

Form No:	 PE&SD	TECHNICAL SPECIFICATION FOR	PY 51769
		GYPSUM DEWATERING SYSTEM PACKAGE	Rev. No. 00
		NTPL –TUTRICORIN 2 X 500 M W TPS - FGD	Page 2 of 59

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CLAUSE NO.	DESCRIPTION	
1.0.00	PROJECT INFORMATION	
a)	Client Name	: NLC Tamil Nadu Power Limited (NTPL)
b)	Plant Name	: NTPL Tuticorin 2X500 MW
c)	Project Name	: NTPL Tuticorin Thermal Power
d)	Consultant Name	: DCPL
e)	Plant capacity	: 2X500 MW
f)	Plant location	: Latitude 8°45'38.09" North Longitude 78°10'15.85" East At Tuticorin Taluk in Tuticorin district in the Southern Part of Tamil Nadu along the Bay of Munnar, India
g)	Site Elevation	: The natural land profile of the site 1.46 m above mean sea level
h)	Buyer	: BHEL-PE& SD (HYD)
	Metrological Data	
a)	Maximum Ambient Temperature(DBT)	: 36.5 Deg C
b)	Minimum Ambient Temperature(DBT)	: 20.8 Deg C
c)	Performance DBT	: 27 Deg C
d)	Earthquake zone	: Zone-II
e)	Maximum Relative Humidity	: 82%
f)	Minimum Relative Humidity	: 35%
g)	Performance Relative Humidity	: 50%
h)	Rainfall-annual	: 437 mm
	Note: 1) Guarantee point conditions shall apply for the Guarantee Values as well as for the Guarantee test/ Performance test 2) Equipment and Material must be suitable for the range of ambient site conditions. 3) Vendor to submit the GA drawings of the vacuum belt filter and associated equipment along with his offer. The dimensions indicated by the bidder in his GA'S shall be binding, and any change of the same shall not be admissible after the award of PO 4) Vendor to quote all the listed items and any incomplete offer will be liable for rejection. 5) In case of any queries on the Technical matters, non-availability of specifications etc., bidder shall contact BHEL within 3 days of receipt of Enquiry for seeking clarifications. This will not be used for extending technical bid submission due date or delay of procurement cycle time. No queries will be entertained after Bid submission is completed. 6) All the documentation and communication shall be in English language only.	
2.0.0	APPLICABLE CODES AND REGULATIONS	
	The design and materials shall confirm to the requirements of applicable codes and regulations of the latest edition. The design, manufacture, installation and testing of the gypsum dewatering system shall follow the latest applicable Indian/ ASME/ BS EN Standards. Other standards are not acceptable.	

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3.0.0	INTENT OF SPECIFICATION	
a)	This specification covers the minimum requirements for the complete design, material, manufacturing, shop inspection, testing at the manufacturer's works, delivery at site, supervision of erection & commissioning and performance testing of Gypsum Dewatering System along with accessories, which is to be furnished in the Flue Gas Desulphurization plant.	
b)	Bidder shall make all possible efforts to comply strictly with the requirements of this specification and other specifications/ attachments to inquiry/ order.	
c)	It is not the intent to completely specify all the details of supply. Nevertheless, the finished product shall conform to highest standards of Engineering & Manufacturing and shall be capable of performing in continuous commercial operation in a manner acceptable to the Purchaser and end customer	
d)	There are (2) units of 500 MW and this unit is envisaged with one (1) FGD system.	
e)	The Bidder shall offer only proven design, which meets the Provenness criteria indicated in the clause no: 4.0. Necessary document evidences as per Annexure-I shall be submitted along with the bid. If bidder doesn't meet the specified provenness criteria, they are denied to participate in this tender.	
f)	In case, the Bidder considers deviations essential (after exhausting all possible efforts), the same shall be separately listed in the Bidder's proposal under separate section, titled as "List of Deviations/Exceptions to the Enquiry Document" (Annexure-V). Any deviation, not listed under the above section, even if reflected in any other portion of the proposal, shall not be considered applicable. No deviation or exception shall be permitted without the written approval of the purchaser.	
g)	In case, the Bidder considers requirement of additional instrumentation, controls, safety devices and any other accessories/ auxiliaries essential for safe and satisfactory operation of the system, he shall recommend the same along with reasons in a separate section along with his proposal and include the same in his scope of supply.	
h)	All accessories, items of work, though not indicated but required to make the system complete for its safe, efficient, reliable and trouble free operation and maintenance shall also be in supplier's scope unless specifically excluded.	
4.0.0	QUALIFICATION REQUIREMENT (QR)	
	Refer to Annexure-I for detail on Qualification Requirement (QR).	
5.0.0	TECHNICAL INFORMATION	
1.	Quantity of gypsum dewatering system	Two (2) Numbers (one working +one standby)
2.	Capacity of gypsum dewatering system	29.8 tones per hour (wet cake) for each belt filter
3.	Moisture content	≤ 10%
4.	Chloride content in output gypsum cake ppm	≤ 100
5.	Gypsum Purity	90 % (Minimum).
6.	Electrical Power Supply Details: Refer to the electrical specification.	

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6.0.0	BIDDER'S SCOPE OF WORK	
	Scope for the bidders shall include Design, Engineering, Manufacturing, Packing, Supply, Supervision of Erection & Commissioning, Performance Guarantee Test, handing over of the Gypsum Dewatering System to final Customer. Design: Includes complete engineering, preparation and submission of drawings / calculations / datasheets/quality assurance documents/ 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: Includes manufacturing/fabrication, shop floor testing, stage inspections, final inspections, painting & packing. Supervision of Erection & commissioning: Includes supervision of erection & commissioning, supervision of trial operation, PG test, training of customer's O&M Personnel and handing over to customer. The scope of supply for Gypsum Dewatering System shall include but not limited to the following.	
1)	Primary hydro cyclone	Two (2) sets (1W+1S)
	i. Hydrocyclone clusters	
	ii. Anchor bolts, nuts and washers	
	iii. Flanges for inlet and overflow	
	iv. A variety size of vortex finders for all the hydro cyclone	
	v. Accessory piping within the skid	
2)	Secondary hydrocyclone	Two (2) sets (1W+1S)
	i. Hydrocyclone clusters	
	ii. Anchor bolts, nuts and washers	
	iii. Companion flanges for inlet and overflow	
	iv. A variety size of vortex finders for all the hydro cyclone	
	v. Accessory piping within the skid	
3)	Vacuum belt filters complete with Accessories including discharge chute, Drivers (VFD with LCP) and driving motors(IE3) with inverter panel	Two (2) numbers (1W+1S)
4)	Vacuum receivers with Anchor bolts, nuts and washers along with the water separators as indicated in PID.	Two (2) numbers (1W+1S)
5)	Vacuum pumps with driver(IE3 motor), All connection bolts/nuts/washers for installation, Required instruments and any safety device. Necessary vibration isolators shall be provided to prevent the transmission of the dynamic loads on to the building structure.	Two (2) numbers
6)	Vent fan including enclosure and its arrangement	Two (2) numbers

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7)	All Interconnected piping (slurry, air and water pipes), which includes the requisite pipe support materials, fitting's, gasket, flange materials, Bolting.	One (1) set *
8)	Complete valves required for the system along with wash water line wherever necessary as per P&ID	One (1) set *
9)	Arrangement for cloth and cake washing, including , spray nozzles	One (1) set*
10)	Cake wash pump with motor (4* 100%)	Two for each vaccum belt filter .
11)	Belt filter washing pump with motor (4* 100%)	Two for each vaccum belt filter .
12)	Companion flanges with gaskets and fasteners	One (1) set*
13)	Filtrate extraction pump with motor (4* 100%)	Two for each vaccum belt filter .
14)	Belt filter & cake washing tank (tank to be sized to include the requirements of the cake wash, and the water requirements of vacuum pump also)	Type : Vertical Cylinder Two (2) numbers
15)	Coupling with guards	One (1) set*
16)	INSTRUMENTS for the entire Gypsum Dewatering System((Minimum Requirement for each gypsum dewatering system as given in the P&ID)	One (1) set*
17)	Valves for the entire Gypsum Dewatering System(Minimum Requirement for each gypsum dewatering system is given in the P&ID)	One (1) set*
18)	Electrics for complete package including but not limited to	
	i. LV/ HV Motors	As required for package
	ii. Cable Adapter chamber for higher size cables if required	As required.
	iii. Electric Actuators	As required for package
	iv. VFD & LCP for Vacuum Belt Filter	As required for package
	v. Cable glands, Lugs & Bimetallic washer for Power and control cables at Vendor's supplied equipment.	As required for package
19)	vi. OEM specific Local Control starter	As required for package
20)	vii. Painting	As required for package
21)	Instrumentation including but not limited to	
	i. Instruments	As required for package
	ii. Junction Box	As required for package
	iii. Instrumentation Cables	As required for package
22)	Expansion Joints at suction & discharge of each pump and also for other equipment wherever applicable	One (1) set*
23)	System control: Each equipment shall be furnished with required instrumentation and electrical accessory devices mounted and connected in a control cabinet. Provisions shall be made for the	

