves		At bearings & stuffing boxes.
e)	Bearings		Antifriction type
f)	Wearing rings		Renewable type (preferable)
g)	Pump speed		Below 1500 rpm for capacity more than 10 m ³ /hr
h)	Head flow characteristics		Suitable for parallel operation.
i)	Materials:		
	(a) Casing		Cast Iron to IS:210, FG 260
	(b) Impeller		Bronze conforming to Gr.I of IS:318
	(c) Impeller Wearing ring		Bronze conforming to Gr.I of IS:318
	(d) Casing Wearing ring		Bronze conforming to Gr.I of IS:318
	(e) Shaft		Medium carbon steel
	(f) Shaft sleeve		Stainless steel conforming to AISI-416 hardened.
	(g) Gland packing		Impregnated teflon
5.	Sump Pumps		
a)	Type		Wet pit type vertical shaft
b)	Duty		Capacity to handle large solids or unscreened liquid.
c)	Materials:		
d)	Casing and rotor housing		Ni-Cast Iron (350 BHN)



Sl. No.	Description	Unit	Data
e)	Rotor		Ni-Cast Iron (350 BHN)
f)	Shaft		Medium carbon steel
g)	Gland		Bronze
h)	Wearing rings		Stainless steel
i)	Shaft enclosing tube		Carbon steel
6.	Piping & Fittings		
a.	Joints		
	(i) Pipe to pipe		
	Pipe size, ≤ 50 NB		Socket welding/screwed
	Pipe size ≥ 65 NB		Butt welding
	(ii) Pipe to valves		
	Pipe size ≤ 50 NB		Screwed
	Pipe size ≥ 65 NB		Flanged
b.	Isolation of flow		Plug / Gate / Sluice valves
c.	Regulation of flow		Globe Valve
d.	Valves		
	(i) Size ≥ 65 NB		Bolted bonnet outside screw rising type.
	(iii) Size ≤ 50 NB		Union bonnet with screwed ends for Globe valve & screwed ends for plug valve
e.	Materials for Pipework		
	(a) For sizes 200 NB and Larger		ERW carbon steel pipes to API-5LGr. BI IS:3589 with minimum thickness 6.35 mm
	(b) For sizes 150 NB to 65 NB		ERW carbon steel black pipes to IS: 1239 (Part-Heavy class).
	(c) For sizes below 65 NB		ERW carbon steel galvanized pipes to IS:1239 (Part-1) Heavy class.
f.	Materials for Valves & Specialities		
	(a) Cast Iron Valves		65 NB and above
	(i) Body and bonnet		Cast Iron to IS:210, Gr.FG-200
	(ii) Disc for non- return		Cast Iron to IS:210, Gr.FG-200 valves
	(iii) Seating surfaces and rings		13% chromium steel
	(iv) Hinge pin for non return valves		Stainless steel type AISI-316
	(v) Stem for gate and globe valves		13% chromium steel
	(vi) Back seat bush		13% chromium steel
	(a) Gun metal valves (50 NB & below and upto a working pressure of 10 kg/cm² (g))		
	(i) Body		Gun metal to IS:318, Gr-2.
	(ii) Trim		Gun metal to IS:318, Gr-2.



Sl. No.	Description	Unit	Data
	(b) Duplex Strainer		
	(i) Body		MS fabricated
	(ii) Strainer		Stainless steel type element AISI-
J	BUCKET ELEVATOR		
a)	Pick-Up velocity		Less than 2.5 m/s
b)	Casing steel plate thickness		Intermediate sections – 4 mm Boot section – 6 mm
c)	Bucket width		Min. four times the maximum particle size.
d)	Bearing life (L ₁₀)		60000 hours.
e)	Dust collecting vent		To be provided for head section and boot section
K	BAG FILTER		
a)	Location		At the top of silo
b)	Quantity	No.	As per flow scheme
c)	Type		Compressed air cleaned, reverse pulse jet type
d)	Duty		Continuous-24 hours/ day
e)	Material Handled		limestone
f)	Material of Construction		
i.	Bags		Polyester needle felt of antistatic type
ii.	Cages		Carbon steel with hot dip galvanised
iii.	Casing & Duty		Carbon steel to ASTM A 36/ equivalent
g)	Volume of Dust Laden Air to be handled	m ³	Will match the flow rate of material-air mixture Into limestone silo
h)	Air-to-Cloth Ratio	m/min	1.5
i)	Maximum Dust Concentration in Air that will be Let Out to Atmosphere	mg/Nm ³	30
j)	Are Controls for Automatic On-line Bag Cleaning System Required?	Yes	
k)	Tests		
	Visual and dimensional check at works	Yes	
	Site tests for functioning of the automatic on-line bag cleaning system	Yes	
	Check for dust concentration in the air to be let out to atmosphere at site	Yes	
l)	Exhaust Fan		
	a) Location		At the air outlet of bag filters
	b) Quantity		As per system requirement
i.	Type		Centrifugal



Sl. No.	Description	Unit	Data
ii.	Capacity	m ³ /s	To suite system requirement
iii.	Suction Pressure (MWC)	K Pa	To suite system requirement
iv.	Discharge Pressure (MWC)	K Pa	To suite system requirement
L	PAY LOADER		
i.	Quantity		2 Nos. (1 No. for Limestone storage shed & 1 No. for Gypsum storage shed)
ii.	Material to be handled		Lime stone / Gypsum
iii.	Engine Power	HP	Shall not be less than 150 HP
iv.	Loader Capacity	m ³	Shall not be less than 2.3 m ³
M	CRAWLER TYPE DOZER		
i.	Quantity		1 No. for Limestone storage shed
ii.	Material to be handled		Lime stone
iii.	Engine Power	HP	Shall not be less than 416 HP
N	WHEEL TYPE DOZER		
i.	Quantity		1 No. for Gypsum storage shed
ii.	Material to be handled		Gypsum
iii.	Engine Power	HP	Shall not be less than 416 HP



VOLUME - II
SUB-SECTION - 2.3

WET BALL MILLS, LIMESTONE SLURRY & GYPSUM PREPARATION

1.0.0 GENERAL

This section covers minimum requirements for design, engineering, fabrication, manufacture & assembly, inspection, erection, testing and commissioning of complete Wet Ball Mills and Limestone Slurry and Gypsum preparation system.

2.0.0 CODES AND STANDARDS

The equipment to be provided shall specifically conform to the latest editions of the following codes, standards, specifications and regulations. Also the system design shall conform to the requirements of applicable codes as specified in the General Technical Specification

IS 5120 / API 610 / HIS/ IS:8034/	
IS:9283	: Centrifugal Pumps
IS 1710 / ANSI / HI	: Vertical Pumps
ASME B 31.3	: Chemical Plant Piping
ISO 4427/4437/IS :4984/ ASTM	
D3350	: HDPE Pipes
ANSI B 16.5	: Flanges (Upto 600 NB)
AWWA C 207	: Flanges (Above 600 NB)
ISO 7919 / ISO 10816	: Vibration
IS 9222 Part 1	: Chemical Handling Devices
OSHA	: Occ. Safety Health Admin.
ISO 1996	: Noise Level

3.0.0 DESIGN CRITERIA

- Gravimetric feeders shall be provided for proper weighing of limestone and conveying to Wet ball mill. Lime stone from Day Silo shall be transferred by gravimetric belt feeder and bucket elevator (if necessary) to the Wet Ball mill for size reduction. The system shall be 2 x 100 %.
- Gravimetric feeders shall be sized to meet 110% of the maximum mill capacity.
- The Ball Mill permeate shall be collected in a mill separator tank. The Mill Separator tank shall have suitable compartments to have maintenance.
- Two (1W + 1S) Mill circuit Pumps transfer the water to the Mill circuit Hydro cyclones.
- The Up flow water shall be transferred to the Limestone slurry tank whereas the down flow is transferred back to the Wet Ball mill for size reduction again.
- FGD shall be provided with One (1) no. limestone slurry tank. Agitator shall be mounted on the tank to enhance proper mixing.
- All tanks shall have level transmitters, local level gauge.
- Gypsum Bleed Pumps (2 x 100 %) shall be provided to bleed the slurry from the Absorber sump out of the system. The bleed is pumped to the Hydro Cyclones to concentrate the solids.



- The Thickened flow from the Hydro Cyclone is taken to the Vacuum Belt Filter for water removal and cake formation. The Gypsum formed shall meet the saleable requirements of the Domestic Market.
- The Gypsum shall be stored in Gypsum storage shed. The System shall also have Provision for Direct Unloading into the Commercial trucks.
- The recovered water from the belt filter shall be collected in filtrate water tank and pumped back to the system.
- Vacuum is maintained in the Belt filter by 2 x 100 % vacuum pumps.
- FGD area and associated buildings shall have a sump to collect the overflow and the drains. The sumps shall be provided with pumps (1W + 1S) to pump the collected water back to the system. The operation of the pumps shall be automatically controlled.
- All parts of the mill including mill body, hydro-cyclones, integral pipes, mill circuit pumps and other parts in contact with limestone slurry shall be provided with replaceable rubber wear liners. The wear liners or wear parts shall have a minimum guaranteed wear life of not less than 8000 hrs without reversal of the liners.
- Necessary Emergency and safety showers shall be envisaged in areas where ever chemicals are handled.

4.0.0 CONSTRUCTION REQUIREMENTS

4.1.0 Gravimetric Feeders

The limestone feeder belt shall be of seamless rubber construction. It should be possible to adjust the belt tension from outside without opening the feeder body.

All parts in contact with limestone except belt shall be of stainless steel construction.

The feeder shall have adequate instrumentation to detect 'loss of flow'.

The feeder shall have a motor/pneumatic operated gate at the outlet.

4.2.0 Ball Mills

Each ball mill shall be sized to process the maximum daily limestone required by the unit for the Worst Coal analysis which requires maximum limestone consumption with 10 % margin.

The system shall be designed for 24 Hrs Operation and also for Start-Stop Condition.

Ball charge shall be suitably designed, sized, and selected hardened balls to accomplish the desired limestone size reduction and minimize ball consumption.

Outlet Size - > 90 % through 325 Mesh or higher as required by the system for an inlet size of 20 mm limestone. Or through 200 mesh for bubbling process.

The ball mill shall be driven by a motor through a peripheral gear/ central drive system. An auxiliary motor shall also be provided for inching of mills after trip and during maintenance.

Mills shall be mounted in horizontal orientation. Service Factor for the Gear Box shall be 2.0. Gear Box shall be as per AGMA standards.



Ball mill shall be statically and dynamically balanced.

All inlet and Outlet Connections shall be Flanged connections.

Mills shall have labyrinth and seals as required to prevent leakage.

Mill Shell shall be of steel plate conforming ASTM equivalent material as approved by Owner. Suitable lining is required; Bidder shall consider the same and furnish the same in the offer. The linings shall have a minimum guaranteed life period of 8000 hrs without reversal of the liners. The guaranteed capacity and fineness of the mill shall not be affected within the guaranteed life of the mill wear parts.

Mills shall have Suitable man Holes adequately sized and suitably located for the purpose of Maintenance and Inspection.

The material of the balls shall be chosen to ensure that the balls do not lose their original shape and to ensure minimum ball consumption. The Bidder shall furnish the details on the various diameters of the balls used and guarantee the ball consumption per ton of limestone.

Mill shall have auxiliary motor for inching of the mills during shut down and maintenance.

Bearings shall have proper lubrication arrangement. Necessary Pressure, Flow and Temperature Measurements shall be provided for the lubrication system. Bearings shall be AFBMA 60,000-hour minimum L10 life.

Facility shall be provided for on-load loading of steel balls to the mill.

The mill auxiliaries like separator tank, mill circuit pump, hydro-cyclones and all connecting pipes handling limestone slurry shall have replaceable rubber linings

The lube oil system shall have 100% stand-by arrangement for lube oil pumps and oil coolers of each circuit with independent pump / cooler. Wherever required duplex oil filters shall be provided.

4.3.0 Classifiers

The Classifiers shall be hydro cyclone type. The hydro cyclones shall have feed input connection, UP flow connection and down flow connections. These shall have suitable lining.

Hydro-cyclones shall be of modular construction. It shall be possible to remove and replace individual hydro-cyclone with the set in service.

All connections shall be flanged so that the equipment shall be taken for maintenance.

The inlet and outlet lines shall have facility to isolate the system with suitable type of valves so that the equipment shall be taken for maintenance.

Necessary Flow, Temperature, density and Pressure measurements shall be provided.

2 x 100 % Hydro cyclones shall be provided for Ball mill area, Primary hydro cyclone and Secondary hydro cyclone area.

Design Criteria:

The equipment shall be designed for continuous and heavy duty Operation.



All the components especially the wear and tear part of the equipment shall be replaceable.

The Equipment shall have the following as minimum:

- Body
- Frustum
- Vortex Chamber
- Overflow Chamber
- Underflow Chamber
- Support Frame
- Necessary flanges, Isolation valves, piping etc.

The inside components shall be selected to resist the erosive and abrasive nature of the process fluid.

Construction

All the replaceable parts shall have flanged connections and shall be interchangeable.

The Material of construction Casing/ shall be as follows:

• Casing / Inlet Casing	:	Mild steel with rubber lining or suitable lining
• Vortex Chamber	:	Molded Rubber
• Overflow/Underflow Chamber	:	MS with rubber lining or other suitable lining.

Bidder shall specify the details of the lining in the offer submitted.

The hydro-cyclone shall be of proven design and shall be provided with replaceable rubber lining. The feed chamber shall be provided with replaceable rubber lining of thickness 12 mm for the feed chamber and 12 mm for the overflow launder. The liners shall have a minimum wear life of not less than 8000 hrs.

4.4.0 Mill Separation Tank

Mill separation tank shall be RCC with lining. This shall be Twin compartment so that the Outlet from Hydro cyclones shall be connected to both the compartments.

Each compartment shall be provided with necessary baffles, agitators, inlet, Outlet, Overflow, drain connections and level measurements.

The limestone mill separation tank shall be installed indoor beneath the hydro cyclone station.

4.5.0 Limestone Slurry Tank

Limestone slurry tank shall be sized to meet 12 hours continuous limestone requirement at Design point. For tank volume calculation, solid concentration (by weight) in the slurry shall be assumed, not more than 30% or actual required whichever is lower.

The storage tank shall be equipped with sufficient number of agitators, to avoid settling of limestone.

The slurry preparation tank shall be CS construction with replaceable chlorobutyl / bromobutyl rubber lining of minimum 5 mm thickness

The slurry storage tank shall be located outdoor.



4.6.0 Gypsum Dewatering System

Two stage gypsum dewatering system shall be provided, consisting of a primary stage of sets of hydro cyclones and secondary stage of vacuum belt filters for dewatering of gypsum from absorber up to less than 10% moisture.

The Bidder shall provide 2x100% gypsum dewatering system with each stream sized to dewater 110% of the maximum gypsum produced by the unit operating at Design point.

4.7.0 Primary Dewatering Hydro-cyclones

The primary hydro-cyclone shall be installed directly above the belt filters. The overflow of the hydro-cyclones shall be taken to Hydro-cyclone Waste Water tank. Secondary hydro-cyclone feed tank and secondary waste water hydro cyclone shall be included as shown in the tender drawing.

Hydro-cyclones shall be of modular construction. It shall be possible to remove and replace individual hydro-cyclone with the set in service. Individual isolation valve shall be provided for each hydro-cyclone for this purpose.

Each set of primary dewatering hydro-cyclone shall be sized to dewater the gypsum slurry produced by operating the unit at Design point with an additional 10% margin. The outlet water content in the gypsum shall be as per the requirement of the vacuum belt filters.

Each set of primary hydro-cyclone shall be provided with 10% spare hydro-cyclones. The capacity defined in the previous clause shall be met with spare hydro-cyclones out of service.

The hydro-cyclone shall be of proven design. The primary hydro-cyclone shall be made up of polyurethane or urethane materials. It shall be possible to remove and replace individual hydro-cyclone with the set in service. Individual isolation valve shall be provided for each hydro-cyclone for this purpose.

The hydro-cyclone shall be of proven design and shall be provided with replaceable rubber lining. The feed chamber shall be provided with a minimum lining thickness of 12 mm. The liners shall have a minimum wear life of not less than 8000 hrs.

4.8.0 Vacuum Belt Filters:

2x100% Vacuum belt filter shall be provided.

Each vacuum belt filter shall be sized to meet the following requirements, all occurring together, with an inlet solid concentration of not more than 45% or outlet of hydro-cyclones whichever is minimum.

The Vacuum belt filters shall be designed for continuous Operation.

Filters shall be suitable for high degree of separation/filtration. Filters shall be washable, reused.

The system shall be designed to handle slurry to the highest concentration.

Suitable Feed/ slurry distribution system shall be envisaged for dispersing the slurry across the complete width of the Horizontal belt filter.

Filter Pan, Scroll discharge and scroll drive mechanism.



To avoid spillage and overflow of the slurry from the filter, roller dam arrangement shall be envisaged.

Wash distributor shall be envisaged to distribute the wash liquor across the complete width of the Horizontal belt filter.

Required number of Flap dams shall be provided.

Vacuum pipe line with necessary isolation valve, pressure transmitters, vacuum box, vacuum pumps etc shall be provided for the system.

The vacuum box shall ensure tight sealing with the belt/cloth and shall be of proven design.

The vacuum box shall be suitably located so that it can be lowered or elevated automatically as well as manually to enable inspection/ cleaning.

The vacuum hose from the filtrate shall be connected to the moisture trap.

The belt shall be SBR of minimum 38 mm Thickness, shore Hardness 65 ± 5 A. Suitable arrangement shall be made to minimize the friction. Bidder shall also alternatively suggest suitable proven material.

The belt filter shall have an automatic cloth tracking mechanism and shall be provided with all required instrumentation.

Necessary limit switches, Safety trip switches, pressure relief valve etc shall be provided for the safe operation of the system.

The Basin below the filter shall be adequately sized and have proper slope to drain the filtrate/wash water.

The filter shall be provided with minimum 2 stages of cake washing for removing impurities in the gypsum.

Gypsum cake from each belt filter shall be discharged through a hopper onto belt conveyor. The elevation of discharge point of vacuum belt filter shall be atleast 5.0 m above GL.

A 2 m (min.) wide platform shall be provided around each belt filter for easy approach & maintenance.

The filtrate from belt filter, cake washing & cloth washing shall be taken to separate receiver tank.

Handling facilities for replacement of heavy components of the belt shall also be provided.

Gypsum generated from Vacuum belt filter shall be conveyed to storage area through series of conveyors.

4.9.0 Vacuum Pump

- Each belt filter shall be provided with an independent vacuum pump sized to meet the requirements of the belt filter operating at its maximum capacity. An additional margin of 10% (min.) over the above capacity shall be provided for each vacuum pump.
- The vacuum pump shall be of low speed liquid ring type of proven design. The design of the vacuum pumps shall avoid cavitations under all operating conditions. The seals shall be of proven design.



- Silencers shall be provided, if required, to limit the noise level to stipulated values.
- The vacuum receiver and pump internals shall be suitably lined to protect against the corrosive environment. The material selected for vacuum pumps & vacuum receivers shall be proven for similar application.
- Each vacuum receiver tank shall be provided with slide plate type pneumatic vacuum breaker. The plate shall be stainless steel with a min. thickness of 3 mm Filtrate System
- Water from vacuum receiver tank and the secondary waste water hydro cyclone underflow shall be taken to a filtrate tank for recirculation in to the system.
- 2x100% horizontal centrifugal pumps (Filtrate feed pumps) shall be provided for recirculation of filtrate water to absorber and Mill separator tank.
- 2x100% horizontal centrifugal pumps (Belt filter wash water pumps) shall be provided for wash water requirements of belt filter.
- The pump shall be capable of pumping of filtrate water with solid concentration of not less than 10% & particle lumps of 6-7mm.
- A 10% margin shall be provided in each of the pump.

4.10.0 Waste Water System

- The overflow of the primary hydro-cyclones shall be taken to a secondary hydro cyclone feed tank for feeding the secondary waste water hydro-cyclones.
- The secondary hydrocyclone feed tank shall be sized to provide a minimum storage of 1 hr of primary hydro-cyclone overflow with unit operating at Design Point and no outflow from the tank
- 2x100% horizontal centrifugal pumps shall be provided to feed the secondary waste water hydro-cyclones. Each pump shall be sized to empty the full storage capacity of the tank in 6 hrs.
- Secondary Hydro-cyclones shall be of modular construction and of proven design. It shall be possible to remove and replace individual hydro-cyclone with the set in service.
- The secondary waste water underflow shall be taken to the adequately sized filtrate tank, while the overflow shall be taken to a waste water tank.
- Waste water tank shall be sized for 8 hrs. storage of waste water with the unit operating at BMCR and no out flow from the tank. 2x100% horizontal centrifugal pumps shall be provided for pumping the waste water to waste water treatment plant.
- Lime tank for neutralization shall be of 2 Cum capacity in carbon steel construction with epoxy painting. The tank shall be provided with SS dissolving basket, agitator of SS construction, drain, overflow and dosing connection.
- All piping, valves & instrumentation upto the employer's terminal point shall be in the contractor's scope. Contractor shall provide the complete lime dosing system to correct the pH of the waste water by lime (83% purity) dosing shall be provided and after mixing of the effluent (using re-circulation system of the pumping system), the effluent shall be discharged once the waste water has been neutralized to desired pH. A pH monitor shall



be provided at the discharge of the pumps for measurement and control. Complete lime storage, feeding & dosing system shall be in contractor scope. The complete waste water neutralization system shall be automated and controlled from the control room.

4.11.0 Emergency Slurry Tank

- The bidder shall provide an Emergency slurry tank, sized to contain the complete slurry of one absorber tank at its maximum level equipped with all necessary pumps, valves, piping and controls to transfer the tank's contents back to the absorber to refill the absorber sump. It should be possible to discharge the Absorber into Emergency slurry tank within 2 hours.
- The Bidder shall provide 2x100% pumps to evacuate the slurry from the sump back to the absorber in a maximum time of 8 hours.
- Sufficient number of agitators shall be provided in the tank by the contractor to prevent the solids from settling down. There shall be at least one redundant agitator for this purpose. Type of agitators shall be decided by the Bidder based on the experience and practices followed.
- The tank shall be provided with pump, piping, valves & controls. The tank shall be equipped with opening for easy entry.

4.12.0 Agitators

- The shaft and blades of the agitators shall be of Alloy 926 or better material suitable to the service condition.

4.13.0 Slurry Pumps

- This clause covers the design, manufacture and erection of all slurry pumps for the FGD system including the Absorber slurry recirculation pumps, Gypsum bleed pumps, Limestone slurry feed pumps, Mill circuit pumps and any other pump handling slurries.
- The Contractor shall offer only proven design in successful operation in similar application at previous installations. The design, manufacture, installation and testing of the pumps shall follow the latest applicable Indian I International (ASME IEN I Japanese) Standards.
- The pumps shall be designed for continuous operation. The pump shall be single stage centrifugal type capable of delivering the rated flow at rated head with margins as specified in the respective clauses. The slurry concentration in the pump shall not exceed 30% by weight except for Mill circuit slurry pumps for which the slurry concentration in the pump shall not exceed 55% by weight.
- All the slurry pumps shall be provided with motorized suction and discharge valves. In addition, flushing water lines with motorized/ pneumatic valves shall be provided for each pump for automatic flushing of the pump after each shut down. The flushing water for the pumps shall be taken from the process water supply. The process water lines shall be provided with pneumatic/motorized valves as per the proven practice of the Bidder.
- In case of pump with rubber lined casing, the casing should be radially split to allow easy removal of impeller.
- All the pump wear parts in contact with the slurry shall be provided with replaceable rubber/elastomer liners suitable for the fluid handled. The Bidder can also offer an hi-



chrome alloy line pump if the Bidder has previous experience of the same for similar applications. The material used by the contractor shall be proven in previous installations.

- For absorber recirculation service a Silicon carbide/hi-chrome impeller and SiC lining for casing can also be accepted if the manufacturer has supplied a similar pump for a previous installation for similar service.
- The material and thickness of the liners shall ensure a minimum service life of 2 years before replacement. All the wear parts of the pump shall be guaranteed for a minimum wear life of not less than 14000 hrs.
- The design of the shaft shall ensure that the operating speed is at least 20% above the critical speed of the shaft.
- The pump shall be provided with seals of proven type and shall be designed for minimization of seal water consumption. The shaft shall be supported on heavy duty ball/roller bearings.

4.14.0 Slurry Lines and Valves

- Slurry pipes shall be designed to keep the velocity above the settling velocity under all operating conditions. The Bidder may provide a recirculation line with motorized isolation valve for the above purpose.
- All the pipes handling slurry shall be provided with replaceable rubber lining of proven quality. The Bidder can provide slurry pipes of size lower than 3" made up of FRP material if it has previous experience of providing the same.
- The isolation valves provided in all the slurry lines shall be of knife gate type/butterfly type. Actuator shall be provided as per the scheme provided.
- Bidder shall provide all necessary arrangements for purging & flushing of all the process pipelines, equipments etc.

4.15.0 Process Water/ Slurry Storage Tanks & Pumps

- From the terminal point Bidder shall provide Booster Pumps of required capacity & head to feed process water storage tank designed for the entire FGD process (including absorber system and mist eliminator washing system, limestone grinding and slurry preparation system, gypsum dewatering ,etc.).
- Process water storage level shall be automatically controlled at operating level by controlling the water flow from the makeup water from terminal point. The process water storage tank shall be designed to store 15 minutes of total maximum water required for the entire FGD process for the unit operating at Design point.
- All the Process water tanks (Process water storage tank, Emergency water tank etc.) shall be designed, fabricated, erected and tested in accordance with the IS:803, latest edition. Additional Corrosion allowance of 1.5 mm on the minimum tank shell thickness as calculated by IS:803, latest edition shall be provided by the Contractor. The Tanks shall be provided with drain, manholes, over flow & inlet level control valves etc.
- 2x100% Process Water Pumps shall be provided for unit connected to Process water Storage tank along with all necessary piping, valves, control & instrumentation. The capacity of the pumps shall be such that it shall meet the maximum process water



requirement of unit. A further 10% margin shall be provided over the above capacity for all the above pumps.

- 2x100% Mist Eliminator Wash Water Pumps connected to the Process water Storage tank along with all necessary piping, valves, control & instrumentation shall be provided by the Contractor for Mist eliminator wash water system & Emergency spray water system. Alternatively, Contractor can use process water pumps for mist eliminator washing if it is the standard & proven practice of the Contractor or its Technology Collaborator. The capacity of the pumps shall be such that the total capacity of working pumps is sufficient to meet the maximum wash water requirements of mist eliminators of the absorber. A further 10% margin shall be provided over the above capacity for all the above pumps.
- The type of pumps shall be horizontal centrifugal type designed for continuous operation with semi open or closed impeller. Casing, Gland and Stuffing Box shall be of 2.5 Ni Cast Iron to IS:210 Grade FG 260 or equivalent. Impeller, Wearing rings (as applicable) shall be of Stainless Steel 316 grade and Shaft & Shaft sleeves shall be of SS-410 grade. Pump re-circulation line shall be provided for pumping system. Pumps shall be provided with accessories such as Y-type suction strainers, Coupling guard, drain plugs, vent valves etc.

4.16.0 Gypsum storage Shed

The gypsum cake from the belt filter will be discharged through a hopper to a belt conveyor. The belt conveyor will transport the gypsum to the gypsum storage shed. Gypsum shed of 15 days storage shall be considered. Shed shall be provided with side protection. Adequate space inside shed for truck movement shall be provided. Dozer (1 No.) and Pay loader (1 no.) required for gypsum storage and loading into the truck shall be included in the Bidder's scope. Maintenance area with arrangement required for the Dozer (1 No.) and Pay loader (1 no.) shall also be included in Bidder's scope.

Alternatively, Gypsum can be stored in Eurosilos/equivalent (minimum 2 Nos. to be provided). The silos shall receive gypsum by belt conveyors. The silos shall be provided with rotating auger frame and slotted column internal mechanism for controllable storage and reclamation. Further, simultaneous filling and reclaiming in layers should be possible. Silos shall have a drainage system at bottom. Silos shall permit to unload gypsum directly into trucks. Bidder/sub-vendor shall provide evidence of having executed similar types silos in atleast two thermal power stations and which are in successful operations for atleast one year prior to date of bid opening.

Conventional type silos for gypsum storage are not acceptable.

4.17.0 Tanks

All the slurry tanks (Slurry Tanks, Filtrate Tank, Secondary hydro cyclone feed tank, vacuum receiver tank, Waste water Tank etc.) shall be designed, fabricated, erected and tested in accordance with the IS:803, latest edition. Additional Corrosion allowance of 1.5 mm on the minimum tank shell thickness as calculated by IS:803, latest edition shall be provided by the Contractor. Tanks shall be made from IS:2062 quality mild steel plates of tested quality.

The tanks shall be of welded construction. Interior surface of the tanks shall be lined with the following:

- a. Wastewater tank, Filtrate tank, Secondary hydro cyclone feed tank: Vinyl Ester based flake glass lining of minimum 3 mm thickness
- b. Slurry tanks: Replaceable Chlorobutyl/ Bromobutyl rubber lining of minimum 4 mm thickness



The outside surface of the tanks shall be coated with paint as approved by the Employer.
Coarse-screen(s) at suction-side of slurry recirculation pumps shall be provided.

4.18.0 Approach

- Staircase with minimum width of 1200 mm shall be provided.
- Platform with a minimum clear width of 1000 mm shall be provided all around the lowest absorber spray levels and mist eliminators. Similar platforms shall be provided at subsequent elevations if they are more than 3000 mm apart from each other. An adequately sized manhole with platform (min. 2 sq. m) shall be provided above each spray level. Ladders/staircase shall be provided for the access to the platform.
- The absorber slurry recirculation pumps, gypsum bleed pumps and limestone feed pumps shall be mounted on the ground level. Suitable approach and platforms shall be provided for all the valves required during regular operation.
- A 1500 mm space shall be provided around all pumps, except absorber recirculation pumps, where a 2000 mm space shall be provided.
- A 1000 mm wide platform with suitable approach shall be provided around each hydro-cyclone.
- All other safety requirements as per the Factories Act, National Electricity code shall be complied with while developing Layout.



ANNEX – 2.3.1

SPECIFIED DESIGN DATA

Sl.No.	Description	Unit	Data
A	WET BALL MILL		
1.	Quantity		2 x 100 %
2.	Capacity		Each Mill shall be able to feed 110% design requirement of the FGD Unit
3.	Limestone bond index (kWh/T)		13 (min)
4.	Orientation		Horizontal
5.	MOC of Shell		Outside Shell – Carbon Steel Inside Shell- Carbon Steel lined with 12-14 % High Chrome and manganese steel. (Bidder shall alternatively suggest Superior material / Lining)
6.	Ball MOC		Material of the balls shall be chosen to ensure that the balls do not lose their original shape and to ensure minimum ball consumption.
7.	Drive		Peripheral gear/ central drive
B	MILL SEPARATION TANK		
1.	Number of tank		1 (One)
2.	Number of Compartments		2
3.	MOC of tank		RCC with suitable Lining
C	MILL CIRCUIT PUMPS		
1.	Quantity		2 (1W + 1 S)
2.	Capacity		By Bidder
3.	Type		Horizontal Centrifugal
4.	Material of Construction		
5.	Casing/Housing		CD4MCuN
6.	Shaft , Rotor and sleeve		Rotor - Cr 30A Shaft - 42CrMo Sleeve – CD4MCuN
D	LIME SLURRY TANK		
1.	MOC		IS 2062 construction with replaceable chlorobutyl/bromobutyl rubber lining of minimum 4 mm thickness.
2.	Accessories		
a)	Agitator		Alloy 926 or better material



Sl.No.	Description	Unit	Data
b)	Level Measurements		Required
c)	Inlet, Outlet, Overflow, Drain,		Required
E	LIME SLURRY TRANSFER PUMPS		
1.	Capacity		Each pump to meet the requirement of FGD with 10% margin.
2.	Margin on Head		15%
3.	Solids Concentration		Max. 30% by weight or actual as per suppliers practice, whichever is minimum.
4.	Material of Construction		
a)	Casing/Housing		CD4MCuN
b)	Shaft , Rotor and sleeve		Rotor - Cr30A Shaft - 42CrMo Sleeve – CD4MCuN
c)	Gear Box		As Required for the System
d)	Service Factor		> 2.0
F	GYP SUM OR SLURRY BLEED PUMPS		
1.	Quantity per Unit		Minimum requirement specified
2.	Capacity		By Bidder
3.	Type		Horizontal Centrifugal
4.	Material of Construction		
a)	Casing		Duplex Stainless Steel PREN > 40
b)	Shaft , Rotor, sleeve and Wetted Parts		Duplex Stainless Steel PREN > 40
c)	Gear Box		As Required for the System
d)	Service Factor		> 2.0
G	HYDRO CYCLONES		
1.	Quantity		Mill area- 2 x 100% Primary - 2 x 100 % Secondary- 2x100%
2.	Capacity		To meet the requirement of the FGD Unit.
H	VACUUM BELT FILTER		
1.	Quantity		2 x 100 %
2.	Capacity		To meet the requirement of the FGD Unit.
3.	Gypsum Purity		≥ 90 %



Sl.No.	Description	Unit	Data
4.	Moisture Content		≤ 10 %
5.	Cholorde content		<u>Less than 100 PPM</u>
6.	Filter Frame		SS 316L
7.	Carrier Belt		SBR, 38mm thick
8.	Filter Cloth		PE
9.	Vacuum Box		SS 904L, jacketed
10.	Vacuum box lifting system		SS 316L with pneumatic cylinders,
11.	Spillage gutters		SS 316L
12.	Head and Tail Pulley		MSRL, SS 316 shaft
13.	Cloth Rollers		SS316L, SS 316 shaft
14.	Belt Rollers		MSRL, SS 316 shaft
15.	Belt support system		SS 316L
16.	Slurry Feeder		SS 904L
17.	Wash feeders		SS 904L
18.	Flap dams		EPDM flap
19.	Discharge Chute		SS 317L
20.	Spray Pipes with nozzles and valves at inlet		SS 316L
21.	Cloth Tracking system		To be provided
22.	Moisture Trap upstream of Vacuum pump		To be provided. MOC - FRVE
I	PROCESS WATER TANK & PUMPS		
1.	Capacity	m ³	15 minutes of total maximum water required for the entire FGD process
2.	Code		IS 803
3.	MOC		IS 2062
4.	Corrosion allowance	mm	1.5
5.	Type		Above Ground Tank
	Process Water Pumps		2 x 100 %
1.	Type		Horizontal Centrifugal End suction Pumps
2.	RPM		1450
3.	Material of construction		



Sl.No.	Description	Unit	Data
a)	Casing		CI as per IS:210 FG 260
b)	Impeller		SS 316
c)	Shaft		SS 410
	Mist Eliminator Wash Water Pumps		
1.	Quantity		2 x 100 %
2.	Type		Horizontal Centrifugal End suction Pumps
3.	RPM		1450
4.	Material of Construction		
a)	Casing		2.5 Ni CI as per IS:210 FG 260
b)	Impeller		SS 316
c)	Shaft		SS 410
J	WASTE WATER PUMPS & FILTRATE WATER PUMPS		
1.	Quantity		2 x 100 %
2.	Type		Horizontal Centrifugal End suction Pumps
3.	RPM		1450
4.	Material of construction		
a)	Casing		Duplex SS
b)	Impeller		Duplex SS
c)	Shaft		SS 410
5.	Pipe Routing		On Existing Trestle/ Partly Underground
6.	Coating and Wrapping		AS Per IS:10221 and IS:15537
7.	Road Crossings		Hume pipes if Applicable
K	SUMP PUMPS		
1.	Service		Chemical Over flow/Floor Drains
2.	Capacity	m ³ /h	50
3.	Sump Dimension	m	Minimum 2x2x2 with corrosive resistance tiles.
4.	Quantity per sump		2 x 100 %
5.	Type		Vertical Centrifugal. The pump shall be capable of pumping of filtrate water with solid concentration upto 10% & particle lumps of 6-7mm. Sump pumps handling slurry shall be designed with a maximum concentration of 30% solid by weight.



Sl.No.	Description	Unit	Data
6.	MOC (Casing & impeller)		SS 316
L	WASTE WATER TANK AND SECONDARY HYDRO CYCLONE FEED TANK		
1.	Capacity	Hrs	To hold 8 hrs storage volume
2.	Agitator		Alloy 926 or better material
M	EMERGENCY SLURRY TANK		
1.	Capacity		To hold complete absorber storage volume.
2.	Agitator		Alloy 926 or better material



VOLUME II

SECTION 1

GENERAL TECHNICAL SPECIFICATION

1.0 INTENT OF SPECIFICATION

- 1.1. The specification is intended to cover the design, engineering, manufacture, assembly / reassembly, constructional features, test at manufacturer's works, forwarding (duly packed for transportation), transportation (delivery to site), unloading, handling, storage and in plant transportation at site, complete execution of necessary and allied Civil / Mechanical /Process works, Electrical, Instrumentation works, complete services of erection, testing at site, successful commissioning, operation handing over the Flue Gas Desulphurization (FGD) system for the 1 x 800 MW North Chennai Thermal Power Project Stage III (NCTPS) in flawless operating condition to the Owner.
- 1.2. Construction, supplies and services shall be rendered in conformity with proven design principles, taking into account the current technology. The requirements of the contract must be fulfilled in its entirety. The supplies and services shall be rendered inclusive of all appliances and interconnecting arrangements with other supplies, necessary for installation of all accessories, needed for proper and reliable continuous operation and for satisfactory maintenance and repair.
- 1.3. In so far as data on the execution of supplies and services as contained in drawings, but none in specification and vice versa, such data shall be deemed to be contained in both. Contradictions, if any, between drawings and specifications and within various sections of the specification shall be brought to the attention of the Owner (Employer) / Consultant by the Bidder and the correct requirement shall be obtained before submission of the bid.
- 1.4. All materials & equipment supplied under this contract shall be new and unused.

2.0 DESCRIPTION OF SYSTEM

Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO) is presently executing the 1 x 800 MW plant on an EPC basis for BTG and BOP and it is scheduled to be completed by December 2019. In order to meet the MOEF & CC gazette notification, as an environmental improvement measure TANGEDCO have decided to install FGD for treating 100 % flue gas generated from the plant.

The FGD shall deploy a wet limestone based technology which is proven. The flue gas from the common discharge duct of ID Fans shall be diverted to the proposed FGD plant by installing a by-pass damper. The treated flue gas from the FGD shall be led to the chimney. The FGD system for the Unit shall therefore include untreated flue gas duct, booster fan, Gas heat exchanger, FGD scrubber and the treated flue gas duct complete with dampers, accessories, electrical, instrumentation & controls and necessary civil works. A common Lime unloading, storage and conveying system, Wet ball mills and slurry preparation and pumping system, absorption system and Gypsum recovery system is proposed.

The absorber/scrubber along with the slurry tank, Booster fans, Gas to gas heat exchangers shall be located near the Chimney area identified in the tender drawings.

The limestone handling storage area shall be located in the common area identified in the tender drawings.



The utilities such as power, water and steam shall be provided from the main power plant at terminal points as described in this specification.

The analysis of the flue gas from the power plant is attached as Annex -1.2.

The Service Water analysis is attached as Annex-1.3.

The analysis of the limestone is attached as Annex 1.4.

3.0 SCOPE OF WORK AND SERVICES

3.1 GENERAL

The equipment and works to be provided under this specification shall be as detailed below. Scope of works includes, obtaining necessary approvals/ Statutory clearances, materials, execution as per codes, specification, best engineering practices and to the satisfaction of the Owner for all Civil / Structural, Mechanical, Electrical, Control & Instrumentation works and training of the O&M personnel.

- a) Basic Engineering of the plant including preparation of Plant Definition Manuals;
- b) Detailed design of all the equipment and system(s) including civil, structure steel works included in bidder's scope.
- c) Providing engineering drawings, equipment sizing & performance data, instruction manuals, as built drawings and other information;
- d) Compliance with statutory requirements and obtaining clearances from statutory authorities, wherever required;
- e) Complete manufacturing including shop testing/type testing;
- f) Complete Civil, Structural and Architectural works, including survey, providing construction offices, field laboratory and construction equipment;
- g) Packing and transportation from the manufacturer's works to the site including customs clearance & port clearance, port charges, if any.
- h) Receipt, storage, preservation, handling and conservation of equipment at the site;
- i) Fabrication, pre-assembly, if any, erection, testing, commissioning and completion of facilities including putting into satisfactory operation all the equipment including successful completion of initial operation;
- j) Reliability tests, performance and guarantee tests after successful completion of facilities;
- k) Furnishing of mandatory, and recommended spares;
- l) Reconciliation with customs authorities, as required.
- m) Satisfactory conclusion of the contract.
- n) Insurance and other requirements for the complete FGD package in accordance with the provisions of general conditions of contract.



- o) Complete scope of Dismantling/ Demolition or modification of existing facility if required for the project implementation. Bidder to identify such requirement during pre-bid stage and consult with Owner.

Required site survey for accessing the tie-ins, topography and layout shall be mandatory.

The scope shall include detailed design of the system, complete manufacture including testing, providing engineering drawings, data, operation manual etc. for the Owner/ Consultant's approval, packing and transportation from the manufacturers works to the site, receipt storage preservation and conservation of equipment at the site, erection, testing and commissioning of all the equipment, reliability tests, performance acceptance tests on completion of commissioning all the equipment & furnishing spares.

System shall be complete in all respects with all mechanical, civil, structural, electrical, control and instrumentation works.

The requirements, conditions, appendices etc. given in Technical Specifications shall apply to and shall be considered as a part of this volume as completely as if bound here with. The work to be carried out as per the above scope shall be all in accordance with the requirements, conditions, appendices, etc., stated in GCC, which shall be considered as a part of the Technical Specification as completely as if bound herewith. The Contractor shall be responsible for providing all material, equipment and service, which are required to fulfill 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. It is not the intent to specify completely herein, all aspects of design and construction of equipment, nevertheless, the equipment shall conform in all aspects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation, in a manner acceptable to the Owner, who will interpret the meaning of the specification, drawings and shall have a right to reject or accept any work or material which in his assessment is not complete to meet the requirements of this specification and/or applicable international standards mentioned elsewhere in the specification.

Bidders are requested to carefully examine and understand the specifications and seek clarifications, if required, to ensure that they have understood the specification. The Bidder's offer should not carry any sections like clarifications, interpretations and/or assumptions. In the event of conflict between the Technical Specifications and the Conditions of Contract, the requirements as indicated in the technical specification shall govern, unless confirmed otherwise by the Owner in writing before the award of this contract, based on a written request from the Bidder for such a clarification. However, if the Bidder feels that, in his opinion, certain features brought out in his offer are superior to what has been specified, these may be highlighted separately. The Bidder may also make alternate offers provided, such offers are superior in his opinion, to the requirements of these specifications in which case, adequate technical information, operating feedback, etc., are to be enclosed with the offer, to enable the Owner to assess the superiority and reliability of the alternatives offered. In case of each alternative offer, its implications on the performance, guaranteed efficiency, auxiliary power consumption etc., shall be clearly brought out for the Owner to make an overall assessment. In any case, the base offer shall necessarily be in line with the specifications. Under no circumstances the specified equipment and services shall be brought out as an alternative offer.

In case, all the above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.



3.2 SCOPE OF WORK

3.2.1 Mechanical

The scope shall include design, engineering, supply, installation, testing and commissioning, performance testing and handing over of, but not limited to, the following:

- a) Tapping of new ducts from main ducts (from the terminal points), expansion joints, dampers (including the bypass damper), etc.
- b) Two Nos. (2x50% configuration) Booster Fans each sized for 60% BMCR flue gas flow, with all associated redundant lube oil pumps, coolers, valves and instruments.
- c) Wet Limestone based Scrubbers /Absorbers complete with slurry holding tank, corrosion resistant lining, spray headers, and nozzles.
- d) Gas to Gas heat Exchangers and its auxiliaries.
- e) Return connection of new ducts to main ducts from Gas to Gas heat Exchangers, expansion joints, dampers, etc. including modification of existing duct.
- f) Slurry recirculation pumps, strainers, valves, piping, spray headers, nozzles etc. including expansion joints.
- g) Oxidation Air blowers/Compressors and its piping/injection system.
- h) Mist Washing System for scrubber.
- i) Ducting and its Supports etc.
- j) Raw limestone covered storage shed (for 7 days storage), Limestone Crushers each with associated screens, Crushed limestone silo for 7 days storage, Mills, Limestone silo capable to handle one day consumption along with dust extraction system
- k) Complete Lime unloading system Underground Hoppers, Vibrating feeders, electromagnetic separator, conveyors, Bucket elevators, feeders, etc.,.
- l) Wet ball mills, Hydro cyclones and vacuum filters.
- m) Limestone Slurry Preparation tanks, Limestone Slurry transfer pumps, Slurry circulation pumps, Bleed pumps, sump pumps etc.
- n) Gypsum handling system with shed (for 15 days storage)
- o) Process water tank and pumps.
- p) Tapping of Steam piping from the existing auxiliary steam header including modification of existing auxiliary steam header and further piping inside FGD area.
- q) Complete Air conditioning and ventilation for the buildings related to FGD and its auxiliaries.
- r) Tapping of Service water piping from the existing header including modification of existing header and further piping inside FGD area (refer terminal point).
- s) Tapping of potable water piping from the existing header including modification of existing header and further piping inside FGD area including necessary potable water tanks.
- t) Tapping of Fire hydrant/spray piping from the existing headers including modification of existing header and further piping inside FGD area.
- u) Waste water treatment & recycling system for the FGD effluent (Clarifier, neutralization system, dosing, sludge dewatering etc.) along with necessary handling facilities.
- v) Complete fire protection system consisting of Fire Hydrant system, Detection alarm system, Fire extinguishers all necessary warning instructions and warning plates etc as required for the system as per TAC/NFPA guide lines.



- w) Bidder shall provide buildings for and Milling System, Gypsum Dewatering system, FGD MCC/control room & Analyser room, Recirculation pump & Oxidation blower building . The buildings must be complete in all respect specially facilitating the smooth operation and maintenance of associated equipment of above systems by providing adequate maintenance space, handling facilities, walkways, staircase etc.
- x) Supply, erection, commissioning, testing of Necessary material handling system including Unloading Hopper, Vibrating screens, Grizzlies, Bucket Elevators, conveyors, overhead concrete pillar, beams along with trolleys, chain pulley blocks, tools/tackles for various auxiliaries lifting/moving maintenance/dismantling purpose work in FGD and Auxiliary Area shall be included in bidders scope.
- y) One number Elevator each for servicing FGD Absorber, Limestone building and Gypsum building, any other building as required
- z) One (1) No. Pay loader & One (1) No. Crawler type Dozer for Limestone storage shed
- aa) One (1) No. Pay loader & One (1) Wheel type Dozer for Gypsum storage shed
- bb) Crane and hoist as required.
- cc) Required vibration isolation system for all the rotating equipment as required, and further detailed in Civil specification
- dd) Instrument air & service air compressors, Dryer, receivers and piping as required.
- ee) Necessary modifications, interconnections at the owners Terminal points.
- ff) Isolation valves, insulation, cladding for all utilities at the Owners terminal point.
- gg) Interconnecting platforms between elevator and FGD at various levels of the scrubber.
- hh) Pipe trestle, duct supports, complete pipe rack for piping in Bidder's scope etc.
- ii) Necessary interface and completed piping from the existing facility to the FGD facilities for firefighting, Aux. Cooling water, DM water, Service/potable water, steam, waste water etc.

For the detailed system requirement Refer Vol. II, Section 2 for Detailed Technical Specification for Mechanical System.

3.2.2 Civil

The Scope shall include design, engineering, construction of all related civil, structural, architectural works complete in all respect. The major buildings / structures envisaged for this contract are as listed below:

- a) Absorber Tower Foundation
- b) Process Water Pump House
- c) Electrical & Control Building
- d) Bulk Limestone Silo and Day Limestone Silo
- e) Limestone Slurry Preparation Building
- f) Fan/GGH/ Equipment Foundation
- g) Limestone Unloading Shed and unloading hopper
- h) Dozer shed
- i) Limestone Crusher House
- j) Junction tower
- k) Gypsum Storage Shed
- l) Gypsum Dewatering Building



- m) Waste Water Building
- n) Tanks
- o) Pipe Supports
- p) Trestle for Duct Support , conveyors, Foundation, etc.,
- q) Foundation for Pumps, Booster fans, Blowers, gas to gas heat exchangers, tanks and other miscellaneous equipment's etc.
- r) Drains, paving, trenches, duct banks, collection pit, etc. in FGD area
- s) Access Roads with storm water drains to various building/structures from existing Plant road
- t) All foundation works in FGD area based on the geo technical report attached with this specification.
- u) Each building shall be provided with 2 PVC tanks – one for service water tank of 1000 litres capacity and another for potable water tank of 500 litres capacity.
- v) Plinth protection all around the buildings in FGD area
- w) Micro leveling of the FGD area as required
- x) Dressing up site upon completion of work
- y) Borosilicate Glass Block (or) Titanium or C 276 lining inside the chimney flue can

For detailed Technical Specification, refer Volume II, Section 5 for Detailed Technical Specification for Civil

The work also includes:

- a) Design and preparation of working drawings (Architectural, Civil and Structural), fabrication drawings, excavation drawings, shuttering drawings, bar bending schedule drawing and construction of all structures.
- b) Preparation and submission of As built drawings of all structures and facilities to reflect as built status of construction in AutoCAD latest version in CD / DVD and hard copies
- c) Plumbing & sanitary works
- d) Painting of all Architectural, Civil and Structural works
- e) Anti-weed treatment in all areas / buildings of FGD area.
- f) Anti-termite treatment for all buildings of FGD area.
- g) Handing over of complete FGD area facilities to the satisfaction of Owner.
- h) All temporary roads, approach for main entry and approach roads inside the graded FGD area necessary for construction purpose and for conveying plant equipment with adequate parking area for heavy vehicles and all permanent roads for plant area, cross roads with necessary culverts wherever necessary.
- i) Supply & fixing of inserts, bolts and other embedments specifically for equipment foundations, tanks, structures, etc. as required.
- j) Rain Water Harvesting for all buildings in FGD area. All roof tops shall have RWH with filter arrangement.
- k) All statutory clearances / NOC required for implementation of the project from various departments/agencies shall be obtained by the Bidder.
- l) The Bidder shall fill or excavate the areas to the required formation levels as indicated in the plot plan and dispose the excavated materials as directed by the Owner. If excavation requires blasting, necessary statutory clearance from the concerned body shall be obtained by the Bidder.



- m) All civil works related to arrangement for lifting equipment.
- n) Clearing and removing the buried items if any in the whole proposed plant area and the same is to be deposited to the existing stores.
- o) All underground structures (as applicable) such as basement, sump etc. and water retaining structures shall be water proofed as per specification.
- p) All the buildings shall have one dining room as per Owner's requirement.
- q) All offices, rooms, bays shall be provided with furniture like almirah, tables, chairs, etc. wherever necessary.
- r) Fencing along with gates (main gates and wicket gates as applicable) of suitable size shall be provided wherever necessary due to security / safety / statutory requirements.
- r) Paving for open store yard and silo areas.
- s) An Eye and Face fountain (Combined unit with receptacle) conforming to IS: 10592 shall be provided in Battery room.
- t) Roof parapet wall of 750 mm height is to be provided for all buildings. Concrete staircase may be provided for access to roof for all concrete buildings.
- u) One operator and maintenance room shall be provided in all floors of each building (Min. size of 5m x 5m).

It is not the intent to specify herein all the works in the scope of this contract. All other buildings, structures and works that are necessary which are not specifically mentioned here but required for construction, operation and maintenance of the FGD plant or mentioned elsewhere in the specification are deemed to be included in the scope of the Bidder.

In the event of conflict between requirement of any two clauses of this specification or different codes/standards, the more stringent requirement as per the interpretation of Owner is to be followed by Bidder.

General Requirements

All buildings / structures / areas for the FGD area shall be provided with the following as applicable:

Plastering, painting, plumbing, sanitation, water supply, electrification, lighting, air conditioning, firefighting, anti-termite treatment, plinth protection, damp proof course, garland drains, septic tanks, all modular furniture, doors, windows, rolling shutters, ventilators, approach roads, colour and white washing, sunshades, false ceiling, false flooring, flooring, under deck insulation, water proofing, roof treatment, rain water down take pipes, stair case, lift/elevators, cranes and monorails, porch, potable water tanks, fans, etc.

All Finishing works for buildings covered in FGD area shall be as per finishing schedule mentioned in this specification.

Floor level of all buildings shall be 500mm above FGL.

Protection of existing utilities and services

During construction, the Bidder shall provide all protection for existing utilities and services as may be required by his construction operations. Permanent protection of certain items shall be as included under other sections or as instructed by the Owner.



In addition to the requirements as specified, herein the Bidder shall comply with the following requirements:-

- a) Use all necessary precautionary and protective measures required to maintain existing utilities, services and appurtenances that must be kept in operation. In particular, the Bidder shall take adequate measures to prevent undermining of utilities and services presently in services.
- b) Protect existing or new utilities and services where required by the Bidder's operations and/or as directed by the Owner. The Bidder shall be responsible for bracing and supporting utilities and services to prevent settlement, displacement or damage.
- c) If any existing structure such as pipe line, road drain, culvert, towers, light posts, underground structures, buildings, tanks, rail line, etc. is damaged during execution of project, same shall be reconstructed by Bidder at his own cost at locations wherever approved by owner.

Instruction to bidders

I. Data to be furnished by Bidder at the time of Bid

- a) Detail general arrangements/architectural drawings of all buildings and structures showing dimensions, levels, plans, sections, elevations, loadings, materials proposed, types of framings, wall / cladding, floors, roofs, types of finishes etc.
- b) Detail design criteria proposed to be adopted for each building, structures, foundations, facilities, etc.
- c) Organisation chart with no. of Engineers to be furnished by Bidder.
- d) Details of thermal insulation for ceiling and detail of false ceiling assumed with manufactures catalogue and areas where they propose.
- e) List of equipment to be deployed and rates of labour assumed by the bidder and by their sub-contractors to be furnished.
- f) List of software proposed to be used against various areas for analysis, design, drafting and project monitoring along with their source and validation report for the software.
- g) The list of documents indicated elsewhere of this section to be submitted by the Bidder to the Owner for his approval and manner in which the same need to be submitted. No construction shall commence at site without obtaining approval from the Owner on these documents. Therefore, it is necessary that bar charts for buildings/ structures / area wise shall be submitted for design / drawing activity indicating.
 - i. Level-1 pert chart showing the starting and completion date of all civil construction activities.
 - ii. Level-2 pert chart showing the time required for preparation of design criteria, for approval of design criteria by Owner, time required for detailed design and drawing preparation and time required for approval of design and drawing by Owner. This part shall be taken into account the construction schedule (Level -1 part).
 - iii. Level-3 pert chart for all civil works shall be submitted to Owner for monitoring of progress of works at site.
- h) A detail note on quality plan both for design and construction activity proposed to be adopted for obtaining quality works.



- i) List of all sub-Bidders/Consultants/Architects that the bidder proposes to employ, in case the contract is awarded to him, indicating their addresses with telephone number, experience on similar jobs, name, qualification and experience of persons who shall be involved in the job on behalf of the Bidder etc. shall be submitted to Owner. Only the sub-Bidder approved by Owner shall be engaged by the Bidder on the job.
- j) Write-up on proposed storm water drainage system furnishing layout of the drains, types of drains.
- k) A write-up on dewatering system proposed at the time of construction where deep construction is to be executed.
- l) Tentative plot plan showing location of all buildings, structures, roads, site office, storage etc. with plan dimensions of facilities.

II. Inspection of the site by bidder

- a) Bidder shall inspect the site, examine and obtain all information required and satisfy himself regarding matters and things such as access to site, communications, transport, right of way, the type and number of equipment and facilities required for the work, availability of local labour, materials and their rates, local working conditions, weather, sub-soil conditions, natural drainage etc. Ignorance of the site conditions shall not be accepted by the Owner as basis for any claim for compensation or extension of time.
- b) The submission of a bid by the Bidder will be considered as evidence that such an examination was made and any later claims / disputes in regards to rates quoted shall not be entertained or considered by the Owner.
- c) The Bidder shall organize his own arrangement to transport his equipment, men and materials so as to match the construction schedule.

III. Construction tools and Materials Supplied by Bidder

- a) Bidder shall provide and maintain at the site necessary number and type of machinery and equipment in good working condition for proper setting out and timely completion of the various works cover under this specification. All arrangements for transporting the equipment to and from the site shall be done by the Bidder at his own expenses. No claim shall be entertained for mobilizing additional equipment and/or personnel to complete the work within the stipulated time.
- b) Bidder shall provide all fuels and lubricants required for the operation and maintenance of construction machinery and equipment as well as his transport vehicles at his own cost.
- c) The Bidder shall ensure that the work shall proceed uninterrupted even in the event of power failure. As such, adequate number of diesel operated equipment shall be provided by the Bidder at his own cost as an alternative arrangement, in case electrically operated equipment is proposed to be brought to site.
- d) The Bidder shall maintain sufficient stock of material so that there is no interruption of works at any point of time during the contract period & extended period if any.
- e) All materials supplied by the Bidder shall be original, new and of the best quality and shall conform to the given specifications. Approval in writing shall be obtained from the Owner before any alternative or equivalent material is used other than what is specifically mentioned in the drawings.



- f) Bidder shall furnish manufacturer's test certificate for all the manufactured items supplied by him. Representative specimens of the material shall also be submitted to the Owner and shall be tested at a recognized testing laboratory at Bidder's cost in case Owner so desire.
- g) The Owner reserves the right to test any construction material supplied by the Bidder in an established testing laboratory at Bidder's cost and to instruct the Bidder to remove all materials, which do not meet the specification requirements.
- h) Bidder to arrange third party quality inspection & audit of all construction material at site.
- i) Bidder has to set-up a testing laboratory equipped with the following minimum apparatus, materials and competent trained staff required for carrying out field tests:
 - i. Slump cone apparatus to measure slump.
 - ii. Concrete cube testing machine with adequate number of moulds of (15cm x 15cm x 15cm) to measure compressive strength of concrete.
 - iii. Vicat apparatus to find initial and final setting time of cement.
 - iv. IS sieve with vibrating machine to determine fineness modulus of coarse and fine aggregate.
 - v. Abrasion & impact testing equipment for testing coarse aggregate and apparatus to determine flakiness index of aggregates.
 - vi. Complete apparatus for the test of air content of concrete by pressure method as per IS: 1199.
 - vii. Density bottle to determine sand bulkage.
 - viii. Hydrometer for testing pH value of water
 - ix. Thermometer for checking temperature
 - x. Apparatus for measuring proctor density, water content of compacted soil determining CBR values.
 - xi. All apparatus for determining dry density and water content of sand/soil and aggregates. Any other equipment felt appropriate by the Owner for measurement of paint thickness, testing of structural members, welding. Etc. The testing machines shall be recalibrated periodically and as directed by Owner to detect errors. The moulds for cubes shall be checked frequently and made to conform to specifications contained in IS: 516.

IV. Work Execution and Supervision

- a) Bidder shall have at the site accredited and qualified engineers and foremen /supervisors with adequate number of years of experience in execution of similar works and also operators of machinery and equipment, for satisfactory progress and timely completion of the work.
- b) Bidder's Engineer-in-charge of the work at site shall be capable of interpreting the specification and drawings and make adequate site decisions as and when required. He shall also take instructions from the Owner and be responsible for carrying out the instructions.
- c) Bidder shall be fully responsible for the correctness and accuracy of the tests performed, results obtained / tabulated, interpretation of test results and recommendations made. The work shall be executed in a professional manner, with fully understanding of the importance of work for a project of this magnitude.
- d) In the event of occurrence of any accidents at / near the site of the work or in connection with execution of the work, a report shall be made immediately to the Owner, giving full details of the accidents. He shall also report such accidents to all the competent authorities wherever such reports are required by them.
- e) All temporary electrical installation shall be supervised by a qualified electrical supervisor of the Bidder.



- f) Owner reserves the right to order in writing, from time to time, during the progress of the work, removal and re-execution of any work which in the opinion of the Owner, is not in accordance with the specification.
- g) During inclement weather, rains etc. Bidder shall suspend all works for such time as the Owner may direct and shall protect from damage all works already in progress or completed just then. All such temporary protective measures shall be at Bidder's cost and any damage to works shall be made good by the Bidder at his own expense.
- h) Should the work be suspended by reasons of strikes / riots by Bidder's own employees or any other causes whatsoever save and except the force majeure condition, Bidder shall take all precautions necessary for the protection of works and make good, at his own expenses, any damage arising from any of these causes.
- i) During the course of Bidder's works, other works either by the Owner or by the Bidders or by both simultaneously will be in progress within the project area. Bidder shall make his best effort to work in harmony with others in the best overall interest of the project and towards its speedy completion.
- j) The Bidder shall be responsible for maintaining cleanliness of the site. The site shall be free of unwanted rubbish or filth, which is hazardous & detrimental to health, and affect safety of the work place. Proper watering to be done for dust suppression.
- k) All material supplied shall conform to the specification. Entry of unwanted material also shall be prohibited.

V. List of drawings & documents to be supplied by EPC Bidder after award of contract

- a) The Bidder shall begin further works like preparation of design criteria only after obtaining approval of the report.
- b) General layout drawing with coordinates of roads, boundary wall and facilities, piping/cable corridors, pipe and cable trestles, provision of landscaping and green belt development, diversion roads and drains, equipment laydown area, etc.
- c) Drawing showing underground facilities with coordinates like buried pipes, buried cables, trenches, ducts, sewer, drains, sump pits, culverts, foundation, etc.
- d) Drawing showing loading data at various levels for all buildings and structures
- e) Detailed design calculations / drawings shall be commenced by Bidder only after approval is obtained from the Owner on the basic design criteria for building / structure/ areas to be submitted by the Bidder. No later deviation from the approved design criteria shall be permitted unless specifically approved by the Owner in writing, prior to its adoption.
- f) Civil assignment drawings showing all details such as equipment loads, live loads, erection and maintenance loads, cut-outs, crane capacity and wheel loads and wheel spacing, point loads due to piping / pipe hangers, ventilation duct, cable trays etc. shall be submitted for information. Vertical bracing, brick wall location, etc. shall be based on approved general arrangement (GA) drawings of the equipment, piping / cable tray / ventilation duct layout drawings and shall be submitted by the Bidder for Owner's approval. Interferences shall be indicated in civil GA drawings, Civil GA drawings submitted without prior approval of relevant GA drawings for equipment piping / cable tray / ventilation duct layout shall not be considered for review and approval.
- g) Design calculations and drawings and other documents for all facilities shall be submitted sequentially after obtaining approval in a phased manner as per approved L2 schedule. Bidder shall ensure that design calculations / drawings for several structures are not submitted at one time. For this purpose, design / drawing submission schedule furnished during bidding stage and agreed upon by Owner shall be followed.
Owner will review and furnish comments / approval, if any, to the designs and drawings. The Bidder shall resubmit the design documents and drawings within a maximum period of three weeks thereafter. Timely submission of designs / drawings to the Owner for review / approval is the sole responsibility of the Bidder and postal or other delays as reasons for late / non-submission shall not be entertained by the Owner.
- h) Site Grading and storm water drainage study furnishing levels of various terraces arrangement and details of drains, culverts etc. for storm water drainage system.



- i) Details of corrosion protection measures for all structures.
- k) Construction, fabrication and erection procedure for all major structures and other machine foundations.
- l) Should there be a requirement for preparation of separate drawings to show enlarged details to facilitate construction / erection, then such drawings shall also be prepared by the Bidder at no extra cost.
- m) Design drawings shall indicate structural arrangements, member sizes, member forces, splice location, details of base plate, anchor bolts details of moment connection, construction joints, water stops, loadings etc., so that the drawings indicate clearly all the necessary information brought out in relevant design calculations. Proposed bracing patterns shall be subject to approval by Owner. Design drawings showing typical connection details conforming to design assumptions shall be submitted for approval before starting fabrication drawings.
- n) Preparation and review of structural steel fabrication drawings is entirely of the responsibility of the Bidder and will not be approved by the Owner. However, all fabrication drawings shall be submitted by the Bidder for Owners reference and records prior to commencement of fabrication.
- o) Bar bending schedule for all concrete / structural steel works shall be prepared by the Bidder and submitted to the Owner for his reference.
- p) All architectural features of buildings shall be detailed by the Bidder's qualified architect.
- q) Detailed drawings along with schedule of doors / windows etc. floor / wall finishes including colour scheme shall be submitted for obtaining approval from the Owner.
- r) All construction drawings shall include total quantity of concrete (grade wise), reinforcement (diameter-wise) and structural (section wise).
- s) The designs shall clearly spell out the erection scheme for various structures envisaged by the Bidder and resulting additional loadings, if any, shall be duly accounted for. Before taking up actual erection work, detailed erection scheme proposed to be followed by the Bidder shall be submitted for Owner's approval.
- t) Approval / comments conveyed by the Owner neither relieves the Bidder of his contractual obligations and his total responsibility for correctness of dimensions, materials of construction loadings, quantities, design details assembly fits, performance particulars, safety and stability of the structures including foundation / appurtenances and conformity of supplies with the statutory laws as may be applicable, nor does it limit the Owners right under this contract. No change in the approved designs / drawings shall be permitted without prior written approval of the Owner.
- u) Owner or his representative has every right to go to Bidder's design office to check the quality control being implemented at their design office to ensure that the documents being prepared are of approved quality. The Bidder shall provide all assistance required by Owner for carrying out the audit.
- v) Checking for any interference is the sole responsibility of the Bidder.
- w) Erection scheme for all major equipments shall be submitted to Owner for his approval before taking up detail design works.
- x) All design calculations and drawings shall be in English and shall be in SI units.
- y) Designs drawings and other documents submitted by the Bidder shall be thoroughly checked and approved by the authorized Bidder's engineers. Any unchecked / unsigned documents will not be reviewed by the Owner. Also design calculations not accompanied by supporting engineering drawings, incomplete or shabbily done design calculations, design calculations without adequate reference or backup data and documents where previous comments have not been incorporated will not be reviewed by the Owner. No claim from the Bidder for extension of time or extra cost on this account shall be entertained by the Owner under any circumstances.
- z) No check will be specifically carried out by the Owner to verify arithmetical / numerical accuracy of the calculations, input data, compatibility of dimensions among various drawings or between drawings and design calculations. These shall remain entirely the Bidder's responsibility.
- aa) Bidder shall submit Hard & soft copies of designs / drawings prepared by him in accordance with the distribution schedule for approval.



- bb) All modification suggested by the Owner to meet specification requirements and sound engineering practice shall be incorporated by the Bidder at no extra cost to the Owner. In this respect, the decision of the Owner shall be binding on the Bidder. Owner will accord his approval only after the Bidder has incorporated in the design and drawings all modifications required by the Owner.
- cc) Hard copies & soft copies of all design calculation and drawings shall be submitted for records after approval of the Owner.
- dd) All structural analysis may be done adopting STAAD pro / SAP wherever finite element analysis is needed. The complete input (soft copy with editable format & hard copy) and output data (soft copy & hard copy) is to be submitted for Owner's review and approval. The software's mentioned above are not exhaustive.
- ee) Bidder shall submit hard copy (to Owner) of all revised drawings/ documents, as and when the revisions are made at every stage.
- ff) Payment will not be made for defective works and other works completed without approved design and drawings.
- gg) Final completion report shall be furnished by the Bidder including narrative report with as-built drawing in consultation with Owner.
- hh) Write up on various statutory requirements and their compliance for various buildings and facilities.
- ii) Quality assurance and Quality Control procedures. Third party quality audit is required.
- jj) Copies of all reports on investigation and studies carried out by the BIDDER as per the scope.
- kk) EPC Bidder to ensure that photograph of progress of work at site with required album is being submitted to owner once in every month in soft & hard copy.
- ll) EPC Bidder to ensure that Bill of quantities has been furnished in various construction drawings.
- mm) All drawings are approval category except fabrication drawings which are information category.
- nn) Study note on disposal of sewage and other effluent from the plant to satisfy the statutory requirement.
- oo) All other designs, details / drawings or any other submissions as indicated elsewhere in this specification and as required by the Owner.
- pp) Preparation & Review of structural steel fabrication drawings is entirely of the responsibility of contractor & will not be approved by the owner. However, all fabrication drawings shall be submitted by the contractor for owner's reference & records prior to the commencement of fabrication.

3.2.3 Electrical

The Scope shall include complete design, engineering, procurement, manufacturing, assembly, inspection, testing at manufacturer's works, packing, forwarding, transporting and insurance, including mandatory spares at site, erection, testing, commissioning, Trial/ Reliability Run, conducting performance guarantee tests and final acceptance of the following electrical equipment complete with all accessories:

- a) 11 KV Switchgear and 6.6KV Switchgear for FGD
- b) Auxiliary power transformer (11KV/6.9KV)
- c) Neutral grounding resistor for auxiliary power transformers
- d) Service transformers (11KV/0.433KV)
- e) 1x100% Emergency DG set of minimum 300KVA or as per sizing calculation (whichever is highest) along with AMF panel.
- f) 415V Power Control Centers, Motor Control Centers, Distribution Boards, Local starters and Local Push Button Stations.



- g) 6.6KV Segregated Phase bus ducts, for interconnecting secondary of 11/6.9KV transformer and 6.6KV switchgear incomers
- h) 415V Non Segregated Phase Bus ducts for interconnecting 11KV/0.433KV LT Service transformer and 415V PCC Incomers
- i) 11KV & 6.6KV Motors and LT Motors
- j) Electrical actuators
- k) 1x100%, 220V DC system of minimum 200AH battery & 150A Charger or as per sizing calculation (whichever is highest), including battery, charger and Distribution board
- l) 2x100%, 230V AC UPS of minimum 30KVA or as per sizing calculation (whichever is highest), with 1X100% Battery & ACDB
- m) Elevator
- n) 11KV, 6.6KV & LT Power cables and control cables for all the equipment supplied by the Vendor, including incoming 11KV cables & electrical / process interlock control cables from Owner's 11KV Station switchgears at power house building
- o) Telephone system
- p) Public Address system.
- q) Cabling system complete with cable trays, supports, conduits, glands, lugs etc. for all the cables covered in the Bidder's scope.
- r) Illumination system (Indoor & outdoor) complete with lighting distribution boards, lighting panels, lighting fixtures, lighting poles, winch operated lighting mast, receptacles, fans, conduits, wires, switch boxes etc.
- s) Fire sealing system for cable penetrations in the walls/floors.
- t) Complete earthing system including buried earth mat, equipment earthing and earth.
- u) Electronic earthing system with earth pits
- v) Lightning protection system for all the buildings, structures and equipment.
- w) Safety equipment such as Rubber mats, First aid box, Danger plate, Sand buckets etc.
- x) Engineering of complete Electrical system including preparation of required sizing calculations, fault calculations, layouts, scheme diagrams, cable schedules, Interconnection schedules, relay setting calculation etc.
- y) Construction power supply
- z) Mandatory spares for three years.
- aa) Recommended spares for three (3) years of operation and maintenance
- bb) Any other electrical equipment and accessories required to complete the system

3.2.4 Control and Instrumentation

The FGD System shall be provided with all necessary instruments / equipment for the safe operation, control and monitoring from the FGD Control Room. Bidder Scope of supply and work as mentioned

The primary operations including control & monitoring of the FGD System shall be carried out from the programmable logic control system (PLC) /DDCMIS shall have hot redundant standby processors, redundant power supply modules, redundant communication bus and redundant I/O modules. Minimum **three sets (6 nos) of redundant processors** shall be



considered for the PLC / DDCMIS system. Backup panel system shall be provided as mentioned in the specification.

- a) Two no. Operator station (24"), one no. Operator cum Engineering station(24"), another one no. 80" HD LED screen Operator work station, one no. A3 colour laser printer & one no. of A3 B/W Laser jet printer shall be provided in the FGD control room and one no. operation station (24") along with A4 Color laser printer shall be provided in the Central control room (Refer tender drawing).. This Microprocessor based PLC/ DDCMIS system shall include the total functional requirements of measurement system, control system, protection & interlock, annunciation system, operating system & communication system.
- b) The PLC system shall be interfaced with main plant DDCMIS through redundant bidirectional MODBUS TCP-IP /OPC/ RS 485 link for monitoring and also shall be time synchronised with redundant Plant Master Clock system through via NTP / IRIGB protocol. Supply & Laying of all communication cables shall be considered. In addition to that all necessary hardwiring of I/Os shall also be considered with plant DDCMIS for control , interlock and protection signals. Local Fire alarm panel shall be interfaced with Main Plant Main Fire Alarm Panel for necessary Alarm.
- c) CCTV system shall be provided with 1 no Operating station 48" LED (wall hanging) at FGD control room for CCTV monitoring. FGD CCTV shall be interfaced with existing plant CCTV system located in the existing CCR.
- d) One No. Lap top with necessary master software loaded for PLC / any other control System shall be supplied along with software in CD/DVD Form.
- e) Bidder to note that Vibration Monitoring System shall be envisaged for all the HT driven equipment & HT Motors of FGD plant. However FGD VMS system supplied by bidder shall be hooked-up with the Main plant VMAS system. , The FGD bidder to provide required signals & raw buffered outputs, cables and other accessories and terminal point will be VMAS panel located in main plant building.
- f) Industrial grade 2 x 100 % Parallel redundant UPS with heavy duty battery and Floor mounted ACDB shall be provided for powering PLC, Operator / Engineering work station, Analysers, SOVs and Field instruments, CCTV etc
- g) All field instruments and sensors for remote measurement viz. Flow meters, Smart Transmitters, RTD, Process Switches, and Temperature Transmitters with all accessories shall be supplied as per attached PIDs and detailed specification for the completeness of the system.
- h) All final control elements like solenoid valve, on-off valves and actuators as required.
- i) Instrumentation cables & control cables & any other special cables as required for the system. Bidder shall supply all necessary cable, cable trays, conduits, accessories, between PLC to field / MCC.

Bidder to consider following Cables in their scope.

Supply, laying, glanding and termination of all cables between:

- i. Power, Control, Instrumentation & Core cables: Where any one end equipment/ instruments/ items are in their scope.
- ii. All C&I Cables including OFC shall be Armoured type only. Bidder to suitably select the size (cross Section area) of Instrumentation Cable keeping in mind of Voltage drop due to large distance.



- iii. All necessary cable between Field instruments, limit switches and any other equipment to JB/LCP and from JB/LCP/MCC/SWGR to the PLC panels cabling shall be done by bidder.
- iv. Complete supply, installation and laying of all cables between FGD system PLC and UPS by the bidder.
- v. All necessary cables between Local Fire Alarm system to existing plant Main Fire alarm system in control room.
- vi. All necessary cables for Fire systems, VMAS, CCTV systems.
- vii. All necessary OFC, hardwired cable & any other cable upto mainplant DCS shall be Bidder only.
- viii. Same as any other requirement for FGD PLC/DDCMIS from main plant DDCMIS by bidder only.
- j) Instrument erection hardware which includes all junction boxes, cable trays, cable glands, lugs, cable ties, support, local panels, pneumatic and process hook up hardware, Impulse piping & fittings and other erection materials and accessories required for the system shall be bidder scope of supply.
- k) Industrial grade Control Desk / Furniture in local control rooms and central control room.
- l) Necessary calibrated instruments, valves and accessories for carrying out performance tests of FGD System.
- m) Erection, testing& commissioning of the entire PLC / DDCMIS, control panels, field instruments / final control elements and all other I&C equipments supplied by the bidder.
- n) Earthing of all I&C equipments, control panels, Instruments, Junction boxes and cable trays including above ground panel / below ground / redundant electronic earthing. Bidder shall note that all electronic earthing shall be redundant.
- o) Mandatory, recommended, erection & commissioning spares.
- p) Formats for all engineering documents shall be strictly as per Purchaser's requirement only. Bidder's standard formats shall not be acceptable. All other I&C items, works and services detailed elsewhere in this specification.
- q) Training of Purchasers engineering personnel for PLC / DDCMIS programming, trouble shooting, graphic and logic development
- r) All Panels, junction boxes shall be of exterior color RAL 7035 and interior color of glossy white only. Bidder shall note that the Analog and digital signals shall be wired to different junction boxes.
- s) Drive control philosophy will be submitted during pre-bid engineering stage, However I/O's Be approved during detail engineering.
- t) Bidder shall refer to **FGD PLC SYSTEM CONFIGURATION and other Annexures** for further details in the Volume II, Section -6, Tender Drawings.
- u) All necessary logic work shall be in SAMA Format and all the format of document bidder shall strictly follow the format of Owner only without any commercial implication.
- v) All necessary protection system & remote annunciation system as per latest technology & state of art shall be provided as a safe guard against failure opening of doors at the landing platforms or any other type of emergency, if any.



- w) Required CEMS analyser shall be considered and supplied as per process & technical specification requirement.
- x) All other I&C items, works and services detailed elsewhere in this specification.
- y) Bidder to submit FGD complete detail operation in the 3D animation in English for training purpose.
- z) Station LAN cabling for FGD building by Bidder from Common switch which will be located near the FGD building.

3.2.5 Consumables

- a) Supply of all consumables required for erection, commissioning, trial operation and performance test is included in the basic scope and same shall be supplied by successful Bidder. List of such item shall be identified & furnished with bid & finally included in the bill of material document. The complete list shall be furnished by the Bidder in his offer.
- b) Grouting materials for all equipment, structures, etc.

3.2.6 Maintenance tools and tackles

One (1) set of special tools and tackle required for operation, maintenance, dismantling, erection, inspection and repair shall be supplied in neatly packed-in steel boxes complete with operating instructions for the equipment as necessary. These shall not be used for erection/commissioning purposes by the Bidder and shall be in unused and new condition, when they are handed over to the Owner. The complete list shall be furnished by the Bidder in his offer.

3.2.7 Common Supplies

- a) All necessary painting and corrosion protection. The painting and corrosion protection for the equipment and structures is included in bidder's scope. The painting scheme and the finish color for all the equipment shall be as specified by the Owner after award of contract. Necessary finish paints including touch up paints, if not applied at shop, should be supplied by the Contractor, in sealed containers for site application.
- b) Complete lot of base plates, foundation bolts, inserts, embedment, clamps, nuts, washers etc. as required for the system.

3.3 GENERAL SCOPE OF SUPPLY AND SERVICES

The scope of supply and services covered by this EPC enquiry document shall be complete from site clearing to FGD project take over by the Owner including all supplies and services. The Bidder's scope of supply and services listed below are to be included and shall not be limited to the following:

1. Design, Engineering, Procurement, Testing at Manufacturer's Works, painting, Packing, Forwarding and Supply of all equipment, plants and facilities within the limits of supply and for connection at the boundary limits, as specified in the relevant detailed technical specification for the completion of the FGD on an EPC basis including Special Tools & Tackles, startup/Commissioning spares, Mandatory Spares etc.,
2. Intermediate site storage, transport to erection area, Receipt of material at site including unloading from carriers at site, handling, storage & preservation at site and intra site transport.



3. Inspection, testing, cleaning, painting, marking, etc. at the EPC contractors and/or sub-contractors workshops, delivery and transportation to the site, including insurance, unloading, etc.
4. Overall Project management, project control, quality assurance, site management and coordination for all technical matters, interconnections, connection to off-site facilities, scheduling, contractual matters and obligations, etc. with suppliers, sub-suppliers, subcontractors, vendors, the Owner, authorities as required on a EPC basis for the implementation, construction and putting into commercial operation of the whole project under the overall and sole responsibility of the EPC contractor.
5. Complete civil engineering including design, Geo technical investigation and carrying out all necessary civil and construction works at site as specified.
6. Supply of all information, documents, calculations, drawings, reports, etc. which are required for Owner's approval and to obtain all necessary permits, clearances, from the Government authority.
7. Apply for all permits and get the authorities approval for all actions, which require approval or permit from local government and statutory authorities. The contractor shall obtain and pay for necessary permits as required including license fees for installation and inspection of the equipment, also make such tests as called for by the regulations in the presence of authorized representatives of such authorities as well as in the presence of the Owner's representative. The contractor shall be responsible to obtain license, certificate for operating at site.
8. Supply of all consumable materials required for civil construction, erection, testing and commissioning, reliability run, performance guarantee test, taking over of the plant. However Limestone and water required for these trial / test of the plant will be provided by the Owner at specified terminal point, but shall be under no obligation to do so for any re-run of such tests due to contractor.
9. Provision of all labour, necessary erection equipment, temporary site facilities, temporary connections to power supply, water supply, etc. for erection and commissioning required for the fulfillment of the Contractor's duties in connection with the works and for completion of the entire project in time.
10. Provision of all accommodation, transport, canteen facility, social facilities, etc. for the Contractor's personnel employed at site.
11. Co-ordination with other agencies including with the Owner at the plant interconnections (interfaces). The project in under execution with a separate contract for BTG and BOP on an EPC basis, the FGD contractor need to co-ordinate with both the contractor during the time of execution .
12. Cleaning and application of corrosion protection during erection as required by the Owner and apply final & touch up painting in accordance with the specification.
13. Carry out commissioning, testing, trial operation, reliability run and performance guarantee test of the systems / equipment / plant including civil, structural & architectural works specified and handing over of the plant to the Owner requirements and approval and in compliance with the requirements of this specification.
14. Installation and removal of temporary piping and equipment for carrying out flushing or any other operation.
15. Removal of surplus materials, scraps out of fabrication yard, temporary infrastructures, subsequent cleaning up and handing over of plant to the owner.



16. Provision of supply of all documents required and specified including AS BUILT drawings.
17. Training services for the Owner's operation and maintenance personnel.
18. Supply and Installation of proven and latest air quality monitoring system at the strategic locations of the plant to monitor and comply with norms of various statutory bodies.
19. Conducting Hazop Study with the involvement of the "Company" and furnishing the report.
20. The specification has described the scope of work/supply and endeavored to cover all the major equipment and related activities and work necessary for satisfactory completion of the FGD Project. However any other minor item/service, which has not been specifically mentioned but is required for the completeness of the work shall also be supplied by the contractor without any additional cost to Owner. The bidder is therefore advised to visit the site and acquaint himself with the condition of the plant and equipment to enable him to make assessment of the complete job of FGD Package system for 1 x 800 MW TPS
21. The Contractor shall accept full responsibility for the completeness and for the faultless working of equipment and the plant as a whole. These shall be executed on the basis of proven design principles and in accordance with the state-of-the-art in such a manner that the purpose to be served by the plant is fulfilled in every respect and a maximum of operational dependability and efficiency are assured. Standardization of equipment, materials etc. as well as of buildings shall be employed in the design. Care shall be taken to ensure safe operation as well as simplicity of assembling and dismantling of all parts of the plant.
22. Satisfactory conclusion of the Contract:-

By accepting the Contract, the Contractor shall be deemed to accept the obligation of supplying everything necessary for the purpose mentioned above, regardless of any omission in the specification or on the drawings.

More detailed scope of supply and service is described under this section and the relevant chapter of the detailed technical specification.
23. Scope of Engineering Services:-

The engineering services of the Contract refer to the complete basic and detail engineering of all equipment and equipment systems, Providing engineering drawings, data, instruction manuals, as built drawings and other information for the Owner's review, approval and records.

The Contractor shall be responsible for all licensing applications, however Owner will extend all co-operation required by the contractor.

All services shall be performed by the Contractor to obtain the required permits to commence the works and operate the Plant, including but not limited to:

 - Clarifications with authorities
 - Participation in all clarification meetings
 - All other services as required.

3.4 COMMON EQUIPMENT AND SERVICES

The following supplies and services are to be included in the Bidder's scope

- Plant Hand Book contains the design and performance data of equipment, systems, covering complete supply package including single line diagram.



- All necessary co-ordination with other contractors on site for erection, testing and commissioning of equipment and accessories.
- Making available of all testing and commissioning equipment.
- All necessary pipelines, warm up system, vents, drains, valves, actuators, required for commissioning, operation and preservation in standstill.
- All temporary installations required for tie-in measures including post weld heat treatment complete, inner cleaning, etc.
- All temporary pipe work as required during connection measures
- All support structures, hangers, supports etc.
- All base frames, mounting plates, grouted in parts, rag bolts, covers, etc.
- All required steel parts embedded in concrete
- All couplings and coupling guards for electric motors and other drives
- All lifting equipment required for maintenance
- Required safety equipment, pressure relief valves, etc.
- All thermal (Hot and Cold) and noise insulation including cladding as well as any other noise attenuation measures
- Stairways, ladders, platforms, galleries and walkways to all plant components, including escape routes as necessary, pipe cross overs,
- All necessary steel structures, stairs, ladders and platforms including weather protection
- All required ventilation and / or air conditioning equipment as specified and as required for safe operation of mechanical and electrical equipment, to be supplied
- All necessary corrosion protection measures for plant components and equipment stored or mounted on site up to the time of "Handing Over".
- Complete primer and top coatings conforming to color code, to be agreed with the Owner/Owner's Engineer
- Noise abatements measures to comply with noise pollution control requirement
- Complete labeling of all plant components according to the Owners system in English and also in local language for notices etc.
- All fire protection measures
- Initial lubricant filling and sufficient lubricants for commissioning and reliability test run, minimization of lubricant types by screening and co-ordination with the Owner,
- Provision of all connections and temporary pipe work for steam blowing of the steam pipelines
- Flushing of all other pipelines including disposal of the effluents; protection with wood and/or plastic at all instrumentation and appendages to be installed during construction
- Chemical cleaning
- All standard accessories and auxiliary equipment which normally form part of the scope of supplies
- All tests, inspections and works acceptances as well as all certificates and reports of these
- Cleaning of all filters/strainers before "Handing Over" of the relevant Unit
- Valve trims for purging and subsequent exchange
- Removal of any unused material from site
- Micro leveling of the area
- Earthworks, drainage, excavation and refilling works
- Roads and pavement (to be connected with the existing roads)
- Concrete and reinforced concrete works, masonry and earthing
- Water proofing works for pressing and non-pressing water
- Roofing (non asbestos)
- Plumbing
- Facade works/glazing works; non asbestos
- Non-load bearing walls/installation partitions/dry construction works
- Metalwork and blacksmith work/raised flooring/doors and gates/sheet metalwork
- Flooring work



- Corrosion protection for underground/ over ground RCC and steel structures, equipments and piping
- Crane way works
- Potable water, service water and waste water, sewage water, storm water (permanent and during construction), etc.
- Housekeeping during construction (at least once a week total)
- Transport of all dumping material to dump locations (at least once a week)

4.0 TERMINAL POINTS

4.1 MECHANICAL WORKS

- Untreated Flue gas duct: At the existing ID fan duct. Material Carbon steel. Size – 6500 mm x 7700 mm Design pressure shall be decided based on Booster fan head. (Please refer to the existing ID fan duct layout)
- Treated Flue gas duct: At the existing ID fan common duct. Material- Carbon steel. Size- 6500 mm x 7700 mm. Design pressure shall be decided based on Booster fan head. (Please refer to the existing ID fan duct layout)
- Service water pipe terminal. Shall be tapped from the existing header inside the Filtered water pump house (refer terminal point drawing).
- Potable water pipe terminal. Tapped from the existing header on Pipe Rack (refer terminal point drawing).
- Auxiliary Steam pipe terminal. Tapped from the existing Auxiliary Steam header on Pipe Rack (refer terminal point drawing)
- FGD effluent water (treated clarifier water) pipe terminal- At the inlet of Guard pond.
- Limestone: At the Limestone stockyard
- Gypsum: At the silo outlet .
- Fire water pipe terminal- Tapped from the existing Fire hydrant network. Size to be confirmed during detailed engineering.
- Instrument Air and Service- Contractor has to consider the necessary compressor package to meet the requirement and hence terminal point is “Not applicable”. .
- Cooling Water : Auxiliary Cooling water before the inlet of Self-cleaning strainer of ACW header which will be the inlet and the outlet secondary cooling water line shall be terminated at the CW forebay
- DM water : At the terminal point in the existing pipe rack

All necessary interconnections /Modifications at the interface points is in the Bidder scope. Necessary isolation valves with counter flanges and hardware at the terminal point are in Bidder scope. Bidder shall visit the plant to identify the listed interface/ terminal points at bid stage for physical identification of interface points, and for planning the pipe/cable /duct layout during execution. Bidder shall consider a tolerance of ± 50 m while considering the interface terminal point location from the specified location.

The existing , ID fan , Flue gas duct layout between ID fan & Chimney is furnished as reference drawing 1 & 2 in the specification.

The list of terminal points with co-ordinates are identified in the Terminal Point drawing.



The available utility parameters at the terminal points are listed below.

Terminal Point Number (TP No.)	Utility	Available Process Parameters at T.P
TP 1	Service Water	100 m ³ /hr (max)
TP 2	Potable water	1 m ³ /hr (max) at 2 Kg/cm ² (g)
TP3	Auxiliary Steam	6 TPH (max) at 12 Kg/cm ² (g)/ 210 deg C
TP 4	FGD effluent water outlet (treated clarifier water)	To Guard pond
TP 5	DM water	0.5 m ³ /hr at 1.0 kg/cm ² (g)
TP 6	Auxiliary cooling water (supply)	200 m ³ /hr (max) at 3.0 kg/cm ² (g) normal and max 7.0 kg/cm ² (g)
TP 7	Auxiliary cooling water (return)	At required pressure at terminal point
TP 8	Firefighting water	From the existing hydrant network.

The terminal point details needs to be validated during the detail engineering

4.2 CIVIL WORKS

- Road network from FGD facilities to upto nearest plant road as per General Layout attached.
- Storm water Drain in FGD facilities area upto nearest existing road side drain.

4.3 ELECTRICAL WORKS

- HT Power Supply : HT power supply envisaged at 11 KV station switchgear- OBA-panel no.4 and OBB-panel no.5 located at HV Switchgear room of Power house building. Complete cabling and termination from this point of source including its supply is in bidder's scope.
- Earthing : 2 nos. Test link pits shall be installed by bidder near Chimney by shall connect the same with the existing earth grid near Chimney.
- Telephone System : Existing IP based EPABX system for main plant is located in service building. Bidder shall extend minimum 50 nos extensions from the same to the FGD control building through necessary cablings, terminations and shall terminate in new JB, to be supplied by the bidder, in FGD control building, from which the telephone communication network will be done by telephone cables laid in existing cable racks/trays, drawn through conduits, laid directly buried underground as applicable, in respective zones of FGD area.
- PA System : From the existing main plant central control exchange MDF, bidder to lay 100 pair telephone cable to FGD control room building and terminate at a new SDF, to be supplied by bidder. All further distribution and instruments shall be carried out by the bidder.
- EDMS & IEMS : Integrating the FGD system electrical with EDMS & IEMS of existing main plant (CCR TG building). All necessary cabling and any modification in the existing system for this integration shall also be in bidder's scope.



Cable tray : Bidder shall use the existing cable tray, only if the tray with same voltage grade of cable is available with adequate free space for additional cables. If not available, bidder shall install new tray in the route.

4.4 CONTROL AND INSTRUMENTATION

Cable, cable tray and accessories including supply, laying and termination : No Terminal Point. All cables where one end / both end equipment is supplied by bidder.

- i) Complete supply, installation and laying by bidder between bidder supplied equipments.
- ii) Complete supply, installation and laying between Field instruments / Valves / local control Panels and FGD PLC / DDCMIS by the bidder.
- iii) Complete supply, installation and laying between Switchgear / MCC&FGD PLC system by the bidder.
- iv) Complete supply, installation and laying between Respective UPS terminal and FGD PLC / LCP by the bidder

MODBUS /OPC DDCMIS interface : Terminal Point at Plant DDCMIS end (in CCR)

GPS master clock Time Synchronization : Terminal point at Master Clock end(in CCR)

CCTV : Terminal point at Plant CCTV(in CCR)

Fire system : Terminal point at Plant Main Fire Panel (in CCR)

VMAS : VMS shall be supplied by FGD vendor for all HT drives under his scope. However VMAS shall be supplied by main plant contractor, Required signals & raw buffered output, cables and other accessories shall be supplied by FGD vendor and terminal point will be VMAS panel located in main plant building. Including termination and modification both (Hardwired and software) required in VMAS

CEMS and other Analyzers : Complete supply and installation by Bidder, Terminal point at DDCMIS in CCR.

Field Instruments / Final Control elements / Erection hardware : No terminal point. Complete supply and installation by the bidder within his battery limits.

Earthing : No terminal points. Complete requirement by bidder within his battery limits

UPS/Auxiliary Power Supply System : No terminal points. Complete requirement by bidder within his battery limits



5.0 PROVISIONS BY THE OWNER

Following are the provisions / supplies by the Owner:

- Graded land within the property line limits as indicated in the General Layout for FGD.
- Geotechnical investigation report
- Limestone and water for startup, testing and commissioning. However, Bidder shall indicate in the offer the quantity required in his offer exceeding which the supply by Owner will be on chargeable basis
- All utilities/services up to the terminal points as specified in the specification.
- Permits specifically identified as to be obtained by the Owner. Bidder shall specify the same in the offer submitted.

6.0 QUALIFYING REQUIREMENTS FOR EQUIPMENTS / SYSTEMS

The sub-vendors being engaged by the EPC contractor for the various packages in the scope of works shall have successfully executed similar such works in the last ten years. The credentials of such sub vendors shall be furnished to Owner/ Consultant for review and approval. Sub-vendors who are approved by Owner/Consultants shall only be engaged by the EPC contractor for the various packages under the scope of works.

7.0 SITE CONDITIONS

7.1 GENERAL

The Project Information is enclosed as Annexure 1

7.2 GEOLOGICAL CONDITIONS

7.2.1 Soil Profile

Geotechnical investigation is furnished in **Attachment 1** of this Technical Specification.

7.3 DESIGN REQUIREMENTS RELATED TO SITE CONDITIONS

7.3.1 Design Ambient Data

- **Design ambient conditions for FGD and auxiliaries**

Design ambient temperature : 30 °C
Design ambient air relative humidity : 75%

*Basic conditions as per Schedule of Guaranteed shall also be applicable).

- **Design ambient Conditions for Electrical equipment sizing**

- For electrical equipment : 50 °C
- Relative Humidity Mean Maximum : 90%
- Relative Humidity Mean Minimum : 36%



7.3.2 Wind data

Wind loads to be considered for design of structures shall be based on the design wind speeds arrived at based on IS : 875 (Part -3) – Latest Edition

7.3.3 Seismic Data

Seismic loads to be considered for design of structures shall be as per as per IS: 1893.

8.0 SITE WORK AND ERECTION REQUIREMENTS

8.1 CONSTRUCTION POWER

The construction power supply system by its design and nature shall be temporary system and not a part of permanent supply system. The Purchaser shall be providing 415V 3 Ph, 3 Wire and 50 Hz construction power supply at two (2) points. However bidder shall mention the construction power requirement at various phases of construction, in the bid document. Construction power supply shall be given on chargeable basis at the prevailing rates of Tamil Nadu TRANSCO.

The contractor shall provide metering equipment, comprising of CT, PT units, trivector meters of suitable accuracy and shall be responsible for periodic payment of bills for the energy consumed. Necessary protections for the construction power shall be provided to protect the Client's source from any fault in his system.

Bidder/Contractor may specify in the tender conditions itself, if there is any change in the construction power supply system maximum demand requirement. Bidder shall indicate 6 monthly maximum demand requirements.

Operation and maintenance of all construction power supply equipment is in the scope of Bidder.

Bidder/ Contractor shall maintain a power factor of 0.95 or better for the construction power used.

Distribution of 415V supply shall be done using underground cables. All cables being used for construction power shall be armoured only. For the areas like roads, nearer to buildings and areas where there are frequent vehicle movement the cable shall be routed in hume pipes or GI conduits. Buried cable shall be suitably identified by the route markers.

In any case, non-availability of power, its interruption and variation in supply voltage will not constitute a condition for claim for extra costs and time on part of the contractor. The contractor will be responsible for making all necessary arrangements to ensure that the uninterrupted construction power supply is available during critical erection and commissioning activities. For this purpose, required DG sets has to be arranged by contractor.

The Electrical installation shall be generally be carried out as per Indian Electricity Rules & Acts for road crossing, protective guarding shall be provided. The clearance for the lowest conductor from ground shall be decided keeping in view the vertical clearance required for movement of vehicle /crane, etc.

Adequate safety equipment shall be provided to all the workers, like hand gloves, head gear, etc. Meggers & Testers shall be provided in sufficient quantity. Earthing and Lightning protection system shall be provided as per IS and CEIG requirements.



All the working areas shall be adequately illuminated for safe working with proper fittings/fixtures. The wire shall be laid with proper fixing without any hindrances to personnel or vehicle movement.

After the completion of the job, the contractor shall remove the entire installation and make available the area to the owner.

8.2 CONSTRUCTION WATER

Construction water shall be provided by the Owner to the Contractor at chargeable basis. Bidder shall mention the construction water requirement at various phases of construction, in the bid document.

8.3 CONSTRUCTION COMMUNICATIONS

Any communication system which the Contractor might need is within the scope of the Contractor's supply.

8.4 ACCESS TO CONSTRUCTION SITE

Most transportation will have to be via sea or road. Heavy equipment if transported by rail have to unloaded at the nearest railway station (facility shall be checked by the contractor) and transported to site by other means. Any road transportation to the site will have to be through the existing plant access road and high ways.

8.5 SITE SAFETY & SECURITY

It's Contractor's duty to organize and constitute a safety system for providing protection to installation work, contracting material storage, warehouse, field office, accommodation etc., within the contractor's scope of supply and services.

Guards shall be provided by contractor for safety and security.

The Contractor is responsible for the storage of material and the upkeep of equipment at the working site. There shall be fencing for temporary storage and material storing yard with special duty personnel on duty day and night.

Temporary safe railings shall have safe lighting equipment to send out indications such as material warehouse, field or site office and accommodation.

The duty of the Contractor includes the site management and safety of the engineers.

8.6 FIELD SAFETY AND HEALTH ORGANIZATION

According to both, local safety and health regulations, field safety organization shall provide necessary tools, documentation and other measures especially with respect to handling of dangerous goods and fire risks and medical service.

Contractor shall be in charge of examining field safety under the control of a field safety engineers.

8.7 CLEANING ON SITE

Contractor shall be responsible to keep the construction site clean and remove any waste material or hazardous waste to an appropriated waste disposal site approved by authorities in a safe and orderly way.



8.8 LAYDOWN AND CONSTRUCTION

Space available within the site shall be utilized for Contractor's laydown and construction.

9.0 SPARE PARTS, WEAR AND TEAR PARTS

Spares for the FGD plant shall be divided into two categories namely:

- (a) Start-up and Commissioning Spares
- (b) Operation & Maintenance (O & M) Spares

Start-up and Commissioning Spares

Start-up and Commissioning spares are those which would be required during plant or equipment testing, start-up and commissioning. All spares used until the plant is finally handed over by the Contractor to the Owner come under this category. All start-up and commissioning spares as required shall be provided by the Contractor without any additional cost to the Owner. The list and details of start-up and commissioning spares shall be furnished by Contractor prior to award of Contract.

Contractor shall be responsible for the ready and timely availability for all the start-up and commissioning spares as required during various stages of testing, cleaning and commissioning upto handing over of each system of the plant.

O & M Spares

The spares required for 3 years trouble free operation of the plant shall be identified and listed by the bidder in his offer. Owner will review the list of spares specified and finalise the same including any additional spares that will be necessary for three (3) years trouble free operation to meet the plant O & M requirements. The spares for the plant shall be furnished by the Contractor and delivered during the commissioning of the FGD plant.

The spare parts must be able to replace the original part completely and have the same technical specifications in quality, material, inspection and mechanical aspects.

Contractors shall supply all measurement testing data of any spare part supplied, if applicable.

All spare parts supplied shall be packed and stored for a 5 years reservation based on the local climatic conditions. Small spare parts shall be packed and sealed by transparent plastic bags and drying agents will be used if necessary. Every spare parts shall have operation instructions and design marks of the factory when it is supplied.

When multiple spare parts are packed in one packing box or container, the general indication to the spare parts outside the packing boxes or containers shall include a detailed list. All packing boxes, containers, and other such tanks shall be marked properly and numbered clearly. All electrical equipment including switches, fuse connection easy melting and other similar apparatus shall be protected and insulated.

The identification of all spare parts shall be in the English language.

Spare parts shall be supplied 6 months before start of acceptance test .

Wear and tear parts, to be replaced by the Owner at his own cost, shall be marked separately.

Contractor's recommended/required spare part list shall be confirmed during detail design.

Contractor shall identify in the spare parts list, the items having a delivery time of more than 3 months



10.0 TRAINING REQUIREMENTS

10.1 GENERAL

The Contractor shall be responsible for the instruction and training of the Owner's operation and maintenance personnel and his O & M contractor in all aspects of plant design, construction, erection, commissioning, etc. and in such a way that operation, maintenance and if necessary repairs of all the power plant equipment and facilities specified can be handled competently by said personnel.

Such training of the Owner's personnel shall be performed

- In Contractor's and/or sub supplier's/manufacturer's home office and/or workshops.
- In similar capacity FGD operated power plant and such power plants which are under erection and commissioning as well as at the proposed similar Power Plant by using the training simulator.
- On the job site by the Contractor's and/or his sub-suppliers, supervisors and/or instructors deputed to the site for supervision of erection, commissioning, testing and trial operation and/or by specialized training instructors;
- At the FGD Plant by the supervisors deputed to the Plant during the Warranty Period;

In compliance with the provisions of the Contract and the requirements of this specification.

The personnel required for the safe and efficient plant commercial operation and maintenance of the various types of equipment installed shall be provided by the Owner in accordance with the recommendation to be made by the Contractor.

The training will be performed in English. Translators/interpreters shall be provided by the Contractor.

The Contractor's instructors shall use modern training techniques, procedures and aids and make available to the trainees all required notes, manuals, drawings, etc., to supplement the Operation and Maintenance Instruction Manuals.

The Contractor shall provide a detailed description about the recommended training services, including

- Number, category, seniority, required experience, profile required, etc. of the trainees
- Preliminary training program, showing
 - Training facilities, training aids places of training etc.
 - Training schedule
 - Specialty and details of lectures and training
 - Duration of training courses

for all kind of training activities, abroad, classroom, on the job site, at the proposed FGD Plant, etc.

The recommended training program should be based on the organizational and staff structures of coal fired power plants already in operation in India and should take into consideration not only the training for operation and maintenance staff, such as operators, skilled workers, foremen and technicians etc, but also for senior staff and key personnel employed for the management and organizational duties of the various power plant decisions,

such as for operation, maintenance, instrumentation and control, chemistry, administration, security, spare parts handling, scheduling and engineering, etc.



10.2 CONTRACTOR'S OBLIGATIONS AND TASKS

- 10.2.1 The Contractor shall make every effort to train the Owner's personnel and his authorized O & M contractors so that they can be qualified for the management, operation and maintenance of the Contract Plant.
- 10.2.2 The Contractor shall nominate a person in charge of organization and co-ordination activities for training.
- 10.2.3 The Contractor shall select instructors with proper experience and skillfulness and English speaking capability to train the Owner's personnel.
- 10.2.4 The training program will be carried out according to the requirements of each specialty. It will consist mainly of but not limited to the following:
- a) Systematic explanation in a classroom of specific subjects, such as the equipment performance, construction, main systems, auxiliary systems etc.
 - b) Visit to power plants with FGD;
 - c) Practical training in similar power plants which are under erection and commissioning.
 - d) Practical training on simulators and control rooms of FGD in similar power plants.
 - e) Supply of all necessary training documentation (such as books, manuals, drawings), equipment, tools and instruments etc. The Contractor will make best effort to achieve above item (c) and (d) with utility authority.
- 10.2.5 The Contractor will make available free of charge to the Owner's personnel working cloths, safety helmets, stationery etc. as needed by the training program.
- 10.2.6 The Contractor shall allow the Owner's personnel to carry back all the technical documents supplied during the training.
- 10.2.7 The Contractor shall make at the end of the training period an evaluation of the results obtained by each trainee. These results will be confidentially notified to the Owner.
- 10.2.8 The Contractor shall assist the Owner's personnel in arranging their entry visas and all the formalities staying in foreign countries for training. The Contractor shall also take all the necessary measures to ensure the safety of the Owner's personnel during their stay in the foreign country.
- 10.2.9 The Contractor shall appoint a person in charge of logistic coordination. This person shall take care for booking of rooms according to the requirements of the Owner and arranging for transportation (free of charge) from their living place to the training site.
- 10.2.10 The Contractor shall provide free medical services to the Owner's personnel, but excluding dentistry, buying glasses and tonic medicines.

10.3 OWNER'S RESPONSIBILITIES

- 10.3.1 The Owner shall appoint a person as official representative of the Owner's trainees.
- 10.3.2 The trainees shall understand the English language and shall follow the training courses with due diligence. During their stay abroad the Owner's personnel shall observe the Laws of that country and the rules/regulations of the factories/plants where the training will be conducted.

The official holidays or national holidays, Saturdays and Sundays shall be the holidays of the Owner's personnel.



- 10.3.3 For the successful completion of the training program, unless mutually agreed by the parties, the program cannot be interrupted for vacation leave.
- 10.3.4 The Owner shall take care, at his own cost, for:
- buying round trip air ticket between India and the place of training
 - arranging lodging and boarding for the Owner's personnel from their arrival abroad to the date of their departure.

10.4 TRAINING SCHEDULE AND PROGRAM

- 10.4.1 The Training program for the Owner's personnel will be defined during the liaison meeting.
- 10.4.2 Two (2) months before the arrival of the first group of the Owner's personnel in training site, the Owner shall inform the Contractor of the date when the Owner's personnel are expected to be sent to training site
- 10.4.3 Within 2 (two) weeks after receipt of the Owner's information mentioned above, the Contractor shall confirm its agreement or indicate difficulties, if any, for the staying of the personnel. Thirty (30) days before the arrival of the Owner's personnel in the training site the Owner shall inform the Contractor of the brief career of the personnel including names, date of birth, nationality, specialty, experience, qualification, position and knowledge of foreign languages, passport details etc., so that the Contractor can assist in arranging their entry visas.
- 10.4.4 The Contractor shall not charge the Owner with the costs for the training activities in the respective training sites.
- 10.4.5 In case the Owner fails to send his personnel to attend the above training, the Contractor shall reimburse the relevant amount to the Owner.

11.0 TAGGING

Components whose identity is important for operation and maintenance of the plant viz., all apparatus, signal tapping points, instruments and control equipment, cubicles, as well as the terminal boards, etc., installed in the latter shall be provided with permanently attached tag bearing the Owner's coding together with relevant text clearly inscribed. The inscription shall be approved by the Owner/Consultant. The tag shall be of engraved plate of sufficient rigidity and figures and letters embossed and painted. Such nameplates or labels shall be of white non hygroscopic material with engraved black lettering. The language of inscription shall be English. The method of implementation and labeling shall be informed for all components after award of contract. For equipment identification and tagging KKS numbering system shall be adopted.

12.0 PAINTING AND CORROSION PROTECTION

The painting specification for all the equipment shall be as specified in various sections of this specification Annexure 1.6. The detailed painting specification and colour scheme shall be firmed up by the Purchaser after award of contract. Necessary finish paints including touch up paints, if not applied at shop, should be supplied by the Bidder, in sealed containers for site application.

13.0 PROTECTIVE GUARDS

Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy installation and removal for maintenance purposes.



14.0 QUALITY ASSURANCE

14.1 GENERAL

Contractor shall provide effective quality assurance according to ISO 9001 standard or other equivalent quality standard. The preliminary quality assurance program is part of the contract agreement. The program gives the description to all the management and regulations about the necessary quality assurance activities in relation to the execution of the contract.

Quality achievements shall be ensured by combined factors such as the application of quality system regulations, technical specifications (including acceptance regulation of quality control requirements), the examination of quality achievement, precautionary methods and the control of corresponding data.

All manufacturing, processing, testing and inspection operations affecting the equipment or material shall be subject to surveillance by Owner or Owner's Representative. These will be identified by customer Hold Point.

14.2 QUALITY ASSURANCE SYSTEM

The quality assurance system of the Contractor shall illustrate its organization process, duty and obligation, quality supervision and standards and subject to reexamination by the Owner.

The implementation of the system shall be ensured by the following:

the guidance and training of all staff by management council in application of the quality assurance program and the ordinary supervision through reexamination and management of the quality assurance program.

If an international joint venture is established, the responsibilities shall be specified so as to let the quality assurance group perform its duty, communicate with the Owner formally, and be responsible for the development of the quality assurance program. An agent should be involved to prepare a report book and introduce it to the quality assurance management staff. The report book illustrates the responsibilities to be fulfilled in management and supervision of the quality assurance program and examine the implementation of the quality assurance guarantee program by the staff of the international joint venture enterprise.

14.3 BASIC FILES

The basic working files influencing quality implementation and examination will be developed and kept updated in an orderly manner. The copies of these files should also be supplied to the construction site to be available for the Owner's representative to take examination.