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	interface between the local cabinet and the DCS such that the operation of the equipment's can be controlled from the control console in the FGD Control room.
24)	Alarm Signal: a) Bearing temperature high b) Bearing Cooling water flow Low (As applicable) Interlock signal: a) Belt filter wash tank level low Bearing Temperature Transmitter for initiating alarm during when "Bearing temperature high" shall be supplied by Bidder. Bearing temperature transmitter shall be provided with local display also. Bearing temperature transmitter (with 2V3 logic) shall be provided for HT motors (> 200 KW) at both the driving and Non-Driving ends. Similarly, Vibration transmitters (with 2V3 logic) for measuring vibration in X&Y axis have to be provided for at the driving and Non-driving end for HT Motors. Bearing Cooling Water Flow switch for initiating alarm during when "Cooling water flow Low" shall be supplied by Bidder for each system. In addition, sight glass also shall be provided to view the cooling water flow. Bearing cooling water Flow switch shall take the signal to PLC/ DCS system.
25)	First fill lubricants: All the first fill and one year's toppings requirements of consumables such as grease, oil, lubricants, servo fluids etc. which will be required to put the equipment covered under the scope of specifications into successful commissioning/initial operation and to establish completion to facilities should be provided by contractor/supplier.
26)	Supervision of erection / commissioning of both the gypsum dewatering system. 30 Days per vacuum belt filter.
27)	Mandatory spares with breakup price
28)	Painting and rust prevention during shipment and construction
29)	Seaworthy packing & forwarding to project site-refer clause 1.0.0 for project information
30)	Recommended spare parts (for 3 years operation) with break up price.
31)	Any other items required not covered above but required for the completeness of the system; it shall be included in the offer and shall be supplied by the Bidder/supplier.
	* One set means complete requirement for both the gypsum dewatering system
32)	Detailed Equipment and piping layout preparation and submission for customer approval shall be done by bidder (Post Bid).
6.1.0	TERMINAL POINTS
1.	Primary hydro cyclone feed slurry will be provided by BHEL near the GDW building boundary at ground floor for Primary hydro cyclone. Further piping from terminal point to GDW system is in bidder's scope.
2.	Primary hydro cyclone overflow shall be terminated by bidder up to the secondary hydro cyclone feed tank flange.
3.	Secondary hydro cyclone feed slurry will be provided by BHEL near the GDW building boundary at ground floor for secondary hydro cyclone. Further piping from terminal point to GDW system is in bidder's scope.
4.	Bidder shall terminate secondary hydro cyclone overflow upto waste water tank flange.
5.	Bidder shall terminate filtrate water piping from vacuum belt filter-vacuum receiver up to the filtrate water tank flange.
6.	Bidder shall terminate Wash water piping after belt filter cloth/cake washing up to filtrate water tank flange.

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7.	Bidder shall terminate secondary hydro cyclone underflow up to filtrate water tank flange.
8.	Bidder shall terminate Sealing water piping from vacuum pump upto belt filter washing tank flange. Also piping upto vacuum pump from the belt filter wash pump upto the vacuum pump is also in bidders scope (i.e complete vacuum pump supply and return piping).
9.	Process water, clarified water, Service & instrument air will be provided at one location near plant boundary (i.e. near the building boundary at ground floor). Further piping from terminal point to GDS system utilities are in bidder's scope.
10.	Belt filter Vent fan outlet UPTO outside building wall is in vendor scope.
11.	Discharge of gypsum through discharge chute onto the gypsum belt conveyer is in bidder's scope. Please refer enclosed PFD, P&ID typical layout & elevation drawing of GDS for the details in the scope
	<u>Any piping even though not listed above but is coming inside the gypsum dewatering building is in vendor scope.</u>
12.	<u>Electrical Terminal Points:</u> - HT/LT Motor terminal box, Motor Space Heater terminal box of motor for termination of Purchaser's HT / LT power cables. - Equipment earthing terminals. Necessary hardware (nut/bolts/washers etc) at equipment end shall be provided by Vendor -VFD LCP Terminals for termination of purchaser's LT/control cables.
6.2.0	Exclusions
	<u>Electrical:</u> following items are excluded from Bidder scope, same will be supplied by Purchaser. 1. Power cables 2. Control cables 3. Complete below ground and above ground earthing materials 4. Cable Trays & Supports 5. Local Push button stations 6. Termination Kits for HT cables 7. Cable laying & termination 8. Earth strip laying and termination
7.0.0	PROCESS DESCRIPTION
1.	Common gypsum dewatering system is envisaged . The dewatering system shall receive the gypsum slurry from gypsum bleed pumps.
2.	The overflow from the primary sets of hydro-cyclone shall be taken to a secondary hydro-cyclone feed tank (BHEL Scope). Secondary Hydro cyclone feed pumps (BHEL Scope) shall transfer the slurry from tanks to secondary hydro cyclone. Two sets of Secondary hydro cyclones (1 working+1 stand by) and its accessories shall be in vendor scope.
3.	The underflow from the secondary hydro-cyclone shall be taken to the filtrate water tank. The over flow from the secondary hydro-cyclone shall be taken to a waste water storage tank.
4.	One no. of belt filter washing tank is envisaged for both the belt filters. Each belt filter-washing tank shall be provided with 2 nos (1W+1S) of belt filter wash pump. Belt filter wash pump shall supply water for cloth washing, belt washing & vacuum pump water requirement's .
5.	For maintenance of secondary hydro cyclone, a bypass line will be provided to divert the flow from primary hydro cyclone over flow to filtrate water tank.
	Detailed process description to be derived from the PID furnished elsewhere in the spec.

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8.0.0	DETAILED SPECIFICATION
1.	Bidder/Contractor shall supply two stage gypsum dewatering system consisting of primary hydro cyclones, vacuum belt filters and secondary hydro cyclones for dewatering of gypsum from absorber to less than 10% moisture.
2.	Bidder/Contractor shall supply 2x100% gypsum dewatering system with each stream sized to dewater 29.8 TPH (Wet cake) produced by the FGD units operating at design point. All other stipulations with respect to sizing and design of the dewatering system, auxiliaries and other systems shall be in line with this specification.
8.1.0	Hydro-cyclones
1.	Two (2) sets of primary hydro cyclones are envisaged, each set shall be sized to dewater the gypsum slurry produced by the unit operating at design point.
2.	The primary hydro-cyclone shall be installed on a floor directly above the belt filters. The overflow of the primary hydro-cyclones shall be taken to secondary hydro-cyclone feed.
3.	Two (2) sets of secondary hydro cyclones are to be installed, each sets shall be sized to dewater the gypsum slurry produced by primary hydro cyclone overflow.
4.	Each set of primary/ secondary 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
5.	Both primary and secondary 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.
6.	The cyclone unit shall be made of Polyurethane or steel lined with abrasion resistant polymer, the material of the hydrocyclone case shall be 304 stainless steel.
7.	A 1 m (min.) wide platform with suitable approach shall be provided around Hydro cyclone.
8.	The hydro cyclones shall be fitted with stainless steel filter to prevent blockage of cyclone by big particles
9.	Each set of primary dewatering hydro-cyclone shall be sized to dewater the gypsum slurry produced by units operating 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.
10.	The Hydrocyclone shall be able to operate stably without performance reduction in various loading conditions by controlling number of cyclones to satisfy the lowest slurry flow and pressure; It shall also be able to perform normally in various slurry concentrations (15% to 30%).
11.	The design of Hydrocyclones shall guarantee the separation efficiency of the slurry from the absorber.
12.	The hydro cyclone system shall be self-supported with structural steel framework.
13.	The cyclone unit shall be made of Polyurethane or steel lined with abrasion resistant polymer, the material of the hydrocyclone case shall be 304 stainless.
14.	The design of hydrocyclones shall guarantee the separation efficiency of the slurry from the absorber
15.	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 25mm. The liners shall have a minimum wear life of not less than 7000 hrs.