14.4 PROJECT GUIDANCE AND MANUFACTURE DRAWINGS

Design shall be based as close as possible on the approved design. Some modifications can also be made in order to make major improvements in the manufacture and building technologies and to meet the special needs of the Owner.

Any improvements on the former design shall be checked and examined individually. Those results that have been discussed carefully shall be reflected in project directions and order files of Owner. The plan about the output and input of design, independent design check and evaluation and design changes shall be controlled and quality acceptance standards shall be established.

Quality assurance plan/ overhaul and test plan



The quality assurance plan to ensure necessary quality shall be included in the quality assurance system of the Contractor. This document shall outline overhaul and test principles and record the procedures and steps of the inspection and the requirements for authorizing the inspection as stipulated in the Contract.

The supply of the main elements of equipment to the Owner shall be included in the quality assurance plan and be submitted to the Owner for reexamination.

The Owner can challenge the inspection point and the required quality assurance records illustrated in the combined plan of inspection and test procedures that have been agreed upon. These and other inspection and test procedures used in the manufacturing period shall be illustrated in detail in a separate document for adjusting and formulating the plan.

The Contractor shall give Owner adequate notice 30 working days prior to each test. The confirmation of the inspection and test data shall be delivered to the Owner in less than 30 days.

Instruction manuals on operation procedures shall be supplied to the Owner.

The content of the instruction manuals ensures that special operation procedures are carried out in a controlled way. All the documents in relationship to the quality assurance plan shall be supplied to working site for the convenience of reexamination.

The detailed Quality Assurance plan for the project is enclosed as Annexure 1.7.

14.5 WORKING GUIDANCE

Working guidance shall control quality and production activities mainly and should be supplied to the working site for reexamination.

14.6 NONCONFORMITY POINT

Nonconformity terms shall be reexamined to make it acceptable or modified or renewed with the final goal of attaining the approved standards. The documents for correct operation shall be provided to manufacturing or construction site for inspection.

14.7 QUALITY GUARANTEE RECORD

Contractor shall keep the records for quality guarantee.

These records should prove that the system and equipment has satisfied the requirements of the contract; all staff, operation programs and equipment are qualified in special operation procedure, and that the supervision to the Subcontractor is in accordance with the contract requirements.

The specified quality assurance record that is as approved in the combination plan of inspection and test shall be provided to the Owner.

14.8 SUPERVISION

Contractor shall supervise Subcontractor's implementation of combining quality and production.

14.9 MATERIAL PURCHASE

Material shall be purchased according to project specification and stated standards. The related control data, such as, chemical analysis, mechanical performance, non-destructive tests shall be illustrated in these standards in detail.



Supervision activities shall be performed in Subcontractor's office in connection with the Contractor's orders and quality plan and standards.

Before the delivery of all goods, the goods shall conform to the random examination and parameter rightness examination and pass the check and acceptance of the records of documents of the Subcontractor to ensure that goods are up to standards.

14.10 STANDARD EQUIPMENT AND PARTS

Standard equipment and parts shall be manufactured by a company that has passed quality assurance inspection.

All parts must be manufactured by the standard criteria and quality assurance standards.

14.11 PRODUCTION CONTROL

Working guidance shall illustrate in detail about the program procedure, control files and the field procedures.

Inspections and acceptance tests shall be performed and recorded.

The corresponding type of quality management (ISO 9001, 9002 9003 or equivalent standards) shall be illustrated in Contractor's order in such detail that it corresponds to the type and scope of the equipment supply. The standard industrial products that are purchased with no reference to list or manufacturer's directions need not be illustrated.

In the procedure of planning inspection, adjustment, evaluating adjustment and the corresponding quality examination and confirmation, the production control of the Subcontractor should be supervised.

15.0 EQUIPMENT ERECTION, SITE TESTING, COMMISSIONING

This clause generally covers the standards, scope of works, documentation, scope of installation, testing and commissioning of various requirements to be adhered to during the execution of the mechanical, Civil , electrical works and Instrumentation & Control works.

Works shall be performed in accordance with this technical specification and various other drawings and schedules submitted and approved by the Owner during the execution and the instructions from Engineer-in-charge or his authorized representatives during the progress of the work. All consumables required for the job shall be ensured by the contractor .All necessary equipment & instruments required to carry out the works, recalibration of the instruments required during loop checking and commissioning shall be done by the contractor.

Field quality plans shall be submitted and shall detail out for all the equipment, the quality practices and procedure etc. to be followed by the Contractor's site quality control organization during various stages of site activities including receipt of materials/equipment at site, preservation and storage, pre-assembly, erection, pre-commissioning and commissioning. The Contractor shall provide all necessary means for execution of inspection and testing, according to the requirements.

16.0 SPECIAL TOOLS AND TACKLES

The Bidder shall supply a complete set of unused special tools and tackles, including tool box, as required for erection, maintenance, overhaul or complete replacement of the equipment and components under this Specification. The cost of this shall be included in the base price.



17.0 LANGUAGE TO BE USED

English shall be used as the general Contract language English translations shall be provided for any code and standards not in English language.

Name plates of equipment and instrument scale, etc. shall be marked in English as required for start-up, testing and training etc.

Documents for training shall be provided in English.

18.0 DOCUMENTATION

a. Drawings, Data / Documents to be submitted along with BID

The bid document shall have complete information for the FGD plant offered clearly identifying and describing the plant design, implementation and operation concept.

All documentation, diagrams and drawings necessary for presentation of the desired results and for comprehension and clarification of the related technical and commercial matters shall be included in the technical offer and shall contain the following documents as a minimum requirement

- 1 Time schedule for engineering, manufacturing erections/installations, commissioning and Reliability Test Run
- 2 Construction approach, phases of construction, commissioning and operation
- 3 General arrangement of the various sections showing disposition of FGD unit, Limestone and gypsum storage silos, Sizing calculations, etc
- 4 Description of main features of the design concept
- 5 Description of major equipment, systems, civil works, including site development, Scrubber tank, Ball mill, Ducting, All pumps, blowers, Booster fan, Rotary drum filters, Hydro cyclones, Service water piping, Slurry piping, Effluent piping, agitators, tanks, Silos, Compressors, Air receivers, Service air Piping, Instrument air piping, etc
- 6 General information and technical documentation of process and auxiliary systems
- 7 Information on conditions of operation
- 8 Descriptive Data sheets, performance curves, catalogues for all pumps, fans, blowers, Compressors, AC and ventilation system Heat load calculations, Ducting layout, data sheets.
- 9 Documents on the quality assurance system of the bidder
- 10 Training program and schedule for the Corporation's personnel
- 11 Details of operation, maintenance and training
- 12 Standards, codes and regulations: listing of major standards, codes and regulations (local, international, supplier's own country) which will be applied for the design and construction of plant equipment and facilities, for civil works and for testing of equipment
- 13 Completely Filled in Technical Data sheets as per schedule(Part-II Section-7).
- 14 Sub –vendor list
- 15 Spare lists
- 16 Control System Configuration
- 17 Bill of Quantity for I&C items
- 18 Basic operational and control philosophy of the system offered
- 19 Drive control philosophy

b. Drawings, Data / Documents to be furnished by the successful Bidder

The Bidder shall submit the following data / information / documents/ drawings to the OWNER/CONSULTANT, who in turn shall review and furnish comments on only important drawings/ documents. Bidder shall furnish a list of data / drawings / documents which shall be submitted to the Owner/Consultant with due dates of submission



immediately after award of Contract. The Bidder on fortnightly basis shall update the list. All drawings shall be generated in AUTO CAD.

- Detailed design and drawings for FGD unit, lime and Gypsum storage silos, Electrical and Control room etc.
- Final version of all documents drawings submitted along with the offer.
- Detailed design documents for scrubbers, pipe & detailed Cross Section drawings including support arrangement details & anchoring arrangements details etc.
- Bidder to submit and obtain Owner's Engineer's approval of all drawings / documents design, detail engineering and construction before proceeding with construction and execution. A list of such drawings will be finalised at the time of Award and which will get updated as the detail engineering progresses. The below mentioned list is Preliminary which shall be finalized after award of contract.

Document	Category A – Approval I – Information
General	
• Complete list of documents with proposed submission deadlines	I
• Progress reports	I
• Erection and installation progress reports	I
• Quality assurance procedure and program	I
• List of subcontractors/ manufacturers	A
• Proposed inspection and testing programs	A
• Detailed program for commissioning	A
• Detailed program of Reliability Test Run	A
• Testing documents/Report of results of all tests	A
• As-built-documentation including drawings of all equipment	I
• Spare part lists	I
• Performance guarantee / test procedure	A
• Quality Assurance Plans	A
• Process presentation of FGD plant	I
Mechanical Engineering	
• Layout of FGD and Auxiliaries	A
• GA and Cross sectional drawing of Absorber/ Scrubber, Storage Silos	A
• GA Drawings and Data sheets for All Pumps, Booster fans, Ball mills, GGH, Hydro Cyclones, Rotary drum filter, blowers, Compressors, Crushers, Conveyors, Dampers, valves, etc	A
• Sizing calculations for Absorber, GGH, Limestone requirement, and Gypsum generation.	A
• Slurry balance diagram	A
• P&ID for FGD system and auxiliaries	A



Document	Category A – Approval I – Information
• PFD/P&ID for Lime Stone unloading, crushing & storage system	A
• PFD/P&ID for gypsum handling and storage system, waste water system.	A
• Data sheet for Drain/ Submersible pumps	I
• Data sheet for Electrical hoist/ Cranes, Bucket Elevators, Conveyors, etc	I
• Sectional and detail drawings of all components	I
• Heat load calculations, ducting layout, Data sheet for HVAC	A
• GA drawing for bucket elevators, hopper, conveyor, feeder, crane, hoist, etc	I
• GA drawing for compressor building layout, compressor, air receiver, air dryer etc	A
• Data sheets for Dampers, Valves, Expansion joints	A
• Valve & piping Schedule/ Damper Schedule	I
• Data sheet for Bucket Elevators, Conveyors, feeder, hoist, Cranes, etc	I
• Data sheet for compressor, dryer, filters etc	I
• Drive selection calculation for bucket elevators, conveyor, feeder, hoist, crane, etc	I
• Drive selection calculation for compressor and dryer.	I
• Sizing calculation for hopper & silo	A
• Sizing calculation for pumps, tanks	I
• Piping Layout of Hydrant/ Spray system	I
• P&ID indicating Instruments and the interlocks for Hydrant and Spray (MVWS) system	A
• Hydraulic calculation for Hydrant system, automatic High and Medium velocity spray system.	I
• Layout for Fire Detection and Alarm system	A
• Interface wiring diagram from DV LCP to existing fire alarm panel	A
• Schematic Drawing for fire detection and Alarm system	I
• Data sheet and GA drawings for Hydrants, Detectors, Fire alarm Panel, cabling, Extinguishers etc.	I
• Layout for Make-up water/ Service Water/ Potable/ Auxiliary Steam piping with Cross section and details.	A
• P&ID, data sheet Ducting layout, Wiring drawing of HVAC system	I
• Layout for Effluent Water piping with Cross section and details.	I
• Characteristic correction curves for Booster fans	I
• Gas flow rate Vs SO ₂ removal Efficiency	I
• Inlet SO ₂ concentration Vs SO ₂ removal Efficiency	I



Document	Category A – Approval I – Information
• Inlet Dust concentration Vs dust removal Efficiency	I
• Inlet gas temperature Vs Stack Temperature	I
• Gas flow rate Vs Pressure Drop	I
• Gas flow rate Vs Water Consumption	I
• Characteristic curves for all Pumps, Blowers, Cyclones etc	I
• CFD modeling procedure and reports	A
Electrical engineering	
• Main single line diagram	A
• Design basis report for electrical system	A
• Sizing Calculation for equipment like Transformers, Switchgear, NSPBD, Cables, UPS System, Battery , Earthing, lightning protection, Illumination, etc.	A
• Technical data sheet for all the electrical equipment	A
• General arrangement drawing for all the electrical equipment	A
• Schematic diagram / wiring for all the electrical equipment	I
• Characteristic curves for all the motors	I
• Electrical switchgear room layout, Battery room layout etc.	A
• Cable tray layout for all the area	I
• Earthing layout for all the area	I
• Lightning protection layout for all the area	I
• Lighting layout for all the area	I
• Cable schedule	I
• Interconnection diagram	I
• Catalogues	I
• Relay setting calculation for complete system	A
• List of make or vendors	A
• Spares list	I
• List of Special tools	I
• Quality plan	A
• Test reports	A
Control & Instrumentation Engineering	
• Master Drawing List – Instrumentation	A
• System Description and Configuration for FGD plant, VMAS, Fire Fighting system for FGD plant, HVAC for FGD plant (P&ID wise)	A
• Operation and Control philosophy – Description of closed loop and open loop control schemes along with control schemes/logics	A
• Vendor Data sheets for all the I&C items– Field instruments / analyzers / Detectors / local control panels / Flow elements / Control valves / Final control elements / Cables etc	A
• Vendor Data sheets for all the I&C items of VMAS , Fire detection and protection system, HVAC system	A



Document	Category A – Approval I – Information
• Control Room layout	A
• GA & IA drawings – Pump instrumentation, Local control panels, Junction Box, LIE / LIR	A
• Instrument Hook-up diagrams	A
• Drive Control philosophy	A
• Drive List	A
• Cable tray layouts	A
• Instrument Schedule	A
• Cable Schedule	I
• Cable Interconnection	I
• IO list (hardwire + Soft Link)	I
• Control valve / Flow element sizing calculations	A
• I&C power distribution and earthing scheme	A
• Quality Assurance Procedure (MQP) / Test certificates	A
• Performance guarantee / test procedure	A
• Bill of Quantity for instrumentation items	I
• Spare list (mandatory, recommended, commissioning, consumables)	I
PLC vendor drawings	
• PLC Hardware and Software design specification	A
• System Architecture	A
• Bill of Quantity for PLC	A
• Data sheets for PLC items	A
• GA & IA of cabinets, consoles	A
• FAT & SAT procedure	A
• IO assignment and Panel layout details	A
• Power Distribution and Earthing scheme	A
• Power Consumption Calculations	A
• UPS sizing calculations	A
• HMI displays and Graphics	A
• Closed loop control schemes – SAMA drawings	A
• Open loop control schemes – ISA format	A
• List of software and licenses	A
Other Instrumentation drawings / documents	
• O&M manuals	I
• As-built drawings	I



Document	Category A – Approval I – Information
Civil Drawings	
Detailed civil arrangement drawings of all buildings and RCC/steel structures, with Design Basis Report and foundation system	A
Detailed drawings and documents	
- Foundation for Absorber Tower. - Lime Silos - Gypsum Silos - Building for Lime slurry preparation (Enclosing Ball mill, mill separator tank, Lime Slurry tank etc) - Building for Gypsum Recovery system, compressors, - Pipe trestle for supporting flue gas duct, and other piping - Foundation for Pumps, Booster fans, Blowers, tanks and other miscellaneous equipments etc. - Drains and trenches, collection pit - Electrical Switch gear room, Battery room, cable trenches etc. - PLC Control room - AHU room - Access Roads with storm water drains to various building/ structures from Plant road	A
Other documentation	
Quality assurance manuals	I
Manual of Codes and Standards	I
Operating manual	
- Operating procedures and instructions of the Plant with description of all systems, processes and functional groups - As built documentation - General and individual control concept description	I
Service and maintenance manual	
Maintenance procedures and instructions with description of all equipment and facilities	I

Purpose: A: for Approval
I: for Information

c. General Documents to be furnished by the successful Bidder

- Contract network schedule
- Flow diagram for all systems indicating equipment, piping valves, specialties and instrumentation including performance test scheme, technical write-ups
- Details of painting specification.
- Final technical data sheets for all equipment
- Installation drawings and manuals for all equipment/systems
- Integrated operation and maintenance manuals for the complete plant as well as for all individual equipment.



- g) Test certificates for type/routine and standard acceptance tests
- h) Detailed interface schedule for all terminal points identifying terminal point no., size, material, type of connection, design flow, pressure and temperature at the terminal points
- i) Detailed schedule of LOA to commissioning shall be furnished in the Bar chart.
- j) Lubricants list (with quantities for initial fill and make-up).
- k) Erection procedure.
- l) As-built drawings for all equipment/systems supplied under this contract and all structures / works executed under this contract incorporating all changes/modifications upto the time of commissioning / handing over to the Owner/consultant.
- m) Detailed write-up on all pre-commissioning and commissioning activities.
- n) Storage instructions for all equipment
- o) Drawings/data to be required /submitted to statutory authorities

All documents, data sheets, drawing, schedules, lists, etc., to be submitted by the Bidder against this Contract shall be submitted in soft copies on CD/DVDs in addition to the required number of prints/reproducible. Required number of copies for all revisions shall be arranged by BIDDER, the number of copies and the methodology shall be covered elsewhere in the specification.

d. Engineering Information Submission Schedule

Prior to the award of Contract, a Detailed Engineering Information Submission Schedule shall be tied up with the Bidder. For this, the bidder shall furnish a detailed list of engineering information along with the proposed submission schedule. The list would be a comprehensive one including all engineering data / drawings / information for all bought out items and manufactured items. The information shall be categorized into the following parts.

- i) Information that shall be submitted for the approval to the Consultant. /Owner before proceeding further and
- ii) Information that would be submitted for Consultant. /Owner's information only.

The Engineering Information Schedule shall be prepared month wise.

The schedule should allow adequate time for proper review and incorporation of changes / modifications, if any, to meet the contract without affecting the equipment delivery schedule. The early submission of drawings and data is as important as the manufacture and delivery of equipment and hardware and this shall be duly considered while determining the overall performance and progress.

18.1 TIME SCHEDULING, BASED ON CPM

- Overall time schedule for design, manufacture, supply, assembly and commissioning broken down for the principal plant components and all construction works, stating dates for completion of any preparatory work from others which may be necessary.
- Detailed erection, installation and commissioning schedule.
- The Project is scheduled to be commissioned in 20 months from the date of award of EPC contract.

The Contractor shall ensure that the final draft of all schedules, lists or data sheets / equipment are produced to a uniform format irrespective of whether the source of the above schedules, lists and data sheets is in the main Contractor or a Sub-contractor of the main Contractor. All documents shall carry a uniform numbering system.



All Contractor's drawings which are found to be incorrect during the construction period or which require changes owing to site constraints, shall be corrected by the Contractor to an "as built" condition to reflect any necessary changes.

The stipulations and requirements specified elsewhere in the specification shall also be followed with respect to preparation and submission of drawings.

Apart from those documents named in the various sections of the Specification, the Contractor has to submit as minimum requirement the drawings summarized in the above clause to the Owner or his representatives within the periods specified in months, starting from the "Commencement Date" according to the Definitions of the Contract. The delivery time as far as not specified, shall be proposed by the Bidder in his Tender in accordance with his overall implementation schedule and will be defined finally during Contract negotiations.

18.2 LIAISON MEETINGS

The liaison meetings shall be organised by the contractor (once a month during design period and once in 15 days during construction period) in accordance with stipulations specified elsewhere in the specification.

Contractor shall supply all documents required in the appropriated number as requested by the Owner.

18.3 DISTRIBUTION OF DOCUMENTS

The source, distribution, no. of copies etc shall be as per the following document distribution schedule.

Document Distribution Schedule - After Placement of Order

Sl.No.	Document	Total Copies	Distribution		
			Owner		Consultant
			HQ	SITE	
1.	PERT Network, work schedules, Bar charts, Layout drawings	12	4	4	4
2.	Data, drawings, documents, write-ups, calculation				
	- Preliminary	12	4	4	4
	- Revised	12	4	4	4
3.	Approved drawings, documents etc.	12	4	4	4
4.	Instruction manuals for erection and O&M	12	4	6	2
5.	As built drawings including O & M manual				
	- Hard Copy	12	5	5	2
	- Soft Copy	4	3	-	1



18.4 MANUALS

18.4.1 General

The Contractor shall provide the manuals in a timely manner to enable the Owner / Engineer to review and comments and request changes as necessary.

Payments will be withheld for non-compliance or for late delivery of the drawings, procedures and manuals. In particular the Contractor shall be held responsible for consequential damage to the plant where such damage is due to late delivery of the O&M manual resulting in non-familiarity of the operating technique.

The Contractor shall also note that while all documents, procedures and manuals shall be in the English language including that of the sub vender of the contractor, it is particularly important that the O&M manuals be in clear concise English.

All manuals shall be divided by systems or sections and cross-indexed as necessary.

18.4.2 Certification Manual

This manual shall contain the approved works certification documentation for FGD plant equipment and services as specified in the relevant codes and standards and in this specification and the Contractors Quality Manual. This manual shall also include all material tests certificates. Certificates and test procedures shall be specific to the plant supplied.

18.4.3 Design Manual

This manual shall contain all the design calculations and all equipment and system data sheets and design criteria required under the Contract.

18.4.4 Construction Manual

This shall include a comprehensive record of as built site construction tests and records. Again the manual(s) shall be compiled in separate parts to reflect the plant and services supplied.

18.4.5 Commissioning Manual

This manual shall include all the records, certificates and test results arising from the agreed pre-commissioning and commissioning procedures carried out on site. The performance tests and guarantee test results shall also be included. There is a particular requirement that all commissioned equipment values be recorded in this manual and subsequently incorporated into the O&M manuals.

18.4.6 Operating and Maintenance (O&M) Manuals

The Contractor shall provide the O&M Manual properly bound, within the time specified, to enable the Owner's staff to become fully acquainted with the operation, adjustment and maintenance of the FGD plant. The manuals shall contain full and explicit instructions in respect of the operation of the FGD plant under all operating conditions and the maintenance routines and requirements to be established to maintain the FGD plant in optimum performance. These instructions shall be in the English language and be as comprehensive as possible and the form in which they are to be set out shall be agreed with the Owner / Engineer. The instructions may be divided as appropriate into individual sections and sub-sections as necessary. All section and sub-sections shall be clearly indexed and cross-referenced as required for clarity.



The instructions shall be tailored to suit the specific requirements of the Operations and Maintenance functions and personnel, taking into account the staffing philosophy for the thermal power plants.

The instructions for the related parts shall be accurate and easy to understand and shall contain the necessary sequence of individual activities. The diagram and drawings associated with the instruction shall be clear and unambiguous.

It is an essential requirement that all information and plant data contained in the manual must be project specific and derived from the design, manufacturers / suppliers and commissioning data of the as-built FGD plant. Where the Contractor includes standard brochures the installed item of equipment shall be clearly identified. All sections shall contain an introductory description of the particular item/system including its function and operating criteria and any special features. On the basis of the commissioning and running experience of the FGD Plant, the instructions shall be amended to a final form within three months of the end of commissioning and, for this purpose, the Contractor shall supply the required number of printed copies of all approved amendments for insertion in the bound set of instructions.

The entire O&M manuals including that of the sub venders shall all adopt the same format paper size etc. The Bidder shall prepare manuals integrating all equipments supplied by the sub venders.

19.0 GENERAL REQUIREMENTS

19.1 GENERAL

19.1.1 General design requirements

The equipment of the entire supply, the main parts as well as auxiliary parts and accessories, must be designed in such a way as to ensure its proper operation, easy control, regulation, erection and maintenance under every working condition.

In the design, particular importance shall be assigned to simplicity, accessibility and solidity of the machinery and its parts. It is of particular interest to achieve simple assembly, easy access for maintenance and repair and simple and safe operation.

The equipment must operate without vibrations that may affect its operation, that of other machinery or of civil works under every condition.

The works shall be designed to facilitate inspection, cleaning, maintenance and repair. Continuity of supply is of prime concern. The design shall incorporate every reasonable precaution and provision for the safety of all those concerned in the operation and maintenance of the works. The plant shall be designed to operate satisfactorily under all variations of load, pressure, and temperature, as may be met in normal usage under the variation in climatic conditions.

Corresponding parts throughout shall be made to gauge and be interchangeable wherever possible. In case required, the supplier shall provide the necessary references for all kinds of equipment.

All equipment performing similar duties shall be of the same type and manufacture in order to limit the stock of spare parts required and maintain uniformity of plant and equipment to be installed.

In selecting materials and in manufacturing, it is necessary to take into consideration the anticipated operating conditions of components and the environmental state of the plant site. The selection of materials shall also ensure the effective service life of each of the components used in the FGD plant.



The selection of materials shall conform to the requirement of International Standards Organization. Where there is no sufficient information issued by ISO, it is permissible that the material supplying standards of the manufacturing factory of Contractor are adopted. For all the materials and equipment required by the plant, only new ones or those which have not been used before shall be supplied. This requirement means that the raw material of the equipment and that part of new materials may not be derived from recycled material.

19.1.2 Standards and Codes of Practice

The work must be performed according to the most recent relevant codes, and standards, accident prevention regulations and legal regulations.

All material and equipment supplied and all work carried out as well as calculation sheets, drawings, quality and class of equipment, methods of inspection, constructional peculiarities of equipment and parts and acceptances of partial plants, as far as these are beyond the special requirements of the specifications, shall comply in every respect with the technical codes of the International Organization for Standardization (ISO). IEC/IS recommendations apply to the electrical equipment.

Equipment and special guarantees not covered in the scope of ISO and IEC/IS, shall conform to internationally approved standards.

The Contractor is not only responsible for each piece of equipment being correct but also the completed plant must meet design operating condition and performance requirements.

Where there are no standards or regulations, or the standard is not sufficient to meet the need of design and supply, for such items relating to the power plant, the Contractor shall carry out the design, manufacture, supply and installation on the basis of good engineering practice with Owner's approval.

During the period of Contract execution, if any standards change, the Contractor shall be responsible to notify the Owner and provide the basis for the prospect that it would not cause the lowering of quality, performance and service life of the power plant due to alteration of the standard. Upon mutual agreement, the amended standard can then be followed.

Further requirements about applicable standards and codes are specified in the detailed technical specifications.

19.1.3 Vibration

Vibration shall be reduced to the minimum as far as possible where there is vibration. Amplitude and frequency limitation in the design and supporting structure shall be considered.

Special care shall be taken to avoid operating equipment making resonance with foundations, packing, duct, platform, piping or other components.

Unless otherwise stated or agreed by the Owner each rotating machine has to comply with the requirements for designation as 'good' stipulated by VDI (Verein Deutscher Ingenieure) Specification 2056 for the respective group of machinery. If the vibration is higher than stipulated as 'satisfactory' the Owner has the right to reject the corresponding equipment, subject to the conditions specified elsewhere.

19.1.4 Noise levels

The plant shall be designed and constructed to reduce the operating noise level as much as possible and when the plant is operating at all loads, the noise pressure levels specified "Environmental Requirements"-must not be exceeded.



19.1.5 Units of Measurement

For all the technical tables and diagrams, calculation results, drawings, test data and scales adopted in the design and provided for the FGD plant, the standard international unit system (SI) as per International Standardization Organization (ISO) shall be uniformly employed.

SI system shall be employed for all the first-class plant layout and arrangement drawings of equipment made especially for the project. In spite of the employment of British Standard in the layout or drawings and single item standard drawings made with other measuring units, the principal dimensions and demarcation points on these drawings shall also be converted into SI system to be directly marked onto them.

In all correspondence, technical schedules, drawings and instrument scales, the following units shall be used:

Quantity	Name of Unit	Symbol
Length	Metre	m
Mass	Kilogram	kg
Time	Second	s
	Minute	min
	Hour	h
Temperature	Degree Celsius	°C
	Kelvin	K
Electric Current	Ampere	A
Luminous Intensity	Candela	cd
Area	Square metre	m ²
Volume	Cubic metre	m ³
	Litre	l
Force	Newton	N
Pressure (gauge or absolute)	Bar	bar
	Kilopascal	kPa
	Millimeter of water column	mmwc
	Kilo gram per square centimeter	Kg/Cm ²
Stress	Newton per square millimetre	N/mm ²
Velocity	Metre per second	m/s
Rotational speed	Revolutions per minute	rpm
Flow	Cubic metre per hr	m ³ /h
	Tons per hour	t /h
	Kilogram per second	kg /s
	Litre per second	l/s



Quantity	Name of Unit	Symbol
Density	Kilogram per cubic metre	kg /m ³
Torque, moment of force	Newton metre	Nm
Moment of inertia (mr ²)	Kilogram square metre	Kgm ²
Work, energy or heat	Joule	J
Heat capacity, Entropy	Joule per kelvin	J/K
Calorific value	kilo calorie per kilo gram	kcal/kg
Power, radiatn flux	Watt	W
Heat release rate	Watt per square metre	W/m ²
Thermal conductivity	Watt per metre kelvin	W/mK
Dynamic viscosity	Newton second per square metre	Ns/m ²
Kinematic viscosity	Metre squared per second	m ² / s
Surface tension	Newton per metre	N/m
Concentration	Parts per million	ppm
Electrical conductivity	Microsiemens per metre at 25 °C	μ s/m
Frequency	Hertz	Hz
Electric charge	Coulomb	C
Electric potential	Volt	V
Electric field strength	Volt per metre	V/m
Electric capacitance	Farad	F
Electric resistance	Ohm	
Conductance	Siemens	S
Magnetic flux	Weber	Wb
Magnetic flux density	Tesla	T
Magnetic field strength	Ampere per metre	A/m
Inductance	Henry	H
Luminous flux	Lumen	lm
Illuminance	Lux	lx
Thermal resistivity	Kelvin metre per watt	Km / W



19.1.6 Safety

Special importance shall be assigned to all aspects related with the safety of personnel operating, assembling and maintaining the equipment, including other persons who may come in contact with same.

The possibilities of human failure must be foreseen. Provisions shall be taken to avoid damage caused by human error or to ensure that such damage both to persons as well as to the equipment is the least possible.

Rotating or any other moving part of the machinery, hot parts or any part that may cause accident to the staff, must be adequately protected, in accordance with the safest method known.

All components with surface temperatures exceeding 60°C shall be fitted with insulation to protect personnel. The surface temperature shall not exceed 60°C in the condition of the ambient temperature is 40°C.

When it is required to limit the medium temperature drop due to the medium conveying in order to meet the requirements of anti-block, anti-dew and other process, it must be insulated from the point of view to control the medium temperature.

Bright paints will be used to be agreed upon with the Owner to protect personnel, so that anything representing a potential danger will stand out: such as elements in movement, suspended hot, with electric tension, etc.

Likewise, appropriate colors shall be selected for the equipment for the purpose of diminishing weariness of workers.

It should be possible to carry out frequent maintenance operations required by the equipment without interrupting its operation and without danger to the personnel.

The equipment shall be provided with the necessary elements to keep possible failure of the main, auxiliary or control elements from causing serious consequences. For this purpose, protections shall be installed such as: stops in case of failure of shafts auxiliary suspensions that will keep parts from falling or coming loose because of centrifugal forces or others; stops to limit movement in case of failure of normal limiting devices, etc. Protections that will decrease or deviate liquid or gas escapes shall also be provided for the same purpose.

Brakes, gears, clutch and similar devices will be located preferable in the last stage of the transmission, so that they will remain operational even in case of failure in other stages.

Access stairs to the equipment must be safe, with anti-skid rungs and handrail. Normal circulation areas of the equipment shall be protected to keep personnel from falling or shall be surrounded by strong guardrails, platforms should have kicking plates to keep loose objects placed on the floor from dropping off, entrances and large openings in the equipment shall be provided with lids or doors affixed in such a way as to open them also from the inside.

The equipment should be adequately protected against environmental elements, such as humidity, dust etc., and the influences that other equipment may have, such as heat radiation, induced vibrations, etc. The supply shall include protective cabinets for parts exposed to the open air or sensitive parts requiring such protection.

Lubricated parts and parts containing lubricants should be protected against oil leakages, as well as against contamination with extraneous material, with oil seals, packings and similar devices.

Every equipment or parts of equipment that must operate under certain conditions of maximum pressure, temperature, speed, position etc., should have devices to keep such



limits from being exceeded and, if necessary, to stop the operation of the machine (Safety valves, limit switches, thermal switches, etc.,)

The operational certainty of these devices should be in relation with the importance and operational need to maintain the established limits. Resetting of these devices, either automatic or manual shall be agreed upon with the buyer in each case. These elements shall be installed in such a way as to make it easy to detect the device that caused the machinery to stop.

For protection against the possible failure of the above devices, additional safety elements shall be provided such as stroke limiting stops, diaphragms, bolts, etc. and/or links or other dimensioned rupture elements so that in case of failure, when exceeding extreme operating conditions, additional safety is provided to the equipment.

Ladders have to be installed for inspection of dampers, venturies, etc.

In designing an area where combustible gases are likely to accumulate, due consideration shall be given to providing safety measures to allow the gas to continuously diffuse or leak off to prevent explosion. The electric equipment in those areas shall be of the fireproof and explosion proof type. Suitable grounding shall be provided on the casing of electrical apparatus which might be energized.

The design of FGD plant shall include a complete set of composite fire monitoring, protection, and fighting system to identify, isolate, and distinguish fires as well as minimizing potential fire hazards.

A warning alarm for the FGD plant and alarm for evacuation shall be provided. The alarm is to be audible in the normal working areas of personnel. The selection of the alarming device shall be such that it is audible about the normal background noise of the plant. Visual alarm shall be provided in addition to audio alarms in high noise areas.

Draining of water and venting of gas shall be performed with respect to the safe mode of discharge, and is not allowed to be carried out at or near the places where people exit and at the exit of the plant.

19.1.7 Fire Protection and Precautions

The Contractor shall adopt necessary methods to minimize fire hazards.

The fire protection system shall in general follow the recommendation of Tariff Advisory Committee of India and the system and equipment shall met with their approval.

The basic guiding ideology is to adopt two methods: fire prevention and fire control. The following design philosophy will apply:

- Ensure the safety of personnel;
- Ensure the safety of the important and main equipment of the FGD plant;
- Prevent fire from spreading;
- Limit the damage to equipment.

Fire precaution shall comply with the following principle:

To improve conditions in designing and layout and to reduce potential fire danger, and the spreading of fire by adopting the method of observation.

The following methods shall be adopted to prevent fire from occurring:

- Using as far as possible fire proof or fire resistant materials



- Ensuring that, isolating combustible material is not used or stored in possible fire source area of the FGD plant.
- Reducing the area where cleaning and examination are difficult in FGD plant arrangement.

The following methods shall be taken into account to control the spread of fire:

- Use of fire proof material
- use of fire detection sensors and/or fire proof construction materials;
- providing a set of effective fire extinguishing system;
- providing a set of effective fire detecting equipment;
- providing the fire detection device in civil construction;

The fire detection system should detect a fire quickly and reliably at the beginning of the fire and activate a special alarm device operation.

The designing of detection system shall prevent against erroneous operation.

The supplied fire detection system will be a combination system involving an automated and manual hydrant, water hose, take up reel and special fire extinguisher.

The end connection type of hydrant shall fit in with local fire brigade requirements to ensure the manual device in FGD plant to be compatible with the fire control device of local fire brigade.

During the construction phase of FGD plant, the Contractor adopts advanced and safe working practices and a set of guidelines to keep the site in a clean condition to reduce the possibility of fire.

19.1.8 Markings, Labels

All elements should be properly marked at the workshop, in order to make assembly and maintenance work as easy as possible. Whenever necessary, markings should be indicated in the corresponding drawings and/or special drawings for markings. Marks should be unmistakable and as far as possible follow a logical system that will make it easy to find the marked element. Marks should be indelible and clearly visible. Marks made only with paint will not be accepted. Parts that are the same but are not interchangeable shall be marked so as to differentiate them. Wherever necessary the position of a part within the whole shall be marked.

19.1.9 Signs

General

Safety colors, safety symbols and safety signs must comply in construction, geometrical form, color and meaning with the ISO Recommendation 507 of the ISO committee TC 80 'Safety Colors'. All signs should give the identification number. All signs shall be in the English language.

The signs should be of a material which is weather-resistant and of sufficient durability of 25 years for the conditions prevailing on site. Indian Regulations and codes are to be considered.

The positions for the signs must be chosen so that they are within the field of vision of the persons to whom they apply. The signs should be permanently attached. Temporarily dangerous areas (e.g. construction sites, assembly areas) may also be marked by movable signs. The safety signs must be mounted or installed in such a manner that there is no possibility of misunderstanding.



Information signs

Information signs should supply the necessary information to acquaint personnel with the physical arrangement and structure of site, buildings and equipment, e.g. floor numbers, load-carrying capacities including marking of floor areas, working loads of cranes, lifting gear and lifts, room identification etc.

In the choice of information signs in situations not covered by ISO Recommendation 507 the possibility of using pictograms should be considered. Pictograms are particularly suitable for the identification of rooms, areas and buildings in the non-technical areas of the plant, sanitary and amenities buildings, etc.,

Emergency signs

In the event of accidents, all necessary information should be available immediately to those affected. Thus, a sufficient number of signs of appropriate size should be installed, e.g. escape routes (including marking of floor areas), emergency exits, fire alarms, fire extinguishers, instructions for special fire-extinguishing agents, warnings against fire-extinguishing agents (CO₂), first aid equipment, first aid points, accident reporting points, telephones etc.,

Mandatory signs

Signs indicating obligatory actions must be provided and installed wherever certain action is necessary e.g. do not obstruct the entrance; keep right etc.

Signs should also indicate when the wearing of protective clothing and equipment is necessary and obligatory, e.g., protective goggles, protective clothing, helmets, head guards, breathing equipment, ear muffs etc.

Warning signs

Warning signs should refer to the existence or possible existence of danger, e.g. flammable substances, explosive substances, corrosive or noxious substances, suspended loads, general danger, width/height restriction, steps, risk of trapping, slipping, falling, etc. In addition to warning signs, appropriate black-yellow strip markings should also be used where necessary.

Local indicators

Easily visible indicators have to be arranged for: All dampers, valves, level indicators and flow indicators, dampers, mill classifier, etc.

19.1.10 Package, Storage and Store House

The Contractor should provide all the specifications and instructions for the self purchased and fabricated equipment during the planning period of the Contract. These specifications should include the cleanliness and maintenance requirements of materials during fabrication and the protection measures for the equipment from damage during transportation. Loss of materials during storage should be avoided before installation. The instruction should be worked out especially to suit the particular work site program.

Packing

All equipment and instruments should be fully packed and protected from damage during transportation and field storage. The equipment instruments should be provided with through protecting measures before packing. All machine surfaces should be protected with planks or similar materials and reinforced with metal strips or plates from the outside.



Under actual conditions, all equipment such as motor, switch, Control device, instrument and component should be sealed at the joint with polyethylene insulation board and a corresponding drying agent should be provided.

For all piping ends as well as pipes and tanks, the openings should be protected from damage and sealed to avoid the invasion of ash, moisture and air. These protection measures should be kept intact before the start of installation or moving for periodic inspection. The cost spent for the moving, modification and replacement of the packing and protection device should be paid by the Contractor.

A waterproof enclosed packing list should be provided in each planks or packing case.

The name of articles in the packing case should be marked clearly on the packing list so as to be identified easily.

The articles in the case should be supported by wooden bars in order to be fixed safely and it should not be wedged individually with wooden pad. The marks outside the case should be printed with climate proof materials or paints so as to be protected from being removed during transportation.

All materials and equipment should be packaged according to the typical environmental conditions during storage. In case of severe conditions, these materials and equipment should be packaged carefully by taking a full and appropriate preventive measure to protect from any damage or wear.

The marks should be painted or printed clearly and durably with characters of 40 mm height at minimum on both ends of the packing case. The labels should be well protected to prevent loss.

A mark indicating the correct lifting position should be shown in arrow on the packing case.

Field Storage and Cleaning.

The arrangement requirements of storehouse should be developed during the program contracting period to suit the field conditions and possible storage facilities. Equipment components should be packed and maintained to suit the needs of transportation and field storage. The detailed rules should be worked out in the contract to suit the general requirements and any special requirement of storehouse as well as the inspection requirements for special components.

The Contractor and his appointed Subcontractor for installation should guarantee jointly that a good supplementary storage will be carried out within the equipment site controlled by them.

Classes for Storehouse:

Three classes for storehouse are described as follows:

- Storehouse class A: Special measures are taken to protect the stored goods and the temperature, humidity, ash are controlled within a specified range.
- Storehouse class B: Goods are stored with temperature uncontrolled.
- Storehouse class C: It is an outdoor storage with a drainage system on the ground.

No matter what class of storehouse is used, the following basic requirements shall be satisfied.

For storehouses of class A and B they should be fireproof, heat resisting, waterproof and well ventilated. They should not be wet and should be provided with good drainage system and preferably with a brick laying or concrete ground. For storehouses of class C, they should not be wet and should be well drained, preferably with a brick laying or crushed stone ground.



Component surfaces should not be contacted directly with the ground or ground laying material. There should be a layer of oil cloth or wax or other similar materials between the machine surface and ground surface.

After the store house/field are accepted, all components should be inspected as to whether the paint, seal and packing are mechanically damaged. All these damages should be repaired if these components will not be installed immediately.

The components stored in storehouse class C should be protected from rainfall, salt corrosion, ash and other adverse conditions with a temporary cover or tent if possible. A drainage device should be provided for this temporary cover or tent.

Inspection during Storage:

All components shall be inspected for their painting, storing, sealing etc. and any damage or wear should be repaired during acceptance and storage periodically. The inspection interval is determined by the component function, applied protection measure and storehouse class.

Unpacking or inspection for outdoor package (class C) shall not be carried out during rainfall or big wind (salt corrosion is possible).

Many components are provided with a drying agent or sealed in a coverage (polyethylene or insulating cover) containing drying agent. The drying condition shall be inspected during storage after 4 weeks and 8 weeks from acceptance, and then in an interval of every 12 weeks. If it is necessary to replace the drying agent during any inspection, a full inspection every 4 weeks shall be carried out until a successful inspection result is obtained and in the meantime, the conventional inspection shall be carried out continuously.

19.1.11 Painting, Insulation and Anti-dewling

Anti corrosive coatings and painting should be carried out as a pre-treatment to all equipment and parts. The paint system used should coordinate with the painted objects and surrounding conditions of project.

In multi-layer painting system, different painting layers should be selected to make the painting coordinate. If multi-layer painting system is used, various painting layers should have different colors so that the later layer can be distinguished from the former one.

After the equipment or apparatus finished preliminary or full painting, it can be supplied to field. After the installation is finished, ground coat must be painted.

Entire painting procedure should be supplied in order to repair the injures of painting coat after the equipment is delivered to field.

Color strip indication system should be used for pipes.

These strips should be painted on the joint of pipes, entrance, valves of pipe. This pipe without outside protection layer should be marked by some color in whole length.

The principle color of field equipment should be determined by Owner and Contractor in contracting stage.

Further requirements with regard to painting, insulation, and anti-dewling are specified in the relevant sections in the detailed technical specifications. The specified requirements shall be applied to the whole equipment and facilities of the FGD Plant Contract.



19.1.12 Language to be used

English shall be used as the general Contract language English translations shall be provided for any code and standards not in English language.

Name plates of equipment and instrument scale, etc. shall be marked in English as required for start-up, testing and training etc.,

Documents for training shall be provided in English.

19.2 DISCREPANCIES IN THIS TECHNICAL SPECIFICATION

Any contradiction between Various parts/ sections of this Technical Specification, between text and drawings, the document giving the more extended scope or requirement shall be considered to be within the Contractor's scope of supply.

20.0 FUNCTIONAL GUARANTEES, PENALTIES FOR SHORTFALL IN PERFORMANCE AND PERFORMANCE GUARANTEE TESTS

GENERAL

The term "Performance Guarantees" wherever appears in the Technical Specifications shall have the same meaning and shall be synonymous to "Functional Guarantees". Similarly the term "Performance Tests" wherever appears in the Technical Specifications shall have the same meaning and shall be synonymous to "Guarantee Test(s)".

20.1 PERFORMANCE GUARANTEES / PERFORMANCE TESTS

20.1.1 General Requirements

The Contractor shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in these specifications.

The guaranteed performance parameters furnished by the Bidder in his offer, shall be without any tolerance values whatsoever. All margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures. No tolerance or allowance on the test result will be permitted for instrument errors or inaccuracy, the method of testing or any other causes.

The Contractor shall conduct performance test and demonstrate all the guarantees covered herein. The various tests which are to be carried out during performance guarantee tests are listed in this Sub-section. The guarantee tests shall be conducted by the Contractor at site in presence of Owner on each unit individually.

All costs associated with the tests including cost associated with the supply, calibration, installation and removal of the test instrumentation shall be included in the contract price.

The performance tests shall be performed using only the normal number of Owner supplied operating staff. Contractor, vendor or other subcontractor personnel shall be used only for instructional purposes or data collection. At all times during the Performance Tests the emissions and effluents from the Plant shall not exceed the Guaranteed Emission and Effluent Limits.

It shall be responsibility of the Contractor to make the plant ready for the performance guarantee tests.



20.1.2 Test Instrumentation, Flow Measurement and their Calibration

All instruments required for performance testing shall be of the type and accuracy required by the code and prior to the test, the Contractor shall get these instruments calibrated in an independent test Institute approved by the Owner and submit the same to Owner prior to commencement of test. All test instrumentation required for performance tests shall be supplied by the Contractor and shall be retained by him upon satisfactory completion of all such tests at site. All calibration procedures and standards shall be subject to the approval of the Owner prior to commencement of test. The protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes.

Tools and tackles, thermowells (both screwed and welded) instruments/devices including flow devices, matching flanges, impulse piping & valves etc. and any special equipment, required for the successful completion of the tests, shall be provided by the Contractor free of cost.

The Performance test shall be carried out as per the agreed procedure. The detailed PG test procedure shall be submitted within 90 days of the date of Notification of Award and finalization of the PG test procedure shall be done within 180 days from the date of Notification of Award.

The P&G test procedures shall be submitted for equipment/system & subsystem under Contractor's scope for all Guarantees as mentioned below, as per latest International codes / standard including correction curves, meeting the specification requirements along with sample calculations & detailed activity plan of preparation (including test instrumentation), conductance and evaluation of Guarantees.

The Contractor shall submit for Owner's approval the detailed Performance Test procedure containing the following:

- (a) Object of the test.
- (b) Various guaranteed parameters & tests as per contract.
- (c) Method of conductance of test and test code.
- (d) Duration of test, frequency of readings & number of test runs.
- (e) Method of calculation.
- (f) Correction calculations & curves.
- (g) Instrument list consisting of range, accuracy, least count, and location of instruments.
- (h) Scheme showing measurement points.
- (i) Sample calculation.
- (j) Acceptance criteria.
- (k) Any other information required for conducting the test.

20.1.2.1 Test Reports

After the conductance of Performance test, the Contractor shall submit the test evaluation report of Performance test results to Owner promptly but not later than one month from the date of conductance of Performance test. Preliminary test reports shall be submitted to the Owner after completing each test run. Four (4) hard copies and two (2) soft copies on CD-ROM of each test report of final conducted test on each equipment/plant/system shall be submitted to Owner for approval.



Performance Guarantee Tests on the equipment/systems not covered in this Sub- section shall be carried out as per the procedure/test codes specified in respective detailed specifications.

20.1.3 Acceptance of Guarantee Test Results

(i) For Category-I Guarantees

In case during performance guarantee test(s) it is found that the equipment/system has failed to meet the guarantees, the Contractor shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the Employer and re-conduct the performance guarantee test(s) with Employer's consent. In case the specified performance guarantee(s) are still not met but are achieved within the Acceptable Shortfall Limit as specified in Cl.20.1.4, of this sub-section & Vol I SCC Employer will accept the equipment/system/plant after levying Penalties as per Vol.I SCC. However, if, the demonstrated performance guarantee(s) continue to be beyond the stipulated Acceptable Shortfall Limit, even after the above modifications/replacements within ninety (90) days or a reasonable period allowed by the Employer, after the tests have been completed, the Employer will have the right to either of the following:

Reject the equipment / system / plant and recover from the Contractor the payments already made

OR

Accept the equipment /system/ plant after levying Penalties. The Penalties for shortfall in performance indicated in Vol.I SCC shall be levied separately for each unit. The rates indicated in Vol.I SCC per unit basis. The Penalties shall be pro-rated for the fractional parts of the deficiencies.

(ii) For Category-II Guarantees

In case during performance guarantee test(s) it is found that the equipment/ system has failed to meet the guarantees, the Contractor shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the Employer and re-conduct the performance guarantee test(s) with Employer's consent. In case the specified performance guarantee(s) are still not met even after the above modifications/replacements within ninety (90) days or a reasonable period allowed by the Employer, after the tests have been completed, the Employer will have the right to Reject the equipment /system / plant and recover from the Contractor the payments already made.

Conformance to the performance requirements under Category-II is mandatory as compliance of limiting the SO₂ emission from the plant is a statutory requirement. If the stipulated guarantee is not met, the Purchaser at his discretion will reject the FGD Plant/ System and recover from the Contractor the payments made for the entire contract.



20.1.4 AMOUNT OF PENALTIES APPLICABLE FOR GUARANTEES

20.1.4.1 The rate of penalties and acceptable shortfall limits for different guarantees shall be as under and such penalties shall be deducted from the Contract Price.

Sl.No	Guarantee	Rate of Penalty	Acceptable Shortfall Limit with Penalty
i)	SO₂ Removal Efficiency: For shortfall in guaranteed SO ₂ removal efficiency in percentage points under conditions stipulated in Cl. 20.2 of Vol.II Sec.1.	As specified in Vol.I SCC, AMOUNT OF PENALTIES APPLICABLE FOR GUARANTEES	(-)0.25% point from the guaranteed SO ₂ removal
ii)	Auxiliary Power consumption of FGD and Auxiliaries: For increase in the auxiliary power consumption in KW guaranteed as per the requirements of Cl.20.2 of Vol.II Sec.1	As specified in Vol.I SCC., AMOUNT OF PENALTIES APPLICABLE FOR GUARANTEES	(+) 5% of the guaranteed auxiliary power consumption
iii)	Limestone Consumption: For increase in the limestone consumption of FGD system in T/hr under conditions stipulated in Cl.20.2 of Vol.II Sec.1	As specified in Cl.3.0.0 AMOUNT OF PENALTIES APPLICABLE FOR GUARANTEES, Vol.I SCC.	(+)10% of the guaranteed limestone consumption.

NOTE :

- (i) Each of the penalties specified above shall be independent and these penalties shall be levied concurrently as applicable.
- (ii) Contractor's aggregate liability to pay penalty for failure to achieve the performance guarantee shall not exceed Contract price.
- (iii) All these penalties for short fall in performance shall be deducted from the contract price.
- (v) The guaranteed values shall be referred with documents/drawings enclosed with Contractor's proposal.

20.1.4.3 LD for Non-fulfilment of Time Schedule

As per LD defined in SCC

20.1.4.4 Penalties for Inferior Civil Works

Any Civil Work carried out by the Contractor not meeting the requirements of relevant Technical Specifications for Civil/Structural/Architectural works covered elsewhere in bid documents, relevant Indian Standard Codes and Contract stipulations, the same will be considered as Inferior quality Civil works by the Owner. The Contractor shall dismantle/demolish such inferior quality Civil works and reconstruct the same including supply of material, labour, etc. complete up to the satisfaction of the Owner/Company at no extra cost



to the Owner. No extension in the time will be granted by the Owner for any inferior quality Civil works and Penalties thereupon due delay of work, as stipulated in relevant sections of the bid documents, will be applicable.

For non-fulfillment of PG values the LD will be levied as indicated in above clause of this Section. The ceiling of LD for each unit shall be 10% of the contract value. The

20.1.5 GUARANTEES PARAMETERS

20.1.5.1 Guarantees Under Category-I

The Performance Guarantees which attract Penalties are as follows:

The following shall be guaranteed by the Bidder under guarantee point condition:

(i) SO₂ removal Efficiency

The Contractor shall guarantee their best SO₂ removal efficiency for inlet SO₂ concentration corresponding to worst coal and 100% (TMCR) unit load. The Contractor shall Guarantee that the SO₂ removal efficiency shall not be less than 95 % or the value specified under guarantee point conditions (as specified in table 20.2 of this section).

(ii) Limestone consumption of FGD system

The contractor shall guarantee the limestone consumption of FGD system in kg/h under guarantee point condition at 100 % (TMCR) unit load with worst coal firing, meeting an outlet guarantee of less than 100 mg/Nm³ (6% O₂, dry basis).

(iii) Auxiliary Power Consumption

The Contractor shall guarantee the total auxiliary power consumption for the FGD plant in normal operation at the guarantee point conditions (as specified in table 20.2 Section -1)

20.1.5.2 Guarantees under Category- II

SO₂ removal in treated flue gas: Maximum concentration of SO₂ in treated flue gas at the exit of FGD for the unit shall not exceed the guaranteed values.

20.1.5.3 Guarantees Under Category-III

The parameters/capabilities shall be demonstrated for various systems/ equipment shall include but not limited to the following:-

- a. Minimum SO₂ removal efficiency of scrubber corresponding to the design conditions of the FGD plant.
- b. Mist Outlet Droplet Content

The mist eliminator outlet droplet content shall be guaranteed to be < 20 mg/Nm³ at absorber outlet measured over a period of 24 hrs continuous operation.

Mist outlet-droplet content shall be measured as per applicable clauses in VDI Norm 3679 and the Contractor shall carry out the tests as per the test procedure approved by the Employer

- c. Maximum pressure drop of flue gas across the FGD system, corresponding to the guarantee conditions of the FGD plant, mmwc (g)



- d. Permissible range of plant load variation for design SO₂ removal efficiency of the FGD plant (MW or % of unit MCR)
- e. Permissible maximum SO₂ concentration in the inlet flue gas for design SO₂ removal efficiency of the FGD plant, mg/Nm³.
- f. SO₂ removal efficiency with one spray level out of service corresponding to guarantee conditions of FGD plant*(for multi spray tower systems)
- g. Gypsum purity.
The contractor shall demonstrate that the purity of the gypsum produced shall not be less than 90%, chloride content shall not be more than 100ppm and the moisture content shall not be more than 10% for the range of specified coal(s) and limestone.

h. Noise

All the plant, equipment and systems covered under this specification shall perform continuously without exceeding the noise level over the entire range of output and operating frequency specified in Vol.II, Section.2 of the technical specifications.

Noise level measurement shall be carried out using applicable and internationally acceptable standards. The measurement shall be carried out with a calibrated integrating sound level meter meeting the requirement of IEC 651 or BS 5969 or is 9779.

Sound pressure shall be measured all around the equipment at a distance of 1.0m horizontally from the nearest surface of any equipment/ machine and at a height of 1.5m above the floor level in elevation.

A minimum of 6 points around each equipment shall be covered for measurement. additional measurement points shall be considered based on the applicable standards and the size of the equipment. the measurement shall be done with slow response on the a - weighting scale. the average of a-weighted sound pressure level measurements expressed in decibels to a reference of 0.0002 micro bar shall not exceed the guaranteed value. corrections for background noise shall be considered in line with the applicable standards. all the necessary data for determining these corrections, in line with the applicable standards, shall be collected during the tests.

In addition to the above, the following parameters/capabilities shall also be demonstrated:-

(i) Wet ball Mill capacity at rated fineness

The contractor shall demonstrate the guaranteed capacity of each limestone pulverizer under the following conditions:

- i) Limestone fineness : 90% or higher (as per the requirement of the absorber) through 325 mesh (for spray tower Process) OR 90% or higher (as per the requirement of the absorber) through 200 mesh (for jet bubbling process).
- ii) Limestone Quality : All available quality from the specified range.

Contractor shall demonstrate the above capacity with the originally installed grinding elements in nearly worn-out condition as mutually agreed for the purpose of ascertaining wear life of any of the wear parts.

(ii) Wet ball Mill wear parts guarantee

Contractor shall demonstrate the life of wet ball Mill wear parts in line with requirements stipulated in section 2.0 of the Technical Specification. The establishment of the above guarantee shall be based on the operating records available at the Power station and will be computed for each pulverizer based on actual total hours of operation.



(iii) Wet ball Mill ball consumption

Contractor shall guarantee ball consumption per ton of limestone throughput in line with requirements stipulated in Vol.II, Sec-2.1 of the Technical Specification. Contractor shall furnish the minimum ball diameter below which the balls shall be replaced.

(iv) Vacuum Belt Filter Capacity

Contractor shall demonstrate the capacity of the Vacuum Belt Filters to dewater the quantity of gypsum with the specified purity and moisture content as specified in Vol.II, Sec-2.3 of the Technical Specification.

(v) Waste Water

The Contractor guarantees that the maximum purge flow rate to waste water treatment system for the complete plant shall be 10m³/hr averaged over a 24 hour period from the unit.

(vi) Performance characteristics of booster fans (capacity, head developed, etc.).

(vii) Margins in Booster Fan.

Booster Fans - As specified in Cl. 5.4.0, Sec 2.1, Vol II of Technical Specifications

(viii) GGH Leakage

The leakage through the GGH seals shall not exceed 1.5% of the hot gas inlet flow.

(ix) Passenger cum Goods Elevator for FGD absorber & Limestone Grinding Building: Over load tests, travel and hoist speed checks.

(x) Availability of FGD Plant

The Contractor shall guarantee the maximum availability of FGD Plant for the range of coal and limestone specified inline with the requirements stipulated in this Sub-Section

(xi) Air Conditioning System

A. Following shall be demonstrated at Shop

- 1) Capacity and static pressure of AHU fans at its rated duty point.

B. Following shall be demonstrated at Site

- 1) Capacity (TR) of water cooled condensing units (D-X type) for A/C system of FGD control room building.
- 2) Guaranteed room conditions during summer for all the Air conditioned areas.
- 3) Vibration and noise level of condensing units & centrifugal fans of AHUs.

(xii) Ventilation System

A. Following shall be demonstrated at Shop

- 1) Capacity and discharge pressure of pumps of UAF units at its rated duty point of Ventilation system.
- 2) Capacity and static pressure of UAF fans at its rated duty point of Ventilation system.



B. Following shall be demonstrated at Site

- 1) Vibration & Noise level of centrifugal fans & pumps of UAF units.

(xiii) Equipment Cooling Water System

- i) Vibration, noise and parallel operation without hunting & abnormal noise and with flow sharing within 10% of each other at the rated duty point shall be demonstrated at site.
- ii) Design heat load of plate type heat exchangers and Inlet & Outlet temperatures of the Plate type heat exchangers on the primary and secondary side to be demonstrated at site. Pressure drop across the Plate type heat exchanger on the primary & secondary water circuit to be demonstrated at site.

(xiv) Compressed Air System

A. Following shall be demonstrated at shop

- i. Capacity & Discharge pressure of each air compressor.

B. Following shall be demonstrated at site:

- i. Dew point of air at the outlet of air drying plants of air compressor.
- ii. Pressure drop across air drying plant.
- iii. Vibration and noise level of air compressors, blowers of air drying plant (if applicable).

(xv) Particulate matter in flue gas

Bidder's design shall ensure that the particulate emission at chimney inlet shall not be more than 30 mg/Nm³ or as per the values specified for all the specified operating conditions.

(xvi) Capacity of lime & gypsum handling equipment

The Bidder shall demonstrate the capacity of bucket elevators/steep angle conveyor, Belt Conveyor and Lime Crusher capacity of any one set as per Owners Choice and as specified elsewhere in the specification.

(xvii) Capacity of limestone handling system and Gypsum Handling System:

The contractor shall demonstrate the rated capacities of each belt conveyor for limestone and gypsum and the associated equipment.

20.1.5.4 AUXILIARY POWER CONSUMPTION (PA)

The unit auxiliary power consumption shall be calculated using the following relationship.

$$\begin{aligned} P_a &= P_u + T_L \\ P_a &= \text{Guaranteed Auxiliary Power Consumption.} \\ P_u &= \text{Power consumed by the auxiliaries of the unit under test.} \\ T_L &= \text{Losses of the transformers supplied by bidder based on works test reports.} \end{aligned}$$

While guaranteeing the auxiliary power consumption the bidder shall necessarily include all continuously operating auxiliaries under this package.

Any other equipment required for continuous operation of the system shall also be considered for calculation of auxiliary power consumption. Power consumption of all equipments provided on unitized basis shall be included in the unit auxiliary power consumption. For common



station auxiliaries, the power consumption shall be assigned to each unit based on unit load for the purpose of calculating the unit auxiliary power consumption.

The auxiliaries to be considered shall include all the auxiliaries required to run the system on a continuous basis meeting the requirements of the technical specification but not be limited to the following:

- i. Absorber Recirculation Pump(s)
- ii. Absorber Oxidation Air Blower(s)
- iii. Absorber Oxidation Tank Agitators
- iv. Gypsum Bleed Pumps
- v. Limestone Gravimetric feeder, Wet ball mill and their integral Auxiliaries
- vi. Limestone Slurry Pump(s)
- vii. Vacuum Belt Filter, Vacuum Pump and its integral auxiliaries
- viii. Power consumption of Booster water pump
- ix. Process water pump(s)
- x. Mist Eliminator Wash Water pump(s)
- xi. DM Cooling (normally working) Water pump one(1) to supply cooling water on the primary (DM) side of the plate type heat exchangers in the closed loop Equipment cooling water system.
- xii. Auxiliary Cooling (normally working) water pump one(1) to supply cooling water on the secondary side of the plate type heat exchangers in the closed loop Equipment cooling (unit auxiliary) water system.
- xiii. Booster Fans.
- xiv. Power consumption of Limestone Slurry Tank Agitators
- xv. Power consumption of Filtrate Pump(s)
- xvi. Power consumption of Belt Filter Wash Water Pump
- xvii. Power consumption of Hydro-cyclone Waste Water Sump Pump and Waste Water Pump
- xviii. Power consumption of all other continuous running Agitators
- xix. Air Conditioning System
Power consumption at motor input terminals of working units (i.e. excluding stand-by) at its rated duty point of compressor and condenser fans of air cooled condensing unit, Air handling unit (AHU) fans for the Air conditioning system of FGD Control Room Building
- xx) Guaranteed power consumption of single stream conveyors and associated equipments (vibrating screen, crushers, belt feeders, paddle feeders) for limestone and gypsum handling at rated capacities.

The equipments listed above for calculating auxiliary power consumption are indicative. Any other equipment required for continuous operation of the system shall also be considered for calculation of auxiliary power consumption.

Note :

1. The bidder shall furnish a list of equipments to be covered under auxiliary power consumption, which shall be subject to Employer's approval.
2. The equipments listed above for calculating auxiliary power consumption are indicative. Any other equipment required for continuous operation of the system shall also be considered for calculation of auxiliary power consumption.

20.1.5.5 METHOD OF COMPUTING TEST EFFICIENCY OF FGD

The performance tests shall be carried out in accordance with ASME PTC 40 (1991) code. NO tolerance or allowance on the test result shall be permitted for instrument errors or inaccuracy, the method of testing or any other causes. The details of the test shall, however be mutually agreed upon between the employer and the contractor.



20.1.5.6 METHOD OF COMPUTING AVAILABILITY

FOR CATEGORY-III

The Contractor shall guarantee 98 % availability of FGD plant for a continuous period of 120 days. An availability guarantee test shall be conducted to assure this level of availability for a period of 240 days as per the procedure indicated below.

Availability 'A' in %:

$$A = \frac{T_c}{T_k} \times 100\%$$

T_c – recorded time of FGD operation, expressed in hours,

T_k – recorded time of boiler operation, expressed in hours,

However, it is required that:

- (i) In order to calculate the FGD availability, operation hours will be counted except boiler start-ups when the operation hours counting will start on the moment of shut down of all oil burners,
- (ii) FGD will be regarded as a FGD in operation, when by-pass damper is closed and total flow of flue gas from boiler goes via FGD, and SO₂ content is below 100 mg/Nm³ (dry basis at 6% O₂) in cleaned flue gas for the range of specified coals & loads.
- (iii) If FGD is out of operation during the boiler operation time as a result of the Employer's decision, this time will not be counted as boiler operation time for calculating the FGD availability,
- (iv) Boiler operation hours will be counted based on the recorded boiler operation hours and the recorded data will be made available to the Contractor by the Employer.

Mandatory spares have been identified in the Employer. Contractor can use the mandatory spares supplied under the contract during this period in agreement with the Employer. However, if other additional spares are required for demonstration of availability demonstration guarantee, Bidder to should clearly indicate along with their offer.

If the calculated availability after 120 days availability test is lower than the guaranteed value, the Contractor will undertake actions as per clause **19.1.5.4** of this Sub-Section to achieve the guaranteed availability.

Recovery of Penalties

The Owner may, without prejudice to any method of recovery, deduct the amount for such Penalties from any amount due or which becomes due to the Contractor either under this or any other Contract, including en-cashing of appropriate value of Contract Performance Bank Guarantee. Payment of Penalties shall in no way relieve the Contractor from its contractual obligations to complete the works or from any of the obligations under the contract. Any delay in the levy or recovery of penalty shall not constitute waiver of the right of the Owner under the contract towards levy and recovery of penalty.

Test Condition

The performance test on FGD will commence after a minimum period of Seven hundred Twenty (720) hours of operation after completion of initial operation. During the interval between the commencement of initial operation and the commencement of performance test only routine maintenance shall be carried out.



The performance tests shall be carried out in accordance with ASME PTC 40 (1991) code, as amended/ revised. The test efficiency shall be based on the overall performance of the FGD system over a mutually agreed period of operation under the conditions given elsewhere in this specification and allowing the normal operation of the power unit.

20.2 DESIGN AND GUARANTEE CONDITIONS

Design and Guarantee conditions shall be referred in Annex 1.2.



ANNEX - 1.2

FLUE GAS ANALYSIS

The Flue Gas Desulphurisation (FGD) System shall be designed to comply with the requirements stipulated under “Guarantee Case and Design Case” in the table below

SL. NO	DESCRIPTION	Unit	GUARANTEE CASE (Design Coal)	DESIGN CASE (Worst Coal)	DESIGN CASE (Design Coal)	DESIGN CASE (Best Coal)
1	Boiler Load	MW	100% TMCR	100% BMCR	100% BMCR	100% BMCR
2	Ambient air condition	DBT °C	30 deg c	30 deg c	30 deg c	30 deg c
		RH %	75% RH	75 % RH	75 % RH	75 % RH
3	Total Gas Flow rate at FGD package Inlet – NTP condition	Nm ³ /s	699.9	744.5	764.6	756
4	Gas Temperature	°C	128	131	133	134
5	Total Volumetric Flow rate at FGD package Inlet	m ³ /s	1028	1146	1137	1127
6	Flue Gas Composition at FGD system inlet					
6.1	O ₂	(% V/V Wet)	4.635	4.513	4.596	4.579
6.2	CO ₂	(% V/V Wet)	12.33	12.294	12.361	12.527
6.3	H ₂ O	(% V/V Wet)	11.205	11.764	11.225	10.672
6.4	SO ₂	(% V/V Wet)	0.048	0.055	0.048	0.041
6.4	N ₂	(% V/V Wet)	71.783	71.374	71.770	72.181
6.5	Dust	mg/Nm ³	50	200	200	200
6.7	SO ₂	mg/Nm ³	1390	1570	1390	1200
7	Flue gas pressure at FGD inlet	mmWC	0	0	0	0
8	SO ₂ concentration in flue gas at FGD outlet	mg/Nm ³ (6% O ₂ , dry basis)	<100	<100	<100	<100
9	Minimum SO ₂ removal efficiency	95 %	95%	95%	95%	95%



SL. NO	DESCRIPTION	Unit	GUARANTEE CASE (Design Coal)	DESIGN CASE (Worst Coal)	DESIGN CASE (Design Coal)	DESIGN CASE (Best Coal)
10	Limestone purity	%	80	70	70	70
11	Gypsum purity	%	95	95	95	95

Note:

The flue gas volume in Nm³/s shall be calculated at 101.325 kPa and 273.15 K



ANNEX- 1.3

SERVICE WATER ANALYSIS

The Service water (make-up water) water quality is mentioned below:

Sr. No.	Parameter	Unit	Result
1	Temperature	°C	35
2	pH	-	7.5 – 8.2
3	LSI		0 -0.2
4	Alkalinity		< 100 PPM of Ca CO ₃
5	Hardness		< 80 PPM
6	Chloride		< 350 PPM
7	Sodium		< 170 PPM



ANNEX- 1.4

DESIGN LIMESTONE ANALYSIS

Sl. No	Constituents	Unit	% by Weight	
			Analysis #1	Analysis #2
1.	Silica as SiO ₂	%	7.5	4-6
2.	Iron as Fe ₂ O ₃	%	8.0	1.5-2.2
3.	Aluminium as Al ₂ O ₃	%	1.0	1.8-2.8
4.	CaCO ₃	%	70.0	85-89
5.	MgCO ₃	%	3.4	
6.	Acid Insoluble	%	7.0	Below 1%
7.	Others	%	2.42	-
8.	Inherent Moisture Content	%	Max 0.5	-
9.	Bond Work index	KWH/T	11.61	13

	Title: 1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO, Tamilnadu Technical Specification for Agitators of FGD Slurry Tanks	Specification No: PE-TS-485-571- 8000-A001	
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PROJECT SPECIFIC GENERAL REQUIREMENTS QUALITY ASSURANCE



- ii) Visual inspection of all welds shall be performed in accordance with AWS D1.1.
- iii) NDT requirements of structural steel welds shall be as under:
 - a) 100% RT/UT on butt-welds of plate thickness $\geq 32\text{mm}$.
 - b) For plates of $25\text{mm} \leq \text{thickness} < 32\text{mm}$: 10% RT and 100% MPI. c) For plates of thickness $< 25\text{mm}$: 10% MPI/LPI.
- iv) Edge for shop and field weld shall be examined by MPI for plate thickness $\geq 32\text{mm}$.

1.2.0 ABSORBER

1.2.1 Metal Structures

- i) Only material which has been identified against mill sheet or test certificates shall be used for construction. Check testing shall be carried out in the absence of MTC. All plates above 40mm shall be 100% Ultrasonically tested.
- ii) Visual inspection of all welds shall be performed in accordance with AWS D1.1.
- iii) NDT requirements of structural steel welds shall be as under:
 - a) 100% RT/UT on butt-welds of plate thickness $\geq 32\text{mm}$.
 - b) For plates of $25\text{mm} \leq \text{thickness} < 32\text{mm}$: 10% RT and 100% MPI. c) For plates of thickness $< 25\text{mm}$: 10% MPI/LPI.
- iv) Edge for shop and field weld shall be examined by MPI for plate thickness $\geq 32\text{mm}$.

1.2.2 Spray Nozzles

- i) Spray nozzles shall be tested for physical properties.
- ii) Spray nozzles also shall be subjected to performance test.

1.2.3 Agitators

- i) Rubber lining shall be tested for hardness and spark test.
- ii) Impellers shall be tested for dimensional and balancing check.
- iii) Gear Boxes shall be tested for run test as per standard practice.

1.2.4 Other Critical Equipment

Checks/ NDTs shall be done as per relevant Indian Standards or equivalent International Standards.

1.3.0 GGH

The details of the checks to be carried out for various components are to be submitted by the Contractor for Owner's approval. However, some indicative checks on different items are given below which should necessarily form part of the Quality Assurance Plan to be agreed with the Owner.



shall be carried out by the contractor. All consumables and replaceable items require for the contractor without any extra cost to employer would supply this test would be supplied by the Contractor without any extra cost to employer.

b) Piping Protection:

- Thickness, Holiday by spark test, Adhesion test shall be carried out as per relevant standard.
- Complete piping shall be Hydro pressure tested, at 1.5 X DP or 2

X MWP whichever is higher, before protection.

c) Welding of Pipes:

- ERW Black / rolled welded:
 - 100% DPT on root of butt and finish weld of butt and fillet.
 - RT on 10% randomly selected joints shall be carried out (for underground piping). GI Pipes

Welding on GI Pipes in general shall not be done. Welding of GI Pipes, if permitted by design, (butt / socket / fillet weld) shall be done strictly as per approved drawing and procedure approved by NTPC Engineering. For all such welds 100% DP test and random 1% RT shall be done.

1.15.0 MISCELLANEOUS EQUIPMENT

1.15.1 Pressure Vessels

- i) NDT on weld joint shall be as per respective code requirements or the minimum as specified as below:
 - a) 100% DPT on root run of butt weld, nozzle welds and finished fillet welds.
 - b) 10% DPT on all finished butt welds.
 - c) 10% RT (covering all 'T'/cross joints) of butt welds.
- ii) Butt welds of dished ends shall be stress relieved and subjected to 100% RT.
- iii) Each finished vessels shall be hydraulically tested to 150% of the design pressure for a duration of 30 minutes.

1.15.2 Tanks

- i) Tests shall be carried out on the materials of the tanks to establish their mechanical properties, and chemical compositions
- ii) Plates shall be subject to 100% ultrasonic testing.
- iii) Welding
 - a) Root run of butt welds shall be examined by 100% DPT or MPE.
 - b) Butt welds, full penetration joints and nozzle welds shall be checked by 100% RT and 100% MPE or DPT.



- c) Fillet welds shall be checked by 100% MPE or DPT.
- iv) Rubber lining shall be subject to hardness and spark test, as applicable.
- v) Visual check and dimensional measurement shall be carried out on the completed equipment.
- vi) The fabricated tank shall be subject to water fill test to check for the leakage.

1.16.0 LOW PRESSURE PIPING, VALVES AND FITTINGS ETC.

1.16.1 Pipes, fittings

- i) Tests shall be carried out on the materials on various components to establish their mechanical properties and chemical composition. Further, heat treatment shall be carried out for materials as required.
- ii) Dye penetration test of welds of pipes and fittings (including welds of rolled and welded pipes) shall be carried out.
- iii) All pipes and fittings shall be tested as per applicable codes/ standards at manufacturer's works.

1.16.2 Valves

- i) Tests shall be carried out on the materials on various components to establish their mechanical properties and chemical composition. Further, heat treatment shall be carried out for materials as required.
- ii) Shaft/ spindle of size ≥ 50 mm diameter shall be subjected to ultrasonic test.
- iii) Machined surfaces of casing, disc and shaft shall be subjected to 100% MPI or DPT as applicable.
- iv) All valves shall be hydraulically tested for body, seat and back seat (wherever provided) at 1.5 times the maximum pressure to which respective valves can be subjected during plant operation. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure. For rubber lined valves, hydraulic test shall be carried out before rubber lining.
- v) For butterfly valves, hydraulic test, seat and disc string test and proof of design test (if not carried out earlier) shall be carried out in accordance with latest edition of AWWA-C-504 standard.
- vi) Visual and dimensional check shall be carried out for all valves as per relevant code/ approved drawing.
- vii) Functional/ operational checks for and check for smooth opening and closing of the valves shall be carried out.
- viii) Gate, globe and swing check valves
 - a) Machined surfaces of castings and butt welds shall be subjected to MPE or DPT.
 - b) Blue matching, wear travel for gates, valves, pneumatic seat leakage, reduced pressure test for check valves shall be done as per relevant standard.



2.3.0 MOTORS

Item/ Components/ Sub-system	Tests/ Checks																	
	Visual	Dimensional	Make, Type, Rating, TC, General physical	Mechanical, Chemical properties	NDT, DP or MPI, UT	Metallography	Electrical characteristics	Welding/ Brazing (WPS/ PQR)	Heat treatment	Magnetic characteristics	Hydraulic, Leak, Pressure test	Thermal characteristics	Run out	Dynamic balancing	All tests as per IS:325/ IS:4722/ IS:9283	Vibration	Over speed	Tan delta, shaft voltage and polarisation
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y					Y									
Shaft	Y	Y	Y	Y	Y	Y			Y									
Magnetic material	Y	Y	Y	Y	Y		Y			Y		Y						
Rotor copper/ Aluminium	Y	Y	Y	Y		Y	Y		Y									
Stator copper	Y	Y	Y	Y			Y		Y			Y						
SC ring	Y	Y	Y	Y	Y	Y	Y	Y	Y									
Insulating material	Y		Y	Y			Y					Y						
Tubes for cooler	Y	Y	Y	Y	Y				Y		Y							
Sleeve bearing	Y	Y	Y	Y	Y				Y		Y							
Stator, Rotor coils	Y	Y	Y				Y	Y										
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y										
Fabrication and machining of stator, rotor, terminal box	Y	Y			Y				Y									
Wound stator	Y	Y					Y	Y										
Rotor complete	Y	Y					Y						Y	Y				



Item/ Components/ Sub-system	Tests/ Checks													
	Visual	Dimensional	Make, Type, Rating, TC, General physical	Mechanical, Chemical properties	NDT, DP or MPI, UT	Metallography	Electrical characteristics	Welding/ Brazing (WPS/ PQR)	Heat treatment	Magnetic characteristics	Hydraulic, Leak, Pressure test	Thermal characteristics	Run out	Dynamic balancing
Stator, Rotor, Terminal Box assembly	Y	Y					Y							
Accessories, RTD, BTD, CT, Brushes, Diodes, space heater, antifriction bearing, cable glands, lugs, gaskets etc.	Y	Y	Y											
Complete motor (IS: 325/ IS:4722/ IS:9283)	Y	Y	Y										Y	Y
Y = Test applicable, Y1 = for 11kV and 3.3kV motors only														
Note														
This is an indicative list of tests/ checks. The manufacture is to furnish the detailed Quality Plan indicating the practices and procedure followed along with relevant supporting documents during QP finalization. However QP approval is not envisaged for 415V motors upto 50 KW.														

Site Tests :

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

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



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Chennai, TANGEDCO, Tamilnadu
Technical Specification
for Agitators of FGD Slurry Tanks

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PROJECT SPECIFIC GENERAL REQUIREMENT FUNCTIONAL GUARANTEES



19.1.12 Language to be used

English shall be used as the general Contract language. English translations shall be provided for any code and standards not in English language.

Name plates of equipment and instrument scale, etc. shall be marked in English as required for start-up, testing and training etc.,

Documents for training shall be provided in English.

19.2 DISCREPANCIES IN THIS TECHNICAL SPECIFICATION

Any contradiction between Various parts/ sections of this Technical Specification, between text and drawings, the document giving the more extended scope or requirement shall be considered to be within the Contractor's scope of supply.

20.0 FUNCTIONAL GUARANTEES, PENALTIES FOR SHORTFALL IN PERFORMANCE AND PERFORMANCE GUARANTEE TESTS

GENERAL

The term "Performance Guarantees" wherever appears in the Technical Specifications shall have the same meaning and shall be synonymous to "Functional Guarantees". Similarly the term "Performance Tests" wherever appears in the Technical Specifications shall have the same meaning and shall be synonymous to "Guarantee Test(s)".

20.1 PERFORMANCE GUARANTEES / PERFORMANCE TESTS

20.1.1 General Requirements

The Contractor shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in these specifications.

The guaranteed performance parameters furnished by the Bidder in his offer, shall be without any tolerance values whatsoever. All margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures. No tolerance or allowance on the test result will be permitted for instrument errors or inaccuracy, the method of testing or any other causes.

The Contractor shall conduct performance test and demonstrate all the guarantees covered herein. The various tests which are to be carried out during performance guarantee tests are listed in this Sub-section. The guarantee tests shall be conducted by the Contractor at site in presence of Owner on each unit individually.

All costs associated with the tests including cost associated with the supply, calibration, installation and removal of the test instrumentation shall be included in the contract price.

The performance tests shall be performed using only the normal number of Owner supplied operating staff. Contractor, vendor or other subcontractor personnel shall be used only for instructional purposes or data collection. At all times during the Performance Tests the emissions and effluents from the Plant shall not exceed the Guaranteed Emission and Effluent Limits.

It shall be responsibility of the Contractor to make the plant ready for the performance guarantee tests.



20.1.2 Test Instrumentation, Flow Measurement and their Calibration

All instruments required for performance testing shall be of the type and accuracy required by the code and prior to the test, the Contractor shall get these instruments calibrated in an independent test Institute approved by the Owner and submit the same to Owner prior to commencement of test. All test instrumentation required for performance tests shall be supplied by the Contractor and shall be retained by him upon satisfactory completion of all such tests at site. All calibration procedures and standards shall be subject to the approval of the Owner prior to commencement of test. The protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes.

Tools and tackles, thermowells (both screwed and welded) instruments/devices including flow devices, matching flanges, impulse piping & valves etc. and any special equipment, required for the successful completion of the tests, shall be provided by the Contractor free of cost.

The Performance test shall be carried out as per the agreed procedure. The detailed PG test procedure shall be submitted within 90 days of the date of Notification of Award and finalization of the PG test procedure shall be done within 180 days from the date of Notification of Award.

The P&G test procedures shall be submitted for equipment/system & subsystem under Contractor's scope for all Guarantees as mentioned below, as per latest International codes / standard including correction curves, meeting the specification requirements along with sample calculations & detailed activity plan of preparation (including test instrumentation), conductance and evaluation of Guarantees.

The Contractor shall submit for Owner's approval the detailed Performance Test procedure containing the following:

- (a) Object of the test.
- (b) Various guaranteed parameters & tests as per contract.
- (c) Method of conductance of test and test code.
- (d) Duration of test, frequency of readings & number of test runs.
- (e) Method of calculation.
- (f) Correction calculations & curves.
- (g) Instrument list consisting of range, accuracy, least count, and location of instruments.
- (h) Scheme showing measurement points.
- (i) Sample calculation.
- (j) Acceptance criteria.
- (k) Any other information required for conducting the test.

20.1.2.1 Test Reports

After the conductance of Performance test, the Contractor shall submit the test evaluation report of Performance test results to Owner promptly but not later than one month from the date of conductance of Performance test. Preliminary test reports shall be submitted to the Owner after completing each test run. Four (4) hard copies and two (2) soft copies on CD-ROM of each test report of final conducted test on each equipment/plant/system shall be submitted to Owner for approval.



Performance Guarantee Tests on the equipment/systems not covered in this Sub- section shall be carried out as per the procedure/test codes specified in respective detailed specifications.

20.1.3 Acceptance of Guarantee Test Results

(i) For Category-I Guarantees

In case during performance guarantee test(s) it is found that the equipment/system has failed to meet the guarantees, the Contractor shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the Employer and re-conduct the performance guarantee test(s) with Employer's consent. In case the specified performance guarantee(s) are still not met but are achieved within the Acceptable Shortfall Limit as specified in Cl.20.1.4, of this sub-section & Vol I SCC Employer will accept the equipment/system/plant after levying Penalties as per Vol.I SCC. However, if, the demonstrated performance guarantee(s) continue to be beyond the stipulated Acceptable Shortfall Limit, even after the above modifications/replacements within ninety (90) days or a reasonable period allowed by the Employer, after the tests have been completed, the Employer will have the right to either of the following:

Reject the equipment / system / plant and recover from the Contractor the payments already made

OR

Accept the equipment /system/ plant after levying Penalties. The Penalties for shortfall in performance indicated in Vol.I SCC shall be levied separately for each unit. The rates indicated in Vol.I SCC per unit basis. The Penalties shall be pro-rated for the fractional parts of the deficiencies.

(ii) For Category-II Guarantees

In case during performance guarantee test(s) it is found that the equipment/ system has failed to meet the guarantees, the Contractor shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the Employer and re-conduct the performance guarantee test(s) with Employer's consent. In case the specified performance guarantee(s) are still not met even after the above modifications/replacements within ninety (90) days or a reasonable period allowed by the Employer, after the tests have been completed, the Employer will have the right to Reject the equipment /system / plant and recover from the Contractor the payments already made.

Conformance to the performance requirements under Category-II is mandatory as compliance of limiting the SO₂ emission from the plant is a statutory requirement. If the stipulated guarantee is not met, the Purchaser at his discretion will reject the FGD Plant/ System and recover from the Contractor the payments made for the entire contract.



20.1.4 AMOUNT OF PENALTIES APPLICABLE FOR GUARANTEES

20.1.4.1 The rate of penalties and acceptable shortfall limits for different guarantees shall be as under and such penalties shall be deducted from the Contract Price.

Sl.No	Guarantee	Rate of Penalty	Acceptable Shortfall Limit with Penalty
i)	SO₂ Removal Efficiency: For shortfall in guaranteed SO ₂ removal efficiency in percentage points under conditions stipulated in Cl. 20.2 of Vol.II Sec.1.	As specified in Vol.I SCC, AMOUNT OF PENALTIES APPLICABLE FOR GUARANTEES	(-)0.25% point from the guaranteed SO ₂ removal
ii)	Auxiliary Power consumption of FGD and Auxiliaries: For increase in the auxiliary power consumption in KW guaranteed as per the requirements of Cl.20.2 of Vol.II Sec.1	As specified in Vol.I SCC., AMOUNT OF PENALTIES APPLICABLE FOR GUARANTEES	(+) 5% of the guaranteed auxiliary power consumption
iii)	Limestone Consumption: For increase in the limestone consumption of FGD system in T/hr under conditions stipulated in Cl.20.2 of Vol.II Sec.1	As specified in Cl.3.0.0 AMOUNT OF PENALTIES APPLICABLE FOR GUARANTEES, Vol.I SCC.	(+)10% of the guaranteed limestone consumption.

NOTE :

- (i) Each of the penalties specified above shall be independent and these penalties shall be levied concurrently as applicable.
- (ii) Contractor's aggregate liability to pay penalty for failure to achieve the performance guarantee shall not exceed Contract price.
- (iii) All these penalties for short fall in performance shall be deducted from the contract price.
- (v) The guaranteed values shall be referred with documents/drawings enclosed with Contractor's proposal.

20.1.4.3 LD for Non-fulfilment of Time Schedule

As per LD defined in SCC

20.1.4.4 Penalties for Inferior Civil Works

Any Civil Work carried out by the Contractor not meeting the requirements of relevant Technical Specifications for Civil/Structural/Architectural works covered elsewhere in bid documents, relevant Indian Standard Codes and Contract stipulations, the same will be considered as Inferior quality Civil works by the Owner. The Contractor shall dismantle/demolish such inferior quality Civil works and reconstruct the same including supply of material, labour, etc. complete up to the satisfaction of the Owner/Company at no extra cost



to the Owner. No extension in the time will be granted by the Owner for any inferior quality Civil works and Penalties thereupon due delay of work, as stipulated in relevant sections of the bid documents, will be applicable.

For non-fulfillment of PG values the LD will be levied as indicated in above clause of this Section. The ceiling of LD for each unit shall be 10% of the contract value. The

20.1.5 GUARANTEES PARAMETERS

20.1.5.1 Guarantees Under Category-I

The Performance Guarantees which attract Penalties are as follows:

The following shall be guaranteed by the Bidder under guarantee point condition:

(i) SO₂ removal Efficiency

The Contractor shall guarantee their best SO₂ removal efficiency for inlet SO₂ concentration corresponding to worst coal and 100% (TMCR) unit load. The Contractor shall Guarantee that the SO₂ removal efficiency shall not be less than 95 % or the value specified under guarantee point conditions (as specified in table 20.2 of this section).

(ii) Limestone consumption of FGD system

The contractor shall guarantee the limestone consumption of FGD system in kg/h under guarantee point condition at 100 % (TMCR) unit load with worst coal firing, meeting an outlet guarantee of less than 100 mg/Nm³ (6% O₂, dry basis).

(iii) Auxiliary Power Consumption

The Contractor shall guarantee the total auxiliary power consumption for the FGD plant in normal operation at the guarantee point conditions (as specified in table 20.2 Section -1)

20.1.5.2 Guarantees under Category- II

SO₂ removal in treated flue gas: Maximum concentration of SO₂ in treated flue gas at the exit of FGD for the unit shall not exceed the guaranteed values.

20.1.5.3 Guarantees Under Category-III

The parameters/capabilities shall be demonstrated for various systems/ equipment shall include but not limited to the following:-

- a. Minimum SO₂ removal efficiency of scrubber corresponding to the design conditions of the FGD plant.
- b. Mist Outlet Droplet Content

The mist eliminator outlet droplet content shall be guaranteed to be < 20 mg/Nm³ at absorber outlet measured over a period of 24 hrs continuous operation.

Mist outlet-droplet content shall be measured as per applicable clauses in VDI Norm 3679 and the Contractor shall carry out the tests as per the test procedure approved by the Employer

- c. Maximum pressure drop of flue gas across the FGD system, corresponding to the guarantee conditions of the FGD plant, mmwc (g)



- d. Permissible range of plant load variation for design SO₂ removal efficiency of the FGD plant (MW or % of unit MCR)
- e. Permissible maximum SO₂ concentration in the inlet flue gas for design SO₂ removal efficiency of the FGD plant, mg/Nm³.
- f. SO₂ removal efficiency with one spray level out of service corresponding to guarantee conditions of FGD plant*(for multi spray tower systems)
- g. Gypsum purity.
The contractor shall demonstrate that the purity of the gypsum produced shall not be less than 90%, chloride content shall not be more than 100ppm and the moisture content shall not be more than 10% for the range of specified coal(s) and limestone.
- h. Noise

All the plant, equipment and systems covered under this specification shall perform continuously without exceeding the noise level over the entire range of output and operating frequency specified in Vol.II, Section.2 of the technical specifications.

Noise level measurement shall be carried out using applicable and internationally acceptable standards. The measurement shall be carried out with a calibrated integrating sound level meter meeting the requirement of IEC 651 or BS 5969 or is 9779.

Sound pressure shall be measured all around the equipment at a distance of 1.0m horizontally from the nearest surface of any equipment/ machine and at a height of 1.5m above the floor level in elevation.

A minimum of 6 points around each equipment shall be covered for measurement. additional measurement points shall be considered based on the applicable standards and the size of the equipment. the measurement shall be done with slow response on the a - weighting scale. the average of a-weighted sound pressure level measurements expressed in decibels to a reference of 0.0002 micro bar shall not exceed the guaranteed value. corrections for background noise shall be considered in line with the applicable standards. all the necessary data for determining these corrections, in line with the applicable standards, shall be collected during the tests.

In addition to the above, the following parameters/capabilities shall also be demonstrated:-

(i) Wet ball Mill capacity at rated fineness

The contractor shall demonstrate the guaranteed capacity of each limestone pulverizer under the following conditions:

- i) Limestone fineness : 90% or higher (as per the requirement of the absorber) through 325 mesh (for spray tower Process) OR 90% or higher (as per the requirement of the absorber) through 200 mesh (for jet bubbling process).
- ii) Limestone Quality : All available quality from the specified range.

Contractor shall demonstrate the above capacity with the originally installed grinding elements in nearly worn-out condition as mutually agreed for the purpose of ascertaining wear life of any of the wear parts.

(ii) Wet ball Mill wear parts guarantee

Contractor shall demonstrate the life of wet ball Mill wear parts in line with requirements stipulated in section 2.0 of the Technical Specification. The establishment of the above guarantee shall be based on the operating records available at the Power station and will be computed for each pulverizer based on actual total hours of operation.



(iii) Wet ball Mill ball consumption

Contractor shall guarantee ball consumption per ton of limestone throughput in line with requirements stipulated in Vol.II, Sec-2.1 of the Technical Specification. Contractor shall furnish the minimum ball diameter below which the balls shall be replaced.

(iv) Vacuum Belt Filter Capacity

Contractor shall demonstrate the capacity of the Vacuum Belt Filters to dewater the quantity of gypsum with the specified purity and moisture content as specified in Vol.II, Sec-2.3 of the Technical Specification.

(v) Waste Water

The Contractor guarantees that the maximum purge flow rate to waste water treatment system for the complete plant shall be 10m³/hr averaged over a 24 hour period from the unit.

(vi) Performance characteristics of booster fans (capacity, head developed, etc.).

(vii) Margins in Booster Fan.

Booster Fans - As specified in Cl. 5.4.0, Sec 2.1, Vol II of Technical Specifications

(viii) GGH Leakage

The leakage through the GGH seals shall not exceed 1.5% of the hot gas inlet flow.

(ix) Passenger cum Goods Elevator for FGD absorber & Limestone Grinding Building: Over load tests, travel and hoist speed checks.

(x) Availability of FGD Plant

The Contractor shall guarantee the maximum availability of FGD Plant for the range of coal and limestone specified inline with the requirements stipulated in this Sub-Section

(xi) Air Conditioning System

A. Following shall be demonstrated at Shop

- 1) Capacity and static pressure of AHU fans at its rated duty point.

B. Following shall be demonstrated at Site

- 1) Capacity (TR) of water cooled condensing units (D-X type) for A/C system of FGD control room building.
- 2) Guaranteed room conditions during summer for all the Air conditioned areas.
- 3) Vibration and noise level of condensing units & centrifugal fans of AHUs.

(xii) Ventilation System

A. Following shall be demonstrated at Shop

- 1) Capacity and discharge pressure of pumps of UAF units at its rated duty point of Ventilation system.
- 2) Capacity and static pressure of UAF fans at its rated duty point of Ventilation system.



B. Following shall be demonstrated at Site

- 1) Vibration & Noise level of centrifugal fans & pumps of UAF units.

(xiii) Equipment Cooling Water System

- i) Vibration, noise and parallel operation without hunting & abnormal noise and with flow sharing within 10% of each other at the rated duty point shall be demonstrated at site.
- ii) Design heat load of plate type heat exchangers and Inlet & Outlet temperatures of the Plate type heat exchangers on the primary and secondary side to be demonstrated at site. Pressure drop across the Plate type heat exchanger on the primary & secondary water circuit to be demonstrated at site.

(xiv) Compressed Air System

A. Following shall be demonstrated at shop

- i. Capacity & Discharge pressure of each air compressor.

B. Following shall be demonstrated at site:

- i. Dew point of air at the outlet of air drying plants of air compressor.
- ii. Pressure drop across air drying plant.
- iii. Vibration and noise level of air compressors, blowers of air drying plant (if applicable).

(xv) Particulate matter in flue gas

Bidder's design shall ensure that the particulate emission at chimney inlet shall not be more than 30 mg/Nm³ or as per the values specified for all the specified operating conditions.

(xvi) Capacity of lime & gypsum handling equipment

The Bidder shall demonstrate the capacity of bucket elevators/steep angle conveyor, Belt Conveyor and Lime Crusher capacity of any one set as per Owners Choice and as specified elsewhere in the specification.

(xvii) Capacity of limestone handling system and Gypsum Handling System:

The contractor shall demonstrate the rated capacities of each belt conveyor for limestone and gypsum and the associated equipment.

20.1.5.4 AUXILIARY POWER CONSUMPTION (PA)

The unit auxiliary power consumption shall be calculated using the following relationship.

$$\begin{aligned} Pa &= Pu + TL \\ Pa &= \text{Guaranteed Auxiliary Power Consumption.} \\ Pu &= \text{Power consumed by the auxiliaries of the unit under test.} \\ TL &= \text{Losses of the transformers supplied by bidder based on works test reports.} \end{aligned}$$

While guaranteeing the auxiliary power consumption the bidder shall necessarily include all continuously operating auxiliaries under this package.

Any other equipment required for continuous operation of the system shall also be considered for calculation of auxiliary power consumption. Power consumption of all equipments provided on unitized basis shall be included in the unit auxiliary power consumption. For common



station auxiliaries, the power consumption shall be assigned to each unit based on unit load for the purpose of calculating the unit auxiliary power consumption.

The auxiliaries to be considered shall include all the auxiliaries required to run the system on a continuous basis meeting the requirements of the technical specification but not be limited to the following:

- i. Absorber Recirculation Pump(s)
- ii. Absorber Oxidation Air Blower(s)
- iii. Absorber Oxidation Tank Agitators
- iv. Gypsum Bleed Pumps
- v. Limestone Gravimetric feeder, Wet ball mill and their integral Auxiliaries
- vi. Limestone Slurry Pump(s)
- vii. Vacuum Belt Filter, Vacuum Pump and its integral auxiliaries
- viii. Power consumption of Booster water pump
- ix. Process water pump(s)
- x. Mist Eliminator Wash Water pump(s)
- xi. DM Cooling (normally working) Water pump one(1) to supply cooling water on the primary (DM) side of the plate type heat exchangers in the closed loop Equipment cooling water system.
- xii. Auxiliary Cooling (normally working) water pump one(1) to supply cooling water on the secondary side of the plate type heat exchangers in the closed loop Equipment cooling (unit auxiliary) water system.
- xiii. Booster Fans.
- xiv. Power consumption of Limestone Slurry Tank Agitators
- xv. Power consumption of Filtrate Pump(s)
- xvi. Power consumption of Belt Filter Wash Water Pump
- xvii. Power consumption of Hydro-cyclone Waste Water Sump Pump and Waste Water Pump
- xviii. Power consumption of all other continuous running Agitators
- xix. Air Conditioning System
Power consumption at motor input terminals of working units (i.e. excluding stand-by) at its rated duty point of compressor and condenser fans of air cooled condensing unit, Air handling unit (AHU) fans for the Air conditioning system of FGD Control Room Building
- xx) Guaranteed power consumption of single stream conveyors and associated equipments (vibrating screen, crushers, belt feeders, paddle feeders) for limestone and gypsum handling at rated capacities.

The equipments listed above for calculating auxiliary power consumption are indicative. Any other equipment required for continuous operation of the system shall also be considered for calculation of auxiliary power consumption.

Note :

1. The bidder shall furnish a list of equipments to be covered under auxiliary power consumption, which shall be subject to Employer's approval.
2. The equipments listed above for calculating auxiliary power consumption are indicative. Any other equipment required for continuous operation of the system shall also be considered for calculation of auxiliary power consumption.

20.1.5.5 METHOD OF COMPUTING TEST EFFICIENCY OF FGD

The performance tests shall be carried out in accordance with ASME PTC 40 (1991) code. NO tolerance or allowance on the test result shall be permitted for instrument errors or inaccuracy, the method of testing or any other causes. The details of the test shall, however be mutually agreed upon between the employer and the contractor.



20.1.5.6 METHOD OF COMPUTING AVAILABILITY

FOR CATEGORY-III

The Contractor shall guarantee 98 % availability of FGD plant for a continuous period of 120 days. An availability guarantee test shall be conducted to assure this level of availability for a period of 240 days as per the procedure indicated below.

Availability 'A' in %:

$$A = \frac{T_c}{T_k} \times 100\%$$

T_c – recorded time of FGD operation, expressed in hours,

T_k – recorded time of boiler operation, expressed in hours,

However, it is required that:

- (i) In order to calculate the FGD availability, operation hours will be counted except boiler start-ups when the operation hours counting will start on the moment of shut down of all oil burners,
- (ii) FGD will be regarded as a FGD in operation, when by-pass damper is closed and total flow of flue gas from boiler goes via FGD, and SO₂ content is below 100 mg/Nm³ (dry basis at 6% O₂) in cleaned flue gas for the range of specified coals & loads.
- (iii) If FGD is out of operation during the boiler operation time as a result of the Employer's decision, this time will not be counted as boiler operation time for calculating the FGD availability,
- (iv) Boiler operation hours will be counted based on the recorded boiler operation hours and the recorded data will be made available to the Contractor by the Employer.

Mandatory spares have been identified in the Employer. Contractor can use the mandatory spares supplied under the contract during this period in agreement with the Employer. However, if other additional spares are required for demonstration of availability demonstration guarantee, Bidder to should clearly indicate along with their offer.

If the calculated availability after 120 days availability test is lower than the guaranteed value, the Contractor will undertake actions as per clause **19.1.5.4** of this Sub-Section to achieve the guaranteed availability.

Recovery of Penalties

The Owner may, without prejudice to any method of recovery, deduct the amount for such Penalties from any amount due or which becomes due to the Contractor either under this or any other Contract, including en-cashing of appropriate value of Contract Performance Bank Guarantee. Payment of Penalties shall in no way relieve the Contractor from its contractual obligations to complete the works or from any of the obligations under the contract. Any delay in the levy or recovery of penalty shall not constitute waiver of the right of the Owner under the contract towards levy and recovery of penalty.

Test Condition

The performance test on FGD will commence after a minimum period of Seven hundred Twenty (720) hours of operation after completion of initial operation. During the interval between the commencement of initial operation and the commencement of performance test only routine maintenance shall be carried out.



The performance tests shall be carried out in accordance with ASME PTC 40 (1991) code, as amended/ revised. The test efficiency shall be based on the overall performance of the FGD system over a mutually agreed period of operation under the conditions given elsewhere in this specification and allowing the normal operation of the power unit.

20.2 DESIGN AND GUARANTEE CONDITIONS

Design and Guarantee conditions shall be referred in Annex 1.2.



**EVALUATION / LOADING CRITERIA & PENALTY TOWARDS
SHORTFALL IN PERFORMANCE PARAMETERS:**

Sl. No.	Variation Factor	Loading for evaluation of shortfall in performance	Penalty for shortfall in performance
1	Minimum SO ₂ removal efficiency	Rs.1000000/- (10 Lakhs) for every 1% decrease from the maximum of the efficiency guarantees quoted among the bidders	Rs.1000000/- (10 Lakhs) for every 1% decrease in guaranteed efficiency of the FGD system
2	Auxiliary Power consumption of FGD System & Auxiliaries	Rs.4,70,72,094/- for every 0.01% increase from the least of the power guarantees quoted among the bidders	Rs.4,70,72,094/- for every 0.01% increase or part thereof from guaranteed value
3	Limestone Consumption	Rs. 1,60,000/- for every 1kg/hr increase from the least of the guaranteed Lime Stone consumption of the FGD system quoted among the bidders.	Rs. 1,60,000/- for every 1kg/hr increase in guaranteed Lime Stone consumption of the FGD system

Note: All above loadings & penalties as mentioned in Col. 3 & 4 shall be calculated on pro-rata basis.

The penalty indicated above is in addition to the liquidated damages as stipulated in clause no.6.0 of this Section.

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	1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO, Tamilnadu Technical Specification for Agitators of FGD Slurry Tanks	Section-I, Sub-Section-C2-B	
		REV. 00	Date: August,2022
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CUSTOMER SPECIFICATION PAINTING SPECIFICATION			



ANNEX - 1.6

CLEANING, PROTECTIVE COATING AND PAINTING

1.0 General

This specification covers the general requirements related to the cleaning protective coating and painting of equipment, components and systems that are covered under main equipment / system specifications. The components and/or equipment shall be mechanically and /or chemically cleaned during the following stages of the Contract.

- Cleaning in workshop
- Cleaning before painting and/or corrosion protection (application of prime coat)
- Cleaning before erection and during installation.

Cleaning of fabricated component items shall be carried out after fabrication and final heat treatment or welding at manufacturer's works or at site, as appropriate. No paint shall be applied surfaces within 75 mm of field welded connections. These surfaces shall be coated with a consumable preservative and marked.

For cleaning in workshop and before painting, mechanical cleaning by power tool and scrapping with steel wire brushes shall be adopted to clear the surfaces. However, in certain locations where power tool cleaning cannot be carried out, hand scrapping may be permitted with steel wire brushes and/or abrasive paper. Cleaning with solvents shall be resorted to only in such areas where other methods specified above have not achieved the desired results. Cleaning with solvents shall be adopted only after written approval of the Owner / Engineer.

Machined surfaces shall be protected during the cleaning operations.

In the event of the surfaces not being cleaned to the Owner's satisfaction, such parts of the cleaning procedures or agreed alternatives as are deemed necessary to overcome the deficiencies shall be carried out at the supplier's sole expense.

For reclining small areas, hand cleaning by wire brushing may be permitted.

1.1 Codes and Standards

Painting of equipment shall be carried out as per the Codes indicated below and shall conform to the relevant IS Code for the material and workmanship.

The following codes and standards shall be followed for the surface preparation, surface protection and painting works.

IS: 5	Colors for ready mixed paints and enamels.
IS: 101	Methods of test for ready mixed paints and enamels.
IS: 104	Ready mixed paint, brushing, Zinc Chrome, priming.
IS: 158	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and heat resisting.
IS: 161	Heat resistant paints
IS: 1303	Glossary of terms relating to paints.
IS: 1477	Code of practice for painting of ferrous metals in buildings (Parts I & II).
IS: 2074	Specifications for ready mixed paint, Air drying, red oxide zinc chrome priming.
IS: 2338	Code of practice for finishing of wood and wood based materials: Parts 2 schedules.
IS: 2339	Aluminum paint for general purposes, in dual container.
IS: 2395	Code of practice for painting of concrete, masonry and plaster



	surfaces: Part 2 schedules.
IS: 2524	Code of practice for painting of non-ferrous metals in buildings (Parts I & II).
IS: 2932	Specification for enamel, synthetic, exterior (a) undercoating, (b) Finishing
IS: 3140	Code of practice for painting asbestos cement building products.
IS: 6158	Recommended practice for design safeguarding against Embrittlement of hot dip Galvanized Iron & steel products.
IS: 6159	Recommended practice for design & fabrication of Iron & steel products prior to Galvanizing & metal spraying.
IS: 6278	Code of practice for white washing and Color - Washing.
IS: 10221	Code of practice for coating & wrapping of underground mild steel pipelines.
IS: 33	Inorganic pigments and extenders for paints –Methods of sampling & test.
IS: 13183	Aluminum paint, Heat resistant - specifications.
IS: 144	Specification for ready mixed paint brushing, petrol resisting, Air drying for Interior paints of tanks and containers, Red oxide.
IS: 9954	Pictorial surface preparation standards for painting of steel surfaces.
IS: 11883	Specification for Ready Mixed Paint, Air Drying, Red Oxide Priming for metals.
IS: 9404	Color code for identification of pipelines used in the Thermal Power Plants.
IS: 12744	Specification for Ready Mixed Paint, Air Drying, Red Oxide-Zinc Phosphate Priming.
BS: 2015	Glossary of paint selected terms.
BS: 5252	Final coat color.
BS: 7079A1/S1	Specification for rust grades and preparation grades of uncoated substrates after overall removal of previous coating.
BS: 7079A2	Preparations grades of previously coated steel substrates.
BS: 7079GrC	Surface roughness characteristics of blast cleaned steel substrates.
BS: 7079GrD	Methods for surface preparation.
BS-4232	Surface Finish of Blast cleaned steel for painting.
ASTM	American Standard for Testing Material.
ASTM A 780	Standard practice for repair of damaged galvanized coatings.
AWWA	American Water Works Association.
ASA-A-13.1-1981	Scheme for identification of piping system (American National Standard Institution).
DIN	Deutsehes Institute for Normung
S1S-055900-1967	Surface preparation standards for painting steel surfaces. (Swedish standard Institution)
SSPC-SP	Preparation Specifications (Steel structures painting council, U.S.A.).
	National Association of Corrosion Engineers, U.S.A. (NACE).

1.2 Scope of Work and General Requirements

This specification covers the surface preparation, method of application and material to be used for all coating of equipment, steel structures and piping. Steel material subjected to surface preparation on shop/site shall have minimum requirements in accordance with Rust Grade B (SSPC/SSPM Volume-2).

Coating materials according to SSPC, EN ISO, ASTM, BIS or DIN standards, shall be used. The paint shall comply with applicable laws, regulations, ordinances etc., of the local authority,



state or the nation pertains to the work. The materials shall be matched with each other so that they are compatible. Coatings deviating this specification shall be subject to approval.

Standards of surface preparation and painting shall give a time to first maintenance of minimum 10 years.

The paint to be applied shall be approved by Owner.

All paints & paint material used shall be procured from approved manufacturers. Paint shall be supplied in manufacturers original containers with the description of content, specification No., colour, ref no, date of manufacture, shelf life expiry date & pot life.

The paint manufacturers shall provide coating system data sheet for each coating system to be used containing the following information

- a. Surface preparations
- b. Film thickness (min and max)
- c. Min and max recoating intervals at relevant temperatures
- d. Mixing ratio, thinner details and coating repair systems

The sample for testing the paint being used may be taken by the Owner at any time.

In general Shop fabricated equipment will be delivered to the site coated with a shop applied system or the manufacturer's standard finish in accordance with the requirements of this specification.

For equipment that has received shop prime coat, all touch-up prime coat and additional coats shall be applied in accordance with the coating schedule. It is responsibility of the vendor to ensure compatibility between shop and field applied paint systems.

Necessary precautions shall be provided to all equipment, structures to protect other surfaces from abrasive blasting, coating over spray and spatter. Damage to other surfaces or equipment shall be repaired by the vendor.

The Contractor shall submit the following for review and approval by the Owner:

- a. Manufacturer's recommended paint scheme for the project
- b. Latest published product & instructions for application data,
- c. Procedures for surface preparation and application.
- d. Pre qualification for equipments and blasting materials, product, procedure and personnel qualifications for the paint and painting systems.
- e. Painting repair procedures

Painting records shall contain:

- Equipment/components/location painted
- Date of painting
- Paint details such as specification No, colour, date of manufacture, shelf life, expiry date
- Application equipments
- Ambient conditions at the time of painting
- Surface temperature
- Drying time between coating, DFT and number of coatings
- Appropriate work plan for painting.

The supply of all necessary equipments, weather protection, and scaffolding for painting to ensure work is carried out in accordance with the specification and agreed programme.

Maintenance of the paint work until completion of the contract, this shall include repair of any damaged areas caused by third party.



Disposal of painting waste resulting from painting, shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work and coating materials.

It is a mandatory requirement that all operatives working to this procedure take full cognizance and implement necessary safety precautions.

2.0 Cleaning at manufacturer's works

Mechanical cleaning shall preferably be carried out by abrasive blasting. The Owner is prepared to consider alternative methods such as chemical cleaning provided they achieve the necessary surface condition.