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8.2.0	Vacuum Belt Filters
1.	The Vacuum Belt Filters shall have the following characteristics: - Very rigid frame and rolls, no deformation whatsoever may occur. - All rolls shall be installed perfectly horizontally - There shall be no vacuum under the slurry deposition zone. - Deposit thickness control and directional stability control - The slurry shall be put on the belt in counter current relative to the rotation of the band/belt. - The vacuum chambers shall be easily opened for inspection and cleaning.
2.	Each vacuum belt filter shall be sized to meet the specified requirements, all occurring together, with an inlet solid concentration of not more than 45% or outlet of hydro-cyclones whichever is minimum.
3.	The vacuum belt filter shall be proven design in operation for similar capacities. The filter cloth shall be polyester or polypropylene as per the proven design of the supplier and shall be guaranteed for a minimum life of not less than 8000 hrs.
4.	The complete frame of the filter and all parts in contact with gypsum shall be made of corrosion resistant material.
5.	The vacuum box shall ensure tight sealing with the belt/cloth and shall be of proven design.
6.	The belt filter shall have an automatic cloth tracking mechanism and shall be provided with all required instrumentation as per the bidder's proven practice. The belt filter shall have an automatic cloth tensioning mechanism. Pull chord switches shall be provided for each vacuum belt filter. Four (04) no's of Belt sway switches shall be provided for each vacuum belt filter. Cake thickness sensors with double redundancy shall be provided for each vacuum belt filter which shall control the speed of the vacuum belt filter in turn.
7.	Differential Pressure indicator shall be provided at the discharge line of Belt filter wash Pump for each vacuum Belt filter. Flow indicator shall be provided for cloth washing line of each vacuum belt filter. Flow indicator shall be provided for cake washing line of each vacuum belt filter as per P&ID attached.
8.	The filter shall be provided with minimum 2 stages of cake washing for removing impurities in the gypsum. One stage of cloth washing arrangement shall also be provided.
9.	The filtrate from gypsum slurry and from cake washing shall be taken to a separate vacuum receiver tank(s) as per the proven practice of the supplier. Each belt filter shall have an independent vacuum pump.
10.	Gypsum cake from each belt filter shall be discharged through a hopper onto belt conveyor being provided by the Employer. The elevation of discharge point of vacuum belt filter shall be at least 10.0 m above GL.
11.	A 2 m (min.) wide platform shall be provided all around each belt filter for easy Approach & maintenance. Handling facilities for replacement of heavy components of the belt shall also be provided. The elevation of discharge point of vacuum belt filter shall be as per Annexure-XIII-GA Drawing of Gypsum Dewatering Building. Any changes shall be suggested by Bidder accordingly.
12.	Local control panel shall have display on the front panel and necessary electrical parts.
13.	The service factor of the gear unit (if any) shall be minimum 1.5.
14.	Piping and wiring within the skid should be in the vendor's scope.

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15.	All client end connection flanges shall be ANSI B 16.5/ AWWA
16.	The MOC of all the pipe components of the vacuum belt filter shall be as per Annexure-XII. However the Material of vacuum receiver tank (s) shall be M in 3 mm thick stainless steel.
8.3.0	Vacuum System
1.	The filtrate from each belt filter, cake washing & cloth washing shall be taken to a separate receiver tanks as per the supplier's proven practice. 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 10% margin over the above shall be provided each vacuum pump.
2.	For each vacuum belt filter the vacuum pump shall be installed close to the vacuum belt filter. Each Vacuum pump shall have its own piping system, which connects the pump with the associated vacuum belt filter. Bidder to provide Equipment layout and GA of Gypsum dewatering building along with the offer
3.	The vacuum pump shall be of low speed liquid ring type of proven design. The design of the vacuum pumps shall avoid cavitation under all operating conditions.
4.	The seals shall be of proven design.
5.	Silencers shall be provided, if required, to limit the noise level to values stipulated elsewhere in this specification.
6.	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.
7.	Each vacuum receiver tank(s) shall be provided with slide plate type pneumatic vacuum breaker. The plate shall be stainless steel with a min. thickness of 3 mm.
8.	Please refer to the PID, Accordingly the Vacuum tank shall be provided with the water separators as indicated in PID
8.3.1	COM M ON REQUIREM ENTS FOR PUM PS (VACUUM PUM P , BELT FILTER WASH PUM PS , CLARIFIED WATER PUM PS)
1.	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.
2.	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.
3.	All pumps shall be designed to withstand a test pressure of 1.5 times the maximum possible pump shut off pressure under maximum suction pressure conditions.
4.	Product water flushing lines and drains are to be supplied for each pump handling the prevailing water to avoid corrosion if the pump is out of operation for extended periods.
5.	Pumps must be carefully set to ensure that the net positive suction head available under all operating conditions will be adequate. The NPSH Values are to be referred to the least favorable operating conditions- lowest atmospheric pressure, lowest level of water on the suction side of the pump and highest temperature of the pumped fluid. An adequate safety margin of normally greater than 1m to the max NPSH required shall be provided.

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6.	All pumps shall be fitted with suction and discharge pressure gauges. Pressure gauges shall be with diaphragm seal for slurry application. Pressure gauges for other medium shall be with gate valves. All the wetted parts shall be SS316 or equivalent
7.	Venting valve 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 pipe work to facilitate the dismantling of pumps.
8.	Design pumps not to be damaged during reverse rotation at up to 150% of design RPM, at full discharge head in the event that a pump trips while the other operating pump remain on line.
9.	Pumps shall have stable head-capacity characteristics curve from run-off to shut-off. Shut-off head should be minimum 125% of Best Efficiency Point (BEP).
10.	Selection of Duty point should preferably be at BEP (Best Efficiency Point) or slightly at the left of BEP. Selection of Duty point beyond 115% of BEP will not be acceptable. It should be noted that head variation is due to level variation in tank. Pump has to run in the system without compromising its NPSH requirement at lowest water level in tank. Hence, when tanks are filled-up and are at normal water level, pump will operate at the right of BEP, pump's operating zone should be considered accordingly.
11.	External flushing is required to remove the accumulated particles and all related information should be mentioned in data sheet.
12.	Pump should have adjustment provision of axial clearance between casing and impeller for maintenance of performance at best efficiency when there is wear in between impeller and casing.
13.	In case rubber or nonmetallic linings are used, these will be two piece molded under pressure and adjusted to the screwed metallic clamping which have been welded to the casting.
14.	Each pump will have a coupling of adequate size, designed for full load and capable of supporting start –up on overload moments. Each half of the coupling will be factory mounted and locked to its shaft. The coupling must be able to accept the adjustment of the impeller.
15.	The pumps shall have mechanical seals of cartridge type with self-lubrication sliding ring cartridges. The static part will be mounted on the seal plate with circumferential ring (O-ring) or another flexible sealing ring. Built in seal design will not be accepted.
16.	The sealing areas shall be designed in such a way so that solids do not precipitate in them or affect the cooling or affect the adjustment and mechanical functioning of the seals. Seals which do not need jet cleaning are preferred.
17.	Pump induced vibration due to flow pulsations shall be avoided through suitable design.
18.	Each rotating equipment shall be first statically balanced and then dynamically balanced according to ISO 1940 (in the case of impellers this shall be done before and after mounting of the service rotor shaft).
19.	All the wear parts of the pump shall be guaranteed for a minimum wear life of not less than 25000 hrs.