In case of chemical cleaning, the detailed procedure for chemical cleaning as well as the system for which chemical cleaning is required shall be submitted by the contractor for Owner's approval. The procedure shall comprise of pre-treatment and acid treatment to achieve cleanliness equivalent to that specified for mechanical cleaning.

Surface condition:

The Metal surfaces shall be clean and free of mil scale, rust, dirt, grease and any other deleterious matter.

Where metal surfaces are to be painted the surface profiles shall conform to the painting specification requirements.

Where this does not apply, surfaces shall have a surface texture not coarser than Grade 80 abrasive paper.

Abrasives:

Abrasives containing silica, silicates or slag residues shall not be used for water/steam side surfaces of plant except for cleaning sand castings, where hydro blasting may be employed.

For austenitic materials only, abrasives containing 98% or more of alumina, Al_2O_3 , shall be used.

Removal of abrasive and debris:

After cleaning, abrasive and debris shall be thoroughly removed for components.

3.0 Protection at manufacturer's works

As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti-corrosion protection.

All water, air and steam side surfaces shall be protected by the application of approved water soluble corrosion inhibitors, or vapor phase inhibitors that can be subsequently removed by site water washing or steam blowing.

The gas side of steam generating plant items shall be protected by the application of temporary protective that do not require to be removed before commissioning, but which are removed during initial firing.

The rate of application of volatile corrosion inhibitors shall be at least 10 grams per square meter or 35 grams per cubic metre, whichever is the greater, except for pipes up to 300 mm diameter for which the minimum application rates shall be 5 grams per square metre.



Immediately after the protective treatment has been applied all vessels and pipes shall be suitably sealed off by discs or caps or approved alternatives to prevent ingress from the surroundings. Cylindrical plugs shall not be driven into the ends of pipes. These protective covers shall not be removed until immediately before final connection is made to the associated equipment.

4.0 Weather conditions

Painting shall be done only when the surface temperature is above 5°C. Surface temperature must be at least 3°C above dew point to ensure that condensation does not occur on the surface.

Reasonable protection against precipitation and seawater spray shall be exercised for the painting of outdoor parts.

Precautions shall also be taken against solar radiation to ensure that the specified dry film thickness of priming or finish coats is obtained.

Any prime coat exposed to excess humidity, rain, dust etc., before drying, shall be permitted to dry and the damaged area of primer shall be removed and the surface prepared and primed again.

Sheltered or unventilated horizontal surfaces on which dew may collect require more protection, and to achieve this additional top coat of paint shall be applied.

The temperature quoted as "normal" in the "Paint System Tables" refers to the average local climatic conditions.

5.0 Surface preparation

In preparing any surface to be coated, all loose paint, dirt, grease, rust, scale, weld slag or spatter or any other extraneous material shall be removed and defects repaired, so as to obtain a clean, dry, even surface to receive the priming or finishing coat (s) as called for in the painting schedules. Sharp edges should be rounded, especially when tank linings have to be applied.

All machined surfaces, including flange faces, shall be suitably covered to prevent damage during surface preparation.

All surfaces should be blast cleaned whenever possible.

Surface preparation methods:

Bare steel surfaces should be prepared by one of the methods described below in order of preference and in accordance with Swedish Standard SIS 05 59 00 or Steel Structures Painting Council, SSPC, Vis 1, or DIN 55928, section 4.

The relative humidity level should not be more than 60% & the steel surface temperature at least 3° C above the dew point during dry blast cleaning operations.

a. White metal blast cleaning Sa 3 or SSPC - SP 5

Sa 3 Blast cleaning to bare metal. Mill scale, rust and foreign matter must be removed completely. Subsequently, the surface is cleaned with vacuum cleaner, clean dry compressed air or a clean brush. It must then have a uniform metallic color and correspond in appearance to the prints designated Sa 3.



b. Near white metal blast cleaning Sa 2 1/2 or SSPC - SP 10

Sa 2 1/2. very thorough blast cleaning. Mill scale, rust and foreign matter shall be removed to the extent that the only traces remaining are slight imperfections in the form of spots or stripes. Subsequently, the surface is cleaned with a vacuum cleaner, clean dry compressed air or a clean brush. It must then correspond in appearance to the prints designated Sa 2 1/2.

Mechanical cleaning should only be used when procedures (a) and (b) are not practicable.

c. Near white metal blast cleaning P Sa 2 1/2 DIN 55928

Very thorough blast cleaning. Very adhesive coatings remain. From all other surface mill scale and rust are to be removed to such an extent that the only traces remaining are slight imperfections in the form of spots or stripes. Further treatments see Sub b).

The adhesivity of residual coatings in the transition zone has to be tested even after the application of the primer.

d. Very thorough mechanical scraping and wire brushing St 3

St 3 very thorough scraping and wire-brushing - machine brushing - grinding - etc. are to be preferred. Surface preparation as for St 2. But much more thoroughly. After the removal of dust, the surface must have a pronounced metallic sheen and correspond to the prints designated St. 3.

e. Thorough scraping and wire brushing St 2

St 2 Thorough scraping and wire-brushing - machine brushing - grinding - etc. The treatment shall remove loose mill scale, rust and foreign matter. Subsequently, the surface is cleaned with a vacuum cleaner, clean dry compressed air or a clean brush. It should then have a faint metallic sheen. The appearance must correspond to the prints designated St 2.

f. Air Blasting with Non-Metallic Abrasives Powder

Whenever the "Duplex"-process is to be applied (hot dip galvanising followed by painting), prepare the hot dip galvanised surface by water washing to remove flux residues and careful air blasting with non-metallic abrasive powder. Use an abrasive with grain size from 0.1 to 0.5 mm, at a greatly reduced air pressure, max. 2 bar (g) (28 psig).

This procedure also applies to stainless steel and aluminium surfaces to be coated.

Surface preparation methods	SIS 055900	DIN 55928 Part-4	BS 4232 only for blasting	SSPC-Vis
Blasting acc to item (a),(b),(c),	Sa 3		First quality	White metal SP 5
Blasting acc to item (b)	Sa 2 1/2		Second quality	near White SP 10
Blasting acc to item (c)	Sa 2		Third quality	Commercial blast SP 6
Hand/or power tool derusting acc to item (e)	St 2		--	Hand tool cleaning SP 2
acc to items (d) and (e)	St 3		--	Power tool cleaning SP 3



Surface preparation methods	SIS 055900	DIN 55928 Part-4	BS 4232 only for blasting	SSPC-Vis
Flame jet cleaning		F1	--	Flame cleaning SP 4
Pickling		Be	--	Pickling

Steel structures to be blast cleaned have to be free of pitting and other severely corroded places in accordance with B.S. 4232 and SIS 055900.

The abrasives used for blast-cleaning shall be graded flint, grit, shot or silica sand and shall be such that they will produce an average keying profile on the blast-cleaned surface of not more than 40 microns.

An air pressure of 7 bar g at the nozzle shall be used.

After blast-cleaning, all accumulated grit, dust, etc., must be removed leaving the surface clean, dry and free of mill scale, rust grease and other foreign matter.

In the event of rusting after completion of the surface preparation, the surface must be cleaned again in the manner specified.

Oil, grease, soil, cement, salts, acids or other corrosive chemicals shall be cleaned from steel surfaces, by the use of solvents, emulsions or cleaning compounds. The final wiping shall be with clean solvent and clean rags or brushes. There shall be no detrimental residue left on the surface.

Primed areas which suffer damage must be spot blasted on site to a degree of cleanliness Sa 2 1/2 before, touching up.

Protective coating must be applied as quickly as possible after the completion of surface preparation no matter what cleaning method has been used.

No blast-cleaned surface shall be allowed to remain uncoated overnight.

Steel work protected by shop primer after arrival on site must be cleaned of salt, sand, oil etc. Before the first coat of paint is applied on site. Shop primer damaged during transport must be rectified by blast-cleaning and coating before application of the site coats.

Wood surfaces shall be sanded clean. All nail holes shall be puttied and sanded before priming.

Concrete: If a protective coating is required, concrete shall be allowed to cure before painting.

6.0 Preparation of coating materials

All containers shall remain un-opened until required for use.

Primers and paints which have livered, gelled or otherwise deteriorated shall not be used.

The oldest primer or paint of each kind shall be used first.

All ingredients in any container shall be thoroughly mixed before use, and shall be agitated frequently during application to keep the primer in suspension.

Primer or paint mixed in the original container shall not be transferred until all settled pigment is incorporated into the body of liquid.



Mixing in open containers shall be done in a well ventilated area.

Primer or paint shall be mixed in a manner ensuring the breakdown of all lumps, complete dispersion of pigment and uniform composition.

Two-component primers shall be mixed in accordance with the manufacturer's instructions.

Thinners shall not be added to primers or paints unless necessary for proper application according to the manufacturer's instructions.

When use of thinners is permitted, it must be added to the primer or paint during mixing.

6.1 Primer Paint

After the surface is prepared, one coat of suitable primer shall be applied. After this first coat is dried up completely, second coat of primer shall be applied.

Primer shall be applied by brushing to ensure a continuous film without 'holidays'. The dry film thickness of each coat shall be as specified in Paint System of this specification.

The primer should be worked by brush application to cover the crevices, corners, sharp edges etc. in the presence of inspector.

The shades of successive coats should be slightly different in color in order to ensure application of individual coats, the thickness of each coat and complete coverage should be checked as per specification approved by Engineer before application of successive coats.

The contractor shall provide standard thickness measurement instrument with appropriate range(s) for measuring.

Elko meter for measuring the Dry film thickness of each coat, surface profile gauge for checking of surface profile in case of sand blasting. Holiday detectors and pinhole detectors for checking the painted surface discontinuities should be provided by the contractor.

The contractor shall make arrangements for paint manufacturer to provide expert technical service at site as and when required free of cost and without any obligation to the Owner, as it would be in the interest of the manufacturer to ensure that both surface preparation and application are carried out as per their recommendations.

Final inspection shall include measurement of paint dry film thickness, check of finish and workmanship.

6.2 Rub down and Touch Up of Primer

The shop coated surfaces shall be rubbed down thoroughly with emery paper to remove all dust, rust and other foreign matters, washed, degreased, then cleaned with warm fresh water and air dried.

The portions, from where the shop coat has peeled off, shall be touched up and allowed to dry before applying a coat of primer.

The compatibility between shop coat and field primer shall be ascertained from the paint manufacturer. In case degreasing with white spirit is not effective, the surface shall be finally wiped clean with aromatic solvent like xylol or light naphtha.



6.3 Non Compatible Shop Coat Primer

- a) The compatibility of finishing coat shall be confirmed from the paint manufacturer. In the event of use of primer such as zinc rich epoxy, inorganic zinc silicate etc., the paint system shall depend on condition of shop coat. If the shop coat is in satisfactory condition showing no major defect, the shop coat shall not be removed. The touch up primer and finishing coat(s) shall be identified for application by Engineer. Shop coated (coated with primer & finishing coat) equipment shall not be repainted unless paint is damaged.
- b) Shop primed equipment and surfaces shall only be 'spot cleaned' in damaged areas by means of power tool brush cleaning or hand tool cleaning and then spot primed before applying one coat of field primer unless otherwise specified. If shop primer is not compatible with field primer then shop coated primer shall be completely removed before application of selected paint system for particular environment. For package units/equipment, shop primer shall be as per the paint system given for particular environment.
- c) In case of existing paint, compatibility between finishing coat and new selected finish coat shall be ascertained before application of finish coat. In case, the coat is selected for upgrading existing alkyd coating to high performance coating then, surface preparation shall be by manual/mechanical means to remove loose rust, peeled off/damaged paint, but sound old coating need not be removed. It shall be touched with suitable primer wherever it has peeled off before application of tie coat. The tie coat shall be applied after 7 days of curing of the primer. If, new paint system is not suitable to upgrade existing coating then complete paint shall be removed by mechanical or blast cleaning before application of new coating system.

6.4 Finish Paint

Suitable Finish paints as per the schedule shall be applied for the jobs. The color/shade shall be as approved by the Owner. After cleaning the dust on the dried up primer, first coat of finished paint shall be applied. After this first coat dries up hard, the surface is wet scrubbed cutting down to a smooth finish and ensuring that at no place the first coat is completely removed. After applying second coat, allowing the water to get evaporated completely, third finish coat of finish paint may be applied(if applicable).

7.0 Steel Structures Painting

Generally, all steel structures shall receive two primer coats and two finish coats of painting. First coat of primer shall be given in shop after fabrication before dispatch to erection site after surface preparation as described below. The second coat of primer shall be applied (if required) after erection and final alignment of the erected structures. Two finish coats shall also be applied after erection.

Steel surface which is to be painted shall be cleaned off dust and grease and the heavier layers of rust shall be removed by chipping to grade ST-2 as per SIS05-5900 or as per IS: 1477 (part -I) prior to actual surface preparation. Suitable primer of required DFT shall be applied as specified in the Paint system of this document- Annex-1.

Suitable finish paint of required DFT shall be applied as specified in the Paint system of this document- Annex-1. The undercoat and finish coat shall be of different tint to distinguish the same from finish paint. All paints shall be of approved brand and shade as per the Owner's requirement.

Joints to be site welded shall have no paint applied within 100 mm of welding zone. Similarly where Friction grip fasteners are to be used no painting shall be provided. On completion of the joint the surfaces shall receive the paint as specified.



Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly. Surfaces inaccessible after erection including top surfaces of floor beams supporting gratings or chequered plate shall receive one additional coat of finish paint over and above number of coats specified before erection. Portion of steel member embedded / to be encased in concrete shall not be painted.

8.0 Paint Materials

The paints shall conform to the specifications given in this Annex and class - 1 quality in the products range of any of the following manufacturers:

- a. Asian Paints (India) Ltd.
- b. Bombay Paints
- c. Berger Paints India Ltd.,
- d. Good lass Nerolac Paints Ltd.,
- e. Garware Paints
- f. Jenson & Nicholson
- g. Shalimar Paints
- h. Equivalent other country manufacturer after prior approval of Owner.

9.0 Storage

All paints and painting material shall be stored only in rooms to Engineer's approval. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separated from adjacent buildings. A signboard bearing the words "PAINT STORAGE - NO NAKED LIGHT - HIGHLY INFLAMMABLE - DANGER - NO SMOKING" shall be clearly displayed outside. All paints shall be stored in the safest manner so that no container rolls down and causes accidents. The shelf life of the paints shall be ensured so that the paint materials are not in storage and use after the date of expiry.

10.0 Application

Health and safety of work

The supplier has to check all painting work to be carried out according to the specification of the paint supplier further to all relevant prescriptions and regulations concerning the health and safety of work.

The paint supplier has to present a written specification including at least the flash point of the paints, ventilation requirements, handling precautions such as inhalation, eye and skin protection, and first aid procedure, storage requirements, spill or leak procedure, fire precaution, waste disposal.

Methods

Quality of the surface to be painted or coated has to be tested acc. to DIN 55928 and DIN 8202.

Temporary corrosion protections are to be completely removed prior to applying the definite one, in acc. with DIN 55928.

All prime coatings shall be applied by brush or airless spray or a combination of these methods, as approved by the coating manufacturer.

All doors, windows, stairways, handrails (if painted), bolts, flanges and equipment supports shall be finish painted by brush.

Spray guns should not be used outside in windy weather or near surfaces of a contrasting colour unless the latter is properly protected.



All cold-spray painting shall be done using standard equipment in accordance with accepted standards and methods.

Care has to be taken not to connect spraying devices for nitro and backelite paints simultaneously to oil based paints.

Paint applied to items that are not being painted shall be removed at the supplier's expense, leaving the surface clean, unstained and undamaged.

Dry film thickness (DFT)

To the maximum extent practicable the coats shall be applied as a continuous film of uniform thickness and free of pores. Overspray, skips, runs, sags and drips should be avoided. The different coats shall not be of the same colour.

For a composite paint or coating system consisting of several coats, the total DFT must be at least equal to the sum of the minimal DFT's for the individual coats. If, the paint system does not have the required minimum DFT those areas should be marked & repainted. If the occurrence of those areas is high, the complete surface must be repainted. It is also critically important to check the DFT of primers and intermediate coats and to correct them where necessary.

For paintings based on Zinc silicate the DFT is limited as well on minimum DFT as on maximum (150µm) because of the risk of mud cracking.

Consumption of paints

Has to be evaluated according to DIN 53220. The paints shall be tested as per IS - 101.

Each coat of paint shall be allowed to harden before the next is applied. For epoxy paint the hardening time normally is 12-14 hours. Suppliers' recommendations regarding hardening time of epoxy paints must be followed.

Particular attention must be paid to full film thickness at edges.

The minimum total dry film thickness of the paint systems shall be as recommended in the following tables below. The DFT is given in microns (millionths of a metre).

11.0 Protective coatings and paint systems

The colour coding for identification of pipelines should comply with IS-2379 & IS -9404.

The type and number of protective coats for any item requiring painting are to be in accordance with DIN 55928 and are to be at least of a quality as shown in the attached Annex-1- Paint System.

Alternative to the Annex-1- Paint System specified, are to be presented on the schedule Departure from Specification, as indicated elsewhere.

Generally, all parts shall receive the specified prime coat (s) at the supplier's works to ensure that no corrosion occurs during transport to the site and storage at the site.

Parts which cannot be damaged during transport shall receive the full number of coats.



Types of Substrate, Base metal:

- Ferrous (Surface Temperature during operation < 120° C, EN ISO 12944:1998)

To this group belongs carbon steel, low alloyed steel & high alloyed steel. All paint systems are inevitable for corrosion protection.

- Hot dip galvanized surfaces.

Hot dip galvanized surfaces do require painting in a wet, industrial, chemicals and/or marine environment

- SS (EN ISO 12944:1998 conditionally applicable)

In general, SS surfaces do not require painting unless in a chemical and/or marine environment. In case of chemical and/or marine environments determination of whether or not the surface requires painting depends on the chemical content of the base metal.

The following formula applies
 $W = Cr + 3.3 \times Mo + 22.45 N_2$

If $W < 23$, then the surface has to be painted.

If $W < 28$ & $W > 23$, then the surface to be painted if splash contact with the media (i.e. sea) is possible. This may also occur if there is a strong wind carrying drops to the surface.

If $W > 28$, then the surface need not be painted.

- Aluminium

By default such surfaces/components will not be painted. Exceptions are architectural/aesthetic reasons and high corrosive conditions, which shall be evaluated separately depending on aluminum alloys.

12.0 Galvanizing

Galvanizing works shall conform in all respect to B.S. 729, B.S. 3083 and B.S.C.P. 2008 and to DIN 50976 whatever requires the higher quality and shall be performed by the hot dip process, unless otherwise specified.

It is essential that details of steel members and assemblies which are to be hot-dip galvanized should be designed in accordance with B.S 4479.

Vent-holes and drain-holes should be provided to avoid high internal pressures and air-locks during immersion, which may cause explosions, and to ensure that molten zinc is not retained in pockets during withdrawal.

Careful cleaning of welds is necessary before welded assemblies are dipped. The welds and the surrounding metal should be cleaned separately, preferably be blast-cleaning, because the usual preliminary pickling cannot be relied on to remove the welding slag.

All defects of the steel surface including cracks, surface laminations, laps and folds shall be removed in accordance with B.S. 4360. All drilling, cutting, welding, forming and final fabrication of unit members and assemblies shall be completed, where feasible, before the structures are galvanized. The surface of the steelwork to be galvanized shall be free from paint, oil, grease and similar contaminants in accordance with DIN 55928, part 4 and DIN 50976. The weight of zinc coating per unit area has to be noted in the manufacturing documents in accordance with DIN 50976.



The minimum average coating weight shall be as specified in Table 1 of B.S. 729 or Table 2, DIN 50976, whatever requires higher quality.

Structural steel items shall be initially grit-blasted to B.S. 4232, second quality, (Sa 21/2) or by pickling in a bath and the minimum average coating weight on steel sections 5 mm thick and over shall be 900 g/m².

On removal from the galvanizing bath, the resultant coating shall be smooth, continuous, free from gross surface imperfections such as bare spots, lumps, blisters and inclusions of flux, ash or dross.

Galvanized contact surfaces to be joined by high-tensile friction-grip bolts shall be roughened before assembly so that the required slip factor (defined in B.S. 3294, part 1 and B.S. 4604, part 1) is achieved. Care shall be taken to ensure that the roughening is confined to the area of the mating faces.

Bolts, nuts and washers, including general grade high-tensile friction grip bolts (referred to in B.S. 3139, and B.S.4395 part 1) shall be hot dip galvanized and subsequently centrifuged (according to B.S. 729). Nuts shall be tapped up to 0.4 mm oversize after galvanizing and the threads oiled to permit the nuts to be finger-turned on the bolt for the full depth of the nut. No lubricant, applied to the projecting threads of galvanized high-tensile friction-grip bolt after the bolt has been inserted through the steelwork, must be allowed to come into contact with the mating faces of the steelwork,. A local remelting of the galvanized parts to achieve the nuts to be finger turned on the bolt is possible in accordance with DIN 50976.

Protected slings must be used for offloading and erection. Galvanized work which is to be stored at the works or on site shall be stacked so as to provide adequate ventilation to all surfaces to avoid wet storage staining (white rust).

Small areas of the galvanized coating damaged in any way shall be restored in accordance with DIN 55928, part A and DIN 50976 by:

- Cleaning the area of any weld slag rust and other impurities and by thorough wire brushing to give a metallic clean surface.
- Application of suitable number of coats of zinc-rich paint containing more than 90 % w/w of zinc in dried film. The dry film thickness shall exceed at least 50 % the thickness of the desired galvanization. In case of application of a low melting point zinc alloy repair rod, the rods shall be in accordance with DIN1707, the thickness of the alloy shall be at least as of the desired galvanization.

The restored area is not to exceed 1 % of the galvanized surface.

Surface restoration of parts in contact with drinking water is not allowed and the quality of the galvanization is to be in accordance with DIN 2444.

After fixing, bolt heads, washers and nuts shall receive two coats of zinc-rich paint. Connections between galvanized surfaces and copper, copper alloy or aluminum surfaces shall be protected by suitable preferably hydrophobe tape wrappings to the owner's approval.

13.0 Sprayed Metal Coatings

Corrosion protection may be also achieved by spraying of suitable metals as zinc and/or aluminum on the surfaces of structures. For special cases tin, copper, lead can be used as well. Methods of surface preparation have to conform to B.S. 2569 or to DIN 8567. A proper treatment of the surface followed by an immediate spraying is to apply to ensure adhesion of the sprayed metal. The surface has to be clean, free of impurities, rust, mill scale and rough enough to have binding properties to ensure good enticulation with the sprayed layer. Suitable



roughness can be achieved by blast cleaning acc. to BS 4232 or DIN 8567. Welds are to be cleaned and prepared with special care. All surfaces to be treated have to be dry and accessible.

Application of coatings, requirements for thickness, adhesion, composition of coating metals, and subsequent treatment have to conform to BS 2569, DIN 8565 and 8567.

Testing of the spray coated layers are to be carried out in accordance with DIN 8565.

The contractor has to specify the type, composition and thickness of the sprayed metal and of the sealing coating according to DIN 8565 including the corresponding warranties and tests if, sprayed metal coating will be applied.

Safety of work:

All precautions connected with this type of application of corrosion protection have to be in accordance with German regulation DVS 2307, page 1. 2.

Sprayed, unfused coating of metals and metallic compounds applied by combustion gas flame, plasma arc, detonation and similar processes, and the preparation of components, spraying techniques, sealing, finishing and inspection shall be according to B.S. 4761.

The hot galvanized surface has to be cleaned before the application of the coats to remove corrosion products, dirt, dust, grease.

The cleaning can be achieved by

- brush off
- washing with 1 - 1.5 % ammonia water with up to 0.1 % detergent added and followed by wet grinding to turn the foam to grey color,
- steam blasting.

14.0 Warning Notes / Signals

This Instruction serves the identification of the coated surfaces that are received from shop in assembled condition / module wise.

The warning note shall prevent any possible damage to the coated surfaces during transportation / assembly at site.

Eg.: Welding work OR Heat treatment work on the outside of coated or lined surfaces is prohibited.

15.0 Colour Code for Piping

- a. The colour code scheme is intended for identification of the individual group of the pipeline. The system of colour coding consists of a ground colour and colour bands superimposed on it. The colour coding for the identification of pipelines shall comply with **Annex – 1** of this specification.

Ground Colour shall be applied throughout the entire length for un insulated pipes. For insulated pipes, on the metal cladding or on the pipes of material such as non-ferrous metals, austenitic stainless steel etc., ground colour coating of minimum 2m length or of adequate length not to be mistaken as colour band shall be applied at places requiring colour bands. Colour band(s) shall be applied at the following location.

- i. At battery limit points
- ii. Intersection points & change of direction points in piping ways.



- iii. Other points, such as midway of each piping way, near valves, junction joints of service appliances, walls, on either side of pipe culverts.
- iv. For long stretch/yard piping at 50 M interval.
- v. At start and terminating points.
- b. Flow direction shall be indicated by an arrow in the location stated above and as directed by Engineer. Colors of arrows shall be black or white and in contrast to the color on which they are superimposed. The size of the arrows shall confirm to IS:2379. Product names shall be marked at pump inlet, outlet and battery limit in a suitable size as approved by Engineer. As a rule minimum width of color band shall conform to 75 mm up to 300 NB and to 100 mm over 350 NB. Whenever it is required by the Engineer to indicate that a pipeline carries a hazardous material, a hazard marking of diagonal stripes of red and golden yellow as per IS:2379 shall be painted on the ground color.
- c. All uninsulated piping systems, hangers and supports shall have two coats of suitable primer coats and with suitable finish paints as per Annexure-3 Painting system. Shades shall be as per IS 5 or as indicated by Owner /Engineer. Service of the pipe/line designations shall be painted on all pipes at visible locations.

16.0 Identification of Vessels, Piping etc.

Equipment number shall be stenciled in black or white on each vessel, column, equipment and machinery after painting.

Line number in black or white shall be stenciled on all the pipelines of more than one location as directed by Engineer; size of letters printed shall be 150 mm (high) for column & vessels. 50 mm (high) for pump compressor and other machinery and shall be as per IS: 9404 for piping. The storage tanks shall be marked as detailed in the respective drawing.

17.0 Inspection and Testing

- a) All painting materials including primers and thinners brought to site for application shall be procured directly from manufacturer as per specifications and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates are not acceptable. Engineer at his discretion, may call for tests for paint formulations. Contractor shall arrange to have such tests performed including batch wise test of wet paints for physical & chemical analysis. All costs thereof shall be borne by the contractor. The paints shall be tested as per IS: 101 / equivalent international standard and approved by the Owner.
- b) The painting work shall be subject to inspection by Engineer at all times. In particular, following stage wise inspection shall be performed and contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection shall be surface preparation, primer application and each coat of paint. In addition to above, record shall include type of shop primer already applied on equipment e.g. red oxide zinc chromate or zinc phosphate or Silicate primer etc.
- c) Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of Engineer before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, contractor shall be responsible for making good of any defects found during final inspection/guarantee period/defect liability period as defined in general condition of contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint shall be applied to make-up the DFT specified without any extra coat to the Owner.

**18.0 Guarantee**

The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/to be provided during execution of work. The contractor shall produce test reports from the manufacturer regarding the quality of the particular batch of paint supplied. The Engineer shall have the right to test wet samples of paint at random for quality of the same. Batch test reports of the manufacturer's for each batch of paints supplied shall be made available by the contractor.

19.0 Standard Final Colour of Equipment and Piping**19.1 Standard Colour Code for Mechanical Equipment**

Sl. No.	Description	Ground Colour
A	Service Water System	Sea Green
B	Crane & Hoist	
1	EOT crane	Canary Yellow
C	Compressed Air Plant	
1	Air compressor	Sky Blue
2	Compressed air dryer	Sky Blue
3	Air receiver	Sky Blue
D	Chemical Dosing	Dark Admiralty Grey
E	Fire Protection System	Fire red
F	Air Conditioning and Ventilation System	
1	Refrigerant compressor	Sky Blue
2	Chilled / condenser pumps	Sea Green
3	Condenser water pipe	Sea Green
4	Fans	Grey

Notes:

This color code basically refers to IS:2379 for piping with necessary modifications
For any item left out, color coding will be decided after Owner's approval.

19.2 Standard Colour Code for Electrical Equipment

1	Transformers	Olive grey for power transformers and pebble grey for service transformer	RAL 7002 for power transformers and RAL 7032 for service transformers
2	Bus ducts	pastel turquoise for indoor and olive grey for outdoor	indoor 6034 and outdoor 7002
3	Junction boxes.	Pebble grey	RAL 7032
4	HT/LT Switchboards, Distribution boards, Control & Relay panels		
	a) Indoor	Pebble grey	RAL 7032
	b) Outdoor	Pebble grey	RAL 7032
5	UPS Panel, charger panels	Light grey	Exterior RAL 7032 Interior Brilliant white



7	LT Motor	Pebble grey	RAL 7032
8	HT Motor	Pebble grey	RAL 7032
9	Lighting fittings	As per manufacturer's standard	As per manufacturer's standard
10	Cable trays	Galvanized	

1. For interior coating, manufacturer's standard can be adopted subject to Owner's approval.
2. All panels that are to be erected at control room shall be painted using RAL 7032 (exterior colour). All Electrical, C&I, Fire alarm or any other panel shall have this colour.

19.3 Colour Coding for Identification of Pipelines used in Thermal Power Plants/FGD plants

Sl.No	Medium	Ground Shade		Band Shade		Remarks
		Color	Color No. as per IS:5	Color	Color No. as per IS:5	
1	Water system					White is not included in IS - 5-2007
a)	Untreated or raw / service	Sea green	217	White	-	
b)	Treated/dematerialized	Sea green	217	Light orange	557	
c)	Potable water	Sea green	217	French blue	166	
d)	Service & clarified water	Sea green	217	French blue	166	
2	Steam system					with aluminum
a)	Auxiliary steam	Aluminum	-	Signal red	537	
3	Air system					White not included in IS-5 - 2007 Black not included in
a)	Instrument	Sky Blue	101	White	-	
b)	Service/Plant	Sky Blue	101	White	-	
c)	Vacuum pipes	Sky Blue	101	Black	-	
4	Transformer oil	Light brown	410	Light orange	557	
5	Fire services	Fire red	536	-	-	-
6	Effluent pipes	Black	-	-	-	-



19.4 Colour Code for Structural Steel

SL. NO	ITEM/SERVICE	COLOR	COLOR No. as per IS:5
1	Gantry girder & monorail	Brilliant green	221
2	Gantry girder & monorail stopper	Signal red	537
3	Building structural steel columns brackets, beams bracings, roof truss, purloin, side grit, louvers, stringers	Dark admiralty grey	632
4	Pipe rack structure & trestle	Dark admiralty grey	632
5	Chequered plate (Plain Face)	Black	-
6	Grating	Black	-
7	Ladder	Dark admiralty grey	632
8	Hand railing Hand rail	Signal red	537
9	Middle rail	Signal red	537
10	Toe Plate	Signal red	537
11	Vertical post	Black	-
12	Structural steel for Silo	Smoke grey	692

Notes

1. Covering capacity and DFT depends on method of application. Covering capacity specified above is theoretical. Allowing the losses during application, min specified DFT shall be maintained.
2. All primers and finish coats shall be cold cured and air dried unless otherwise specified.
3. All paints shall conform to relevant Indian Standard and shall be applied in accordance with manufacturer's instructions for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship shall be ensured.
4. Technical data sheets for all paints shall be supplied at the time of submission of quotations.
5. In case of use of epoxy tie coat, manufacturer shall demonstrate satisfactory test for inter coat adhesion. In case of limited availability of epoxy tie coat, alternate system may be used taking into consideration the service requirement of the system.
6. Contractor will submit the final colour shade for all equipments & piping under his scope for final approval by client / consultant.



Painting Systems						
Cleaning, Protective Coating and Painting. - Systems designed as per ISO 12944 with service life of 10 yrs.						
Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
Structural Steel work, piping (Oil + Water), tanks outside surface, transmission towers cranes, steel floors, galleries, stairways, Outdoor.	< 130 Deg	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1	75
			Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Mid coat	1	2 pack High build High Solid Lamellar MIO based Epoxy Mid coat.	200
			Finish	1	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of at least 90% on QUVB exposure of minimum 1000 hrs.	75
					Total	350
Surface/ Location	Temp					
Structural Steelwork, piping, indoor and outdoor	130 to 200 Deg	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
			Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Sealer	1	Single pack Heat Resistant Silicon Acrylic Finish paint.	25
			Finish	2	Single pack Heat Resistant Silicon Acrylic Finish paint.	25
					Total	150
Alternative -2		SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
				1	Single pack Moisture Cured, Inorganic Silicate based heat resisting finish up to 400 Deg - Grey shade./ white/ Aluminium.	50
			Finish	1		50
					Total	175



Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
Alternative-3			Finish	1	Single pack Heat Resistant Silicon Acrylic Finish paint. - either Aviation White/ Aviation Orange.	80
					Total	155
Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
Structural Steel work Piping, Un-insulated Carbon Steel Indoor and Outdoor	200 to 400 mmmm mDeg C.	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
			Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level 2.	(75)
			Finish	2	Heat Resisting Silicon Aluminium Paint. VS to be min 28%.	20
					Total	115
Structural Steel work, Piping (Oil + water) , Tanks Indoor.	<130 Deg.C	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
			Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Mid coat	2	2 pack High build High Solid Lamellar MIO based Epoxy Mid coat.	100
			Finish	2	Two component Polyamide Cured Epoxy Coating.	25
					Total	325
Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
Structural Steel work in the battery rooms, chlorination plant and water treatment plant, (extremely aggressive atmosphere)	Ambient	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1	75
			Touch up		Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)



Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
			Mid coat	1	Two component, high build rust encapsulating, aluminium pigmented modified epoxy coating.	125
			Finish	1	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%	150
					Total	350
Steel Tanks inside Surface (Total) for Oil Storage	Normal	SA 2.5	Primer	1	Two component high build amine cured epoxy Primer with zinc phosphate pigment.	75
			Finish	2	Two component Self priming High Build Polyamine adduct cured epoxy coating.	125
					Total	325
Alternative-1			Finish	3	Two component Self priming High Build Polyamine adduct cured epoxy coating. (No primer required. Self priming coating post blasting)	125
					Total	375
Alternative-2			Finish	2	Two component High build high solid Solvent free epoxy coating - certified by CFTRI for Potable water usage. (Primer same as above)	150
					Total	300
Surface/ Location	Temp					
Steel Tanks inside Surface (Total) for Water Storage (Potable and Distilled Water)	Ambient	SA 3	Primer	1	Two component high build polyamide cured zinc phosphate Primer	75
			Finish	2	Two component Self priming High Build Polyamine adduct cured epoxy coating - certified by CFTRI for Potable water usage.	125
						325
Alternative 1			Finish	2	Two component High build high solid Solvent free epoxy coating - certified by CFTRI for Potable water usage. (No primer required. Self priming coating post blasting)	200
						400
Steelwork immersed in water such as inlet/	< 60 Deg C	SA 3	Primer	1	Two component High Build High Solid Rapid Curing Epoxy Zinc Phosphate Primer.	75



Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
outlet structures, dolphins, sheet piling			Finish	1	Two component High build High Solid Modified Epoxy coating.	500
					Total	575
			Wherever TAR based product is not to be recommended.			
			Finish	1	Two component High build High Solid Modified Epoxy coating	500
					Total	500
			Finish	1	Two component High build High Solid Modified Epoxy coating with Glass Flake.	500
					Total	500
Alternative 1						
Cast Iron Water pipelines - Outside surface, buried in Soil	< 60 Deg C	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1	75
			Finish	2	Polyamide Cured Coal Tar Epoxy, Vs min 65% black.	200
					Total	475
Alternate-1			Finish	1	Two component High build High Solid Modified Epoxy coating	500
Alternate -2			Finish	1	Two component High build High Solid Modified Epoxy coating with Glass Flake	500
Surface/ Location	Temp					
Steel Pipes - Inside surfaces such as cooling water lines.	< 60 Deg C	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
			Finish	2	Coal Tar Epoxy, Vs min 65% black.	225
					Total	525
Water Pipelines - Outside Surface, Indoor	< 60 Deg C	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75



Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
			Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Finish	2	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%	100
					Total	275
Oil pipelines - Outside surface, above ground	< 100 Deg C	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
			Touch up		Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Mid coat	2	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%	100
			Finish	1	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of at least 90% on QUVB exposure of minimum 1000 hrs.	75
					Total	350
Surface/ Location	Temp					
Pumps, Motors, Turbine, Claddings, Steam Turbine Condenser, Indoor	Up to 90 Deg	SA 2.5	Primer	1	Catalysed Zn rich Primer with a VS of 60% min, complying to SSPC Paint 20 level 2.	75
			Finish	2	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%.	100
					Total	275
Alternative 1		SA 2.5	Primer	1	Catalysed Zn rich Primer with a VS of 60% min, complying to SSPC Paint 20 level 2.	75
			Mid coat	1	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%.	100
			Finish	2	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of at least 90% on QUVB exposure of minimum 1000 hrs.	75



Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
					Total	250
Heat Exchangers - Inside Surface.	Up to 60 Deg	SA 2.5	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
			Finish	2	Coal Tar Epoxy, Vs min 65% black.	200
					Total	475
Instrument panels, Electrical cubicles and similar steel sheet – indoor (Can be used on Aluminium, steel, stainless steel and galvanized substrates.)	Ambient	Oil grease and contaminants must be removed	Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	75
			Mid coat	1	Two component High Build Surface Tolerant Epoxy coating pigmented with Aluminium and Lamellar Micaceous iron oxide	100
			Top coat	1	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%	100
					Total	275
Surface/ Location	Temp					
Instrument panels, Electrical cubicles and similar steel sheet – outdoor (Can be used on Aluminium, steel, stainless steel and galvanized substrates.)	Ambient	Oil grease and contaminants must be removed	Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	100
			Mid coat	1	Two component High Build Surface Tolerant Epoxy coating pigmented with Aluminium and Lamellar Micaceous iron oxide.	150
			Top coat	1	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of atleast 90% on QUVB exposure of minimum 1000 hrs.	75
					Total	325
Substrate, base metal: Carbon steel, HDG acc ISO 1461 Or. Equiv. Non Insulated. - Outdoor	<120 Deg	Air blasting with Nonmetallic	Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	50



Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
		abrasive Powder	Mid coat	1	Two component High Build Surface Tolerant Epoxy coating pigmented with Aluminium and Lamellar Micaceous iron oxide	150
			Finish	1	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of atleast 90% on QUVB exposure of minimum 1000 hrs.	75
					Total	275
Substrate, base metal: Carbon steel, HDG acc ISO 1461 Or. Equiv. Non Insulated.- Indoor	<120 Deg	Air blasting with Nonmetallic abrasive Powder	Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level 2.	75
			Primer	1	Two pack, high build siloxane modified epoxy primer with zinc phosphate pigment.	125
			Finish	1	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%.	100
					Total	225
			For Outdoor Application			
			Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	125
			Finish	1	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of at least 90% on QUVB exposure of minimum 1000 hrs.	75
					Total	200
			For Indoor Application			
Substrate, Stainless Steel - Non insulated.	< 120 Deg	Air blasting with Nonmetallic abrasive Powder	Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	125
			Finish	1	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%	100
					Total	225
			For Outdoor Application			
			Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	125



Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
			Finish	1	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of atleast 90% on QUVB exposure of minimum 1000 hrs.	75
					Total	200
Applicable for Water - Water Cooled heat Exchangers like Condensers, Flash box, Water - Water coolers etc. For Outdoor installations in corrosive atmosphere - like Chemical/ Marine.			For Indoor Application			
	< 120 Deg	Air blasting with Nonmetallic abrasive Powder	Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	75
			Top coat	2	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%.	100
					Total	275
			For Outdoor Application			
			Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	125
			Mid coat	1	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%.	100
			Top coat	1	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of at least 90% on QUVB exposure of minimum 1000 hrs.	75
				Total	300	



Title:
1 X 800 MW NCTPP STAGE-III,
Chennai, TANGEDCO, Tamilnadu
Technical Specification
for Agitators of FGD Slurry Tanks

Specification No: PE-TS-485-571-18000-A001

Section-I, Sub-Section-C3

REV. 00

Date: August,2022

Sheet: 1 of 1

TECHNICAL SPECIFICATION ELECTRICAL PORTION

Tamil Nadu Generation and Distribution Corporation Ltd.

**1X800MW TANGEDCO NORTH CHENNAI TPP STAGE-III
(FGD SYSTEM AND AUXILIARIES)**

**AGITATOR
TECHNICAL SPECIFICATION
(ELECTRICAL PORTION)**



**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT,
NOIDA, U.P., INDIA**

	TITLE: TECHNICAL SPECIFICATION FOR AGITATOR 1X800MW TANGEDCO NORTH CHENNAI TPP STAGE-III(FGD SYSTEM & AUXILIARIES)	SPECIFICATION NO.
		VOLUME NO. : II-B
		SECTION: C
		REV NO. : 00 DATE: 24.09.21
		SHEET: 1 OF 1

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The requirements mentioned in Section-I shall prevail and govern in case of conflict between the same and the corresponding requirements mentioned in the descriptive portion in Section-II.



**ELECTRICAL EQUIPMENT SPECIFICATION
FOR
AGITATOR
1X800MW TANGEDCO NORTH CHENNAI TPP
STAGE-III (FGD SYSTEM & AUXILIARIES)**

SPECIFICATION NO.

VOLUME NO. : II-B

SECTION : C

REV NO. : 00 DATE : 24.09.21

SHEET : 1 OF 1

SPECIFIC TECHNICAL REQUIREMENTS: ELECTRICAL

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER/ PURCHASER

- a) Services and equipment as per "Electrical Scope between BHEL and Vendor".
- b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The same shall be provided by the bidder without any extra charge.
- c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
- d) Electrical load requirement for AGITATOR.
- e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
- f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer/BHEL approval without any commercial and delivery implications to BHEL.
- g) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.
- h) Motor shall meet minimum requirement of motor specification.
- i) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.
- j) Cable BOQ worked out based on routing of cable listing provided by the vendor for "both end equipment in vendor's scope" shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

2.0 EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:

Refer "Electrical Scope between BHEL and Vendor".

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

- 3.1 The electrical specification without any deviation from the technical/ quality assurance requirements stipulated shall be deemed to be complied by the bidder in case bidder furnishes the overall compliance of package technical specification in the form of compliance certificate/ No deviation certificate.
- 3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

4.0 LIST OF ENCLOSURES

- 4.1 Electrical Scope Between BHEL & Vendor (Annexure-I).
- 4.2 Electrical Load Data Format (Annexure-II).
- 4.3 Cable Schedule Format (Annexure-III).
- 4.4 Data Sheet-A.
- 4.5 Data Sheet-C.
- 4.6 Technical Requirements-Motors.
- 4.7 Standard Quality Plan.
- 4.8 Motor Sub Vendor List

REV: 0 DATE:

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)**PACKAGE: AGITATOR (Supply Package)****PROJECT: 1X800MW TANGEDCO NORTH CHENNAI TPP STAGE-III (FGD SYSTEM & AUXILIARIES)**

<u>S.NO</u>	<u>DETAILS</u>	<u>SCOPE SUPPLY</u>	<u>SCOPE E&C</u>	<u>REMARKS</u>
1	415 V MCC	BHEL	BHEL	415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motors.
3	Power cables, control cables and screened control cables	BHEL	BHEL	Incoming cable from BHEL supplied MCC will be informed by BHEL. Vendor shall provide lugs & glands accordingly.
4	Cable trays, accessories & cable trays supporting system	BHEL	BHEL	
5	Cable glands and lugs for equipments supplied by Vendor	Vendor	BHEL	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
6	Conduit and conduit accessories for cabling between equipments supplied by vendor	BHEL	BHEL	
7	Equipment grounding & lightning protection	BHEL	BHEL	
8	Below grade grounding	BHEL	BHEL	
9	LT Motors with base plate and foundation hardware	Vendor	BHEL	Makes shall be subject to BHEL approval at contract stage.
10	Mandatory spares	Vendor	-	Vendor to quote as per specification.
11	Recommended O & M spares	Vendor	-	As per specification
12	Any other equipment/material/service required for completeness of system but not specified above (to ensure trouble free and efficient operation of the system).	Vendor	BHEL	
13	Electrical equipment GA drawing	Vendor	-	For necessary interface review.

NOTES:

1. Make of all electrical equipments/items supplied shall be reputed make & shall be subject to approval of BHEL after award of contract.
2. All QPs shall be subject to approval of BHEL after award of contract without any commercial implication.

ANNEXURE III

[illegible]

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.
2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.
3. The field properties shall be as under:
 - a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
 - b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
 - f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
 - g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.
4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).
5. The cables shall be described as per the scheme listed below:

A	NN	A	NNN
Cable	No. of cores	Cable code	Cable size
Voltage	(e.g. 01,03,3H, 07)	(See C below)	(e.g. 035,185,2.5, 0.5)
Code (see B below)			

(A) SYSTEM VOLTAGE CODES:

(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V

(dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) CABLE VOLTAGE CODES:

A = 11KV (Power cables)

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

B = 6.6KV (Power cables)
C = 3.3KV (Power cables)
D = 1.1KV (LV & DC system power & control cables)
E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

A = Armoured FRLS	B = Armoured Non-FRLS
C = unarmoured FRLS	D = Unarmoured Non-FRLS

PVC Aluminium

E = Armoured FRLS	F = Armoured Non-FRLS
G = unarmoured FRLS	H = Unarmoured Non-FRLS

XLPE Copper

J = Armoured FRLS	K = Armoured Non-FRLS
L = unarmoured FRLS	M = Unarmoured Non-FRLS

XLPE Aluminium

N = Armoured FRLS	P = Armoured Non-FRLS
Q = unarmoured FRLS	R = Unarmoured Non-FRLS

S = FIRE SURVIVAL CABLES
T = TOUGH RUBBER SHEATH
U = OVERALL SCREENED
V = PAIRED OVERALL SCREENED
W = PAIRED INDIVIDUAL SCREENED
Y = COMPENSATING CABLES
I = PRE-FABRICATED CABLES
Z = JELLY FILLED CABLES



SECTION : 3.1- MOTORS

1.0.0 INTENT OF SPECIFICATION

This section covers the technical requirements of HT and LT Motors.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the following Indian Standards (IS), IEC publications and other codes, especially the Indian Statutory Regulation, except where modified and /or supplemented by this specification.

a) IS: 325	Three phase induction motors
b) IS: 12615	Energy efficient induction motors
c) IS: 900	Code of practice for installation and maintenance of induction motors
d) IS: 996	Single-phase AC induction motor for general purpose
e) IS: 1231	Dimensions of three-phase foot-mounted induction motors
f) IS: 2223	Dimensions of flange mounted AC induction motors
g) IS: 4029	Guide for testing three-phase induction motors
h) IS: 8789	Values of performance characteristics for three-phase induction motors
i) IS: 13555	Guide for selection and application of 3-phase AC induction motors for different types of driven equipment
j) IS: 5571	Guide for selection of electrical equipment for hazardous areas
k) IS: 12065	Permissible limits of noise level for rotating electrical machines
l) IS: 12075	Mechanical vibration of rotating electrical machines
m) IS: 9334	Electrical motor operated actuators
n) IS 60034-5	Degree of protection provided by Integral design of rotating electrical machines
o) IS 60034-8	Terminal marking and direction of rotation
p) IS 60079-1	Equipment protection by flame proof enclosure
q) IS 60034-1	Rotating electrical machines.
r) IS 60079	Explosive atmospheres
s) IS/IEC 60529	Degrees of protection provided by enclosures (IP code)
t) IEC 60034	Rotating electrical machines.

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Design ambient temperature

Motors shall be suitable for an ambient temperature of 50 degree C and relative humidity of 95% and shall deliver the rated output without exceeding its guaranteed temperature limits. The equipment shall operate in highly polluted environment.

3.2.0 Supply voltage

Motors rated up to and including 415V are termed as LT motors and the motors rated higher than 415V are termed as HT motors.

Motors shall be capable of delivering the rated output under following voltage and frequency variations without exceeding its guaranteed temperature limits.



- Frequency variation : (+) 3% and (-) 5%
- Voltage variation for LT motors : (±) 10%
- Voltage variation for HT motors : (±) 10%
- Combined variation of voltage and frequency : 10% (absolute sum)

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

3.3.0 System Parameters

Sl. No.	Description	HT System	LT System
1.	Voltage level	11 KV Above 2000 KW 6.6KV above 160KW & upto 2000KW	240 V : up to 0.2 KW 415 V : >0.2 KW and up to 160 KW.
2.	System earthing	Earthed through resistance. Earth fault current : 300 Amps	415V: Solidly grounded.
3.	System fault level	50 KA for 3 sec for 11KV 40KA for 1sec for 6.6KV	50 KA for 1 second
4.	Fault withstand rating of motor terminal box (Breaker operated)	50 KA for 0.25 sec for 11KV 40KA for 0.25 sec for 6.6KV	50 KA for 0.25 second

3.4.0 Type

- AC Motors shall be squirrel cage induction type unless otherwise it is specified. All the motor shall be bi-directional.

3.5.0 Duty

- All AC motors shall be squirrel cage three phase/single phase induction motors. All the motor shall be designed for bi-directional rotation.
- Motors shall be suitable for installation in hot, humid and tropical atmosphere and polluted at places with coal ash and fly ash or any dusty chemical handling area.
- All LV motors above 10KW shall be with S1 duty.

3.6.0 Design margin

- Motor rating shall be selected higher than the maximum load demand of the driven equipment, as per the criteria stated in mechanical section of this specification, under entire operating range, including voltage and frequency variation.
- The motor name plate rating shall have 15% margin over duty point input (or) 10% margin over the maximum demand of driven equipment whichever is higher considering highest system frequency.
- The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating; pull up, breakdown and full load torques are available for the intended service.
- Service shall be considered as 1.0 only.



3.7.0 Method of Starting

- All the motors shall be suitable for direct on-line starting on full load.
- HT Motors will be controlled through vacuum circuit breaker.
- LT motors rated less than 90KW will be controlled through MPCB/MCCB and contactor. LT motors rated 90 KW and above will be controlled through air circuit breaker (ACB).

3.8.0 Efficiency

All the continuous duty motors shall be energy efficient type. For LT motors, it shall be IE3 class as per IS 12615. For HT motors, efficiency shall be more than 95%.

3.9.0 Temperature rise

- Winding Insulation shall be Class F.
- Temperature rise of motors shall not exceed 70°C over air temperature of 50°C by resistance method, while delivering its maximum rated output.

3.10.0 Starting voltage

- a) Motors shall be capable of starting and accelerating the load at following starting voltage, with direct on line starting, without exceeding specified winding temperatures.
 - HT Motors : 85% of rated voltage
 - LT motors : 80% of rated voltage
- b) During fast changeover of power supply source, vector difference between the motor residual voltage and the incoming supply voltage will be about 150% of the rated voltage and the motors shall withstand voltage stress and torque stress developed during that time, which may last for a period of one (1) second.
- c) The motor shall be capable of operating at full load at a supply voltage of 80% of the rated voltage for 5 minutes.
- d) The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.
- e) Motor shall not stall if the supply voltage drops to 70% of the rated voltage two (2) second duration

3.11.0 No. of Starts

Continuous duty motors shall be suitable for the following starting requirements under the specified conditions of load, torque and inertia.

- No. of consecutive hot starts shall be 2 (with initial temperature of the motor at full load operating level).
- No. of consecutive cold starts shall be 3 (with initial temperature of the motor at ambient temperature).
- For conveyor motors, no. of consecutive hot starts shall be 3 (with initial temperature of the motor at full load operating level).



3.12.0 Starting current

- Motor shall be designed for direct online starting at full voltage. Starting current shall not exceed 6 times full load current for all auxiliaries. No further tolerances are applicable on starting current specified above for HT motors.
- For LT motors, the applicable starting current shall be limited to 7.2 times of full load current including all tolerance.

3.13.0 Locked rotor withstand time

- The locked rotor withstand time for HT motors under hot conditions at 110% rated voltage shall be more than the starting time at minimum permissible voltage specified above by atleast three seconds or 15% of the accelerating time whichever is greater.
- For the LT motors having starting time upto 20 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 seconds more than the starting time.
- For the motors having starting time more than 20 seconds and up to 45 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 seconds more than the starting time.
- For motors having starting time more than 45 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.
- The motors shall be designed to withstand 120% of rated speed for 2 minutes without any mechanical damage
- All motors shall be so designed that maximum in rush currents and locked rotor and pull out torque developed by them at extreme voltage and frequency variation do not endanger the motor & driven equipment.

3.14.0 Torque Requirements

- Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.
- Pull out torque at rated voltage shall not be less than 205% of full load torque.
- Motors subjected to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% of rated speed in reverse direction.
- The motor shall be designed to withstand momentary overload of 60% of full load torque for 15 second without any damage.

3.15.0 Enclosure

- a) All motor enclosures shall conform to the degree of protection IP 55 unless otherwise specified. Motor for outdoor or semi outdoor service shall be of weather proof construction.
- b) For hazardous location, the enclosure of motors shall have flame proof construction conforming to applicable standard.



3.16.0 Cooling

- LT motors shall be totally enclosed fan cooled (TEFC), type IC411. The cooling shall be effected by self-driven bi-directional centrifugal fan protected by fan cover.
- HT motors can be totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or closed air circuit air cooled (CACA) type.
- Motors rated >3000KW can be closed air circuit water cooled (CACW).
- Motors with CACA/CACW heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate the following:
 - Hot and cold air temperatures of the closed air circuit for CACA motors.
 - Hot and cold, air and water temperatures for CACW motors.
- The Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 5A at 240 V AC.

3.17.0 Winding

- Winding shall be class F insulation with temperature limited to class B. Insulation shall be Non-hygroscopic, oil resistant, and flame resistant. Winding, fittings and hardware shall be corrosion resistant. Winding shall be tropicalized and suitably varnished, baked and treated for operating satisfactorily in humid and corrosive atmosphere.
- For the VFD operated drives, insulation shall be designed to take care of stresses due to high Dv/dt . Motors shall be wound with dual coated winding wires and impregnated with VPI process. Further for such application, insulated bearings shall be provided to avoid circulating current caused by shaft induced voltages.
- Space heaters rated for 240V AC, 50 Hz supply shall be provided for motors rated 30KW and above to maintain windings in dry condition when motor is standstill.
- For HT motors, insulation shall be Vacuum Impregnated (VPI).
- HT motors shall withstand 1.2/50 microsec impulse Voltage wave of 4U+5 KV (U=Line voltage in KV). The coil inter-turn insulation shall be suitable for 0.3/3msec surge of 32KVp and 12KVp for 11KV & 6.6KV system respectively, followed by 1 min power frequency high voltage test of appropriate voltage on inter turn insulation.