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20.	Coupling halves shall be machine matched to ensure accurate alignment. Couplings must have a rated capacity of at least 120% of the maximum potential power transmission requirement.
21.	All rotating parts such as coupling shall be covered with suitable protective guards. Guards shall be easily removable type. Coupling shall be of flexible type made of cast steel. The bidder shall furnish both halves of the coupling. Both the Coupling halves shall be bored and keyed to fit shafts of the pump and the motor by bidder. The coupling between shafts shall be so designed that they become tight during pump operation.
22.	A common base plate shall be provided for pump assembly & Motor and the same shall be rigidly constructed, adequately braced and provided with finish pads for mounting pump.
23.	Pump manufacturer is to supply base plate along with Foundation bolt & Nut, “Taper wedge” and the necessary fastener for Pump and Motor with Base plate. Even if Motor is excluded from their scope, necessary fastener for motor foot with base plate will remain in pump scope of supply in order to avoid any problem.
24.	Limit of connection: The buyer (BHEL) has an intention to minimize interface for utilities as much as possible. The bidder shall consider this requirement in the planning stage of layout for the equipment. The bidder shall provide the header piping for utilities and branch piping to each location. Terminal points for all utilities shall be located at skid edge. The bidder shall specify all terminal points with tie-in number in the P&ID and submit it in the proposal to confirm the scope of supply.
25.	Nameplate: All equipment shall be provided with name plates indicating the item number and service name. Nameplates 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.
26.	Rotation arrows shall be cast in or attached with stainless steel plate on each item of rotation equipment at a readily visible location.
27.	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 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.
28.	Skid Mount/ Transportation: Equipment shall be fabricated as skid mount design as much as practical to minimize erection at the site.
29.	Two pieces of stainless steel earth lugs shall be provided with equipment diagonally. The position of earth lugs shall be shown on each GA and/or outline drawing.
30.	Provide double nuts for anchor bolts.
31.	Bidder shall provide allowable vibration level on foundation in foundation drawings and/or general arrangement drawings.
32.	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.
33.	Bidder shall provide the mating flanges with the necessary gaskets.
34.	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.

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35.	Bidder to provide capacity of crane or hoist required for material handling and the details of heaviest component to be handled.	
36.	The list of all Bought out items with makes and country of origin to be mentioned along with offer to be submitted.	
37.	Pump shall be supplied with Discharge line pressure gauge and suction line pressure/vacuum gauges complete with isolating cocks for each pump set.	
38.	Pump shall be supplied Air release cocks and drain plugs for each pump set.	
39.	All internal/integral piping with valves, fittings, and pressure gauges for lubrication, cooling and sealing, wherever applicable, shall be tapped of directly from respective pump discharge.	
40.	Impeller, casing and shaft of vacuum pumps shall be tested for chemical and mechanical properties as per relevant standard. All plates above 40mm shall be 100% ultrasonically tested.	
41.	UT on shaft (if greater or equal to 40mm) and impeller shall be carried out.	
42.	All vacuum pumps shall be tested at shop for capacity, power, pressure, efficiency, noise and vibration etc.	
9.0.0	TECHNICAL REQUIREMENTS	
I	DESIGN CONSTRUCTION –VACUUM BELT FILTERS	Bidder To Confirm
1.	The vacuum belt filter shall be proven design in operation for similar capacities.	
2.	The complete frame of the filter and all parts in contact with gypsum shall be made of corrosion resistant material.	
3.	In case, the contractor offers a design with an underlying belt for carrying the filter cloth, the same shall be endless, factory vulcanized rubber belts. The belt shrouds and the sealing belts shall provide a leak tight arrangement to prevent overflow of gypsum slurry. The sealing belt shall have minimum life of not less than 7000 hrs.	
4.	The vacuum box shall ensure tight sealing with the belt/cloth and shall be of proven design.	
5.	The belt filter shall have an automatic cloth tracking mechanism and shall be provided with all required instrumentation as per the supplier's proven practice. The belt filter shall have an automatic cloth tensioning mechanism.	
6.	The filter shall be provided with minimum 2 stages of cake washing for removing impurities in the gypsum. One stage of cloth washing arrangement shall also be provided.	
7.	Local control panel shall have display on the front panel, inverter, PLC controller and necessary electrical parts.	
8.	The service factor of the gear unit (if any) shall be minimum 1.5.	
9.	Piping and wiring within the skid should be in the vendor's scope.	
10.	Nozzles and connections The suction and discharge pipes will be flanged and will have the same nominal test procedure as the body of the pump. Threaded connections are not admitted in these pipes.	
11.	The flanges shall comply with the following standards: - Steel flanges as per ANSI B16.5 (raised face type, at least class 150) - Cast iron flanges as per ANSI 16.1 (flat face type, at least class 125) The pipe shall be designed according to API676 with regards to the force.	

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II	DESIGN AND CONSTRUCTION OF VACUUM PUMPS	
	Design and construction of various components of the pumps shall conform to the following general specifications. For material of construction of the components, data sheets shall be referred to.	
a)	Pump Casing	
	Pumps shall be radial split casing, close/semi-open, over-hang, end suction type back pull-out design, vertical discharge type for horizontal centrifugal pump. The casing shall be designed to withstand the maximum shut-off pressure developed by the pump at the pumping temperature. Pump casing shall be provided with a vent connection and piping with fittings & valves. Casing drain as required shall be provided complete with drain valves, piping and plugs. It shall be provided with a connection for suction and discharge pressure gauge as standard feature. It shall be structurally sound to provide housing for the pump assembly and shall be designed hydraulically to minimum radial load at part load operation.	
b)	Impeller	
	Impeller shall be closed, semi-closed or open type as specified elsewhere and designed in conformance with the detailed analysis of the liquid being handled. The impeller shall be secured to the shaft, and shall be retained against circumferential movement by keying, pinning or lock rings. On pumps with overhung shaft, impellers shall be secured to the shaft by a lockout or cap screw which tightness in the direction of normal rotation.	
c)	Impeller/ Casing Wearing Rings	
	Replaceable type wearing rings shall be provided at suitable locations of pumps. Suitable method of locking the wearing ring shall be used. Wearing rings shall be provided in pump casing and/or impeller as per manufacturer's standard practice.	
d)	Shaft	
	The critical speed shall be well away from the operating speed and in no case less than 130% of the rated speed. The shaft shall be ground and polished to final dimensions and shall be adequately sized to withstand all stresses from rotor weight, hydraulic loads, vibration and torques coming in during operation.	
e)	Shaft Sleeves	
	Renewable type fine finished shaft sleeves shall be provided at mechanical seals. Shaft sleeves shall be fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.	
f)	Bearings	

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	Heavy duty bearings, adequately designed for the type of service specified in the enclosed pump data sheet and for long, trouble free operation shall be furnished. The bearings offered shall be capable of taking both the radial and axial thrust coming into play during operation. In case, sleeve bearings are offered additional thrust bearings shall be provided. Antifriction bearings of standard type, if provided, shall be selected for a minimum life 20,000 hrs. of continuous operation at maximum axial and radial loads and rated speed. Proper lubricating arrangement for the bearings shall be provided. The design shall be such that the bearing lubricating element does not contaminate the liquid pumped. Where there is a possibility of liquid entering the bearings suitable arrangement in the form of deflectors or any other suitable arrangement must be provided ahead of bearings assembly. Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearings housing.	
g)	Mechanical Seals	
	Mechanical seals shall be of single type with either sliding gasket or bellows between the axially moving face and shaft sleeves or any other suitable type. The sealing faces should be highly lapped surfaces of materials known for their low frictional coefficient and resistance to corrosion against the liquid being pumped.	
	The pump supplier shall coordinate with the seal maker in establishing the seal chamber of circulation rate for maintaining a stable film at the seal face. The seal piping system shall form an integral part of the pump assembly. For the seals under vacuum service, the seal design must ensure sealing against atmospheric pressure even when the pumps are not operating. Necessary provision for seal water supply along with complete piping fittings and valves as required shall form integral part of pump supply.	
h)	Pump Shaft Motor Shaft Coupling	
	The pump and motor shafts shall be connected with an adequately sized flexible coupling of proven design with a spacer to facilitate dismantling of the pump without disturbing the motor. Necessary coupling guards shall also be provided.	
i)	Base Plate	
	A common base plate mounting both for the pump and motor shall be furnished. The base plate shall be fabricated steel and of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the piping unit so mounted as to minimize misalignment caused by mechanical forces such as normal piping strain, internal differential thermal expansion and hydraulic piping thrust. Suitable drain troughs and drip lip shall be provided.	
j)	Vibration isolation system :Complete vacuum pump assembly shall be provided with the vibration isolators to prevent the transmission of the dynamic load on to the civil structure.Refer the layout for checking the location of the pumps on the building.	
k)	Drive Motor (Prime Mover)	
	The kW rating of the drive shall be based on continuously driving the connected equipment for the conditions specified.	