Temperature Detectors

- All 11KV motors shall be provided with six (6) nos. duplex, or twelve (12) nos. simplex type winding temperature detectors, i.e. two (2) nos. duplex or four (4) nos. Simplex per phase.
- 11KV motor bearing shall be provided with duplex type temperature detectors.
- The temperature detector mentioned above shall be resistance type, 3 wire, platinum wound, 100 Ohms at 0°C.
- Leads of all simplex type motor winding RTDS and motor bearing RTDS shall be wired up to respective switchgear metering & protection compartment. From which one set of RTDS will be connected to numerical protection relay and another set shall be kept free for DCS/PLC connectivity.
- Five number of Temperature detectors / thermistors shall be provided for L.T. motors above 90 KW (3 numbers winding temperatures & 2 numbers bearing temperatures)



3.18.0 Bearings

- Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application. Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.
- Sleeve bearings shall be split type, ring oiled with permanently aligned, close running shaft sleeves. Grease lubricated bearings shall be pre-lubricated and shall have provisions for in-service positive lubrication with grease nipple and relief holes.
- Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred. However, if anti-friction bearings can take vertical thrust, thrust and guide bearings are not required.
- Lubricant shall not deteriorate under all service conditions. The lubricants shall be limited to normally available types. For motors rated 30KW and above re-lubrication facility shall be provided.
- For motor with forced lubrication, a shaft driven oil pump shall be provided along with an electrical auxiliary pump. Alternatively, two motor driven pumps may be provided, one working and one standby. All necessary auxiliaries and accessories shall be provided to complete the system. A pressure gauge and pressure switch for low oil pressure warning and to start the standby oil pump automatically shall also be provided. A motor driven jacking oil pump may be provided, for heavy shaft loads.
- Flow switches shall be provided for monitoring oil flow of forced lubrication bearings, if used. Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10A at 230 V AC.
- For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired upto the terminal box.
- Each bearing shall be provided with dial type thermometer.
- For all VFD operated motors and motors rated above 1000KW shall have insulated bearings to prevent flow of shaft currents.

3.19.0 Terminal Boxes

- For single core cables, gland plate shall be non-magnetic material. Terminal box shall be capable of being turned 360° in steps of 90°, unless otherwise approved. The terminal boxes shall be split type with removable cover with access to connections.
- Terminals for motors shall be stud type, thoroughly insulated from the frame. The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.
- The terminal box shall be capable of withstanding maximum system fault current for 0.25 sec for all breaker operated motors and shall be provided with explosion vent.
- For contactor operated LT motors, the terminal box shall be capable of withstanding the fault current for 0.2 sec minimum and operating time of MPCB/MCCB.
- Removable gland plates of thickness not less than 2.5 mm sheet steel or 3 mm aluminium (for single core cables) shall be provided for cable boxes.
- Cable spreader box shall be provided for larger cable sizes.



- Cable boxes of HT motors shall be phase segregated type. The terminals of three phases shall be segregated by barriers of metal or fibre glass. For HT motors, cable box design shall be suitable for accommodating cable termination kits.
- Separate terminal box for space heaters shall be provided.
- A separate terminal box of IP 55 degree of protection shall be provided for temperature detectors.
- Motor 1000 KW and above shall be provided with three differential current transformers mounted over the neutral leads within the enclosure. Loose 3 numbers CT for mounting on switchgear side shall be in bidder's scope. The arrangement shall be such as to permit easy access for C.T. testing and replacement. Current transformer characteristics shall match Owner's requirements to be intimated later to the successful bidder. The CT details shall be finalized during detail engineering. Neutral terminal box shall have IP 55 degree of protection.
- The secondary leads of CT shall be wired to separate auxiliary terminal box of IP 55 degree of protection
- All the accessory terminal boxes shall be located on the same side of the main (power) terminal box.
- For LT motors, terminal box shall be located on top, unless otherwise specified.

3.20.0 Earthing Terminals

The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer. The terminal box shall have a separate grounding terminal.

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

Above 100 to 200 KW	: 75x10 mm GS flat
Above 55 KW to 100 KW	: 50x6 mm GS flat
Above 22 KW to 55 KW	: 50x6 mm GS flat
Above 5.5 KW to 22 KW	: 25x6 mm GS flat
Fractional HP LV Motors	: 8 SWG GS Wire

3.21.0 Noise and Vibration

- Motors shall be selected with low noise levels in accordance with IS 12065. Noise level for all motors shall be limited to 85db (A).
- The peak amplitude of the vibration shall also be within the specified limits of IS: 12075.
- All HT motors shall be provided with vibration pads for mounting vibration detectors. Motors shall withstand vibration produced by driven equipment.

3.22.0 Name Plates

Motor shall have stainless steel nameplate(s) showing diagram of connections, all particulars as per IS: 325 / IS: 12615 and shall also have 'BEE' marking.

In addition to the minimum information required by IEC/IS, the following information shall be shown on motor rating plate:

- Temperature rise in °C under rated condition and method of measurement.



- Degree of protection.
- Bearing identification no. and recommended lubricant.
- Location of insulated bearings.

3.23.0 Drain plug

Motor shall have drain plugs so located that they will drain the water, resulting from the condensation or other causes from all pockets of the motor casing.

3.24.0 Lifting provision

Motor weighing 25 Kg. or more shall be provided with eyebolt or other adequate provision of lifting.

3.25.0 Dowel pins

The motor shall be designed to permit easy access for drilling holes through motor feet or mounting flange for installation of dowel pins after assembling the motor and driven equipment

4.0.0 INSTALLATION

Installation shall be carried out as per IS: 900.

5.0.0 PAINTING

Painting shall be carried out by an approved process. Pretreatment shall conform to applicable standard. The equipment shall be subject to a coat of red oxide primer paint. All inside and outside surface shall be painted with epoxy based paint. The final thickness of paint film on steel shall not be less than 100 microns. Paint Shade for the Motor shall be RAL 7032 (Siemens Grey). Sufficient quantity of touch-up paint shall be furnished for application at site.

6.0.0 TESTING AND INSPECTION

- 6.1.0 Tests shall be performed in presence of Owner's representatives. Successful Bidder shall give atleast fifteen (15) days advance notice for witnessing the tests. Copies of certified reports of all tests carried out at the works shall be furnished. The equipment shall be dispatched from works, only after receipt of Owner's written approval of the test reports.
- 6.2.0 Routine and Type Tests are to be conducted for all HT motors and for LT motors above 60 KW rating in presence of customer's representative as per IS:325, IS:4722, IS:9283 and required copies of test certificates are to be furnished for approval.
- 6.3.0 Test certificates for Routine tests conducted as per IS:325, IS:4722, IS:9283 for motors of rating 60 KW and below shall be submitted for TANGEDCO review, approval and dispatch clearance.
- 6.4.0 The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out
 - i) Measurement of vibration.
 - ii) Measurement of insulation resistance and polarization index
 - iii) Measurement of full load current.
 - iv) Test running of the motors, checking the temperature rise and identifying the hot spot etc.



7.0.0 OTHERS

7.1.0 The responsibility of co-ordination with electrical agencies and obtaining all necessary clearances shall be the contractor.

7.2.0 Canopy shall be provided for outdoor motors.

7.3.0 Contractor shall provide fully compatible electrical system, equipment, accessories and services.

8.0.0 SPECIFIC REQUIREMENTS

8.1.0 The following shall be considered for control & protection of motors.

- a) Motors below 18.5 KW: MPCB incomers
- b) Above 18.5 KW but below 90 KW: contactor controlled with MCCB
- c) 90 KW and above but 160 KW & below: ACB controlled with numerical relays
- d) HT Motors shall have vacuum breakers
- e) HV motors 1000KW above shall have differential protection
- f) For motors 1000KW & above, neutral CT of CI. PS shall be provided as each box on separate terminal box
- g) Key phasor arrangement shall be provided for all motors
- h) All motors shall be provided with an emergency stop PB near motor as per Indian Statutory regularity.
- i) Spacious platform shall be provided around motor area with min. of 300mm below the level of motor base plate.
- j) Capillary type temp. Gauge cum shall be provided for DE/NDE of HV motors
- k) After erection of electrical equipment at site, corrosion proof paint touch up to be done before test & commissioning of equipment.



2.3.0 MOTORS

Item/ Components/ Sub-system	Tests/ Checks															
	Visual	Dimensional	Make, Type, Rating, TC, General physical	Mechanical, Chemical properties	NDT, DP or MPI, UT	Metallography	Electrical characteristics	Welding/ Brazing (WPS/ PQR)	Heat treatment	Magnetic characteristics	Hydraulic, Leak, Pressure test	Thermal characteristics	Run out	Dynamic balancing	All tests as per IS:325/ IS:4722/ IS:9283	Tan delta, shaft voltage and polarisation
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y					Y							
Shaft	Y	Y	Y	Y	Y	Y			Y							
Magnetic material	Y	Y	Y	Y	Y		Y			Y		Y				
Rotor copper/ Aluminium	Y	Y	Y	Y		Y	Y		Y							
Stator copper	Y	Y	Y	Y			Y		Y			Y				
SC ring	Y	Y	Y	Y	Y	Y	Y	Y	Y							
Insulating material	Y		Y	Y			Y					Y				
Tubes for cooler	Y	Y	Y	Y	Y				Y		Y					
Sleeve bearing	Y	Y	Y	Y	Y				Y		Y					
Stator, Rotor coils	Y	Y	Y				Y	Y								
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y								
Fabrication and machining of stator, rotor, terminal box	Y	Y			Y				Y							
Wound stator	Y	Y					Y	Y								
Rotor complete	Y	Y					Y						Y	Y		



Item/ Components/ Sub-system	Tests/ Checks													
	Visual	Dimensional	Make, Type, Rating, TC, General physical	Mechanical, Chemical properties	NDT, DP or MPI, UT	Metallography	Electrical characteristics	Welding/ Brazing (WPS/ PQR)	Heat treatment	Magnetic characteristics	Hydraulic, Leak, Pressure test	Thermal characteristics	Run out	Dynamic balancing
Stator, Rotor, Terminal Box assembly	Y	Y					Y							
Accessories, RTD, BTD, CT, Brushes, Diodes, space heater, antifriction bearing, cable glands, lugs, gaskets etc.	Y	Y	Y											
Complete motor (IS: 325/ IS:4722/ IS:9283)	Y	Y	Y										Y	Y
Y = Test applicable, Y1 = for 11kV and 3.3kV motors only														
Note														
This is an indicative list of tests/ checks. The manufacture is to furnish the detailed Quality Plan indicating the practices and procedure followed along with relevant supporting documents during QP finalization. However QP approval is not envisaged for 415V motors upto 50 KW.														

Site Tests :

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

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

	TITLE LV MOTORS <u>DATA SHEET-A</u>	SPECIFICATION NO.	
		VOLUME	II B
		SECTION	D
		REV NO. 00	DATE 24.09.2021
		SHEET 1	OF 1

1.0	Design ambient temperature	:	50 °C
2.0	Maximum acceptable kW rating of LV motor	:	Upto 160KW
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Degree Of Protection	:	IP55 (INDOOR), IPW55(OUTDOOR)
5.0	Cooling	:	TEFC
6.0	Details of supply system		
	a) Rated voltage (with variation)	:	415V ± 10%
	b) Rated frequency (with variation)	:	50 Hz (Variation: +3% TO –5%)
	c) Combined voltage & freq. variation	:	10% (sum of absolute values)
	d) System fault level at rated voltage	:	50 kA for 1 sec
	e) Short time rating for terminal box	:	50 kA for 0.25 sec
	f) LV System grounding	:	Solidly
7.0	Class of insulation	:	Class ‘F’, with temp rise limited to class B.
8.0	Minimum voltage for starting (As percentage of rated voltage)	:	80% of rated voltage
9.0	Power cables data	:	Shall be given during Detailed engg.
10.0	Earth Conductor Size & Material	:	Shall be given during Detailed engg.
11.0	Space heater supply (30KW & ABOVE)	:	240 V, 1Φ , 50 Hz
12.0	Rating up to which Single phase motor	:	Acceptable upto 0.20 Kw
13.0	TYPE OF STARTER PROVIDED IN MCC	:	DOL
14.0	Locked rotor current		
	a) Limit as percentage of FLC	:	As per IS 12615
	b) Permissible tolerance, if any	:	
15.0	Additional tests	:	As per QP
16.0	Flame-proof motor		
	a) Enclosure suitable (As per IS:2148)	:	As per requirement
	b) Classification of Hazardous area (As per IS: 5572 part-I)	:	As per requirement
	c) Degree of protection	:	IP65
17.0	Makes	:	AS PER ANNEXURE-I
19.0	Paint shade	:	RAL 7032
20.0	Efficiency class	:	IE3

NOTE :1. Also detailed Customer spec. for Motors is to be referred as enclosed with technical spec.

The list of approved make of the LT Motors are as mentioned below:

S. NO.	LIST OF MOTORS	
1	NON FLAME PROOF	ABB
2		BHARAT BIJLEE LTD.
3		CROMPTON GREAVES
4		GE-POWER
5		KIRLOSKAR ELECTRIC CO LTD.
6		LAXMI HYDRAULICS PVT. LTD
7		MARATHON
8		NGEF
9		RAJINDRA ELECT INDUSTRIES
10		SIEMENS
11	FLAME PROOF	RAJINDRA ELECT INDUSTRIES

However, the final list of makes for the LT Motors is subjected to BHEL/Customer approval, during contract stage, without any commercial implications.

	TITLE LV MOTOR DATA SHEET - C	SPECIFICATION NO.
		VOLUME II B
		SECTION D
		REV NO. 00 DATE
		SHEET 1 OF 2

S. No.	Description	Data to be filled by successful bidder
A. General		
1	Manufacturer & country of origin	
2	Motor type	
3	Type of starting	
4	Name of the equipment driven by motor & Quantity	
5	Maximum Power requirement of driven equipment	
6	Rated speed of Driven Equipment	
7	Design ambient temperature	
B. Design and Performance Data		
1	Frame size & type designation	
2	Type of duty	
3	Rated Voltage	
4	Permissible variation for	
5 a)	Voltage	
6 b)	Frequency	
7 c)	Combined voltage & frequency	
8	Rated output at design ambient temp (by resistance method)	
9	Synchronous speed & Rated slip	
10	Minimum permissible starting voltage	
11	Starting time in sec with mechanism coupled	
12	a) At rated voltage	
13	b) At min starting voltage	
14	Locked rotor current as percentage of FLC (including IS tolerance)	
15	Torque	
a)	Starting	
b)	Maximum	
16	Permissible temp rise at rated output over ambient temp & method	
17	Noise level at 1.0 m (dB)	
18	Amplitude of vibration	
19	Efficiency & P.F. at rated voltage & frequency	
	a) At 100% load	
	c) At 75% load	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

	TITLE LV MOTOR DATA SHEET - C	SPECIFICATION NO.
		VOLUME II B
		SECTION D
		REV NO. 00 DATE
		SHEET 2 OF 2

S. No.	Description	Data to be filled by successful bidder
	c) At starting	
C. Constructional Features		
1	Method of connection of motor driven equipment	
2	Applicable Standard	
3	DOP of Enclosure	
4	Method of cooling	
5	Class of insulation	
6	Main terminal box	
a)	Type	
	b) Power Cable details (Conductor, size, armour/unarmour)	
	c) Cable Gland & lugs details (Size, type & material)	
	d) Permissible Fault level (kArms & duration in sec)	
7	Space heater details (Voltage & watts)	
8	Flame proof motor details (if applicable)	
a)	Enclosure	
	b) suitability for hazardous area	
	i Zone	O / I / II
	ii Group	IIA / IIB / IIC
9	No. of Stator winding	
10	Winding connection	
11	Kind of rotor winding	
12	Kind of bearings	
13	Direction of rotation when viewed from NDE	
14	Paint Shade & type	
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	
D.	Characteristic curves/ drawings (To be enclosed for motors of rating $\geq 55\text{KW}$)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			



TITLE :
GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.
PE-SS-999-506-E101
VOLUME NO. : **II-B**
SECTION : **D**
REV NO. : **00** DATE : 29/08/2005
SHEET : 1 OF 1

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.: PE-SS-999-506-E101 Rev 00

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101
		VOLUME NO. : II-B
		SECTION : D
		REV NO. : 00 DATE : 29/08/2005
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1.0

INTENT OF SPECIFIATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer’s work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0

CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement for rotating electrical machnines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechanical vibration of rotating electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0

DESIGN REQUIREMENTS

3.1

Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2

Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

3.3

Starting Requirements

3.3.1

Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.3.2

Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

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The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.		
3.3.3 The following frequency of starts shall apply i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature. ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour) iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for minimum 20,000 starts during the life time of the motor		
3.4 Running Requirements		
3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.		
3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.		
3.5 Stress During bus Transfer		
3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.		
3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.		
3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.		
3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.		
4.0 CONSTRUCTIONAL FEATURES		
4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691 and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy		
4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362. Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled		
4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.		

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4.4.	Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.	
4.5	Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.	
4.6	In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation. In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.	
4.7	Terminals and Terminal Boxes	
4.7.1	Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A. Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A".	
4.7.2	unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.	
4.7.3	Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or U W & V respectively.	
4.7.4	Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.	
4.7.5	Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.	
4.7.6	Degree of protection for terminal boxes shall be IP 55 as per IS 4691.	
4.7.7	Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.	
4.7.8.	Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.	
4.7.9	Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.	
4.8	Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.	
4.9	General	

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4.9.1 Motors provided for similar drives shall be interchangeable.

4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.

4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

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

4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.

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

4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

5.0 **INSPECTION AND TESTING**

5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.

5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.

5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan.

5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.

6.0 **DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT**

a) OGA drawing showing the position of terminal boxes, earthing connections etc.

b) Arrangement drawing of terminal boxes.

c) Characteristic curves:
(To be given for motor above 55 kW unless otherwise specified in Data Sheet).

i) Current vs. time at rated voltage and minimum starting voltage.

ii) Speed vs. time at rated voltage and minimum starting voltage.

iii) Torque vs. speed at rated voltage and minimum voltage.
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.

iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

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		PROJECT:		PO NO.:	DATE:
		ITEM: AC ELECT. MOTORS UPTO 55KW (LV (415V))	SYSTEM:	SECTION: II	SHEET 1 of 2

S. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS		
1	2	3	4	5	6		7	8	9				
					M	C/ N							
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	-	MFG. SPEC.	MFG. SPEC.	LOG BOOK	P	-	-	
		2.DIMENSIONS	MA	VISUAL	100%	-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	LOG BOOK	P	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	-	MFG.SPEC./	MFG.SPEC.	LOG BOOK	P	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	-	MFG. SPEC/ APPROVED DATASHEET	MFG. SPEC/ APPROVED DATASHEET	LOG BOOK	✓	P	V	-
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST	MA	VISUAL	100%	-	IS-325 / IS-12615/ APPROVED DATA SHEET	IS-325 / IS-12615/ APPROVED DATA SHEET	TEST/ INSPN. REPORT	✓	P	V *	-
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	-	APPROVED DRG/ DATA SHEET	APPROVED DRG/ DATA SHEET	TEST/ INSPN. REPORT	✓	P	V *	-

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Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	RITESH KUMAR JAISWAL

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		3.NAMEPLATE DETAILS	MA	VISUAL	100%	-	IS-325 / IS-12615 / APPROVED DATA SHEET	SAME AS COL. 7	TEST/ INSPN. REPORT	✓	P	V	-	
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MFG. STANDARD / (#)	AS PER MFG. STANDARD / (#).	INSPC. REPORT	✓	P	W	-	(#) REFER NOTE-8

NOTES:

1. Routine tests on 100% motors shall be done by the vendor. However, BHEL/ Customer shall witness routine tests on random samples. The sampling plan shall be mutually agreed upon.
2. For exhaust/ventilation fan motors of rating up to 1.5 KW, only routine test certificates shall be furnished for scrutiny.
3. In case test certificates for these tests on similar type, size and design of motor from independent laboratory are available, the same is valid for 5 years.
4. BHEL reserves the right to perform repeat test, if required.
5. After packing and prior to issue MDCC, photographs of items to be despatched shall be sent to BHEL for review.
6. In case of any changes in QP commented by customer at contract stage, same shall be carried out by bidder without any implication to BHEL/ Customer.
7. Project specific QP to be developed based on customer requirement.
8. For export job, BHEL technical specification for seaworthy packing to be followed.
9. Packing shall be suitable for storage at site in tropical climate conditions.
10. Latest revision/ year of issue of all the standards (IS/ ASME/ IEC etc.) indicated in QP shall be referred.

LEGENDS:

*RECORDS, IDENTIFIED WITH "TICK"(✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,

** **M:** SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, **B:** MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C:** CUSTOMER,

P: PERFORM, **W:** WITNESS, **V:** VERIFICATION, AS APPROPRIATE

MA: MAJOR, **MI:** MINOR, **CR:** CRITICAL

D: DOCUMENTATION

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Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:		RITESH KUMAR JAISWAL			Approved by:			

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		PROJECT:		PO NO.:		
		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))		SYSTEM:		SECTION: II

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	.	..			
					M	C/N				D	M	C	N	
1.0	RAW MATERIAL & BOUGHT OUT CONTROL													
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK	P	-	-		
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	LOG BOOK	P	-	-		
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	SAMPLE	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TEST REPORT	P/V	-			
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%	-		FREE FROM CRACKS, UN-EVENNESS ETC.	TEST REPORT	P	-	-		
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TC	P/V	-	-	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR	
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%	-	MANUFACTURER'S DRG./SPEC	FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK	P/V	-			
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TC	P/V	-		HEAT NO. SHALL BE VERIFIED	
		3.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG.	MANUFACTURER'S DRG.	LOG BOOK	P/V	-			
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	LOG BOOK	P/V	-			

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		CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
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SI No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	.	**			
					M	C/N				D	M	C	N	
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S DRG./ STD.	TC		P/V	-		
		3. DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S DRG.	LOG BOOK		P/V	-		
		4.INTERNAL FLAWS	CR	ULTRASONIC TEST	100%	-	ASTM-A388	MANUFACTURER'S STD.	INSPECTION REPORT	✓	P/W	V	-	FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNNECTORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	100%	-	MANUFACTURER'S DRG./STD.	MANUFACTURER'S DRG./STD.	INSPECTION REPORT		P/V	-	-	
		2. PHYSICAL COND.	MA	VISUAL	100%	-	MANUFACTURER'S DRG./STD.	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	INSPECTION REPORT		P/V	-	-	
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG./ STD	MANUFACTURER'S DRG. / STD.	INSPECTION REPORT		P/V	-	-	
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-	MANUFACTURER'S DRG./ STD	MANUFACTURER'S DRG. / STD.	TEST REPORT		P/V	-	-	

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		CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
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		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 3 OF 9

SI No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	.	..			
					M	C/N				D	M	C	N	
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	-	NO VISUAL DEFECTS	TEST REPORT		P/V	-	-	
		2.DIMENSION(BORE DIA, WALL THICKNESS, BDV AS RECEIVED, BDV AFTER FOLDING AT 180°	MA	TEST	SAMPLE	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK AND OR SUPPLIER'S TC		P/V	-	-	
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK		P	-	-	
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG. .	MANUFACTURER'S DRG.	LOG BOOK		P/V	-	-	
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	SAMPLE	-	MANUFACTURER'S DRG./ STD.	MANUFACTURER'S DRG./ STD.	TC		P/V	-	-	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		*P/V	-	-	* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY
		2.ELECT. PROP. & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S / SPEC.	TC & VENDOR'S TEST REPORTS		P/V	-	-	

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	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO.:		DATE:17.04.2020
		CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04		
		PROJECT:		PO NO.:		
		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))		SYSTEM:		SECTION: II

SI No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY		
1	2	3	4	5	6		7	8	9	.	..		
					M	C/N				D	M	C	N
1.10	BEARINGS	3.DIMENSIONS	MA	MEASUREMENT	SAMPLES	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S / SPEC.	LOG BOOK		P/V	-	-
		1.MAKE & TYPE	MA	VISUAL	100%	-	MANUFACTURER'S DRG./ APPROVED DATASHEET	MANUFACTURER'S DRG./ APPROVED DATASHEET	LOG BOOK		P/V	-	-
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	APPROVED DATASHEET	APPROVED DATASHEET/ BEARING MANUF'S CATALOGUES	LOG BOOK		P/V	-	-
		3.SURFACE FINISH	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P/V	-	-
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-
		3.TEMP WITH-STAND CAPACITY	MA	ELECT.TEST	SAMPLE	-	MANUFACTURER'S STD./ APPROVED DATASHEET	MANUFACTURER'S STD./ APPROVED DATASHEET	LOG BOOK		P/V	-	-
		4.HV/IR	MA	-DO-	100%	-	MANUFACTURER'S STD./ APPROVED DATASHEET	MANUFACTURER'S STD./ APPROVED DATASHEET	LOG BOOK		P/V	-	-
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	-	MANUFACTURER'S DRG/SPECS	MANUFACTURER'S DRG./ SPECS.	LOG BOOK		P	-	-
		2.SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-

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2.0	IN PROCESS													
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-	MANUFACTURER'S DRG	GOOD FINISH	LOG BOOK		P/W	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-	-DO-	GOOD FINISH	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	100%	-	MANUFACTURER'S STD./ASTM-E165	MANUFACTURER'S STD./APPROVED DATASHEET.	LOG BOOK	✓	P	V	-	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		3.SHADE	MA	VISUAL	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	

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					M	C/N				D	M	C	N	
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-	
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-	
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		2.CLEANLINESS	CR	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	100%	-	IS-325//IS-12615//IEC-60034 PART-1	IS-325//IS-12615//IEC-60034 PART-1	TEST/INSPC. REPORT	✓	P	V	-	
		4.RESISTANCE	CR	ELECT. TEST	100%	-	IS-325//IS-12615//IEC-60034 PART-1	IS-325//IS-12615//IEC-60034 PART-1	TEST/INSPC. REPORT	✓	P	V	-	
		5.INTERTURN INSULATION	CR	ELECT. TEST	100%	-	IS-325//IS-12615//IEC-60034 PART-1	IS-325//IS-12615//IEC-60034 PART-1	TEST/INSPC. REPORT		P	-	-	
2.6	IMPREGNATION	1.VISCOSITY	MA	PHY. TEST	AT STARTING	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		3.NO. OF DIPS	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK	✓	P	V	-	THREE DIPS TO BE GIVEN

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					M	C/N				D	M	C	N	
2.7	COMPLETE STATOR ASSEMBLY	4.DURATION 1.COMPACTNESS & CLEANLINESS	MA MA	PROCESS CHECK VISUAL	CONTINUOUS 100%	- -	MANUFACTURER'S STANDARD MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD MANUFACTURER'S STANDARD	LOG BOOK LOG BOOK	✓ -	P P	V -	- -	
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS 2.SOUNDNESS	CR CR	VISUAL MALLET TEST & UT	100% 100%	- -	MANUFACTURER'S STANDARD MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD MANUFACTURER'S STANDARD	LOG BOOK TEST/INSPC. REPORT	- ✓	P P	- V	- -	
2.9	COMPLETE ROTOR ASSEMBLY	3.HV 1.RESIDUAL UNBALANCE	MA CR	ELECT. TEST DYN. BALANCE	100% 100%	- -	MANUFACTURER'S STANDARD MANUFACTURER'S SPEC./ ISO 1940	MANUFACTURER'S STANDARD MANUFACTURER'S DWG.	TEST/INSPC. REPORT LOG BOOK	✓ -	P P	V -	- -	
2.10	ASSEMBLY	2.SOUNDNESS OF DIE CASTING 1.ALIGNMENT 2.WORKMANSHIP 3.AXIAL PLAY 4.DIMENSIONS 5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE 6. RTD, BTD & SPACE HEATER MOUNTING.	CR MA MA MA MA MA MA	ELECT. (GROWLER TEST) MEAS. VISUAL MEAS. MEAS. VISUAL VISUAL	100% 100% 100% 100% 100% 100%	- - - - - -	MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S DRG./ MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S DRG./ MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S SPEC.	TEST/INSPC. REPORT LOG BOOK LOG BOOK LOG BOOK LOG BOOK LOG BOOK	✓ - - ✓ - -	P P P P P P	V - - V - -	- - - - -	

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					M	C/N				D	M	C	N	
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS	MA	ELECT.TEST	1/TYPE/SIZE	1/TYPE/SIZE	IS-325//IS-12615/APPROVED DATASHEET	IS-325//IS-12615/APPROVED DATASHEET	TEST REPORT	✓	P	W*	-	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST	MA	ELECT.TEST	100%	-	IS-325//IS-12615/APPROVED DATASHEET	IS-325//IS-12615/APPROVED DATASHEET	TEST REPORT	✓	P	√ ^s	-	^s NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	ELECT.TEST	100%	-	IS: 12075 / IEC 60034-14 & IS-12065	IS: 12075 / IEC 60034-14 & IS-12065	TEST REPORT	✓	P	√ ^s	-	^s NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET &	TEST/INSPC. REPORT	✓	P	W	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	-	IEC 60034-5/IS-12615	APPROVED DATASHEET	TC	✓	P	V	-	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	ELECT. & MECH. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1/IS: 12802	IS-325//IS-12615/IEC-60034 PART-1/IS: 12802	TC	✓	P	√ ^s	-	^s NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	ELECT. & MECH. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325//IS-12615/IEC-60034 PART-1	TC	✓	P	√ ^s	-	^s NOTE - 2
		8. NAME PLATE DETAILS	MA	VISUAL	100%	-	IS-325//IS-12615& DATA SHEET	IS-325//IS-12615 & DATA SHEET	TEST/INSPC. REPORT	✓	P	√ ^s	-	^s NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	-	IS 2148 / IEC 60079-1	IS 2148 / IEC 60079-1	TC	✓	P	V	-	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	SAMPLE	APPROVED DATASHEET	APPROVED DATASHEET	TC	✓	P	W\$	-	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY ^s NOTE - 2

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					M	C/N				D	M	C	N
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MANUFACT. STANDARD / (#)	AS PER MANUFACT. STANDARD / (#)	INSPC. REPORT	✓	P	W	-
											(#): REFER NOTE-8		

NOTES:

- 1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED.
- 2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL/CUSTOMER SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON.
- 3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THE SAME IS VALID FOR 5 YEARS.
- 4 BHEL RESERVES THE RIGHT TO PERFORM REPEAT TEST, IF REQUIRED.
- 5 AFTER PACKING AND PRIOR TO ISSUE MDCC, PHOTOGRAPHS OF ITEMS TO BE DESPATCHED SHALL BE SENT TO BHEL PURCHASE GROUP FOR REVIEW.
- 6 IN CASE , ANY CHANGES IN QP COMMENTED BY CUSTOMER AT CONTRACT STAGE SHALL BE CARRIED OUT BY BIDDER WITHOUT ANY IMPLICATION TO BHEL/ CUSTOMER.
- 7 PROJECT SPECIFIC QP TO BE DEVELOPED BASED ON CUSTOMER REQUIREMENT.
- 8 FOR EXPORT JOB, BHEL TECHNICAL SPECIFICATION FOR SEAWORTHY PACKING TO BE FOLLOWED.
- 9 PACKING SHALL BE SUITABLE FOR STORAGE AT SITE IN TROPICAL CLIMATE CONDITIONS.
- 10 LATEST REVISION/ YEAR OF ISSUE OF ALL THE STANDARDS (IS/ ASME/ IEC ETC.) INDICATED IN QP SHALL BE REFERRED.

LEGENDS:

*RECORDS, IDENTIFIED WITH "TICK"(✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,
 ** M: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, C: CUSTOMER,
 P: PERFORM, W: WITNESS, V: VERIFICATION, AS APPROPRIATE
 MA: MAJOR, MI: MINOR, CR: CRITICAL
 D: DOCUMENT

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SECTION - 3.15: CABLES

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of HT cables, LT cables and Control cables.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the following Indian Standards (IS), IEC publications and other codes except where modified and / or supplemented by this specification.

a) IS: 3975	Mild steel wires formed wires and tapes for armouring of cables.
b) IS: 4905	Methods for random sampling.
c) IS: 5831	PVC insulation and sheath of electric cables.
d) IS: 7098 Part-I	Cross-linked polyethylene insulated PVC sheathed cables (LV)
e) IS: 7098 Part-II	Cross-linked polyethylene insulated PVC sheathed cables (HV)
f) IS: 8130	Conductors for insulated electric cables and flexible cords.
g) IS: 10418	Drums for electric cables.
h) IS: 10810	Methods of tests for cables.
i) IS: 3961	Recommended current ratings for cables
j) ASTM-D-2843	Standard test method for density of smoke from the burning or decomposition of plastics
k) ASTM-D-2863	Standard method for measuring the minimum oxygen concentration to support candle like combustion of plastics
l) IEC-754 (Part-I) -	Test on gases evolved during combustion of electric cables.
m) IEC-332 -	Tests on Electric cables under fire conditions Part-3 : Tests on bunched wires or cables (category –B)
n) IEEE-383 -	Standard for type test of Class IE Electric Cables.
o) SS-4241475 class F3 –	Swedish Chimney test
p)	

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Power cables shall be sized to satisfy the following Criteria:

- Short circuit withstand capacity for applicable fault current and duration.
- Full load current carrying capacity under installation conditions considering Site ambient temperature & site installation (Grouping) conditions based on Manufacturer's recommendation.
- Permissible voltage drop limits under steady state/transient state as applicable.

3.2.0 For breaker operated feeders, Short circuit withstand duration for conductors shall be not less than 160 m.sec for motor / transformer feeders, 500 m.sec for tie feeders and 1 sec for incomers in general. For HT cables, screen/armour shall be sized to withstand 300 A for 3 sec.

3.3.0 To maintain voltage at motor terminals /equipment end with in desirable limit, it is proposed to limit the voltage drop in the cables within 3% during normal running condition and 10% during starting of Motor.

3.4.0 Cables can be armoured type only.

3.5.0 Power cables shall be XLPE insulated. Control cables shall be HRPVC insulated.

3.6.0 HRPVC insulation shall be suitable for continuous conductor temperature of 85°C and short circuit conductor temperature of 160°C. XLPE insulation shall be suitable for continuous conductor temperature of 90 °C and short circuit conductor temperature of 250 °C.



- 3.7.0 Cables for 11 KV system shall be rated for unearthed grade. Cables for 415/230 V AC and 220V DC shall be rated for 1.1 KV grade.
- 3.8.0 To minimize the damage that can be caused by a fire, cables installed in electrical cable tray systems shall have sheaths which have low smoke, non-propagating, and self-extinguishing characteristics. Outer sheath shall be of HRPVC black in colour. These cables shall meet the following test requirements.
- Oxygen index of minimum 29 when tested as per IS 10810 Part-58 / ASTM D-2863/1977
 - Temperature index of minimum 250°C when tested as per IS 10810 Part-64// ASTM D-2863/1977
 - Acid gas emission of maximum 20% when tested as per IS 10810 Part-59 / IEC-754-I
 - Average light transmission of 40% minimum when tested as per IS 10810 Part-63 // ASTM D-2843/1977. (average smoke density is maximum 60%)
 - Flame test requirements as per IS 10810 Parts-53 and 62, IEEE-383-1974, IEC-332-1 & SS-4241475, Class-F3
 - Flame retardant test requirements as per IS 10810 Part-61
- 3.9.0 For power cables, copper conductor shall be used for current rating of up to 10A. For higher current rating, conductor can be aluminium/copper. Minimum size of copper conductor shall be 2.5 sq.mm and aluminium conductor shall be 16 sq.mm.
- 3.10.0 Conductor of control cables shall have plain annealed copper. The minimum size of control cable shall be of 1.5 Sq.mm. For CT circuits minimum size shall be 2.5 sq.mm copper.
- 3.11.0 Power cables shall carry the full load current of the circuit continuously under site conditions considering the various derating factors like thermal resistivity of soil, ambient air/ground temperature, grouping, method of laying, etc.
- 3.12.0 Design ambient air temperature and ground temperature shall be considered at 50°C and 40°C respectively for cable sizing.
- 3.13.0 Power cables shall be sized to withstand the fault current of the circuit for the fault clearing time indicated below:
- HT motor feeders and transformer feeders: 0.16 second.
 - LT ACB operated motor feeders & outgoing feeders: 0.16 second.
 - Tie between two 415V switchboards: 0.5 second.
 - Incomers: 1.0 second.
- 3.14.0 Voltage drop from transformer secondary to motor terminals during starting of motors shall be limited to the following values:
- For HT motors: 15% of the rated voltage.
 - For LV motors: 15% of the rated voltage.
- 3.15.0 The voltage drop in feeder cables between PMCC/MCC to motor terminals shall be limited to 3% during full load running condition. However, the voltage drop from transformer secondary to motor terminals during full load running of motors shall be limited to 5 % of rated voltage.
- 3.16.0 Method of curing for HT XLPE insulation shall be Triple Extrusion Dry Cure (CCV) process using nitrogen gas.
- 3.17.0 Conductor screen and insulation screen shall both be of extruded semi-conducting compound and shall be applied with XLPE insulation in one operation through triple extrusion.
- 3.18.0 For armoured cables, armouring shall be of aluminium for single core cables. For multicore armoured cables, armouring shall be of galvanized steel.



- 3.19.0 All the cables shall be protected against rodent and termite attack. Necessary chemicals shall be added into the PVC compound of the outer sheath. The sheath shall be resistant to water, UV radiation, fungus, etc.
- 3.20.0 Multi-core cable color coding shall be as follows:
- Red, yellow, blue, black and gray for five core cables
 - Outer sheath shall be of black in colour.
 - For more than 5 cores, core identification shall be by alpha numerical numbering system at an interval of one meter.
- 3.21.0 Three core HT unearthed grade cables shall constitute the following as per IS-7098-Part-2:
- Circular stranded and compacted aluminium conductor
 - Extruded semi conducting compound as conductor screen
 - Extruded XLPE insulation
 - Extruded semi conducting compound as insulation screen
 - Copper tape as metallic screen for each core
 - Extruded HRPVC inner sheath
 - Galvanised steel formed wire/strip
 - Extruded FRLS HRPVC outer sheath
- 3.22.0 Single core HT unearthed grade cables shall constitute the following:
- Circular stranded and compacted aluminium conductor
 - Extruded Semi conducting compound as conductor screen
 - Extruded XLPE insulation
 - Extruded Semi conducting compound as insulation screen
 - Extruded HRPVC inner sheath
 - Hard drawn aluminium wire armour
 - Extruded FRLS HRPVC outer sheath
- No separate metallic screen for insulation is required, in case of single core armoured cable, as armour constitute the metallic screen.
- 3.23.0 Multicore 1.1 KV earthed grade cables shall constitute the following as per IS-7098-Part-1::
- Circular / shaped, stranded aluminium conductor (compacted for >10 sq.mm)
 - Extruded XLPE insulation
 - Extruded HRPVC inner sheath
 - Galvanised steel formed wire/strip
 - Extruded FRLS HRPVC outer sheath
- 3.24.0 Single core 1.1 KV earthed grade cables shall constitute the following:
- Circular stranded and compacted aluminium conductor
 - Extruded XLPE insulation
 - Hard drawn aluminium wire armour
 - Extruded FRLS PVC outer sheath
- 3.25.0 Multicore 1.1 KV earthed grade control cables shall constitute the following as per IS:1554-1:
- Multi stranded annealed copper conductor
 - Extruded HRPVC insulation
 - Extruded HRPVC inner sheath
 - Galvanised steel formed wire/strip
 - Extruded FRLS HRPVC outer sheath



3.26.0 Multi pair 1.1 KV earthed grade, overall screened signal cables shall constitute the following as per BS EN 50288-7:

- Multi stranded annealed copper conductor
- Extruded PVC insulation
- Twisted pair
- Overall polyester taped, Al-mylar screened with ATC drain wire
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

3.27.0 Multi pair 1.1 KV earthed grade, individual and overall screened signal cables shall constitute the following as per BS EN 50288-7:

- Multi stranded annealed copper conductor
- Extruded PVC insulation
- Twisted pair
- Individual polyester taped, Al-mylar screened with ATC drain wire
- Overall polyester taped, Al-mylar screened with ATC drain wire
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

3.28.0 **Cable drums**

Cables shall be supplied in non-returnable steel drums of heavy construction. All ferrous parts shall be treated with suitable rust protective finish or coating to avoid rusting during transit and storage. The surface of the drum and the outer most cable layer shall be covered with waterproof layer. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/rubber caps, secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS 10418.

Each drum shall contain minimum 500 metres single length of cable. Allowable tolerance on individual drum length is +5%.

Bidder will be required to obtain Owner's approval before packing the non-standard length of cables on drums. Non-standard lengths shall not be less than 100 metres in any case.

Cable identification shall be provided by embossing on every meter on the outer sheath the following:

- a. MSPGCL
- b. Manufacturer's name or trademark
- c. Voltage grade
- d. Year of manufacture
- e. Type of insulation and sheath, e.g. XLPE /HRPVC FRLS as applicable.
- f. Type of improved fire performance, e.g.FRLS
- g. No. of core and size of cables.
- h. Reference Standard
- i. ISI Mark
- j. Sequential length marking at an interval of 1m throughout the length of the cable.



3.29.0 Packing

Cable shall be wound and packed on drums in such a manner that it will be properly sealed and firmly secured to the drum. The ends of each length shall be sealed before shipment. Heat shrinkable cable seals shall be used for this purpose.

A label shall be securely attached to each end of the reel indicating the details mentioned below. A tag containing the same information shall be attached to the leading end of the cable inside. Drum numbers are to be indicated on cable drums.

The cable drums should carry the following details in printed form (non returnable):

- a) MSPGCL & Manufacturer's name or trade make
- b) Type of cable & voltage grade
- c) Year of manufacture
- d) Type of insulation / sheath e.g. XLPE /HRPVC FRLS as applicable.
- e) No. of core and size of cables
- f) Cable code
- g) Length of cable on drum
- h) ISI Mark
- i) Direction of rotation, by arrow
- j) Approx. gross mass.
- k) IS/IEC number

3.30.0 Tests

Cables offered shall be type tested and proven type.

All tests, i.e. routine, acceptance & type tests including special FRLS type & acceptance test shall be witnessed by Owner and/or Owner's representative. The Contractor shall give at least fifteen (15) days advance notice of the date on which the tests are to be carried out.

Acceptance tests shall be carried out on 1 drum out of every 10 or less number of drums selected on random basis from each lot for each type & size of cable.

Type tests shall be carried out on 1 drum per each lot selected on random basis for each type & size of cable.

Type & size shall mean voltage grade, type of insulation, and no. of cores read in conjunction with area of cross section of conductor.



SECTION-3.19: EARTHING & LIGHTNING PROTECTION SYSTEM

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of Earthing & Lightning protection system. The scope shall include the following:

- Buried earth mat for the FGD system
- Embedded earth mat in the concrete floor of buildings.
- Equipment enclosure earthing for all electrical equipment
- Earthing of all metallic structures including cable racks
- Electronic earthing for all PLC/electronic equipment
- Lightning protection for the FGD system

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Standards except where modified and /or supplemented by this specification.

- a) IS: 3043 Code of Practice for Earthing practice
- b) IS: 2062 Structural Steel (Standard Quality)
- c) IS: 1079 Specification for hot rolled carbon steel sheet and strips
- d) IS: 1730 Dimensions for steel plates, sheet, and strip for structural and general engineering purposes
- e) IS: 280 Specification for mild steel wire for general engineering purposes
- f) IS: 2629 Recommended practice for hot dip galvanizing on iron & steel
- g) IS: 816 Code of practice for use of metal arc welding for general construction of mild steel.
- h) IS: 4826 Specification for hot-dipped galvanized coatings on round steel wires.
- i) IS: 4759 Specification for hot-dip zinc coatings on structural steel and , allied products
- j) IS: 6745 Methods for determination of weight of zinc-coating on zinc coated articles.
- k) IEEE 80 IEEE Guide for safety in AC substation grounding
- l) IEC 62305 Protection of building and allied structures against lightning
- m) IEEE 142 Grounding of industrial & commercial power system.
- n) Indian Electricity Rules

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Earthing System

3.1.1 Bidder shall provide earth mat of spacing 5 m x 5m below switchgear/MCC room/Switchyard and transformers. Suitable number of earth electrodes shall be provided. Perimeter earthing shall be provided around the building. The above grade earthing works including connection of equipments shall be in bidder's scope. Earthing conductor for ground mat shall be minimum of 40 mm dia. M.S rod.

3.1.2 The earthing system shall meet the following requirements:

- Ensure adequate earth fault current for operation of earth fault protection



- Earthing conductors and connections shall withstand earth fault current for the duration of the fault
- 3.1.3 The mild steel earth grid shall be designed to withstand 25 years of corrosion. Corrosion rate shall be arrived at as per soil resistivity report.
- 3.1.4 Buried earthing conductors shall have at least 1000mm of earth cover unless stated otherwise.
- 3.1.5 Wherever earthing conductor crosses cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid minimum 300mm below them and shall be circumvented in case it fouls with equipment / structure foundations.
- 3.1.6 Earthing conductors or leads along their run on cable trench, ladder, walls etc. shall be supported by suitable welding / cleating at intervals of 750mm. Wherever it passes through walls, floors etc., galvanized iron sleeves shall be provided for the passage of the conductor and both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.
- 3.1.7 Earthing conductor around the building shall be buried in earth at a minimum distance of 1500mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500mm away from such location.
- 3.1.8 Earthing conductors crossing the road shall be laid 300mm below road or at greater depth to suit site conditions.
- 3.1.9 Earthing pads shall be provided for the apparatus / equipment at accessible position. The connection between earthing pads and the earthing grid shall be made by two short earthing leads (one direct and another through the support structure) free from kinks and splices.
- 3.1.10 Steel / RCC structures & columns, metallic stairs etc. shall be connected to the nearby earthing grid conductor by two earthing leads. Electrical continuity shall be ensured by bonding different sections of handrails and metallic stairs.
- 3.1.11 Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system.
- 3.1.12 Metallic conduits shall not be used as earth continuity conductor.
- 3.1.13 Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam conduits, etc. and steel reinforcement in concrete it shall be bonded to the same.
- 3.1.14 Flexible earthing connectors shall be provided for moving parts.
- 3.1.15 A continuous earth conductor of 16 SWG GS wire shall be run all along each conduit run. The conductor shall be connected to each panel earth bus. All junction boxes, receptacles, switches, lighting fixtures etc. shall be connected to this 16 SWG earth conductor.
- 3.1.16 50mm x 6mm galvanized steel flat shall run on the top tier and all along the cable trenches and the same shall be welded to each of the racks. Further, this flat shall be earthed at both ends and at an interval of 30m.
- 3.1.17 Earthing connections with equipment earthing pads shall be bolted type. Contact surfaces shall be free from scale, paint, enamel, grease, rust or dirt. Two bolts shall be provided for making



earth connection. Equipment bolted connections, after being checked and tested, shall be painted with anti-corrosive paint / compound.

- 3.1.18 Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded type. For rust protection, the welds shall be treated with red lead and afterwards coated with two layers bitumen compound to prevent corrosion.
- 3.1.19 Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingress.
- 3.1.20 Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.
- 3.1.21 All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.
- 3.1.22 Metallic sheaths and armour of all multi-core power cables shall be earthed at both equipment and switchgear end. Sheath and armour of single core power cables shall be earthed at switchgear end only.
- 3.1.23 Earthing terminal of each lightning arrester and capacitor voltage transformer shall be directly connected to rod earth electrode which in turn, shall be connected to station earthing grid.
- 3.1.24 For electronic equipment such as PLC, chemical earthing pit shall be provided. The earth pit shall be tested and proven type and shall be guaranteed for service life of 25 years. The chemical earth pit shall comprise pipe electrode, crystalline conductive mixture, bentonite etc. constructed in a pit of not less than 3500mm depth. The pit shall be effective in all weather conditions and offer low resistance.
- 3.1.25 Size of the earthing conductor shall be as follows:

Sl.No.	Equipment	Size/ type of Earthing material
1.	Main earthing conductor	Mild steel rod of 40mm dia size
2.	Earth risers	Mild steel rod 40 mm dia
3.	Rod earth electrode	Mild steel rod 40 mm dia
4.	Treated earth pit	Minimum 65 mm dia galvanized steel pipe electrode as per IS:3043
5.	Electronic earthing	Chemical earth pit
6.	LT transformers (enclosure and neutral)	75X10mm GS flat
7.	HT Switchboards, HT motors, HT busducts	75X10mm GS flat
8.	LT Switchboards (PMCC & MCC), LT busduct	75X10mm GS flat
9.	All distribution boards	75X10mm GS flat
10.	Charger / UPS	50X6mm GS flat
11.	Lighting panels	25X6mm GS flat
12.	Cable trays	50X6mm GS flat
13.	Control Panel & Control desk	50X6mm GS flat
14.	Push Button & JB	8SWG GI Flat
15.	Column, structures, Cable tray, Fence,	50X6mm GS flat



Sl.No.	Equipment	Size/ type of Earthing material
	Gate and bus duct enclosures	
16.	Crane, Rail, Rail tracks & other non-current carrying metal parts	50X6mm GS flat

- 3.1.26 All earth electrodes shall preferably be driven to a sufficient depth to reach permanently moist soil. Electrodes shall preferably be situated in a soil which has a fine texture and which is packed by watering and ramming as tightly as possible. The electrodes shall have a clean surface, not covered by paint, enamel, grease or other materials of poor conductivity.
- 3.1.27 Earth pits shall be located avoiding interference with road, building foundation, column, equipment foundation etc. The disconnect facility shall be provided for individual earth pits to check their earth resistance periodically. Proper symmetry and distance between earth pits shall be maintained as per applicable standards and procedures. Treated earth pits shall conform to relevant standard.
- 3.1.28 Construction of trench for earthing conductor shall include excavation, laying of conductor, back filling and compacting. Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150mm. Minimum earth coverage of 300mm shall be provided between earth conductor and the bottom of trench / foundation / underground pipes at crossings.
- 3.1.29 On completion of installation, continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured in presence of Owner's representatives. Equipment required for testing shall be furnished by Contractor.
- 3.1.30 Electronic panels and equipment shall be grounded utilizing an insulated copper ground wire terminated at separate earth electrode.
- 3.1.31 Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system, each of 100% capacity. Steel RCC columns, metallic stairs, hand rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing.
- 3.1.32 Metallic sheaths, screens, and armour of all multi core cables shall be earthed at both ends. Sheaths and armour of single core cables shall be earthed at switchgear end only unless otherwise instructed by Owner.
- 3.1.33 Railway tracks within the plant area shall be bonded across fish plates and connected to earthing grid at several locations.
- 3.1.34 For prefabricated cable trays, a separate ground conductor shall run along the entire length of cable tray and shall be suitably clamped on each cable tray at periodic intervals. Each continuous laid out lengths of cable tray shall be earthed at minimum two places by G.S. flats to Owner's earthing system, the distance between earthing points shall not exceed 30 metre. Wherever earth mat is not available Contractor shall do the necessary connections by driving an earth electrode in the ground.
- 3.1.35 The LV neutral of LT Service transformer shall be directly connected to earth and also connected to neutral of LT switchgear. Each earthing lead from the neutral of the Transformers/NGR shall be directly connected to two electrodes in treated earth pits which in turn shall be connected to station earthing grid.



- 3.1.36 Neutral connections and metallic conduits/pipes shall not be used for the equipment earthing. Lightning protection system down conductors shall not be connected to other earthing conductors above the ground level.
- 3.1.37 All ground conductor connections shall be made by electric arc welding and all equipment earth connections shall be made by bolting with the earthing pads through flexible insulated cable leads. Ground connections shall be made from nearest available station ground grid risers. Suitable earth risers approved by Owner shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of main earth conductor.
- 3.1.38 Resistance of the joint shall not be more than the resistance of the equivalent length of conductor. For rust protection the welds should be treated with red lead compound and afterwards thickly coated with bitumen compound.
- 3.1.39 Earthing conductors buried in ground shall be laid minimum 600 mm below grade level unless otherwise indicated in the drawing. Earthing conductors crossings the road shall be installed at 1000 mm depth and where adequate earth coverage is not provided it shall be installed in hume pipes. Earthing conductors embedded in the concrete floor of the building shall have approximately 50mm concrete cover.
- 3.1.40 A minimum earth coverage of 300mm shall be provided between earth conductor and the bottom of trench/foundation/underground pipes at crossings. Wherever earthing conductor crosses on runs at less than 300mm distance along metallic structures such as gas, water, steam pipe lines, steel reinforcement in concrete, it shall be bonded to the same.
- 3.1.41 Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding/cleating at interval of 1000mm.
- 3.1.42 Earth pit shall be constructed as per approved drawing. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 6000mm. Earth pits shall be treated with salt and charcoal. Earthing conductor around the building shall be buried in earth at a minimum distance of 1200mm from the outer boundary of the building.
- 3.1.43 Earthing of cabling system
- Armour of the HT cables and LT single core cables shall be earthed only at one end of cable.
 - Armour of other cables shall be earthed at both ends of cable.
 - Screen of HT power cables shall be earthed at one end only.
 - Screen of C&I screened control cables shall be earthed at one end.
 - Screen of electronic earthing system cables shall be earthed as per the requirements to be furnished to the Contractor during contract stage.
- 3.1.44 Installation of earth conductors in outdoor areas, buried in ground, shall include excavation of earth up to 600mm deep and 450mm wide, laying of conductor at 600mm depth, brazing / welding / cad welding, if required, of main grid conductor, joints as well as risers of length 500mm above ground at required locations and then backfilling. Backfilling material to be placed over buried conductor shall be free from stones and other harmful mixtures. Backfill shall be placed in layers of 150mm, uniformly spread along the ditch, and tampered utilizing pneumatic tampers or other approved means. If the excavated soil is found unsuitable for backfilling, the Contractor shall arrange for suitable soil from outside.



- 3.1.45 Installation of earth pit shall include excavation, construction of the earth pits including all materials required for construction of earth pits, placing the rod and fixing test links on pipe / rod / plate electrodes in test pits and connecting to main earth grid conductors.
- 3.1.46 Each lighting poles and lighting / lighting mast junction box shall be earthed by 25 x 3mm GS flat bonded to one (1) 20mm diameter MS earth electrode of 3m length driven vertically in the ground. The flat and electrode shall be supplied by the Contractor and price of these shall be included in the erection price of individual pole / mast. 14 SWG GI wire shall be taken from fixture to JB.
- 3.1.47 After completion of grounding system installation, the measurement of ground resistance shall be performed by the Contractor. Before measurement, the overhead ground wires shall be disconnected from the GIS Switchyard. The method of measurement shall be as per relevant standards / codes. The ground resistance of GIS Switchyard grounding system shall be not more than 1 ohm.