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III	GYPSUM DISCHARGE CHUTE	
a.	The minimum valley angle of chutes shall be 60 degrees at the feeding point to guide the material in the direction of belt travel. Transfer chutes shall be adequately sized and sloped to ensure smooth flow of Gypsum without any accumulation anywhere.	
b.	Chutes shall be made of minimum 20 mm thick TISCRAAL / SAILHARD/ LSLAS07 or equivalent material. All chutes should have one inspection door at every floor and for the ones in between the floors (more than 1.5 meter above the operating floor level) suitable access for trouble free maintenance shall be provided. For sealing of inspection doors labyrinth type arrangement to be provided.	
c.	Complete chute work in the region of flap gates shall be fabricated from 20 thk TISCRAAL or equivalent. In case of vertical chute (valley angle more than 80 degree) complete chute, work shall be of 20 mm thick TISCRAAL or equivalent material. While finalizing the chute work inside the building, arrangement for shifting and replacing chute legs, proper handling arrangement/wall openings, trolleys, hoists shall also be provided. While fabricating the chute, no welds in between shall be allowed.	
	CHUTE BLOCKAGE SWITCHES One no. chute blockage switch for each belt filter of proven type (subject to approval of the employer) shall be provided. Chute blockage switch shall trip the feeding conveyor in case of Chute blockage and protect the feeding conveyor equipment.	
	Chute arrangement shall be provided along with flap gate arrangement for parallel -flow or perpendicular flow of gypsum on to the gypsum conveyor.	
IV	PIPING	
a.	The slurry pipes shall be sized to minimize erosion and avoid settling of the gypsum at all load operation. 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 wear resistant natural rubber lining of minimum 6 mm thickness. Additional thickness of 2 mm shall be provided at the bends. The bidder can provide slurry pipes of size lower than 3" made up of FRP material (silicon carbide coating on slurry exposed surface) if it has previous experience of providing the same. All the rubber-lined pipes shall be of flanged connection.	
b.	The isolation valves provided in all the slurry lines shall be of knife gate type/butterfly type unless specifically mentioned. Motorized actuators shall be provided for valves requiring frequent operation as indicated in the relevant scheme.	
c.	The valves shall be of proven type and the contractor shall submit a detailed valve schedule for employer's approval. Reference list for previous installations for similar application shall also be furnished to BHEL.	

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d.	Bidder shall provide all necessary arrangements for purging & flushing of all the process pipelines, equipments etc	
e.	Belt filter washing pumps shall have a minimum flow line to tank with a restriction orifice to control.	
f.	All Lube oil , Instrument Air piping shall be made up of Gr.304 Stainless Steel material	
g.	All process water & Cooling water piping shall be made up of Carbon Steel Pressure Piping	
h.	For details on Pipe schedule kindly refer to P&ID	
V	VALVES	
	For details on Valve schedule kindly refer to P&ID. For valve specification, bidder shall refer to the Annexure-XII-Pipe & valve material specification	
VI	ACCESSORIES:	
1)	Expansion Joints:	
i.	Expansion Joints shall be provided at suction and discharge of each pump and also for other equipment's wherever applicable.'''	
2)	System control:	
i.	Each equipment shall be furnished with required instrumentation and electrical accessory devices mounted and connected in a control cabinet.	
ii.	Provisions shall be made for the interface between the local cabinet and the DCS such that the operation of the equipment's can be controlled from the control console in the FGD Control room.	
VII	ELECTRICALS	
i.	Bidder shall provide cable glands, lugs, Bimetallic washers for all equipment in the scope of Bidder. Glands and lugs for power cable, control cable, Space heater cable and earthing cable (if any) suitable at motor/equipment end has to be supplied along with the main equipment. --Glands shall be weather proof (as per motor category) double compression type Nickel plated Brass (ET) shall be provided with back nut and PVC shroud. --Lugs shall be tinned copper heavy duty lug Cable dimensions shall be furnished during detail engineering, accordingly glands, lugs shall be supplied.	
ii.	HT/ LT MOTORS -For Technical specification, refer Annexure-X	
iii.	Electrical Actuators -For Technical specification, refer Annexure-X	
iv.	Bidder should strictly fill the electrical Auxiliary load list as per attached format given in this specification.	
VIII	Instrumentation	

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i.	JUNCTION BOX Bidder to refer to the specification given in Annexure- XI	
ii.	INSTRUMENTS Bidder shall refer to the P&ID for the details on the instruments to be supplied. The instruments indicated are minimum requirements. All instruments & actuators shall be connected to DDCMIS through fieldbus i.e. FOUNDATION Fieldbus/ PROFIBUS PA protocol complying to IEC 61158 .All instruments shall be as per specification enclosed in Annexure- XI. Vendor to supply all the instruments as given in the P&ID. All electrical actuators shall be with integral starters (non-intrusive with SIL2 certificate)	
iii.	INSTRUMENTATION CABLE: Instrumentation cable upto the junction box is in vendor's scope.	
iv.	LOCAL CONTROL PANEL: Local control panel is not required for operation. Supplier shall provide all Control logics to hook up in main DCS. In case vendor recommends local based Panel as per their design, vendor may supply the same in the package.	
	For sub Vendor list of electrical & Instrumentation and control refer Annexure - XV	
10.0.0	PACKING AND FORWARDING	
1.	Proper packing to be ensured. Indigenous Supply: Gypsum Dewatering System & sub system assembly shall be wrapped in polythene bags & packed in a strong rigid wooden crate. Rain water should not enter into the pump internals during storage in the outer yard of power plant. Imported Supply: All imported supply should be packed as per Sea worthy packing standards Annexure - VIII. All imported items should have Sea worthy packing. Liberal packing materials and struts shall be provided to arrest rolling and to protect from transit damages.	
2.	Equipment and process materials shall be packed and semi-knocked down, to the extent possible, to facilitate handling and storage and to protect bearings and other machine surfaces from oxidation. Each container, box, crate or bundle shall be reinforced with steel strapping in such a manner that breaking of one strap will not cause complete failure of packaging. The packing shall be of best standard to withstand rough handling and to provide suitable protection from tropical weather while in transit and while awaiting erection at the site.	
3.	Equipment and materials in wooden cases or crates shall be properly cushioned to withstand the abuse of handling, transportation and storage. Packing shall include preservatives suitable to tropical conditions. All machine surfaces and bearings shall be coated with oxidation preventive compounds. All parts subject to damage when in contact with water shall be coated with suitable grease and wrapped in heavy asphalt or tar impregnated paper.	
4.	The entire system have to be supplied in containers and it should be suitable for storing in the outer yard of the plant for a minimum period of 12 months. Crates and packing material used for shipping will become the property of owner.	
5.	Packaging or shipping units shall be designed within the limitations of the unloading facilities of the receiving ports and the ship will be used. It shall be the	

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	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 follows. BHEL SITE OFFICE : NTPL–TUTRICORIN 2 X 500 M W TPS– FGD, TUTRICORIN, TAMILNADU,INDIA. EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LIMITED, INDIA” In addition, each package or shipping unit shall have the symbol painted in red on at least two sides of the package, covering one fourth of the area of the side.	
9.	Each part of the equipment which is to be shipped as a separate piece or smaller parts packed within the same case shall be legibly marked to show the unit of which it is part, and match marked to show its relative position in the unit, to facilitate assembly in the field. Unit marks and match marks shall be made with steel stamps and with paint.	
10.	Each case shall contain a packing list showing the detailed contents of the package. When any technical documents are supplied together with the shipment of materials no single package shall contain more than one set of such documents. Shipping papers shall clearly indicate in which packages the technical documents are contained.	
11.	The case number shall be written in the form of a fraction, the numerator of which is the serial number of the case and the denominator the total number of case in which a complete unit of equipment is packed.	
12.	Wherever necessary besides usual inscriptions the cases shall bear special indication such as “Top”, “Do not turn over”, “Care” , “Keep Dry” etc. as well as indication of the center of gravity (with red vertical lines) and places for attaching slings (with chain marks)	
13.	Marking for Safe handling: To ensure safe handling, packing case shall be marked to show the following: a. Upright position	

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	b. Sling position and center of Gravity position c. Storage category d. Fragile components (to be marked properly with a clear warning for 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 pump & accessories, BHEL item Code, Gross Weight and Net weight of Supplied items.	
16.	Prior to transport from manufacturer's work to destination, components of the unit shall be completely cleaned to remove any foreign particles. Flange faces and other machined surfaces shall be protected by an easily removable rust preventive coating followed by suitable wrapping.	
17.	All necessary painting, corrosion protection & preservation measures shall be taken as specified in painting schedule. Supplier shall consider the coastal environment zone which is defined as "very severe" during final finishing/shipping.	
18.	Successful bidder shall furnish the detail packing /shipment box details with information like packing box size, type of packing, weight of each adressment, sequence no. of dispatch, no. of consignment for each deliverable item against each billing break up units/ billable blocks. Without these details the BBU shall not be approved during detail engineering. Also, complete billing break-up with above mentioned details shall be submitted within 10days of LOI.	
19.	All items/ equipment shall be dispatched in properly packed condition (i.e. no item shall be dispatched in loose condition such that it becomes difficult to store/identify its location at site at a later stage).	
20.	Cases which cannot be marked as above shall have metal tags with the necessary markings on them. The metal tags shall be securely attached to the packages with strong steel binding wire. Each piece, Skid, Case or package shipped separately shall be labelled or tagged properly.	
11.0.0	SUPERVISION OF ERECTION, TESTING AND COM MISSIONING	
1.	The erection of Gypsum Dewatering System will be done by owner as per Erection Manual and check List. However, the bidder shall make one visit per VACCUM BELT FILTER boiler for the supervision of erection, pre-commissioning &	

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	post- commissioning check-up, start-up, testing and trial runs of all the items covered under the scope of supply.	
2.	There will be one visit for each system and totally 2 visits. The bidder will be informed well in advance for the visit. Bidder shall include 60 Man Days and 2 Visits to site.	
3.	TA/ DA, boarding and lodging shall be borne by the bidder and shall be inclusive in supply portion.	
12.0.0	INSPECTION REQUIREMENT	
1.	Hydro cyclones visual, dimensional etc.	
2.	Pumps :	
a.	All pressure parts shall be hydraulically tested at 150% of the shut-off header 200% of rated head, whichever is higher for 30 minutes. No leakage is allowed	
b.	Impeller and rotor shall be first statically balanced and then dynamically balanced according to ISO 1940 (in the case of impellers this shall be done before and after mounting of the service rotor shaft).	
c.	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. (as already stated above.)	
d.	List of Non-Destructive test over and above the material test are as follows: Casing: Material test, Magnetic particle (MPI), DP and Hydro test as applicable Impeller- DPT and MPI as applicable Shaft- Ultrasonic (UT), DPT and MPI Sleeve- DP and Hardness test/ Manufacturer's recommendation Mechanical Seal- Manufacturer's recommendation. Base Plate- Stress relieving of weld. Replaceable Rubber liner- Shore Hardness, Class and Type certificate	
e.	Vibration test and Noise level test shall be witnessed at shop. (as already stated above.)	
f.	Mechanical running and the performance test shall be conducted for Pump at the Bidder's works before dispatch or where the test facilities are available. All pumps to be performance tested as per Hydraulic Institute Standard/ Indian Standard. Performance test to include check for noise, vibration level and temperature rise.	
g.	The Bidder shall conduct performance test for the remaining pump and submit the reports.	
3.	Vacuum Belt Filters:	
a.	Impeller, casing and shaft of vacuum pumps shall be tested for chemical and mechanical properties as per relevant standard. All plates above 40mm shall be 100% Ultrasonically tested.	

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b.	UT on shaft (if greater or equal to 40mm) and impeller shall be carried out.				
c.	All vacuum pumps shall be tested at shop for capacity, power, pressure, efficiency, noise and vibration etc.				
d.	Filter cloths and belts shall be tested for physical properties as per relevant Standard.				
4.	General Inspection requirements to be considered are as below :				
1.	S.No	Item	Inspection & Test item	Remarks	
	1.	Hydrocyclones	Material certificate check		
			Dimensional Inspection		
	2.	Pumps	Material certificate check	Shaft & impeller only	
			Dimensional inspection		
			Non destructive testing	DPT on shaft & impeller	
			Hydrostatic test		
			Balancing Test	Static & dynamic	
			Performance test	Incl. Noise & Vibration	
	3.	Motors	Material certificate check		
			Non Destructive Testing		
			Dimensional inspection		
			Balancing Test	Static & dynamic	
			Function test		
	4.	Vacuum Belt filter (with Accessories)	Material certificate check		
			Dimensional inspection		
			Function test	Short time no load test	
	5.	Vacuum Receiver	Material certificate check		
			Dimensional inspection		

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		Hydrostatic Test	
6.	Belt Filter Vent Fan	Material certificate check	
		Dimensional inspection	
		Performance Test	
7.	Conveyor & Silo Extraction Device	Material certificate check	
		Dimensional inspection	
		Function Test	Short time no load test
8.	Rubber lining Pipe	Dimensional inspection	
		Visual Inspection	
		Spark Test	
9.	Butterfly Valve	Material certificate check	
		Non destructive testing	
		Hydrostatic test	
		Operation test	Motorized valve only
10.	Control Panel	Insulation Resistance Test	
		Dielectric Strength Test	
		Function Test	
		Dimensional Inspection	
11.	Control valve & valves	Material certificate check	
		Hydrostatic test	
		Seat leak test	
		Function test	
		Dimensional Inspection	
12.	RTD	Material certificate check	

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			Performance test		
			Hydrostatic test		
	13.	Shut off valve	Material certificate check		
			Hydrostatic test		
			Seat Leak test		
			Function Test		
			Dimensional Inspection		
	14.	Flow meter	Material certificate check		
			Calibration Test		
			Dimensional Inspection		
			Hydrostatic test		
15.	Flow Nozzles	Material Certificate check			
		Dimensional Inspection			

2.	Valves and Specialties shall be tested as per relevant standards / codes. Seat Leakage and hydraulic test to be carried out as per relevant standards / codes.	
3.	Pipes and fittings shall be tested as per relevant standards/ codes	
4.	MQP (Manufacturing Quality plan) shall be submitted by the bidder along with the technical offer. Above mentioned item-wise inspection requirement is tentative only and shall be mutually discussed and finalized during detail engineering.	
5.	Bidder shall furnish written copies of shop production, fabrication and quality test procedures and drawings to be used for review by BHEL / BHEL APPROVED AGENCY prior to manufacture. Inspection of above mentioned tests by BHEL/ BHEL APPROVED AGENCY representative at bidder's works is envisaged	
6.	The Bidder shall furnish performance test procedure along with standard. The test procedure will be reviewed and approved by the BHEL/ BHEL APPROVED AGENCY.	
7.	A dynamic balancing certificates stating that the rotating assembly has been balanced dynamically shall be sent to BHEL/ BHEL APPROVED AGENCY within one (1) week of the successful completion of balancing.	
8.	Vibration levels shall be measured during shop running/ performance tests.	
9.	For surfaces with rubber lining Welding shall be visually inspected to verify the absence of rough area and unacceptable transition between surfaces which	

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	prevent the adequate adherence of rubber. The acceptance criteria shall be as per latest standard.	
10.	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.	
11.	Test certificates shall be issued for each lot of raw material used in the coating, corresponding to specific weight and traction resistance.	
12.	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.	
13.	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.	
14.	Equipment shall not be released for shipment, until shop tests data and performance tests curves have been approved by Owner.	
15.	Bidder should furnish performance guarantee as per applicable standard guarantee for the design, manufacture, material and safe operation of the equipment's.	
16.	BHEL shall witness the test at Bidder's works and a notice of minimum three (3) weeks shall be given for attending the inspection.	
17.	Bidder to arrange all calibrated gauges, Instruments during inspection at works and also during performance test at site. All inspection, measuring and test equipment used by Bidder shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Bidder shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by the Owner. Wherever asked specifically, the Bidder shall re-calibrate the measuring/test equipment in the presence of Project Manager/Inspector.	
18.	Mechanical running test shall be carried out for Vacuum Belt Filter, Vacuum Pump & Belt Filter wash Pump. Bidder to arrange Motor for the shop test and inspection.	
19.	In case of supplies from outside India, vendor has to finalize Inspection agency from the List enclosed in Annexure IX at their own cost and carry out inspection as per the approved Quality plan. Vendor has to furnish BHEL the inspection reports and other documents required as per approved Quality plan duly signed by the Inspection Agency after their witness for our review and acceptance.	
13.0.0	GURANTEE AND LIQUIDATED DAM AGES FOR POWER CONSUMPTION	
I.	POWER GUARANTEE Bidder to specify the guaranteed power consumption of per Gypsum Dewatering system as well as individual equipment in their offer. The following equipment's (i.e working system) shall be considered for Guaranteed Power consumption calculation (GPC).	