4.0.0 LIGHTNING PROTECTION SYSTEM

- 4.1.0 All areas of the FGD shall be provided with lightning protection as per IEC 62305. The lightning protection system for buildings shall consist of Galvanised Steel horizontal air terminations, copper clad steel rod vertical air terminations, down conductors, test link and earth electrodes.
- 4.2.0 Air termination network consisting of vertical or horizontal conductors or combination of both shall be provided for the building. Down conductors shall follow the most direct path possible between the air terminal network and the earth termination network. Each down conductor shall be provided with a test link for testing. An earth electrode shall be connected to each down conductor.
- 4.3.0 For Lightning protection, material & sizes shall be as follows:
- Vertical air termination : 20mm dia Galvanised MS Rod 1000mm long
 - Horizontal air termination : 25X6 mm Galvanised MS Strip
 - Down conductor : 25X6 mm Galvanised MS Strip
 - Test link : 150x50x6mm Galvanised MS Strip with Box
 - Earth Electrodes : Treated earth pit with pipe electrode as per IS:3043
- 4.4.0 The lightning protection system shall not come in direct contact with other equipment/systems such as cables, conduits, electrical equipment, underground metallic ducts etc. All metallic structures within 200 mm. vicinity shall be bonded to the lightning protection system.
- 4.5.0 All welded/brazed joints shall be coated with anti- corrosive paint for rust protection.
- 4.6.0 Lightning conductor when used above ground level and shall be connected through test link with earth electrode/earthing system. Down conductors shall be as short and straight as practicable and shall follow a direct path to earth. Down conductor shall not be connected to other earthing conductors above ground level.
- 4.7.0 Each down conductor shall be provided with a test link at 1500 mm above ground level for testing but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point. All joints in the down conductors shall be of welded type.



- 4.8.0 Down conductors shall be cleated on outer side of building wall/ welded to outside building columns at 1000mm interval.
- 4.9.0 Lightning conductor on roof shall not be directly cleated on surface of roof. Supporting blocks of PMCC/insulating compound shall be used for conductor fixing at an interval of 1500mm.
- 4.10.0 Thickness of galvanising shall be atleast 610gm/sq.m for all galvanised steel conductors.
- 4.11.0 Installation of lightning conductors on the roofs of buildings shall include construction of support, laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods wherever necessary, laying, fastening / cleating / welding of the downcomers on the walls / columns of the building and connection to the test links to be provided above ground level.
- 4.12.0 On completion of installation, continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured in presence of Owner's representatives. Resistance of individual earth electrode shall be measured after disconnecting it from the grid. Tests shall be carried out as per IS : 3043 for earthing installation including the following:
- a) Earth continuity checks
 - b) Earth resistance of the complete system, sub-system and earth pits



SECTION-3.16: CABLE TRAYS, SUPPORTS & ACCESSORIES

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of Cable trays & accessories. List of items shall include the following:

- Ladder type Cable trays
- Perforated type Cable trays
- Cable troughs
- Cable Tray bends, Tees, Cross, Coupler plates, etc.
- Cable tray covers
- Bolted (Unistrut type) cable tray support system
- Erection hardwares

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Indian Standards, except where modified and /or supplemented by this specification.

- a) IS: 1079 Specification for hot rolled carbon steel sheet and strip.
- b) IS: 1730 Dimensions for steel plates, sheet strips and flats for general engineering purposes.
- c) IS: 1363 Hexagon head bolts, screws and nuts.
- d) IS: 6005 Code of practice for phosphating iron & steel.
- e) IS: 2629 Recommended practice for hot dip galvanising on iron and steel..
- f) IS: 2633 Methods for testing uniformity of coating on zinc coated articles.
- g) IS: 6745 Methods for determination of mass of zinc coating on zinc coated iron and steel articles.
- h) IS: 816 Code of practice for use of metal arc welding for general construction of mild steel.
- i) IS:4759 Specification for hot-dip zinc coatings on structural steel and allied products

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Cable Trays

3.1.1 Cable trays shall be ladder type for power and electrical control cables and perforated type for signal cables, prefabricated, made out of hot / cold rolled mild steel sheets, complete with matching fittings, accessories and hardware as required for indoor purposes and made out of FRP for outdoor purposes. Cable trays shall be with standard width of 150mm, 300mm, 450mm, 600mm and 750mm and standard lengths of 2.5m or more. Minimum thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2mm. For ladder trays, rung spacing shall be 250mm maximum. The thickness of side coupler plates shall be minimum 2.5mm and of tray covers shall be minimum 1.6mm.

3.1.2 Separate cable trays shall be provided for the following cables:

- HT Cables
- LT power cables



- Electrical Control cables
- Signal cables
- Fiber optic cables

Cable trays shall be designed to cater to a load of minimum 75kg/m.

- 3.1.3 Cable trays shall be complete with matching fittings and accessories (like elbows, bends, reducers, tees, crosses, side coupler plates, etc.) and hardware (like bolts, nuts, washers, etc.) as required. At both the ends of cable trays, four holes shall be provided for fixing side coupler plates. All the slots and coupler holes shall be machine punched.
- 3.1.4 Cable trays, fittings and accessories shall be hot dip galvanized. Thickness of galvanizing shall be not less than 610grams/sq.m. Fasteners like bolts, nuts, screws washers etc. shall also be hot dip galvanized.
- 3.1.5 For branch cabling routes involving fewer cables, sheet steel galvanised cable trough of size 50/75/100mm shall be provided.
- 3.1.6 Cable tray covers shall be provided for outdoor trays on top most tray. It shall be prefabricated made out of hot/cold rolled mild steel sheets, complete with hardware as required. Tray cover shall be hut type. Special clamps shall be provided for fixing tray covers without drilling holes on trays. Tray covers shall be hot dip galvanized. Thickness of galvanizing shall be not less than 610grams/sq.m.

3.2.0 Load Test for Cable trays shall be carried out as follows:

A 2.5 metre straight section of each type of cable tray shall be simply supported at the two ends. A uniformly distributed load of 100 kg per meter shall be applied along the length of tray. The maximum deflection at mid span shall not exceed 7 mm.

4.0.0 CABLE TRAY SUPPORT SYSTEM

- 4.1.0 Cable tray supports shall be of prefabricated preformed sections of sheet steel, bolted type and shall be hot dip galvanized.
- 4.2.0 Cable tray support system shall be similar or equivalent to "Unistrut make". Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of following two types:
- Single channel strut support for supporting cable trays on one side
 - Double channel strut support for supporting cable trays on one side
- 4.3.0 Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardware such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.
- 4.4.0 The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardware fittings and accessories shall be prefabricated factory galvanized..



- 4.5.0 The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc of the components shall not be allowed.
- 4.6.0 All steel components, accessories, fittings and hardware shall be hot dip galvanised after completing welding, cutting, drilling and other machining operation.
- 4.7.0 The typical arrangement of flexible support system shall comprise the following:
- The main support channel and cantilever arms shall be fabricated out of minimum 2.5 thick rolled steel sheet conforming to IS.
 - Cantilever arms of required length to match cable tray width shall be as shown in the enclosed drawing. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.
 - The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above or in the enclosed drawings are indicative only.
 - Main support channels may be supplied in any suitable lengths to minimize the wastage. Nevertheless, the support system shall be designed by the bidder to fully meet the requirements of type tests as specified.
- 4.8.0 Thickness of galvanizing on steel sections shall be not less than 610gm/sq.m on all steel sections.
- 4.9.0 Horizontally running cable trays shall be clamped by bolting to cantilever arms at an interval of 2000 mm. Vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 2000 mm. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000mm.
- 4.10.0 The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm.



SECTION-3.17: CABLING ACCESSORIES

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of cabling accessories. List of major items shall include the following:

- Cable joints & terminations
- Cable glands
- Cable lugs
- Camps
- Tags
- Conduits & Pipes
- Junction boxes

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Standards except where modified and /or supplemented by this specification.

- a) VDE 0278 : Joints and Terminations
- b) IS: 13573 : Joints and Terminations for polymeric cables for working voltages from 6.6 KV up to and including 33 KV-Performance requirements and type tests.
- c) BS:6121 : Mechanical cable glands (Part 1 –Specification for metallic glands)
- d) IS: 12943 : Brass Glands for PVC Cables
- e) IS:8309 : Specification for compression type tubular terminal ends for aluminium conductors of insulated cables.

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Joints & terminations

3.1.1 Termination and jointing kits shall be of proven design and make which have already been extensively used and fully type tested. Kits shall be complete with all accessories and consumables required for complete termination or jointing. Copper cable lugs & jointing ferrules for straight through joints shall form part of the kit.

3.1.2 Termination and jointing kits shall be suitable for the following types of cables as per IS.

- 11 KV unearthed grade cable
- 1.1 KV grade power cables

3.1.3 Termination kits shall be 'elastimold' or 'Push on type' or 'heat shrinkable type'. Jointing kits shall be 'Tapex type' or 'heat shrinkable type'.

3.1.4 Straight through joint and termination shall be capable of withstanding the fault level of 44KA for HT Cables.

3.1.5 Straight through joints shall be protected against mechanical damage, rodent and termite attack. It shall be suitable for directly buried cables.



3.2.0 Cable glands

Cables shall be terminated using cable glands suitable for the voltage grade of cables. Cable glands shall be heavy duty brass machine finished and tinned. Cable glands shall be supplied with neoprene seal and earth lugs suitable for the fault capacity of the armour of the installed cables. Cable glands shall be double compression type for armoured cables. For flame proof equipment cable glands shall be of flame proof type.

3.3.0 Cable lugs

3.3.1 Cable lugs shall be of aluminium for aluminium cables and tinned copper for copper cables. Thickness of tinning shall be not less than 10 microns Type of end connection shall be solderless crimping type.

3.3.2 Cable lugs for conductors of power cables shall be "heavy duty" type. The type & size of cable lugs for power cables shall be selected according to the number and sizes of strands of the cable.

3.3.3 Solder less crimping of terminals shall be done by using corrosion inhibiting compound. Cable lugs for control cable termination shall be insulated. These lugs shall be pin type/flat type/ ring type/U Type to suit the terminals provided in the panels.

3.3.4 Type of cable lugs shall be as follows:

• Power cables with aluminium conductor	: Aluminium crimping type.
• Power cables with copper conductor	: Copper crimping type.
• Control Cables	: Copper pin type /Copper screw type
• Special cables	: pin type / maxi-termi type

3.4.0 Trefoil Cable Clamps

- Clamps required for single core cables carrying alternating current shall be suitable for holding three cables together in delta formation. Clamps shall be of FRP material.
- Clamps shall be of suitable sizes to firmly hold the cables of various outer diameters including tolerance in OD.
- Clamps should have been type tested for Short Circuit Withstand Test .
- For Trefoil clamps run spacing shall be 2000 mm and Axial spacing shall be Double the diameter of larger adjacent trefoils cable or 150 mm whichever is less. Supports shall also be provided at each bend

3.5.0 Omega Cable clamps

- Omega clamps shall be of galvanized mild steel and shall be used to fasten the individual multi-core cables.
- Clamps shall be of simple construction, made of 2mm thick, 25mm wide strip of omega shape and suitable for clamping on the rungs / perforated sheet of tray with the help of two bolts.
- Clamps shall be of different sizes for different outer diameters of cables. Omega cable clamps shall be used for individual cables above 35mm outer diameter.
- Steel clamps shall be hot dip galvanized. Weight of zinc not less than 610 gms. per sq. metre
- For cables of above 35 mm OD, cables shall be individually clamped at 5000 mm interval for Horizontal runs and shall be individually clamped at 1000 mm interval for Vertical runs. Supports shall also be provided at each bend.



- For cables of up to 35 mm OD, cables shall be collectively clamped at 5000 mm interval for Horizontal runs and shall be collectively clamped at 1000 mm interval for Vertical runs. Supports shall also be provided at each bend.
- For cables supported along structures/ceiling, clamp spacing shall be 750 mm. Supports shall also be provided at each bend.

3.6.0 Strip Cable Clamps

- Strip clamps shall be of galvanized mild steel and shall be used to fasten the group of multi-core cables up to 35mm diameter only on a full or part of the tray width.
- Clamps shall be of simple construction, made of 3mm thick Steel, 25mm wide strip to cover the entire width up to 300mm wide tray and part of the tray for more than 300mm wide trays. Strip shall have two right angle bends at each end for fixing on to the rung/ perforated sheet of tray with the help of two bolts.
- Clamps shall be of different sizes for different sizes of tray width. However, the maximum size of clamp shall be 300mm and for cable trays of greater width, two clamps shall be used.
- Clamps shall be hot dip galvanized. Weight of zinc not less than 610 gms. per sq. metre

3.7.0 Self-locking Clamps

- Clamps shall be of FRP material. Clamps shall have self-locking feature when the cord is looped. Clamps shall be provided with manual lock release.
- Clamp cord shall not move in the backward position once it has been locked, unless the lock release is applied.
- Type test certificates to ascertain the strength of clamps shall be submitted for Owner's approval.
- Not more than four (4) cables shall be clamped together, wherever collective clamping is permitted.
- Clamp length shall be selected such that not more than 80% of lockable length is utilized for clamping.
- Nylon self-locking tie strips for collective clamping (up to 35mm OD max. group of 4 cables) shall be 4 mm having Tensile strength 30 kg.
- Nylon self-locking tie strips for Individual multicore clamping (above 35mm OD up to 55mm OD) shall be 4 mm having Tensile strength 20 kg.
- Nylon self-locking tie strips for Individual multicore clamping (above 55mm OD) shall be 7 mm having Tensile strength 60 kg.

3.8.0 Tags

- Cables shall be provided with cable number tags for identification.
- Cable tags shall be of aluminium.
- Cable numbers shall be engraved type
- Tags shall be of durable quality of size 60mm x 12mm with a tie hole at each end.
- Samples of tags shall be approved by the Owner before delivery.
- Tags shall be provided with non-corrosive wire of sufficient strength for tagging.

3.9.0 Junction Boxes

- 3.9.1 Junction box with IP 55 degree of protection, shall comprise of a case with hinged door constructed from FRP material. The junction box shall be provided with canopy. The boxes shall include brackets, bolts, nuts, screws, glands, lugs, M8 earthing stud etc.



- 3.9.2 Terminal blocks shall be of 650V grade, rated for 10A and in one piece moulding. It shall be complete with insulating barriers, clip-on-type terminal numbering on wiring diagrams. Terminal block shall be suitable for terminating 2C $\times$ 2.5mm² cable on both sides and arranged to facilitate easy termination. Cable entry shall be from bottom.
- 3.9.3 The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable / conduit entry knockouts and terminals.

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		Section-I, Sub-Section-D-ANNEXURE-I	
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ANNEXURE-I

LIST OF MAKES OF SUB-VENDOR ITEMS

	Title: 1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO, Tamilnadu Technical Specification for Agitators of FGD Slurry Tanks		Specification No: PE-TS-485-571-18000-A001	
			Section-I, Sub Section-D- ANNEXURE-I	
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Sl.no.	Item	Category of Inspection	Sub-vendor	Place	Remarks
1.	PAINT	III	ASIAN PAINT		
		III	BERGER		
		III	KANSAI NEROLAC		
		III	JOTUN		
		III	SHALIMAR		
		III	JENSON & NICHOLSON (I) LTD		
		III	CDC CARBOLINE (I) LTD.		
		III	ADDISON PAINTS LTD		
		III	GRAND POLYCOAT		

NOTES: INSPECTION CATEGORIZATION

CAT I: INSPECTION BY OWNER, BHEL/BHEL NOMINATED TPIA & VENDOR. MDCC WILL BE ISSUED BASED ON INSPECTION REPORT IN LINE ITH APPROVED QAP.

CAT II: INSPECTION BY BHEL/BHEL NOMINATED TPIA & VENDOR. MDCC WILL BE ISSUED BASED ON INSPECTION REPORT IN LINE ITH APPROVED QAP.

CAT III: MDCC WILL BE ISSUED BASED COC & MTC ISSUED BY VENDOR AND VERIFICATION BY BHEL / OWNER IN LINE WITH APPROVED QAP/CHECK LIST

- The list of all bought out items like gearbox, coupling, bearings etc. with makes and country of origin and contact details of the manufacturers to be mentioned along with offer to be submitted in the format attached in Section II, Annexure-6 as information to BHEL.
- Acceptance of makes shall be subject to BHEL/ End customer acceptance during the detailed engineering without cost and delivery implication to BHEL.
- Bidder has to submit the sub-vendor questionnaire (attached herewith) along with necessary credentials in case the proposed sub-vendor is not as per the list provided.
- Make of any unlisted items shall be subject to customer / BHEL approval during detail engineering. For such items, bidder to furnish list of sub-vendors during detail engineering stage for Customer / BHEL's review and approval. Bidder shall furnish following supporting documentation within 1 month of placement of LOI. Thereafter no request for additional sub-vendor shall be entertained.
 - a) Documentation to show that the equipment /system has been supplied for a plant of similar or higher capacity.
 - b) Documentation in the form of certificate that the equipment/system has been operating satisfactorily for two years as on the scheduled date of bid opening.
- The complete list will be necessarily submitted within one month of placement of LOI to ensure timely placement of order for BOIs. Bidder to assess the capability of their proposed 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.

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ANNEXURE-II

MANDATORY SPARE LIST

1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO TECHNICAL SPECIFICATION FOR AGITATORS OF FGD SLURRY TANKS		SPECIFICATION NO. :PE-TS-485-571-18000-A001
MANDATORY SPARE LIST		ANNEXURE-II
Sl. No.	PARTICULARS	Unit /Quantity (Nos./SET/%)
1.06.00	AGITATORS	
A	AUXILIARY ABSORBENT TANK AGITATOR	
1	Impeller Assembly	1 no. of each type and size
2	Bearing Assembly	1 no. of each type and size
3	Motor	1 no. of each type and size
4	Belt and Pulley (If applicable)	1 no. of each type and size
5	Gear Box Assembly (If Applicable)	1 no. of each type and size
6	Agitators shaft assembly	1 no. of each type and size
7	Shaft seal	1 no. of each type and size
8	Complete Agitator Assembly	1 no. of each type and size
B1	LIMESTONE SLURRY STORAGE TANK AGITATORS	
1	Impeller Assembly	1 no. of each type
2	Bearing Assembly	1 no. of each type
3	Motor	1 no. of each type
4	Belt and Pulley (If applicable)	1 no. of each type
5	Gear Box Assembly (If Applicable)	1 no. of each type
6	Agitators shaft assembly	1 no. of each type and size
7	Complete Agitator Assembly	1 no. of each type and size
B2	FILTRATE WATER RECEIVER TANK AGITATOR	
1	Impeller Assembly	1 no. of each type
2	Bearing Assembly	1 no. of each type
3	Motor	1 no. of each type
4	Belt and Pulley (If applicable)	1 no. of each type
5	Gear Box Assembly (If Applicable)	1 no. of each type
6	Agitators shaft assembly	1 no. of each type and size
7	Complete Agitator Assembly	1 no. of each type and size
B3	SECONDARY HYDROCYCLONE FEED TANK AGITATOR	
1	Impeller Assembly	1 no. of each type
2	Bearing Assembly	1 no. of each type
3	Motor	1 no. of each type
4	Belt and Pulley (If applicable)	1 no. of each type
5	Gear Box Assembly (If Applicable)	1 no. of each type
6	Agitators shaft assembly	1 no. of each type and size
7	Complete Agitator Assembly	1 no. of each type and size
B4	FILTRATE WATER TANK AGITATOR	
1	Impeller Assembly	1 no. of each type
2	Bearing Assembly	1 no. of each type
3	Motor	1 no. of each type
4	Belt and Pulley (If applicable)	1 no. of each type
5	Gear Box Assembly (If Applicable)	1 no. of each type
6	Agitators shaft assembly	1 no. of each type and size
7	Complete Agitator Assembly	1 no. of each type and size
B5	WASTE WATER TANK AGITATOR	
1	Impeller Assembly	1 no. of each type
2	Bearing Assembly	1 no. of each type
3	Motor	1 no. of each type
4	Belt and Pulley (If applicable)	1 no. of each type
5	Gear Box Assembly (If Applicable)	1 no. of each type

1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO TECHNICAL SPECIFICATION FOR AGITATORS OF FGD SLURRY TANKS		SPECIFICATION NO. :PE-TS-485-571-18000-A001
MANDATORY SPARE LIST		ANNEXURE-II
Sl. No.	PARTICULARS	Unit /Quantity (Nos./SET/%)
6	Agitators shaft assembly	1 no. of each type and size
7	Complete Agitator Assembly	1 no. of each type and size
B6	AGITATOR FOR ABSORBER AREA DRAIN SUMP	
1	Impeller Assembly	1 no. of each type
2	Bearing Assembly	1 no. of each type
3	Motor	1 no. of each type
4	Belt and Pulley (If applicable)	1 no. of each type
5	Gear Box Assembly (If Applicable)	1 no. of each type
6	Agitators shaft assembly	1 no. of each type and size
7	Complete Agitator Assembly	1 no. of each type and size
B7	AGITATOR FOR GYPSEM AREA DRAIN SUMP	
1	Impeller Assembly	1 no. of each type
2	Bearing Assembly	1 no. of each type
3	Motor	1 no. of each type
4	Belt and Pulley (If applicable)	1 no. of each type
5	Gear Box Assembly (If Applicable)	1 no. of each type
6	Agitators shaft assembly	1 no. of each type and size
7	Complete Agitator Assembly	1 no. of each type and size
B8	AGITATOR FOR LIMESTONE AREA DRAIN SUMP	
1	Impeller Assembly	1 no. of each type
2	Bearing Assembly	1 no. of each type
3	Motor	1 no. of each type
4	Belt and Pulley (If applicable)	1 no. of each type
5	Gear Box Assembly (If Applicable)	1 no. of each type
6	Agitators shaft assembly	1 no. of each type and size
7	Complete Agitator Assembly	1 no. of each type and size
Note:		
1)One set means 100% complete replacement of the particular component/equipment, as mentioned i.e., Set for the particular equipment, would include all components required to replace the item. For example, a set of bearing shall include all hardware normally required while replacing the bearings. It is further, intended that the assembly / sub-assembly which have different orientation (like left hand or right hand, top or bottom), different direction of rotation or mirror image positioning or any other reasons which result in maintaining two different sets of the spares to be used for the subject assembly / sub-assembly, these shall be considered as different types of assembly/sub-assembly.		
2) Wherever the quantities have been indicated for each type, size, thickness, material, radius, range etc. these shall cover all the items supplied and installed.		
3) In case spares indicated in the list are not applicable to the particular design offered by the bidder, the bidder should offer spares applicable to offered design with quantities generally in line with the approach followed in the above list.		
4) Any item which is quoted as "not applicable" in the above list and is found to be "applicable" at a later date shall be supplied by the bidder without any commercial implications. The Bidder shall note that if there is any change/ variation in equipment/ system during detail engineering which causes any change/ variation in the essential spares quantity, the same shall be supplied without any commercial implications. The price indicated for the mandatory spares shall be considered for the purpose of evaluation.		
5) Mandatory spares shall not be dispatched before dispatch of corresponding main equipment. Pls. refer NIT for delivery schedule. The spares shall be treated and packed for a long storage under the climatic condition prevailing at site.		
6) All spares supplied under this contract shall be strictly interchangeable with parts for which they are intended for replacements. These spares should include all mounted accessories like components, boards, add or items, fitting, connectors etc. and be complete in all respects so that the replacement of the main items by these spares does not require any additional item. The vendors must conform the pair to pair compatibility of each electrical spares modules with the modules supplied in the original package. All electronic modules should be pre-set and/or pre-programmed for ready use at site. Alternatively, suitable instruction sheet indicating the details of required PCB jumper position, BCD which is setting, EPROM/PROM listing etc should be packed along with each module. Also a caution mark sign should be put on all such module which needs pre-setting/pre-programming before putting them in to service. The spare shall be treated and properly packed for long term storage.		
7) Each spare shall be clearly marked and labelled on the outside of the packing with its description. When more than one spare part is packed in single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purpose of identification.		

1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO TECHNICAL SPECIFICATION FOR AGITATORS OF FGD SLURRY TANKS		SPECIFICATION NO. :PE-TS-485-571-18000-A001
MANDATORY SPARE LIST		ANNEXURE-II
Sl. No.	PARTICULARS	Unit /Quantity (Nos./SET/%)
8) Set for the particular equipment, would include all components required to replace the item, for example a set of bearing shall include all hardware normally required while replacing the bearings. It is further intended that the assembly / sub-assembly which have different orientation (like left hand or right hand, top or bottom), different direction of rotation or mirror image positioning or any other reasons which result in maintaining two different sets of the spares to be used for the subject assembly / sub-assembly, these shall be considered as different types of assembly/sub-assembly.		
9)All the spares shall be manufactured along with the main equipment components as a continuous operation as per same specification and quality plan.		
10)The Contractor shall warrant that all spares supplied will be new and in accordance with the Contract Documents and will be free from defects in design, material and workmanship.		
11) Any cell left blank in the unpriced schedule shall be teated as "Quoted"		
12) Bidder to provide mandatory spares as asked above for each type of tank separately ,even in case type & size of tank of agitator is similar.		

	Title: 1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO, Tamilnadu Technical Specification for Agitators of FGD Slurry Tanks	Specification No: PE-TS-485-571-18000-A001	
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ANNEXURE-III

SIZING CALCULATION, SELECTION PARAMETER FOR ALL TANKS (SLURRY & WATER)

02	26.02.2022	Updated with customer comments	VV	PNR	ACR
01	23.09.2021	Updated with customer comments	VV	PNR	ACR
00	04.06.2021	Fresh Issue	VV	PNR	ACR
REV	DATE	DESCRIPTION / NOTE	PRD	CHD	APD

REVISIONS

TITLE:

SELECTION PARAMETER FOR ALL TANKS (SLURRY & WATER)

OWNER/PROJECT: TANGEDCO



TANGEDCO NORTH CHENNAI
1X800 MW – FGD SYSTEM PACKAGE

EPC CONTRACTOR:



BHARAT HEAVY ELECTRICALS LTD.
BOILER AUXILIARIES PLANT, RANIPET

COLLABORATOR & QFGDM



MITSUBISHI HITACHI POWER SYSTEMS, LTD
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION, JAPAN

	BHEL	Sign	
PREPARED BY	Vidya V	-sd-	STATUS : FOR APPROVAL
CHECKED BY	P Naveen	-sd-	BHEL CUST NO : G802
APPROVED BY	AC Rao	-sd-	BHEL DOC NO : 4-FW-000-01318
			REV NO : 02

BHEL DRG./DOC NO. : 4-FW-000-01318

SI No.	TANGEDCO / FI Comments	BHEL Response	TANGEDCO / FI Comments	BHEL Response
1	Please refer the comments in the document, "Mass balance data 4-FW-000-1311". As the comments are Upon the closure of all comments, this document will be considered for formal review.	Noted		
2	The process water storage tank shall be designed to store 24 hrs of total maximum water required for the entire FGD process for the unit operating at Design point. Please clarify why 50% of process water required for belt filter wash is considered. However total added values are different.	Please be noted that 805 belt wash includes both the water quantity required for belt wash and cake wash. The quantity of water required for belt and cake wash are equal. To bring clarity, it is suitably modified in mass balance data MDL. Process water furnished in tender has a high chloride content and the same cannot be used for cake wash. Please refer to gypsum dewatering system PID or Process flow drawing PFD, a separate RO system is envisaged for reducing the chloride content to meet requirements for cake washing. This water will be separately tapped off from process water terminal point. Hence this quantity of water is not envisaged for process water storage tank sizing. Total added value is corrected as 64.73 m3 and tank size is suitably modified to accommodate 24 hours storage requirement for 64.73 m3 water quantity.	Noted. M/s. BHEL shall clarify whether the process water having high chloride content to be used for absorber make up, ME wash, wet/dry wash needs RO treatment. Otherwise, the high chlorine content present in process water has to be taken in arriving the lime stone requirement (in mass flow document) to account for chlorine inhibition in absorption of SO2. In SI. No. 2 BHEL shall ensure the storage tank for cake washing shall meet the 24 hours requirement.	Please be noted that it was informed in the meeting held at TANGEDCO HQ on 15th FEB, 2022 that chloride content in process water does not form part in arriving limestone quantity. As informed in the meeting, process water tank will be sized for 24 hours inline with MOM dated 15th Feb, 2022. Inline with S.no 21 of the MOM, process water composition will be included in the mass balance document
3	As per tender clause Vol.II, Section 2 Page : 16 of 16Vol 2 Sec 2-3_Wetball mills, Sec.2.3 WBM & Limestone slurry &Gypsum preparation, clause no.L, capacity of Secondary Hydro Cyclone Feed tank shall be designed to hold 8 hrs storage volume.	Noted and revised	Noted and point closed.	
4	Tender calls for "BHEL shall provide an Emergency slurry tank, sized to contain the complete slurry of one absorber tank at its maximum level equipped with all necessary pumps, valves, piping and controls to transfer the tank's contents back to the absorber to refill the absorber sump." Please also indicate the capacity of absorber tank.	Please be noted that auxiliary absorbent tank is sized 20% over absorber tank volume. Please be noted that the tank capacity is indicated in the MDL (serial number 9)	Noted.	
5	For Auxiliary Absorbent Tank, As the tank is handling limestone slurry, this auxiliary absorbent tank shall be emptied and slurry shall not be storied even as dead storage. Necessary flushing shall be added.	Noted, flushing line is already considered.	Noted.	
6	ABSORBER SUMP IS MISSING.	It is understood that customer is referring to absorber slurry tank. The same is included in MDL absorber sizing data 4-FW-000-01313. Noted that the bottom of the absorber sump shall be designed so that there will be an easy entrance for a man with a wheelbarrow. Therefore the arrangement and dimensions of the inspection door of the absorber at ground level shall be designed to allow for this. The bottom of the absorber sump shall be designed in such a way that complete drainage of the absorption liquid/slurry is possible and is accessible without damage of lining.	Noted. The same shall be incorporated in the absorber sizing data 4-FW-000-01313.	Noted and included in absorber sizing data MDL
7	Mill separation tank, DMCW/ECW overhead tank are missing.	Mill separation tank is part of bought out item (BOI). Will be submitted in separate BOI datasheet. DMCW/ECW overhead tank will be submitted by PEM BHEL unit in their respective MDL.	Noted.	
8	All the atmospheric tanks shall have sufficient free board above the "Level High" / "Normal Level" as the case may be. The overflow level shall be kept least 100 mm above the "Level High" / "Normal Level" for all the tanks. Further, a minimum 100 mm free board shall be provided above the top of overflow level to the top of the tank. The vertical type storage tanks shall be provided with a manhole of 500 mm dia minimum on the top cover and one man hole of 500 mm in shell, if the diameter of the tank is 2000 mm or more. All the vessels and tanks shall be normally provided with a hand hole of 150 mm gasketed located near the bottom of the straight side. The required lining / coating for the inside surface of the manhole / hand hole, nozzle and cover plate of the manhole / hand hole shall be same as that of the respective vessel / tank.	Free board level criteria above level high/normal level and overflow level is met. Man hole/hand hole sizing details will be discussed in tanks MDL submitted by PEM BHEL Noted that the required lining / coating for the inside surface of the manhole / hand hole, nozzle and cover plate of the manhole / hand hole shall be same as that of the respective vessel / tank.	Noted. Noted. Noted. The above details shall be indicated in the document.	Noted and included in revised document
9	For cake wash tank, Please clarify why 50% of process water required for belt filter wash is considered.	Please refer reply across point 2	Noted.	
10	As per Specification secondary hydro cyclone feed tank retention time is 8 hours whereas the same is given in the calculation as 1 hour. Please clarify.	8 hours storage considered in revised document.	Noted.	

11	In the Process flow diagram absorber systems, the capacity of process water tank is given as 2155 cu.m capacity whereas in the sizing calculation & selection parameter for all tanks document the same is given as 1695.4 cu.m. Please clarify the same.	please be noted that 2155 was tank's full volume while 1695.4 was effective volume. However, please be noted that tank volume is now changed as indicated in reply against point no. 2	Noted.	Inline with serial no. 2 process water tank's size increased in revised document
12	General: However, if there is any change in the Mass flow diagram approval, the sizing calculations and selection parameter of all tanks has to be updated based on the approval of mass flow balance data approval.	Noted	Noted.	

Sizing Calculation & Selection parameter for all tanks

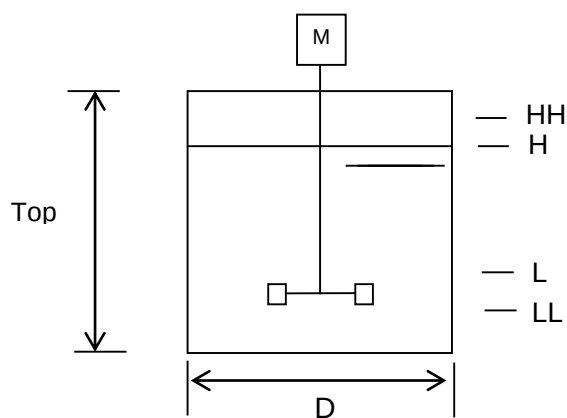
1. Gas condition for Tank Sizing:

S.No.	Gas Condition	Feature
1	Design case worst coal	FGD Design Point

2. Tank Sizing Basis

Tank size is decided as per the following

- LL – Pump LL level m
- L – LL + 0.2 m
- H – Effective height m
- HH – H + 0.2 m
- Top – HH + 0.5 m(If tank Ht. <10m)
– HH + 0.8 m(If tank Ht. >10m)



Effective volume = $3.14 / 4 \times \Phi^2 \times (H-L)$

Hold volume = $3.14 / 4 \times \Phi^2 \times (HH)$

H/D ratio = 1-1.2

Note:

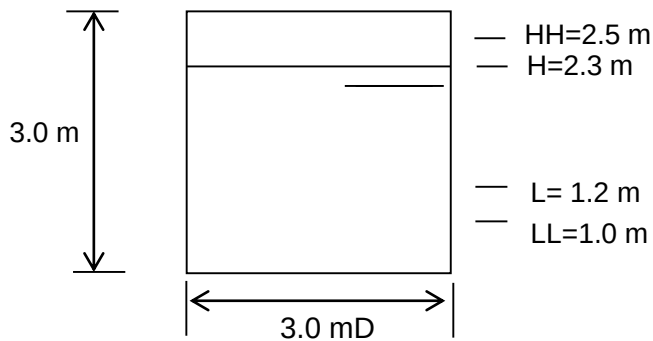
The required lining / coating for the inside surface of the manhole / hand hole, nozzle and cover plate of the manhole / hand hole shall be same as that of the respective vessel / tank.

Rev02

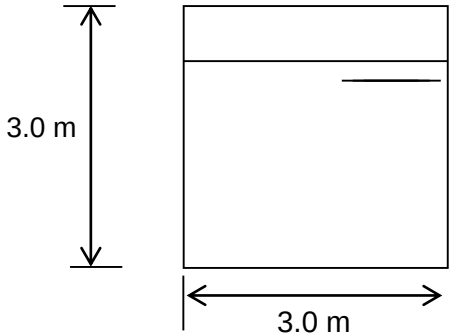
S. No	Item No	Service	Design Spec	Process Parameter	Design Basis
1	00HTQ0 0BB001	Process Water Tank	14000 mmD X 14000 mmH Quantity = 1 nos.	Process Capacity	70.64 m3/h (Refer Mass Flow Balance (Design Point) data stream no. (<801> + <802> + <803> + <804> + <805>) x 1 units).
				Retention Time	24 hr
				Required volume	70.64 m3/h x 24 hr = 1695.36 m3
				14.0	

* LL level will be finalized by vendor's information of Process water pump.

S. No	Item No	Service	Design Spec	Process Parameter	Design Basis
2	00HTQ0 1BB001	Cake wash (Clarified water) Tank	3000 mmD X 3000 mmH Quantity = 1nos.	Process Capacity for each tank	5.91 m ³ /h (Refer Mass Flow Balance Design Point data stream no.(<805>/2))
				Retention Time	1 hr
				Required volume	5.91 m ³ /h x 1.0hr = 5.91 m ³
				Tank Level is designated as follows	
				Top	3.0
				HH	2.5
				H	2.3
				L	1.2
				LL	1.0*
				Effective volume $= 3.0 \text{ m } \Phi^2 / 4 \times \pi \times (2.3-1.2) \text{ m}$ $= 7.77 \text{ m}^3 > 5.91 \text{ m}^3$ Hold Volume $= 3.0 \text{ m } \Phi^2 / 4 \times \pi \times 2.5 \text{ m}$ $= 17.67 \text{ m}^3$	



*LL level is finalized by vendor's information of Cake wash tank pump.

S. No	Item No	Service	Design Spec	Process Parameter	Design Basis	
3	00HTM0 1BB001	Belt Filter Wash Tank	3000 mmD X 3000 mmH Quantity = 1 nos.	Process Capacity for each tank	5.91 m3/h (Refer Mass Flow Balance Design Point data stream no.(805)/2)	
				Retention Time	1 hr	
				Required volume	5.91 m3/h x 1.0hr = 5.91 m3	
					Tank Level is designated as follows	
					Top	3.0
					HH	2.5
					H	2.3
L					1.2	
LL					1.0*	
				Effective volume = 3.0 m $\Phi^2 / 4 \times \pi \times (2.3-1.2)$ m =7.77 m3 >5.91 m3 Hold Volume = 3.0 m $\Phi^2 / 4 \times \pi \times 2.5$ m =17.67 m3		

*LL level is finalized by vendor's information of belt filter wash tank pump.

S. No	Item No	Service	Design Spec	Process Parameter	Design Basis
4	00HTM 03 BB001	Filtrate water Tank	3500 mm D X 3500 mmH Quantity = 1 no	Process Capacity	23.99 m3/h (Stream No: <405>)
				Retention Time	0.5 Hr
				Required volume	23.99 m3/h x 0.5 hr =11.995 m3
				<	

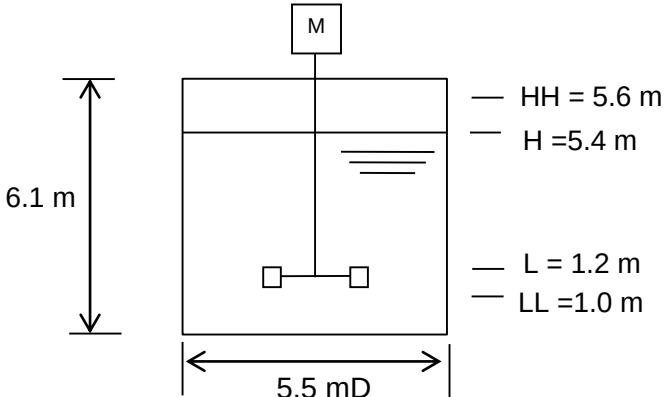
*L and LL level is finalized by vendor's information of filtrate water pump and agitator.

S.No	Item No	Service	Design Spec	Process Parameter	Design Basis
5	00HTM00 BB001	Filtrate water Receiver Tank	3500 mm D X 3500 mmH Quantity = 1 no	Process Capacity	23.2 m3/h (Stream No: <403>)
				Retention Time	0.5 Hour
				Required volume	23.2 m3/h x .5 hr = 11.6 m3
				</	

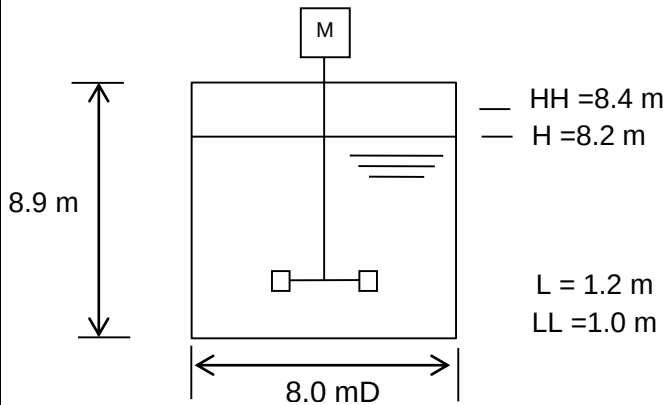
*L and LL level is finalized by vendor's information of hydro cyclone feed pump and agitator.

S.No	Item No	Service	Design Spec	Process Parameter	Design Basis
6	00HTM04 BB001	Secondary Hydro cyclone feed Tank	7500 mm D X 8100mmH- Quantity = 1 no.	Process Capacity	31.5 m3/h (Stream No: <202>)
				Retention Time	8 Hours
				Required volume	31.5 m3/h x 8 hr = 252 m3
				Rev01	
M					

*L and LL level is finalized by vendor's information of hydro cyclone feed pump and agitator.

S. No	Item No	Service	Design Spec	Process Parameter	Design Basis	
7	00HTM 05BB0 01	Waste water storage Tank	5500 mmD X 6100mmH- Quantity = 1 no.	Process Capacity	11.72 m3/h (Stream No: <205>)	
				Retention Time	8.0 Hours	
				Required volume	11.72 m3/h x 8.0 hr = 93.76 m3	
					Tank Level is designated as follows	
					Top	6.1
					HH	5.6
					H	5.4
					L	1.2*
					LL	1.0*
	Circular Tank					
Effective volume						
$= 5.5 \text{ m } \Phi ^ 2 / 4 \times \pi \times (5.4-1.2) \text{ m}$						
$= 99.78 \text{ m3}> 93.76\text{m3}$						
Hold Volume						
$= 5.5 \text{ m } \Phi ^ 2 / 4 \times \pi \times 5.6 \text{ m}$						
$=133 \text{ m3}$						

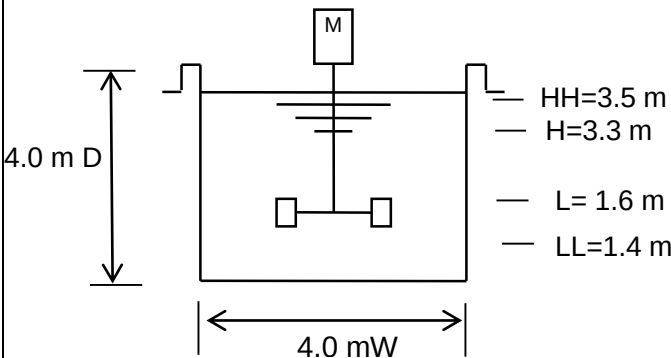
*L and LL level is finalized by vendor's information of Waste water pump and agitator.

S. No	Item No	Service	Design Spec	Process Parameter	Design Basis	
8	00HTK03BB001	Lime stone slurry storage Tank	8000 mmD X 8900mmH Quantity = 1 no.	Process Capacity	27 m3/h (Stream No: <510>)	
				Retention Time	12.0 hr	
				Required volume	27 m3/h x 12 hr = 324 m3	
					Tank Level is designated as follows	
					Top	8.9
					HH	8.4
					H	8.2
					L	1.2*
					LL	1.0*

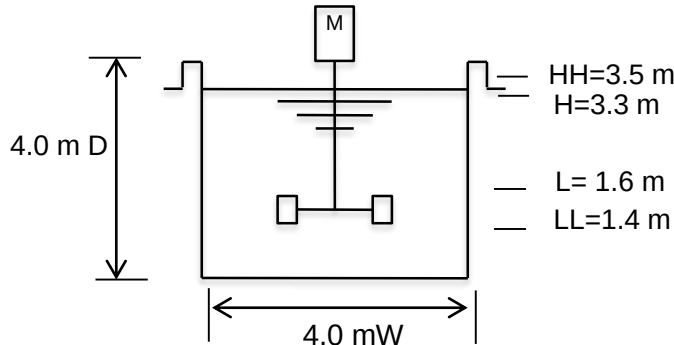
*L and LL level is finalized by vendor's information of Limestone slurry Feed pump and agitator.

S. No	Item No	Service	Design Spec	Process Parameter	Design Basis
9	00HTK0 0BB001	Auxiliary Absorbent Tank	12500mmDX 12600mmH Quantity = 1 no	Process Capacity	Absorber Tank Volume = 1419.66 m3 (with 20% margin)
				Retention Time	Batch Operation
				Required volume	1419.66
				<	

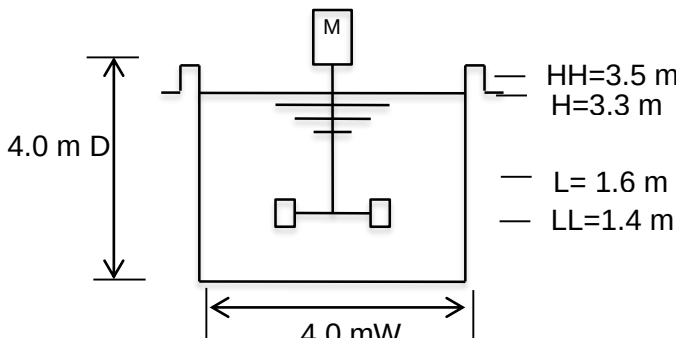
*L and LL level is finalized by vendor's information of Auxiliary Absorbent tank pump and agitator.

S. No	Item No	Service	Design Spec	Process Parameter	Design Basis
10	10HTT00 BB001	Absorber Area Drain Sump	4000mmW X 4000mmL X 4000mmH Quantity = 1 nos.	Process Capacity for each Sump	25 m3
				Retention Time	Batch Operation
				Required volume	25 m3
					
Tank Level is designated as follows					
Top	4.0				
HH	3.5				
H	3.3				
L	1.6*				
LL	1.4*				
<u>Rectangular Tank</u>					
Effective volume = 4.0 m x 4.0 m x (3.3-1.6) m = 27.2 m3 >25 m3					
Hold Volume = 4.0 m x 4.0 m x 3.5 m = 56 m3					

*L and LL level is finalized by vendor's information of Sump pump and agitator.

S. No	Item No	Service	Design Spec	Process Parameter	Design Basis	
11	00HTT01 BB001	Gypsum Area Drain Sump	4000mmW X 4000mmL X 4000mmH Quantity = 1 no.	Process Capacity	25 m3	
				Retention Time	Batch Operation	
				Required volume	25 m3	
					Tank Level is designated as follows	
					Top	4.0
					HH	3.5
					H	3.3
					L	1.6*
LL					1.4*	
<u>Rectangular Tank</u> Effective volume = 4.0 m x 4.0 m x (3.3-1.6) m = 27.2 m3 >25 m3 Hold Volume = 4.0 m x 4.0 m x 3.5 m = 56 m3						

*L and LL level is finalized by vendor's information of Sump pump and agitator.

S. No	Item No	Service	Design Spec	Process Parameter	Design Basis	
12	00HTT02 BB001	Lime Stone Area Drain Sump	4000mmW X 4000mmL X 4000mmH	Process Capacity	25 m3	
				Retention Time	Batch Operation	
				Required volume	25 m3	
					Tank Level is designated as follows	
					Top	4.0
HH					3.5	
H					3.3	
L					1.6*	
LL	1.4*					
<u>Rectangular Tank</u>						
Effective volume = 4.0 m x 4.0 m x (3.3-1.6) m = 27.2 m3 >25 m3						
Hold Volume = 4.0 m x 4.0 m x 3.5 m = 56 m3						

*L and LL level is finalized by vendor's information of Sump pump and agitator.

The above data is basic design data and may vary based on actual piping layout and selected vendor's recommendations.

Reference Documents

- Mass Flow Balance (Design Point) data – 4-FW-000-01311

	Title:		Specification No: PE-TS-485-571-18000-A001	
	1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO, Tamilnadu		Section-I, Sub-Section- D-ANNEXURE-IV	
	Technical Specification for Agitators of FGD Slurry Tanks		REV. 00	Date: August,2022
			Sheet: 1 of 1	

ANNEXURE-IV

MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION



Title:
1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO,
Tamilnadu -Technical Specification for Agitators of FGD
Slurry Tanks

Spec. no.: PE-TS-485-571-18000-A001

Section-I, Sub-Section- D-ANNEXURE-IV

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DRAWINGS/ DOCUMENTS REQUIRED DURING DETAIL ENGINEERING

The successful bidder shall submit the following drawings / documents during detail engineering for approval / information / reference
(as the case may be): -

Sl. No.	BHEL Drawing / Document No.	Title	Schedule Date	Drawing Classification
1	PE-V0-485-571-A001	GA drawing, Exploded view, sectional view with Material of construction, mechanical seal, gearbox for all Agitator models	2 weeks from LOI	Primary
2	PE-V0-485-571-A002	Data sheet for all Agitator	2 weeks from LOI	Primary
3	PE-V0-485-571-A003	Agitator Performance curve of all Agitators	2 weeks from LOI	Primary
4	PE-V0-485-571-A004	Electrical motor GA drawing & Data sheet and performance curves of all motors	2 weeks from LOI	Primary
5	PE-V0-485-571-A005	Quality plan & Inspection and Test Procedure	2 weeks from LOI	Primary
6	PE-V0-485-571-A006	Agitator and Motor Sizing Calculation	2 weeks from LOI	Primary
7	PE-V0-485-571-A007	O&M Manual for Agitator	4 weeks from LOI	Secondary
8	PE-V0-485-571-A008	Utility Consumption	4 weeks from LOI	Secondary
9	PE-V0-485-571-A009	Foundation Data including Anchor plan	4 weeks from LOI	Secondary
10	PE-V0-485-571-A010	Lubricating oil list	4 weeks from LOI	Secondary
11	PE-V0-485-571-A011	Special tools list, Start-up & Commissioning Spares	4 weeks from LOI	Secondary
12	PE-V0-485-571-A012	Installation and assembly procedure including Pre-Commissioning Check List	4 weeks from LOI	Secondary



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NOTE:

1. Drawing/ Document shall be uploaded by the successful bidder on WRENCH /DMS.Procedure for the same will be informed after award of contract.
2. The above drawing list is tentative and shall be finalized with the successful bidder after placement of order. While some of the drawings indicated above may not be applicable, some additional drawings may also be required based on scope of work.
3. Drawings shall be prepared in Auto-Cad latest edition. Required no. of hard and soft copies (editable) of the drawings shall be furnished as per requirement specified elsewhere in the specification.
4. Only manual calculation with authentic supporting literature (e.g. extracts of hand Book/ standard/codes) shall be acceptable. All design calculations and drawings shall be in SI system only.
5. All the drawings and documents including general arrangement drawing, data sheet, calculation etc. to be furnished to the customer during detailed engineering stage shall include / indicate the following details for clarity w.r.t. Inspection, construction, erection and maintenance etc.:
 - a. All drawings and documents shall indicate the list of all reference drawings including General Arrangement.
 - b. All drawings shall include / show plan, elevation, side view, cross-section, skin section, blow-up view; all major self-manufactured and bought out items shall be labelled and included in BOQ / BOM in tabular form.
 - c. Painting schedule shall also be made as a part of general arrangement drawing of each equipment / item indicating at least 3 trade names.



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Slurry Tanks

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- d. All the drawings required to be furnished to customer during detailed engineering stage shall include technical parameters, details of paints and lubrication, hardness and BOQ / BOM in tabular form indicating all major components including bought out items and their quantity, material of construction indicating its applicable code / standard, weight, make etc.
- e. Void.
- f. Drawings and documents not covered above but required to check safety of machines/ system, shall be submitted during detailed engineering stage without any commercial implication.
- g. All drawings shall include "B.O.M" and indicate quantity, material of construction, make along with IS/BS No., Technical parameters, dimensions, hardness, machining symbol and tolerance, requirement of radiography and hydraulic tests, painting details, elevation, side view, plan, skin section and blow-up view for clarity.
- h. All drawings shall be prepared as per BHEL's title block and shall bear BHEL's drawing No. Documents marked for submission to BHEL's Customer shall also bear BHEL's Customer's drawing No.
- i. Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to BHEL's/ Customer's/ Consultant's office for across the table resolution of issues and to get documents approved in the stipulated time.
- j. Bidder to follow the following the drawing submission schedule:
- k. 1st submission of drawings from date of LOI as per the submission schedule.
- l. Every revised submission incorporating comments – within 7 days.



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m. Bidder to submit revised drawings complete in all respects incorporating all comments.

n. The primary drawings are to be considered as the basic engineering drawings.

Any incomplete drawing submitted shall be treated as non-submission with delays attributable to bidder's account. For any clarification/ discussion required to complete the drawings, the bidder shall depute his personal to BHEL for across the table discussions/ finalizations/ submissions of drawings.

COMPANY SEAL

SIGNATURE: _____

NAME: _____

DESIGNATION: _____

COMPANY: _____



Title:
1 X 800 MW NCTPP STAGE-III,
Chennai, TANGEDCO, Tamilnadu
Technical Specification
for Agitators of FGD Slurry Tanks

Specification No: PE-TS-485-571-18000-A001

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REV. 00

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ANNEXURE-V

SEA-WORTHY PACKING PROCEDURE



CORPORATE STANDARD

AA0490004

Rev. No. 02

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SEAWORTHY PACKING (PACKING INSTRUCTIONS FOR GENERAL COMPONENTS / ASSEMBLIES / EQUIPMENT)

1 GENERAL

This standard lays down packing instructions for seaworthy packing of Components /Assemblies/ Equipment to be dispatched against Customer's contracts, for which there are no special instructions issued by the Engineering Departments.

The Components/Assemblies need to be packed suitably to avoid physical damage & corrosion during transit for storage. For specific applications the concerned engineering department shall issue a product standard. Reference of this standard, must appear in the Shipping list/Packing List.

2 SCOPE

This procedure gives minimum guidelines for seaworthy packing to be complied with for packing of Components /Assemblies / Equipment. This packing shall be suitable for different handling operations and for the adverse conditions during transportation and during indoor / outdoor storage for periods more than one year.

3 CROSS REFERRED SPECIFICATION

- Multi-layered cross laminated plastic film	: AA51420
- Packing Wood	: AA51401
- Silica gel	: AA55619
- Thermocole	: AA51416
- Packing slip holders	: AA7240901
- Corrugated Fibre Board	: AA51414
- Rubber sheet	: AA59001
- VCI paper	: AA51406
- High quality full glossy out door finishing paint	: AA56126
- Polyethylene air bubble film	: IS 12787
- Structural steel - standard quality (plates, sections, strips flats & bars)	: AA10108
- International Standards For Phytosanitary Measures No. 15	: ISPM-15:2009

4 WOOD SPECIFICATION FOR PACKING

The wood shall conform to specification AA51401.

For export packing wood in addition to the above the following has to be met:

The standard requires the use of debarked wood in the construction of compliant wood packaging material. Debarked wood is defined in the ISPM 5.