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	a. Vacuum Belt Filter - 1 No. b. Vacuum Pump - 1 No. c. Belt Filter Vent Fan- 1 No d. Belt filter wash pump – 1 No. e. Cake wash pump -1 NO The total power consumption for all the above power sources (a to e) put together shall not exceed 210. KW , Corresponding capacity of to rated 26.8 tph of dry cake .
II.	LIQUIDATED DAMAGES FOR POWER CONSUMPTION If actual Power Consumption during prove out (or) PG Test operating at the duty point exceeds the value guaranteed by the bidder, liquidated damages for shortfall in performance shall be deducted from contract price as per the formula given below Liquidated damage deductible in INR = (APC-GPC) X P X 1No of working system ▪ GPC- Guaranteed Power Consumption quoted by bidder in KW ▪ APC- Actual Power consumption during PG test ▪ P- Penalty @2,71,000.0 INR per KW
14.0.0	Process Flow Diagram & P&ID Diagram
	Piping and Instrumentation Diagram are enclosed in Annexure VII.
14.0.1	PROCESS PARAMETERS FOR PRIMARY HYDROCYCLONE AT OPERATING POINT
	Process parameters for primary Hydrocyclone at operating point are enclosed in Annexure XVI.
14.0.2	PROCESS PARAMETERS FOR SECONDARY HYDROCYCLONE AT OPERATING POINT
	Process parameters for Secondary Hydrocyclone at operating point are enclosed in Annexure XVI.
14.0.3	DATA SHEET OF BELT FILTER AT OPERATING POINT
	Data sheet of Belt filter at operating point are enclosed in Annexure XVI
14.0.4	GYPSUM PARTICLE SIZE AT HYDRO CYCLONE FEED SLURRY
	Gypsum Particle size at Hydro cyclone feed slurry are enclosed in Annexure XVI
14.0.5	Gypsum particle size at belt filter feed slurry is shown below
	Vendor to submit the PSD based on their design for PHC & SHC underflow and overflow
14.0.6	PROCESS WATER(TREATED WATER) CHARACTERISTICS
	Process water Data sheet are enclosed in Annexure XVI
	Note: Process water will be used for both belt/cloth & gypsum cake washing .
15.0.0	SPARES, TOOLS & TACKLES
15.1.1	START UP & COMMISSIONING SPARES
	Start-up & Commissioning Spares shall be part of the main supply of the WBM. 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 WBM 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.
15.1.2	Vendor to supply the following items additionally ,along with the main offer : (Note: These items indicated in Sl.no 15.1.2 are not part of startup & commissioning spares, but

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	need to be supplied additionally as part of main supply).
	a. Filter Cloths : 2 sets
	b. Belt : 2 set
	c. Vacuum box seals : 1 set
	d. Pump Bearing (for all pumps) : 1 sets
	e. Pump Seals (for all pumps): 1 sets
	f. Slurry Valves : 1 numbers for each size and type
	g. Slurry Line Bends : 4 numbers for each size and type
	h. Slurry Line pipe : 4 numbers for each size and of each length is 6 .0 meter
	i. Hydro-cyclone isolation valve : 1 numbers for each size and type
	j. Vortex finder & Apex inserts: 1 numbers for each size and type
15.2.0	MANDATORY SPARES:
	Mandatory spares shall be supplied as per the list furnished.
15.3.0	Recommended Spares:
	Bidder shall provide, In addition to the spare parts mentioned above, the Contractor shall also provide a list of recommended spares for three (3) years of normal operation of the plant and indicate the list and total prices in relevant schedule. The list shall take into consideration the mandatory spares specified and should be independent of the list of the mandatory spares. The purchaser reserves the right to buy any or all of the recommended spares. The recommended spares shall be delivered at project site at least two months before the scheduled date of initial operation of first unit. However, the spares shall not be dispatched before the dispatch of the main equipment. 2. Prices of recommended spares will not be used for evaluation of the bids. The price of these spares will remain valid up to execution of the contract. However, the Contractor shall be liable to provide necessary justification for the quoted prices for these spares if desired by the purchaser.
15.4.0	SPECIAL TOOLS & TACKLES:
	Any special tools & tackles required for the entire equipment to disassemble, assemble or maintain the units, they shall be included in the quotation and furnished as part of the initial supply of the machine. List of special tools & tackles shall be decided by bidder as per his proven practice. When special tools are provided, they shall be packaged in separate, boxes with lugs and marked as "Special Tools for (tag / item number)." Each tool shall be stamped or tagged to indicate its intended usage. Levers and eye bolts for the removal of parts to be serviced shall be submitted with special tools. Any special equipment, tools and tackles required for the successful completion of the performance tests shall be provided by the vendor free of cost.
16.0.0	PERFORMANCE GUARANTEE
	Bidder shall meet the schedule of guarantee as enclosed in Annexure XVI
17.0.0	WARRANTY
1.	The Bidder warrants that the equipments/items shall be free from defects in the design, engineering, materials and workmanship of the Plant and Equipment supplied and of the work executed. The Warranty/Defect Liability Period shall be thirty six(36) months from the date of delivery or twenty four (24) months from the date of commissioning, whichever first occurs. If during the Defect Liability Period any defect should be found in the design, engineering, materials and workmanship of the Plant and Equipment supplied or of the work executed by the

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	Bidder, the Bidder shall promptly, in consultation and agreement with BHEL regarding appropriate remedying of the defects, and at its cost, repair, replace or otherwise make good (as the Bidder shall, at its discretion, determine) such defect as well as any damage to the Facilities caused by such defect.
2.	In case of failure of the equipment to meet the guarantee, END CUSTOMER /BHEL reserves the right to reject the equipment. However, END CUSTOMER /BHEL reserves the right to use the equipment until new equipment supplied by bidder meets the guaranteed requirement .
18.0.0	FIRST FILL OF CONSUM ABLES:
1.	Bidder's scope shall also include supply and filling of all chemicals, reagents, resins, lubricants, grease, filters and consumable items for operation up to commissioning including top up requirements. All lubricants proposed for the plant operation shall be suitable for all operating and environmental conditions that will be met on site consistent with good maintenance procedures as instructed in the maintenance manuals.
2.	Detailed specifications for the lubricating oil, grease, gases, servo fluids, control fluids, chemicals including items qualities and quantities required per month of the plant operation for the END CUSTOMER /BHEL's approval herein shall be furnished within 2 months of placement of Order. On completion of erection complete list of bearings/equipment giving their location and identification marks shall be furnished to BHEL along with lubrication requirements. All types of 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.
19.0.0	TRAINING
	Successful bidder shall provide comprehensive training for END CUSTOMER /BHEL Engineering, O&M, Erection & Commissioning staffs at site covering all aspects of the GDS system - Operation & Maintenance, Troubleshooting etc.
20.0.0	CONFLICT
	Bidder's equipment shall be designed for and shall meet the service, performance and minimum level of quality requirements specified. Bidder shall be solely responsible for advising END CUSTOMER in writing of any conflicts between the specifications and Bidder's design, including performance and levels of quality. Bidder agrees that its obligations, liabilities and warranties shall not be diminished or extinguished due to its meeting the requirements of the Specification.
21.0.0	DOCUM ENTATION
A	DOCUM ENTS TO BE SUBM ITTED 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 evaluation as per Annexure VI. Annexure VI documents are required for proper evaluation purpose and vendors are requested to comply with above in all respect.

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B	DOCUMENTS TO BE SUBMITTED AFTER AWARD OF CONTRACT
	The Successful bidder shall submit necessary data, documents and drawings for review, approval as specified under Annexure VI. Drawings that are reviewed by the END CUSTOMER / BHEL will be returned to bidder with a transmittal letter with any comments and / or questions marked on the drawings or noted in the letter. All comments and questions must be resolved before a resubmission of drawings / documents. If the design has not developed enough to resolve some of the comments or questions, bidder shall place a “hold” on those items or areas of design. END CUSTOMER/ BHEL reserves the right to return drawings unprocessed to bidder if there exists any evidence that bidder has not acknowledged all comments and questions. All necessary GA drawings, sections, sub-assembly drawings, specifications of main and sub components and necessary set of operation & maintenance manual as asked by END CUSTOMER must be furnished by bidder in soft and hard copy forms. For all documents softcopy format shall be searchable pdf, however in addition all drawings, diagrams like P&IDS shall be supplied in ACAD or other editable format and all lists in Excel format. Further break up of technical documents will be discussed during finalization of the purchase contract. Unless agreed otherwise, Ten (10) hard copies and five (05) sets of electronic copies of all documents are to be submitted in the English language. Electronic Copies shall be submitted in primary original data format (e.g. DOC, XLS, DWG) as well as in a printable non-proprietary document format (e.g. PDF). Especially P&IDs shall be submitted as DWG files and PDF files. Bidder to ensure submission of hard copies as per END CUSTOMER requirement for all engineering drg/doc and for all subsequent revisions along with a soft copy through email to concerned project team. However all the engineering related information shall be furnished in soft form to BHEL. Note : The vendor shall submit the drawings / documents for BHEL's review/approval as per the schedule given in Annexure-VI. BHEL shall furnish approval/comments within 2 weeks of receipt of drawings/ documents. Turnaround time for submission of revised drawing/document shall be 1 week from receipt of commented drawing/document.