5 TYPE OF PACKING

The following 5 types of packings have been standardized for packing of General Components /Assemblies.

Revisions:			APPROVED: PROCEDURAL GUIDELINES COMMITTEE – PGC (Packing)		
Rev. No. 02	Amd. No.	Reaffirmed	Prepared	Issued	Dt. of 1 st Issue
Dt: 27-07-2018	Dt:	Year:	HPEP, Hyderabad	Corp. R&D	17-08-2013



- ‘OP’ - Open Type
- ‘PP’ - Partially Packed
- ‘CP’ - Crate Packing - Components/Equipment requiring physical protection
- ‘CQ’ - Case Packing - Small medium Components/ Assemblies/ Equipment which require corrosion & physical protection
- ‘CR’ - Case Packing - Electrical Components/Assemblies which require special packing viz. Water Proof, Shock Proof, etc.

6 DESCRIPTION OF TYPES OF PACKING

The various types of packing, as standardized above, are described below.

6.1 ‘OP’ - Open Type

In case, of components which are not affected by water & dust & do not require special protection &, are generally not machined, shall be sent as open packages. However these components may be sent in crates, wherever necessary.

6.2 ‘PP’ - Partially Packed

Components which need special protection, at selected portions only, shall be dispatched partially packed. Machined surfaces should not be allowed to come directly in contact with the wood. Such surfaces after application of TRP should be protected with Multi-layered cross laminated plastic film to AA51420.

6.3 ‘CP’ - Crate Packing – General

Assemblies/Components which need only physical protection from the point of view of handling shall be dispatched duly packed in crates.

6.4 ‘CQ’ - Case Packing - Machined Components/Assemblies/Equipment

- a) Small & Medium sized components/assemblies/equipment due to size/weight & to avoid handling, and pilferage, problems shall be packed in Case/Containers.
- b) Wherever required adequate quantity of silica gel to AA55619 or VCI Powder/ Tablets, packed in thin muslin cloth cotton bags shall be suitably placed.
- c) Small machines/components of less weight shall be provided with suitable cushioning. Wood Wool/Expanded Polyethylene Foam Sheet, if used, shall be sandwiched between polyethylene sheets and sealed.
- d) The components inside the case shall be entirely covered with Multi-layered cross laminated plastic film to AA51420, where-ever required.

6.5 ‘CR’ - Case Packing - Electrical & Electronic Components/Assemblies

Delicate components likely to be damaged e.g. Gauges, Instruments etc. are to be wrapped in waxed paper or polyethylene air bubble film and packed in cartons.

- a) Adequate quantity of Silica gel to AA55619 packed in cotton bags, of 100 grams each are to be suitably placed in the cartons. The cartons shall be entirely covered with Multi-layered cross laminated plastic film to AA51420, before being packed in the cases.
- b) VCI Powder/Tablets can be used as an alternative to Silica Gel to AA55619.
- c) Empty space in the cartons shall be filled with small chips of Expanded Polystyrene (Thermocole), Wood Wool etc. Polyethylene air bubble film shall conform to IS 12787/AA51420 Expanded polystyrene (Thermocole) shall conform to AA51416.
- d) The cartons shall be manufactured from corrugated Fibre Board, meeting requirements of AA51414.

6.6 Special Packing

Components requiring special packing (as per customer/contractual/ engineering requirements) not included in this specification shall be covered by product standards.



CORPORATE STANDARD

AA0490004

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7 PREPARATION OF PACKING CASE

- 1) Cases and crates with gross weight up to 1,000 kgs. shall be provided with bottom cleats of min. 40 mm thicknesses to ensure clearance for handling by forklift. Cases and crates exceeding gross weight of 1,000 kgs. shall be provided with skid runners, number and size according to weight of package.
- 2) The base of the case shall be made of wooden batons for planks giving necessary reinforcement, such that the bottom of the equipment is at a height of 100 to 200 mm from the ground level depending upon size & weight of equipment. However for packing cases of smaller size equipment can be at a height of 40 mm from the ground level.
- 3) In case of 'CR1 - Packing Viz. Electrical & Electronic components for instruments/assemblies, a rubber sheet, Self-expanded polyethylene foam sheet, preferably 10 mm thick, shall be fixed on to the base to act as cushioning to the equipment.
- 4) The four sides, shall be lined, from inside with multi-layered cross-laminated polyethylene sheet of 90GSM as per AA51420 and tacked at suitable places.

Whenever specified the top cover will have a layer of multi-layered cross laminated polyethylene sheet of 90 GSM over the cover. This should project about 100 - 250mm on all sides.

It is preferable to have a single piece of the above Multi-layered cross laminated polyethylene sheet fixed on the four sides. In case jointing is unavoidable, it should be done by overlapping of approximately 100mm.
- 5) Place the Components/cartons with corrosion inhibitors duly applied wherever necessary for place suitably, thin muslin cloths bags containing 100 grams (approx.) of activated Blue Silica Gel to AA55619, wherever necessary. Alternatively VCI Powder or Tablet may be used.
- 6) In case, depression is formed, at the top, after the equipment is lowered, provide ply board/wooden batons.
- 7) Cover the whole equipment with polyethylene sheet of at least 100 micron thickness, on all sides preferably by a single piece.
- 8) For indoor panels/equipment, provide suitable packing batons with covering of Thermocole/expanded soft polyethylene foam/polyethylene air bubble film wrapped with suitable cords, to avoid cutting of the polyethylene sheet so that finished surface is not damaged.
- 9) Empty space in the box shall be filled with adequate cushioning material e.g. Thermocole Chips, Wood Wool etc. to avoid movement for shocks. Alternatively put wooden blocks/batons wherever necessary.
- 10) The inner side of the top cover shall be lined with polyethylene sheet, of at least
- 11) 100 micron thickness, which shall project approximately 25 to 150 mm depending upon the size of the case on all sides of the top cover shall be provided below the top cover. This projection, after nailing the top cover, shall be folded over, on the sides of the crates & tacked, to, prevent ingress of water from the top.
- 12) For specific requirement of packing the cases are to be provided with Tongue and Groove joints.

8 STEEL CONTAINERS

Steel containers for packing can be used in case of repeated supplies of the same equipment. Empty steel containers are to be returned back from customer's end and to be reused for the next supplies.

The containers are to be made of structural steel as per AA10108 with proper reinforcement with I, C and T Sections.

Following precautions are to be taken during packing:

- Put the Components/Assemblies/Equipment in the steel container properly. Cover the Components/Assemblies/Equipment with polythene.
- To arrest the movement in the steel container necessary wooden Blocks/Batons may be put.
- Put cover on steel, container and Bolt Properly.



9 SEALED PACKING

Components sub-assemblies and assemblies sensitive to climatic conditions shall be packed seal tight. All the openings of the sensitive components, sub-assemblies and assemblies shall be blanketed to prevent the ingress of dust and moisture.

The components sub-assemblies and assemblies are completely covered with 2 layers of polyethylene sheet. All sharp corners and edges are to be protected by rubber mats to prevent the polyethylene sheet from damage. Top surface of the case shall be free from dents to prevent rain water pockets.

10 SLING PLATE

Sling plate shall be provided to prevent damage to the packing box during lifting. Size of the sling plate shall be selected depending upon the net weight of the consignment.

11 PACKING SLIP HOLDERS

Two nos. steel packing slip holders, specification no. AA7240901 containing the packing list, sealed in thick polyethylene film, shall be fixed one inside and the other outside the packing box.

12 Volatile Corrosion Inhibitor (VCI) Paper

- a) Un-protected surfaces of steel and cast iron components, tools bearing, shaft seals etc. are covered with VCI paper. VCI paper has been impregnated with corrosion inhibitors which by evaporation and chemical conversion protect metals in an enclosed area against corrosion.
- b) 7 m³ VCI paper is necessary for 1 m³ of packed item approximately as per AA51406.

Application Limitation:

VCI paper shall not be used for components made of aluminium, aluminium alloys as well as Zinc, copper, brass, cadmium and silver.

VCI powder is sprinkled inside the piping components ends shall be protected with end cover as specified in plant standards, drawings.

13 Moisture Absorber

Silica gel is used for this purpose to protect the contents over sufficiently long time from corrosion. At the time of use, silica gel should be so dried that its colour becomes dark blue. These shall be filled in small cotton bags. Before sealing the equipment, the silica gel bags should be kept inside the polyethylene film cover at different locations. The quantity of silica gel should not be less than 1.0 kg per cubic metre volume of the packing box

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14 GENERAL PRECAUTIONS

a) While fixing nails during packing, necessary care shall be taken to ensure that materials used for protection inside the case e.g. paper, polyethylene sheet, coir etc. do not get damaged.

b) Sling protection brackets to be provided on cases wherever required.

c) It shall be ensured that all stencil marks external, front & rear sides of the casing shall be of water proof Material to prevent obliteration in transit.

d) The various caution signs shall be marked with stencil on both sides of the packing box.

e) Do not pack any other Mechanical items with this case (do not use any other non-permitted packing materials).

THE FOLLOWING DETAILS ARE TO BE MARKED ON THE PACKING CASES.

a) Address of consignee.

b) Purchase Order No./ SO No/WO No.

c) Description of item or title of packing list.

d) Case identification Number/ Packing List No.

e) Net Weight.

f) Gross Weight.

g) Dimensions of box

h) Marking showing upright position.

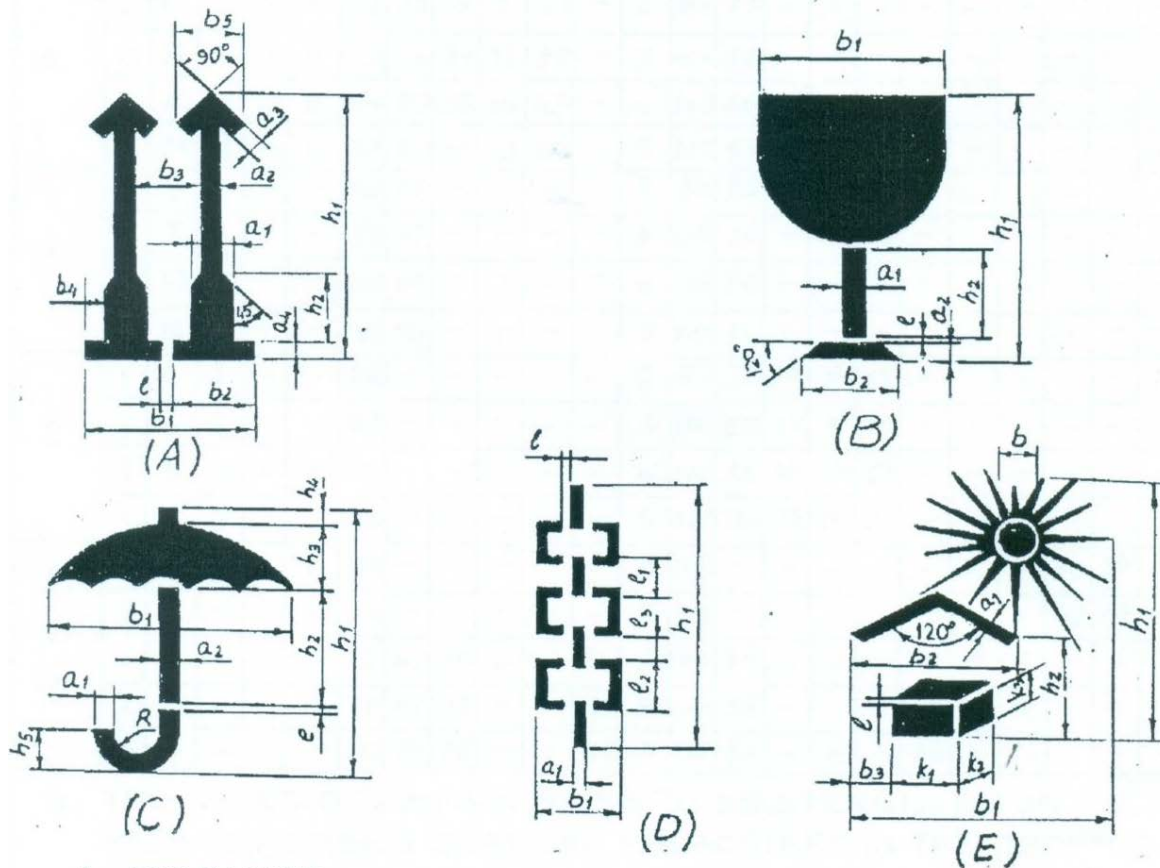
i) Marking showing sling position.

j) Marking showing umbrella (i.e. for machines/components to be stored under covered storage.

k) Loading and unloading precautions

MARKINGS ON PACKING CASE S

1. THIS PLANT STANDARD PRESCRIBES THE VARIOUS CAUTION SIGNS AND OTHER MARKINGS ON PACKING CASES.
2. DIMENSIONS IN THE TABLE 1 SHALL BE USED FOR MAKING STENCILS ONLY.



- A. UPRIGHT
 B. FRAGILE
 C. PROTECTION FROM FALLING OR CONDENSING MOISTURE.
 D. SLINGING POSITION
 E. PROTECTION FROM DIRECT RADIATIONS.

Figure 1



Figure 2

Table 1

DESIGN- ATION		DIMENSIONS IN mm.																							
		a ₁	a ₂	a ₃	a ₄	b ₁	b ₂	b ₃	b ₄	b ₅	b	ℓ	h ₁	h ₂	h ₃	h ₄	h ₅	K ₁	K ₂	K ₃	ℓ ₁	ℓ ₂	ℓ ₃	R	
A	1	12	5	5	4	52	25	19	8	21	-	2	84	23	-	-	-	-	-	-	-	-	-	-	-
	2	17	7	7	6	75	36	29	11	30	-	3	119	33	-	-	-	-	-	-	-	-	-	-	-
	3	24	10	10	8	104	50	38	16	42	-	4	168	46	-	-	-	-	-	-	-	-	-	-	-
	4	34	14	14	11	147	71	59	23	60	-	5	239	65	-	-	-	-	-	-	-	-	-	-	-
B	1	5	5	-	-	50	33	-	-	-	-	2	84	25	-	-	-	-	-	-	-	-	-	-	-
	2	7	7	-	-	71	47	-	-	-	-	3	119	36	-	-	-	-	-	-	-	-	-	-	-
	3	10	10	-	-	100	66	-	-	-	-	4	168	50	-	-	-	-	-	-	-	-	-	-	-
	4	14	14	-	-	142	94	-	-	-	-	5	239	71	-	-	-	-	-	-	-	-	-	-	-
C	1	4	3	-	-	66	-	-	-	-	-	2	80	39	19	5	11	-	-	-	-	-	-	-	6
	2	6	4	-	-	85	-	-	-	-	-	3	114	55	27	7	16	-	-	-	-	-	-	-	9
	3	8	6	-	-	120	-	-	-	-	-	4	160	78	38	10	22	-	-	-	-	-	-	-	12
	4	11	9	-	-	170	-	-	-	-	-	5	227	110	54	14	31	-	-	-	-	-	-	-	17
D	1	6	-	-	-	30	-	-	-	-	-	4	148	-	-	-	-	-	-	-	30	30	10	-	-
	2	9	-	-	-	42	-	-	-	-	-	5	209	-	-	-	-	-	-	-	42	42	14	-	-
E	1	3	-	-	-	69	47	10	-	-	16	2	91	26	-	-	-	17	8	11	-	-	-	-	-
	2	4	-	-	-	98	67	15	-	-	23	3	128	33	-	-	-	24	11	16	-	-	-	-	-
	3	6	-	-	-	138	94	20	-	-	32	4	182	62	-	-	-	34	16	22	-	-	-	-	-

Black and Red Marking Ink to IS: 1234 "Ink, Stencil, Oil Base, For Marking Porous Surfaces" or duplicating ink stencilling, oil base for marking porous surfaces.

All cases containing fragile items are to be stencilled with red marking and stencilling paint/ink.

"HANDLE WITH CARE", "FRAGILE DO NOT TURN OVER".

Besides the caution signs the product information shall be stencilled of letters with 13mm to 50mm height.

In case of consignment consists of more than one package, each package shall carry its Package No. as given in shipping list. All caution signs shall be stencilled in higher quality full glossy out door finishing paint red in colour (AA56126). All other markings shall be carried out in black enamel (AA56126).

Caution signs & other markings shall be stencilled on both the end shooks & the side shooks. Caution sign (for slinging) shall be stencilled only on side shooks at the appropriate place.

Note: In case the size of package is small for using the stencils, then hand written letters/figures shall be allowed.



15 PROCEDURE FOR HANDLING OF COMPONENTS

The purpose of this procedure is to protect the quality of the components/equipment while handling in various stages of manufacturing packing & despatching.

- 15.1** Adequate care shall be taken in handling the material, and components to avoid damage during receipts, storage issue manufacture & despatch operations.
- 15.2** Appropriate material handling equipment like fork lifters, cranes etc. Shall be used where needed.
- 15.3** Lifting by crane and transportation by trolley of critical items and large components like rotors castings etc. Shall be done carefully.
- 15.4** For critical items, where specified, special handling fixtures shall be used for lifting.
- 15.5** Slings and shackles used for lifting the components/equipment shall be checked for fitness and suitability before use.
- 15.6** Slings used on machined surfaces shall be suitably padded. No slings shall be used on journal surfaces.
- 15.7** Precision machined components like blades, catches, rollers etc. Shall be lifted using suitable wooden pallets.

15.8 HANDLING OF COMPONENTS ON RECEIPT/DESPATCH:

Before loading/unloading a packing case from the carrier look for the following shipping instructions painted on the packing case.

- The markings showing the upright position.
- The markings showing the sling position
- Markings showing the fragile contents.
- Other required markings as per Clause No. 12

- 15.8.1** Appropriate cranes and slings should be used for different components/ cases. Slings should normally make an angle as minimum as possible (width wise) but in no case more than 15°.
- 15.8.2** Handling and lifting should be done without jerks or impacts.
- 15.8.3** Immediately after receipt of the goods, the packing should be examined all-round for any sign of damage. If necessary, lift the cover or a number of boards of the case so as to make the contents visible. In the event of sealed packing being used the plastic sheeting should not be damaged. It is imperative that the packing material is restored in original condition after the inspection.
- 15.8.4** On receipt of the equipment it should be checked with the shipping list and missing or damage if any should be reported immediately. It is important to arrange for immediate examination to determine the extent of the damage, the cause of the damage and where applicable the person or persons responsible for the damage. According to general practice when transporting by railway or by road vehicle the carrier concerned should be immediately called upon (within specified periods) for jointly establishing a statement of the damage. This is essential as a basis for a subsequent claim and possible damage report to the insurance company.
- 15.8.5** Protective coating applied on machined surfaces should not be disturbed. The plastic covering should be put back carefully so that it prevents ingress of dust and moisture. Some packing may have vapour phase inhibitor (VPI) paper enclosed inside the packing cases. This should be restored to its original place as far as possible.
- 15.8.6** Silica gel and such other chemicals kept in the box as desiccants and indicators should also be left in the box itself.

16 GI SHEET

The packing cases are covered with GI sheet on outside for sides and top; inside for bottom as per the Figure-3 (GI sheet covering is applicable for all closed type of wooden packing).



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17 Treatment of Wood & Application and use of the mark

For seaworthy export packing, treatment of wood has to be carried out as below subject to BHEL Engg & QC approval.

As per customer requirement for export packing, wood to be treated as applicable should be done as per International Standards for Phytosanitary Measures ISPM: 15 to control the growth stages viz. egg to adult of structural insects (beetles, borers, bugs, fleas, flies, lice, moths, roaches, termites) and other pests (mice, rats, spiders) etc. in stored products.

The specified marks applied to wood packaging material treated in accordance with ISPM 15 must conform to the requirements described in Annex 2 of ISPM 15.

17.1 Heat treatment using a conventional steam or dry kiln heat chamber (treatment code for the mark: HT)

When using conventional heat chamber technology, the fundamental requirement is to achieve a minimum temperature of 56 °C for a minimum duration of 30 continuous minutes throughout the entire profile of the wood (including its core).

This temperature can be measured by inserting temperature sensors in the core of the wood. Alternatively, when using kiln-drying heat chambers or other heat treatment chambers, treatment schedules may be developed based on a series of test treatments during which the core temperature of the wood at various locations inside the heat chamber has been measured and correlated with chamber air temperature, taking into account the moisture content of the wood and other substantial parameters (such as species and thickness of the wood, air flow rate and humidity). The test series must demonstrate that a minimum temperature of 56 °C is maintained for a minimum duration of 30 continuous minutes throughout the entire profile of the wood.

Treatment schedules should be specified or approved by the National Plant Protection Organisation (NPPO). Treatment providers should be approved by the NPPO.

17.2 Heat treatment using dielectric heating (treatment code for the mark: DH)

Where dielectric heating is used (e.g. microwave), wood packaging material composed of wood not exceeding 20 cm when measured across the smallest dimension of the piece or the stack must be heated to achieve a minimum temperature of 60 °C for 1 continuous minute throughout the entire profile of the wood (including its surface). The prescribed temperature must be reached within 30 minutes from the start of the treatment.

Treatment schedules should be specified or approved by the NPPO.

17.3 Methyl bromide treatment (treatment code for the mark: MB)

Wood packaging material containing a piece of wood exceeding 20 cm in cross-section at its smallest dimension must not be treated with methyl bromide.

The fumigation of wood packaging material with methyl bromide must be in accordance with a schedule specified or approved by the NPPO (National Plant Protection Organisation) that achieves the minimum concentration-time product (CT) over 24 hours at the temperature and final residual concentration specified in Table 1. This CT must be achieved throughout the profile of the wood, including its core, although the concentrations would be measured in the ambient atmosphere. The minimum temperature of the wood and its surrounding atmosphere must not be less than 10 °C and the minimum exposure time must not be less than 24 hours. Monitoring of gas concentrations must be carried out at a minimum at 2, 4 and 24 hours from the beginning of the treatment. In the case of longer exposure times and weaker concentrations, additional measurement of the gas concentrations should be recorded at the end of fumigation.

If the CT is not achieved over 24 hours, corrective action needs to be taken to ensure the CT is reached; for example, the treatment is restarted or the treatment time extended for a maximum of 2 hours without adding more methyl bromide to achieve the required CT (see the footnote to Table 2).

CORPORATE STANDARD**Table 2 – Minimum CT over 24 hours for wood packaging material fumigated with methyl bromide**

Temperature (°C)	CT (g·h/m ³) over 24 h	Minimum final concentration (g/m ³) after 24 h#
21.0 or above	650	24
16.0 – 20.9	800	28
10.0 – 15.9	900	32

In circumstances when the minimum final concentration is not achieved after 24 hours, a deviation in the concentration of ~5% is permitted provided additional treatment time is added to the end of the treatment to achieve the prescribed CT.

One example of a schedule that may be used for achieving the specified requirements is shown in Table 3.

Table 3 – Example of a treatment schedule that achieves the minimum required CT for wood packaging material treated with methyl bromide (initial doses may need to be higher in conditions of high sorption or leakage)

Temperature (°C)	Dosage (g/m ³)	Minimum concentration (g/m ³) at:		
		2 h	4 h	24 h
21.0 or above	48	36	31	24
16.0 – 20.9	56	42	36	28
10.0 – 15.9	64	48	42	32

Treatment providers should be approved by the NPPO.

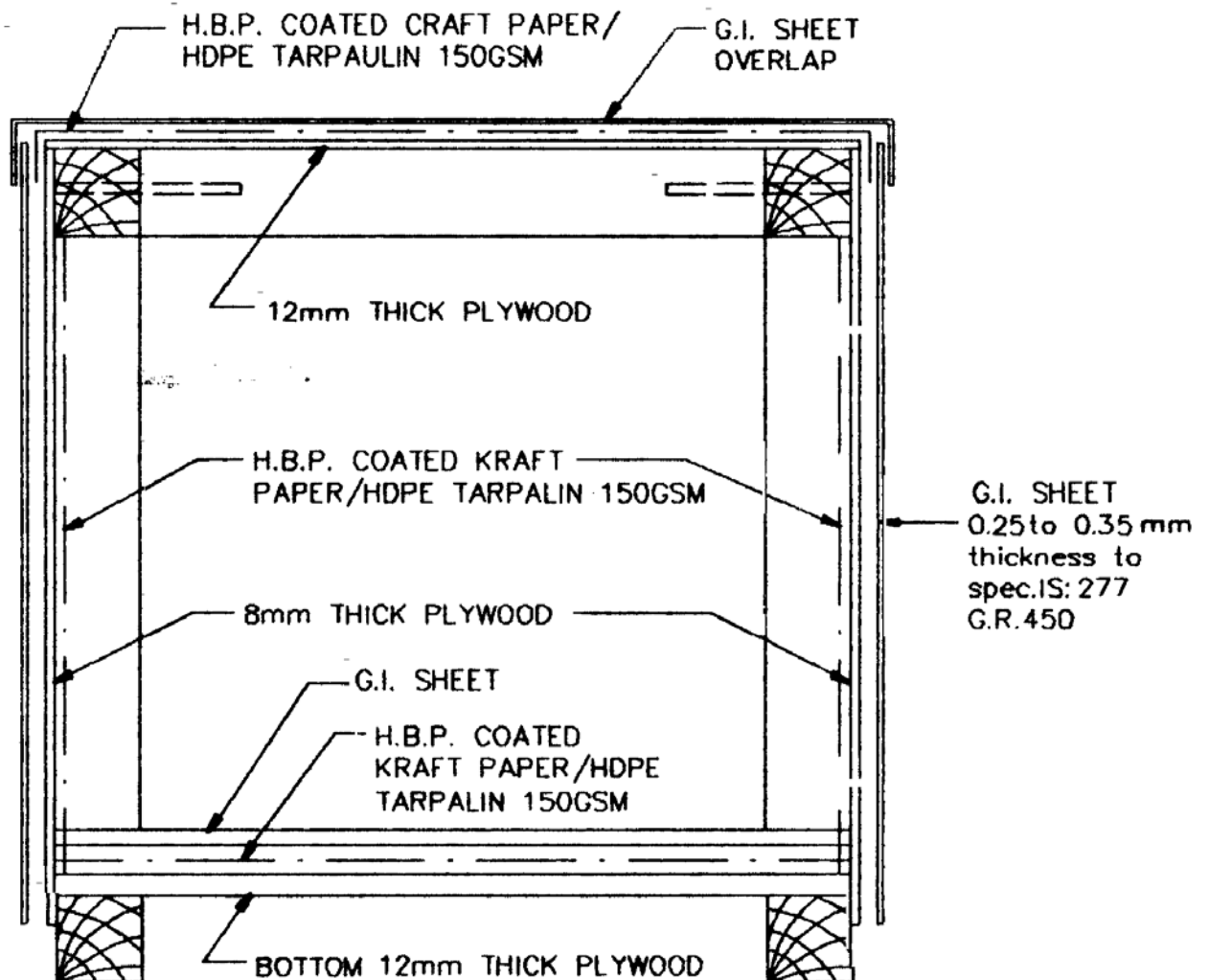
17.4 Marking

The specified marks applied to wood packaging material treated in accordance with ISPM 15 must conform to the requirements described in ISPM 15.

18 PROVISION FOR INSPECTION

This clause is applicable only where contractual requirement of customer is there. For other packings this is not applicable.

Each transportable packing's shall have provision for inspection by customer authority etc. during transport from origin of dispatched till destination. This inspection may require opening of the package and subsequently closing it again. For this purpose suitable designed opening with bolted cover shall be provided. Such an opening shall be clearly marked as "OPENING" with clear instruction for opening & closing written on this cover. For large consignment the size of the opening shall be suitable to facilitate entry of personnel.



CLOSED PACKING CASE WITH
G.I.SHEET SHOWING LAYERS
OF PACKING MATERIALS

Figure 3



Title:
1 X 800 MW NCTPP STAGE-III,
Chennai, TANGEDCO, Tamilnadu
Technical Specification
for Agitators of FGD Slurry Tanks

Specification No: PE-TS-485-571-18000-A001

Section: II - ANNEXURE-1

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SECTION-II

ANNEXURE-1

LIST OF DOCUMENTS TO BE SUBMITTED WITH BID



Title:
1 X 800 MW NCTPP STAGE-III,
Chennai, TANGEDCO, Tamilnadu
Technical Specification
for Agitators of FGD Slurry Tanks

Specification No: PE-TS-485-571-18000-A001

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**BIDDER SHOULD SUBMIT THE SIGNED AND STAMPED COPY
OF THE FOLLOWING DOCUMENTS:**

Document for Evaluation:

1. Compliance cum confirmation certificate (Refer Annexure-2 of section-II).
2. Pre-bid clarification, if any, as per format given under Section-II (Annexure-3)
3. Amendment to specification, if any, issued by BHEL dully signed and stamped.
4. Deviation schedule as per format given under Section-II (Annexure-4), in case of any deviations by bidder.
5. Documents for meeting the Pre-Qualification Requirement Annexure-10, section-II).
6. List of special tools and tackles (Refer Annexure-7 of section-II).
7. Dully filled Guaranteed power consumption format (In the format attached with the price schedule) declaring guaranteed power consumption value in KW along with the Technical offer. **Bid with GPC more than 26 KW will not be considered for evaluation.**

Document for Reference:

1. Agitator Schedule filled up by the bidder (Refer Annexure-8 of section-II).
2. GA drawing, exploded view with Material of construction, total weight of all Agitators models offered.
3. Agitator Motor Sizing Calculation.
4. Electrical Load data filled up by the bidder (Refer Annexure-5 of section-II).
5. Test arrangement at shop
6. Product catalogue for offered agitators
7. Utility requirement (Air, water etc.)

Details mentioned under reference documents are subject finalization during detail engineering meeting requirements mentioned in various parts of the specification.

	Title: 1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO, Tamilnadu Technical Specification for Agitators of FGD Slurry Tanks	Specification No: PE-TS-485-571- 18000-A001	
		Section-II, ANNEXURE-2	
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ANNEXURE-2 **COMPLIANCE CUM CONFIRMATION** **CERTIFICATE**

	Title: 1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO, Tamilnadu Technical Specification for Agitators of FGD Slurry Tanks	Specification No: PE-TS-485-571-18000-A001	
		Section: II - ANNEXURE-2	
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COMPLIANCE CUM CONFIRMATION CERTIFICATE

The bidder shall confirm compliance with following by signing / stamping this compliance certificate (every sheet) and furnish same with the offer.

- a) The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions, other than those mentioned under “exclusion and those resolved as per ‘Schedule of Deviations’, with regard to same.
- b) There are no other deviations w.r.t. specifications other than those furnished in the ‘Schedule of Deviations’. Any other deviation, stated or implied, taken elsewhere in the offer stands withdrawn unless specifically brought out in the ‘Schedule of Deviations’
- c) Bidder shall submit QP in the event of order based on the guidelines given in the specification & QP enclosed therein. QP will be subject to BHEL / CUSTOMER approval & customer hold points for inspection / testing shall be marked in the QP at the contract stage. Inspection / testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc. This is within the contracted price without any extra implications to BHEL after award of the contract.
- d) All drawings/ data-sheets / calculations etc. submitted along with the offer shall not be taken cognizance off.
- e) The offered materials shall be either equivalent or superior to those specified in the specification & shall meet the specified / intended duty requirements. In case the material specified in the specifications is not compatible for intended duty requirements then same shall be resolved by the bidder with BHEL during the pre-bid discussions, otherwise BHEL / Customer’s decision shall be binding on the bidder whenever the deficiency is pointed out. For components where materials are not specified, same shall be suitable for intended duty, all materials shall be subject to approval in the event of order.
- f) The commissioning spares shall be supplied on ‘As Required Basis’ & prices for same included in the base price itself.
- g) All sub vendors shall be subject to BHEL / CUSTOMER approval in the event of order.
- h) Guarantee for plant/equipment shall be as per relevant clause of GCC / SCC / Other Commercial Terms & Conditions

	Title: 1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO, Tamilnadu Technical Specification for Agitators of FGD Slurry Tanks	Specification No: PE-TS-485-571-18000-A001	
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i) In the event of order, all the material required for completing the job at site shall be supplied by the bidder within the ordered price even if the same are additional to approved billing break up, approved drawing or approved Bill of quantities within the scope of work as tender specification. This clause will apply in case during site commissioning, additional requirements emerges due to customer and / or consultant's comments. No extra claims shall be put on this account. j) Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to BHEL's / Customer's / Consultant's office for across the table resolution of issues and to get documents approved in the stipulated time. k) As built drawings shall be submitted as and when required during the project execution. l) The bidder has not tempered with this compliance cum confirmation certificate and if at any stage any tempering in the signed copy of this document is noticed then same shall be treated as breach of contract and suitable actions shall be taken against the bidder. m) Successful bidder shall furnish detailed erection manual for each of the equipment supplied under this contract at least 3 months before the scheduled erection of the concerned equipment / component or along with supply of concerned equipment / component whichever is earlier. n) Document approval by customer under Approval category or information category shall not absolve the vendor of their contractual obligations of completing the work as per specification requirement. Any deviation from specified requirement shall be reported by the vendor in writing and require written approval. Unless any change in specified requirement has been brought out by the vendor during detail engineering in writing while submitting the document to customer for approval, approved document (with implicit deviation) will not be cited as a reason for not following the specification requirement. o) In case vendor submits revised drawing after approval of the corresponding drawing, any delay in approval of revised drawing shall be to vendor's account and shall not be used as a reason for extension in contract completion.			

	Title: 1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO, Tamilnadu Technical Specification for Agitators of FGD Slurry Tanks	Specification No: PE-TS-485-571- 18000-A001	
		Section-II, ANNEXURE-3	
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ANNEXURE-3

PRE-BID CLARIFICATION SCHEDULE



Title:
1 X 800 MW NCTPP STAGE-III,
Chennai, TANGEDCO, Tamilnadu
Technical Specification
for Agitators of FGD Slurry Tanks

Specification No: PE-TS-485-571- 18000-A001

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PRE-BID CLARIFICATION SCHEDULE

S. No	Section/Clause / Page No.	Statement of the referred clause	Pre-bid Query	BHEL Reply

SIGNATURE: _____

NAME: _____

DESIGNATION: _____

COMPANY: _____

DATE: _____

COMPANY SEAL

	Title: 1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO, Tamilnadu Technical Specification for Agitators of FGD Slurry Tanks	Specification No: PE-TS-485-571- 18000-A001	
		Section-II, ANNEXURE-4	
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ANNEXURE-4
SCHEDULE OF TECHNICAL DEVIATION
(PLEASE REFER GCC FOR THE FORMAT OF DEVIATION SCHEDULE)

	Title: 1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO, Tamilnadu Technical Specification for Agitators of FGD Slurry Tanks	Specification No: PE-TS-485-571- 18000-A001	
		Section-II, ANNEXURE-5	
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ANNEXURE-5

ELECTRICAL LOAD DATA

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.	VERIFICATION FROM MOTOR DATASHEET (Y/N)	KKS NO
	NAME PLATE	MAX. CONT. DEMAND (MCR)		SIZE CODE	NOS															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
ANNEXURE-5																				
AUXILIARY ABSORBENT TANK				3	0				C											
LIMESTONE SLURRY STORAGE TANK				1	0				C											
FILTRATE WATER RECEIVER TANK				1	0				C											
SECONDARY HYDROCYCLONE FEED TANK				1	0				C											
FILTRATE WATER TANK				1	0				C											
WASTE WATER TANK				1	0				C											
ABSORBER AREA DRAIN SUMP				1	0				C											
GYPSUM AREA DRAIN SUMP				1	0				C											
LIMESTONE AREA DRAIN SUMP				1	0				C											
NOTES: 1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)/ CUSTOMER 2. ABBREVIATIONS : * VOLTAGE CODE (7): - (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (cc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V : ** FEEDER CODE (8): - U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTOR CONTROLLED)																				
LOAD DATA (ELECTRICAL)	JOB NO.		485								ORIGINATING AGENCY									
	PROJECT TITLE		1 x 800 MW NCTPP Stage-III(FGD), Chennai, TANGEDCO								NAME						DATA FILLED UP ON			
	SYSTEM		AGITATOR								SIGN.						DATA ENTERED ON			
	DEPTT. / SECTION		MAUX								SHEET 1 OF 1		REV. 00		DE'S SIGN. & DATE					

	Title: 1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO, Tamilnadu Technical Specification for Agitators of FGD Slurry Tanks	Specification No: PE-TS-485-571- 18000-A001	
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ANNEXURE-6

LIST OF MAKES OF SUB VENDOR ITEMS



Title:
1 X 800 MW NCTPP STAGE-III,
Chennai, TANGEDCO, Tamilnadu
Technical Specification
for Agitators of FGD Slurry Tanks

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LIST OF MAKES OF SUB -VENDOR ITEMS

<u>S.N.</u>	<u>ITEM NAME</u>	<u>MANUFACTURER</u>	<u>LOCATION</u>

	Title: 1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO, Tamilnadu Technical Specification for Agitators of FGD Slurry Tanks	Specification No: PE-TS-485-571- 18000-A001	
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ANNEXURE-7

LIST OF TOOLS AND TACKLES



Title:
1 X 800 MW NCTPP STAGE-III,
Chennai, TANGEDCO, Tamilnadu
Technical Specification
for Agitators of FGD Slurry Tanks

Specification No: PE-TS-485-571- 18000-A001

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LIST OF TOOLS AND TACKLES

Bidder 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 and tackles shall be submitted along with the offer in the format below.

Sl.no.	Description of item	Quantity

In case bidder indicates that no special tools and tackles are required but the same is found applicable during detailed engineering the same shall be supplied by the bidder without any commercial and delivery implications.

SIGNATURE: _____

NAME: _____

DESIGNATION: _____

COMPANY: _____

DATE: _____

COMPANY SEAL

	Title: 1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO, Tamilnadu Technical Specification for Agitators of FGD Slurry Tanks	Specification No: PE-TS-485-571- 18000-A001	
		Section-II, ANNEXURE-8	
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ANNEXURE-8

AGITATOR SCHEDULE

ANNEXURE-8 -AGITATOR SCHEDULE (To be submmitted with the offer by Bidder), 1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO,SPEC PE-TS-485-571-18000-A001										
Sl.no.	Description	AUXILIARY ABSORBENT TANK	LIMESTONE SLURRY STORAGE TANK	FILTRATE WATER RECEIVER TANK	SECONDARY HYDROCYCLONE FEED TANK	FILTRATE WATER TANK	WASTE WATER TANK	ABSORBER AREA DRAIN SUMP	GYPSUM AREA DRAIN SUMP	LIMESTONE AREA DRAIN SUMP
1	Agitator Sl No.	1	2	3	4	5	6	7	8	9
2	Type	Blade turbine - vertical entry or marine propeller side entry	Vertical Type – (Center Mounted)	Vertical Type – (Center Mounted)	Vertical Type – (Center Mounted)	Vertical Type – (Center Mounted)	Vertical Type – (Center Mounted)	Vertical Type – (Center Mounted)	Vertical Type – (Center Mounted)	Vertical Type – (Center Mounted)
3	Medium to be handled	Gypsum slurry	Limestone slurry	Gypsum slurry	Gypsum slurry	Gypsum slurry	Gypsum slurry	Gypsum slurry	Gypsum slurry	Limestone slurry
4	Seal Type	Mechanical seal (emergency flush start) required in case of side entry	Not required	Not required	Not required	Not required	Not required	Not required	Not required	Not required
5	Agitator Location	Outdoor	Outdoor	Outdoor	Outdoor	Outdoor	Outdoor	Outdoor	Outdoor	Outdoor
6	Duty	Intermittent - Whenever FGD is under maintenance	Continuous	Continuous	Continuous	Continuous.	Continuous.	Intermittent	Intermittent	Intermittent
7	Tank details									
a)	Tank Shape	Circular	Circular	Circular	Circular	Circular	Circular	Rectangular	Rectangular	Rectangular
b)	Tank name	AUXILIARY ABSORBENT TANK	LIMESTONE SLURRY STORAGE TANK	FILTERATE WATER RECEIVER TANK	SECONDARY HYDROCYCLONE FEED TANK	FILTRATE WATER TANK	WASTE WATER TANK	ABSORBER AREA DRAIN SUMP	GYPSUM AREA DRAIN SUMP	LIMESTONE AREA DRAIN SUMP
c)	Capacity (in m3)	1546.3 m ³	447.4 m ³	33.7 m ³	353 m ³	33.7 m ³	145 m ³	56 m ³	56 m ³	56 m ³
	Dimension (in m)							4 W X4 L X4 H	4 W X4 L X4 H	4 W X4 L X4 H
d)	Diameter	12.5	8.0	3.5	7.5	3.5	5.5	-	-	-
e)	Length	-	-	-	-	-	-	4	4	4
f)	Breadth	-	-	-	-	-	-	4	4	4
g)	Height	13.1	9.40	4.0	8.50	4.0	6.6	4.5	4.5	4.5
8	MOC of Agitator	If side entry - Agitator Shaft (which is continuously in contact with slurry) and blades shall be made with Alloy 926 or better material. If Top entry Agitator blades shall be made with Alloy 926 or better material & Agitator shaft can be rubber lined.	Agitator blades shall be made with Alloy 926 or better material & Agitator shaft can be rubber lined.	Agitator blades shall be made with Alloy 926 or better material & Agitator shaft can be rubber lined.	Agitator blades shall be made with Alloy 926 or better material & Agitator shaft can be rubber lined.	Agitator blades shall be made with Alloy 926 or better material & Agitator shaft can be rubber lined.	Agitator blades shall be made with Alloy 926 or better material & Agitator shaft can be rubber lined.	Agitator blades shall be made with Alloy 926 or better material & Agitator shaft can be rubber lined.	Agitator blades shall be made with Alloy 926 or better material & Agitator shaft can be rubber lined.	Agitator blades shall be made with Alloy 926 or better material & Agitator shaft can be rubber lined.
9	Quantity of Agitator per tank	3 nos. - side entry (refer note2)	1No.	1No.	1No.	1No.	1No.	1No.	1No.	1No.
10	Total quantity of agitators (for all units)	3 nos. - side entry (refer note2)	1 No.	1 No.	1 No.	1 No.	1 No.	1 No's	1 No.	1 No.
11	Slurry Analysis									
a)	Slurry to be handled	Gypsum slurry	Limestone slurry	Gypsum slurry	Gypsum slurry	Gypsum slurry	Gypsum slurry	Gypsum slurry	Gypsum slurry	Limestone slurry
b)	Maximum solid particle size	200 mesh (74 μ)	200 mesh (74 μ)	200 mesh (74 μ)	200 mesh (74 μ)	6-7 mm	200 mesh (74 μ)	6-7 mm	6-7 mm	6-7 mm
c)	Normal solid particle size, d50	325 mesh (44 μ)	325 mesh (44 μ)	325 mesh (44 μ)	325 mesh (44 μ)	325 mesh (44 μ)	325 mesh (44 μ)	325 mesh (44 μ)	325 mesh (44 μ)	325 mesh (44 μ)
d)	Solid to be handled	Gypsum along with Limestone & other impurities	Limestone + impurities	Gypsum along with Limestone & other impurities	Gypsum along with Limestone & other impurities	Gypsum along with Limestone & other impurities	Gypsum along with Limestone & other impurities	Gypsum along with Limestone & other impurities	Gypsum along with Limestone & other impurities	Limestone + impurities
e)	Chloride concentration	max 25000 ppm	max 1000 ppm	max 25000 ppm	max 25000 ppm	max 25000 ppm	max 25000 ppm	max 25000 ppm	max 25000 ppm	max 1000 ppm
f)	Hardness of particle	5-7 mohs scale	5-7 mohs scale	5-7 mohs scale	5-7 mohs scale	5-7 mohs scale	5-7 mohs scale	5-7 mohs scale	5-7 mohs scale	5-7 mohs scale
g)	Slurry concentration, wt%	30%	30 wt %	0.3%	16.60%	20%	3%	30%	30%	30 wt %
h)	Sp. Gravity of slurry	1.219	1.23	1.005	1.114	1.138	1.024	1.219	1.219	1.23
i)	Sp. Gravity of Lime Stone & Gypsum	2.32(avg)	2.32(avg)	2.32(avg)	2.32(avg)	2.32(avg)	2.32(avg)	2.32(avg)	2.32(avg)	2.32(avg)
j)	Viscosity of Slurry	10 cP	30 cP	<3 cP	4 cP	>4 cP & < 10 Cp	3 cP	10 cP	10 cP	30 cP
k)	pH	4 to 8	5 to 8	4 to 8	4 to 8	4 to 8	4 to 8	4 to 8	4 to 8	5 to 8
l)	SiO ₂ Content	4 to 6 g/l	4 to 6 g/l	4 to 6 g/l	4 to 6 g/l	4 to 6 g/l	4 to 6 g/l	4 to 6 g/l	4 to 6 g/l	4 to 6 g/l
m)	Temperature	Normal -55 deg C; Design-70 deg C.	Normal -35 deg C; Design-55 deg C.	Normal -45 deg C; Design-70 deg C.	Normal -55 deg C; Design-70 deg C.	Normal -55 deg C; Design-70 deg C.	Normal -55 deg C; Design-70 deg C.	Normal -55 deg C; Design-70 deg C.	Normal -55 deg C; Design-70 deg C.	Normal -55 deg C; Design-70 deg C.
12	Motor									
a)	Total Power consumed	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder
b)	Motor Rating	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder
c)	Motor Explosion Proof Class	Non-Flame Proof	Non-Flame Proof	Non-Flame Proof	Non-Flame Proof	Non-Flame Proof	Non-Flame Proof	Non-Flame Proof	Non-Flame Proof	Non-Flame Proof
d)	Motor Protection Class	IP-55/ Outdoor	IP-55/ Outdoor	IP-55/ Outdoor	IP-55/ Outdoor	IP-55/ Outdoor	IP-55/ Outdoor	IP-55/ Outdoor	IP-55/ Outdoor	IP-55/ Outdoor
e)	Motor Efficiency Class	IE-3	IE-3	IE-3	IE-3	IE-3	IE-3	IE-3	IE-3	IE-3
13	Various Tank Levels									
a)	Minimum Liquid level (m)	1.0	1.0	1.0	1.0	1.0	1.0	1.4	1.4	1.4
b)	Normal Liquid level (m)	11.6	8.2	2.80	7.30	2.8	5.4	3.3	3.3	3.3
c)	Maximum Liquid Level (m)	11.8	8.4	3.0	7.5	3.0	5.6	3.5	3.5	3.5
14	Impeller									
a)	Type of impeller	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder
b)	No. of impeller stages	2	2	1	2	1	1	1	1	1
c)	Impeller diameter	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder

d)	Impeller tip speed (Refer sl. No 19 C)	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder
e)	Operating speed	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder
f)	Agitator Pumping Capacity	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder
g)	Volume/Agitator	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder
15	Baffle Plates (not in bidder's scope)									
a)	No. & size of baffle plates	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder
b)	Thickness of baffle plates (mm)	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder
c)	Distance from Bottom of the tank	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder
16	Nozzle (not in bidder's scope)									
a)	Size of the nozzle on which agitator frame is mounted	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder
17	Loads									
a)	Static Load	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder
b)	Dynamic load	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder
c)	Torsional Moment (Nm)	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder
d)	Bending Moment (Nm)	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder
e)	Power Number of Agitator	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder	To be filled by bidder
18	Power loading for Auxiliary power consumption	Not applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Not applicable	Not applicable	Not applicable
19	Parameters to be considered compulsarily by bidder for design of Agitators									
a)	Uniform suspension of solids by Agitators	The agitators shall keep the solid particles in suspended mode in liquid slurry with “Full off-Bottom Suspension” of solid particles to 98% of liquid column to virtually “Uniform Solid Concentration”.								
b)	Mounting of Agitator (For Vertical mounting)	The Agitators shall be mounted on the Agitator platform which shall be approximately at a height of 1.0 m from the tank roof. However, the Agitator platform is excluded from bidder's scope.								
c)	Maximum permitted impeller tip speed	12 m/s								
d)	Impeller tip dia/ tank dia	1/3 (approx)	1/3 (approx)	1/3 (approx)	1/3 (approx)	1/3 (approx)	1/3 (approx)	-	-	-
Notes										
1	There shall be complete re-suspension of all solids after a 24 hour outage. Accumulation of solids shall not prevent agitator restart.									
2	Agitation shall be provided to prevent settlement of slurry by side entry agitators . All the side-entry agitators shall be similar									
3	Maximum Sound Pressure Level at a height of 1.5 m above floor level in elevation, and at a distance of 1.0 m horizontally shall not exceed 85 dBA.									
4	Although the height of all tanks is fixed above, same may vary slightly during detailed engineering as per design calculation of tanks.									
5	Normal solid particle size shall be used for design of all Agitators in tanks and sumps.									
6	Slope of roof shall be considered approximate 5 deg for all the tanks.									

	Title: 1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO, Tamilnadu Technical Specification for Agitators of FGD Slurry Tanks	Specification No: PE-TS-485-571- 18000-A001	
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ANNEXURE-9

LIST OF COMMISSIONING SPARES

1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO,
Agitators of FGD Slurry
List of Commissioning Spares
Break up Price for Commissioning Spares

Sl. No.	Description	Quantity	Unit
	Total (Rs)		

Note-

Bidder shall furnish unit price of commissioning spares in above format along with the Bid.
Any part even though not mentioned in list furnished but required at later date shall be supplied free of cost.

	Title: 1 X 800 MW NCTPP STAGE-III, Chennai, TANGEDCO, Tamilnadu Technical Specification for Agitators of FGD Slurry Tanks	Specification No: PE-TS-485-571- 18000-A001	
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ANNEXURE-10

PROVENNESS CRITERIA



concentrations between minimum and maximum without exceeding the emission values of SO₂ emission of less than 100 mg/Nm³ (6% O₂ dry).

In case of failure of the SG and ancillary equipment, the FGD plant shall be brought automatically to the off-load operation without restriction by the current load case by suitable measures.

In case of a power failure all items of equipment (minimum one agitator in absorber and limestone slurry tank, process water pump & lube oil system of booster fan & ball mill) which may cause irreversible damage to the FGD System shall be connected to the emergency power supply system to be provided by the Contractor. Bidder shall furnish a list of all of all such Auxiliaries in their bid proposal.

In case of shutdown and outage periods, draining and flushing of limestone slurry and gypsum slurry pipe work, tanks and all other items being in contact with limestone slurry or gypsum slurry shall be possible without restriction and without necessity of extensive or unusual preparation and activity. Draining and flushing which are required even during short time outages or an emergency shutdown shall be started automatically and by remote control from the Control Room.

All items or equipment which are subject to wear, abrasion or failure (e.g. nozzles, pumps, pipe work, etc.) shall be designed and installed for easy replacement, repair and maintenance.

The design and the construction shall be performed so as to avoid stress corrosion cracking, galvanic or other types of corrosion. Especially when using two different alloys, appropriate measures shall be taken to avoid corrosion. This is subject to approval by the Employer.

All items of equipment including flue gas ducts, expansion joints, etc. shall be designed considering thermal and mechanical strength as a function of the maximum temperature which might occur in case of a failure of any upstream equipment.

Waste water which might be generated during flushing and cleaning procedures of the equipment (e.g. lime slurry bins, pipes, trucks, etc.) shall be collected in sump and shall possibly be reused in the wet absorber.

In case distance from Limestone Grinding system/ Gypsum Dewatering and Absorber is more than 500M, Bidder shall provide the following:-

Flushing system at intermittent locations for the lime stone slurry pipeline which shall contain tank and pumps. Intermittent location distance of flushing system shall be based on their proven practice

4.1.0 Justification of Proposed Design

All the design procedures, systems, and components proposed shall have already been adequately developed and have demonstrated good reliability under similar or more arduous conditions elsewhere.

Booster Fans, Slurry Recirculation Pumps, Oxidation Blowers, Wet Limestone Grinding Mills, Slurry Pumps, Agitators, Vacuum Belt Filters, Gas to Gas Heat exchanger (GGH) & Booster Fan Motor for the Wet Limestone based Flue Gas Desulphurisation (FGD) System offered by the Bidder shall be only from such manufacturer(s) who has previous experience of manufacturing and supplying the respective equipment(s) and have been in successful operation in at least one (1) plant for a period not less than one(1) year prior to the date of Techno-Commercial bid opening



The Bidder shall submit with the offer, comprehensive information on how the L/G ratio, mass balance, spray nozzle cone angle, spray nozzle arrangement; limestone consumption etc. of the proposed design has been arrived at. The Bidder shall also submit along with the offer, a detailed write up on the proposed design features with recent design modifications, if any, and their specific advantages over the previous designs.

4.2.0 Statutory Approval

The engineering, design, supply and installation of FGD system and the associated auxiliaries shall comply with the applicable safety code and regulation of the locality where the system is being installed.

4.3.0 Location & Layout Requirements

The Bidder shall offer the best design to accommodate the Flue Gas Desulphurisation (FGD) System and Lime stone & Gypsum handling & storage system within the confines of the space available.

Approach road to every entity, facility, building etc. shall be provided by the contractor. Sufficient maintenance space to be ensured for FGD auxiliary by the contractor.

Fouling of the FGD structure with functioning of existing auxiliaries/structure shall be avoided.

The layout of FGD System have been indicated in the tender drawings No. FCE-1116127-GE-DWG-LAY-3000-001. The layout indicated is only for the purpose of the tender, Bidder shall consider necessary facilities required for the system in the available area allocated for the FGD, any interface with the existing shall be taken care by the Contractor without affecting the existing systems. Any relocation of the existing system (if required) shall be discussed and based on which a proposal shall be submitted and take the necessary approval from the Owner before execution of such changes.

Capital Overhaul of FGD System

Employer envisages to carryout the capital overhaul of units once in three (3) years. The design and materials for various equipment/auxiliaries etc. shall be selected by the Contractor keeping in view the above requirement of the Employer, such that no major repairs/replacements, requiring shutdown of the unit, are needed in between the capital overhauls.

4.4.0 Approach & Handling Facilities

Proper approach shall be provided for access to all equipment during normal operation and maintenance. Unless otherwise specified, platforms, staircase and ladders shall follow the stipulations specified elsewhere in this specification.

Equipment requiring monitoring during regular operation shall be approachable from the ground floor through staircase. Staircase with minimum width of 1200 mm shall be provided for approach to elevated structures at 5m height from the nearest platform. Below this height a vertical ladder with minimum clear width of 600 mm may also be acceptable.

Platform with a minimum clear width of 1000 mm shall be provided all around the lowest absorber spray levels and mist eliminators. Similar platforms shall be provided at subsequent elevations if they are more than 3000 mm apart from each other. An adequately sized manhole with platform (min. 2 sq. m) shall be provided above each spray level. Ladders/staircase shall be provided for the access to the platform.