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ANNEXURE-I-QUALIFICATION REQUIREMENT (PROVENNESS CRITERIA)

1.0	The bidder shall be manufacturer who has previously designed (either by themselves or under collaboration/ licensing agreement), manufactured / got manufactured (Non-manufacturers refer Note-D) Vacuum Belt Filter for dewatering process in a Wet Limestone based FGD application of the minimum capacity 10 Tons per hour (wet cake) which has been in successful operation in at least one (1) plant for a period not less than Two (2) year as on date of enquiry.
2.0	In case the Bidder does not have above credential, but is a manufacturer, who has previously designed and manufactured (either by themselves or under collaboration/ licensing agreement), at least one (1) number Vacuum Belt Filter operating in any other process application, of minimum capacity 10 Tons per hour (wet cake), which has been in successful operation for a period of not less than Two (2) year as on Date of enquiry.
3.0	If the bidder does not meet the proven ness criteria as per clause no 1.0 or 2.0 on their own, such bidder is still eligible to submit their bid, if they are a JV / Subsidiary Company meeting the requirements specified in Annexure-1A.
4.0	Details of the supply references made satisfying the above pre-qualification criteria shall be submitted as per Table-1 along with copies of the following mandatory documentary proof: a) Purchase order (or) Letter of intent (or) Letter of Award (or) Work Order b) Commissioning / Installation Certificate (from the end user) c) Performance Certificate (from the end user) for satisfactory operation for a period of not less than two (2) year as on date of enquiry. Bidder shall ensure that the above documentary evidence provided pertains to the same reference project.
5.0	Bidder shall submit design documents to substantiate technical parameters specified in PQR, if the same is not mentioned in performance certificate/purchase order.
6.0	Bidder to submit all supporting documents in English. If documents submitted by bidder are in language other than English, a translation of its pertinent passages in English language shall be provided by the bidder, in which case, for purposes of interpretation of the bid, the translation shall govern. The English Translation of the documents shall be carried out by professional translators and the translator shall certify that he is proficient in both languages in order to translate the document and that the translation is complete and accurate. Further, translation shall be authenticated by the Indian Consulate located in the Country where the documents have been issued or the Embassy of that Country in India.
7.0	Notwithstanding anything stated above, BHEL/ END CUSTOMER reserves the right to assess the capabilities and capacity of the bidder to perform the contract, should the circumstances warrant such assessment in the overall interest of BHEL/ END CUSTOMER.
8.0	After satisfactory fulfilment of all the above criteria/ requirement, offer shall be considered for further evaluation as per NIT and all the other terms of the tender.
9.0	Whenever the term 'coal fired' is appearing, 'Coal' shall be deemed to also include Bituminous coal/ Brown coal/ Anthracite coal/ Lignite.

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Table-1 :: Supply References

Sl. No.	Project Name	Wet Limestone Based FGD (Yes/ No)	Model & make	Date of Commissioning	Qty	Capacity

Notes:

- A. BHEL is in the process of seeking with END CUSTOMER (NTPL) approval for relaxation with respect to clause no. 2.0 and clause no. 3.0.**
- B. Bidders are advised to furnish the PQR documents in line with Clause no. 1.0 which is specific requirement of BHEL's end customer. However, in case the bidder feels that they are not meeting the requirement of clause no. 1.0, but can meet the requirement of clause no. 2.0 or clause no. 3.0, then they are advised to submit the bids along with PQR documents meeting the clause no. 2.0 or clause no. 3.0. **The bids meeting the requirement of clause no. 2.0 or clause no. 3.0 shall be technically reviewed and recommended by BHEL (if found suitable) and shall be forwarded to end customer for acceptance of any relaxation in line with the clause no. 2.0 or clause no. 3.0. Acceptability of offers by such bidders are strictly subjected to approval by END CUSTOMER.****
- C. In case BHEL's end customer does not consider any relaxation with respect to clause no. 2.0 or clause no. 3.0 above, the acceptance of bids shall be governed with respect to clause no. 1.0 of PQR and bidder will not have any claim with respect to clause no. 2.0 or clause 3.0.**
- D. Acceptability of bids submitted by Non-Manufacturers who are having the qualified design as per Clause no 1.0, is strictly subjected to approval by END CUSTOMER.**
- E. Acceptability of bids who are having the qualified Criteria , is strictly subjected to approval by end customer.**

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ANNEXURE-IA

1. A JV / Subsidiary Company formed for manufacturing and supply of equipment(s) as listed at clause no. 1.0 or 2.0 of document no. Annexure-1, in India can also manufacture such equipment(s), provided that it has a valid collaboration or licensing agreement for design, engineering, manufacturing of such equipment(s) in India with a qualified equipment manufacturer who meets the requirements stipulated at the said clause (or the technology provider of the qualified equipment manufacturer) for the equipment(s). Before taking up the manufacturing of such equipment(s), the bidder/ his sub-vendor(s) must create / have created manufacturing facilities at his works as per collaborator's/licenser's design, manufacturing and quality control system for the equipment(s).
2. Further, in such a case, such qualified equipment manufacturers should have, directly or indirectly through its holding company/ subsidiary company, at least 26% equity participation in the Indian Joint Venture Company/ Subsidiary Company, which shall be maintained for a lock-in period of seven (7) years from the date of incorporation of such Joint Venture/ Subsidiary or up to the end of defect liability period of the contract, whichever is later.
3. In such case(s), the bidder shall furnish the following details of JV/ Subsidiary company:
4. Copy of document of incorporation of JV/ Subsidiary company in India
 - a. Copy of valid ongoing collaboration and technology transfer agreement for design, engineering, manufacturing, supply of such equipment in India with the collaborator who meets the requirement stipulated at clause 1.0 or 2.0 of document no. Annexure-1.
 - b. Copy of document of at least 26% equity participation of qualified equipment manufacturer in the Indian JV company/subsidiary company directly or indirectly through its holding/ Subsidiary company, which shall be maintained for a lock-in period of seven (7) years from the date of incorporation of such JV/ Subsidiary or up to the end of defect liability period, of the contract whichever is later.
 - c. Further, the details of collaborator or technology provider/licensor of the qualified equipment manufacturer who meets the requirement stipulated at clause 1.0 or 2.0 of document no. Annexure-1 shall be submitted by the bidder.
5. Before taking up the manufacturing of such equipment(s) as per above clauses, the Bidder must create (or should have created) manufacturing and testing facilities at its works as per Collaborator / licensor's design, manufacturing and quality control system for such equipments duly certified by the Collaborator / licensor. Further, the Collaborator / Licensor shall provide (or should have provided) all design, design calculation, manufacturing drawings and must provide (or should have provided) technical and quality surveillance assistance and supervision during manufacturing, erection, testing, commissioning of equipments.
6. BHEL/ END CUSTOMER reserve(s) the right to fully satisfy himself regarding capability and capacity of Bidder and the proposed arrangement and may prescribe additional requirement before allowing manufacture of the equipment listed above for this contract.

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ANNEXURE-II-TECHNICAL DATA SHEET

Sl. No	Description	Data
1.0	GENERAL	
	a. Client	: NLC Tamil Nadu Power Limited (NTPL)
	b. Project	: NTPL Tuticorin Thermal Power
	c. End Customer	: NLC Tamil Nadu Power Limited (NTPL)
	d. Location	: At Tuticorin Taluk in Tuticorin district in the Southern Part of Tamil Nadu along the Bay of Munnar, India
	e. Service	: Continuous
	f. Installation	: Inside the Building
	g. Quantity for all FGD units	: 2 sets (1W+1S)
2.0	MANUFACTURER DETAILS	
	a. Model	: Bidder to Provide
	b. Type	: Bidder to Provide
3.0	OPERATING CONDITION	
	Medium to be handled	: Gypsum Slurry
4.0	Technical Data	
4.1.0	PRIMARY HYDRO-CYCLONE	
	i. Stage	Bidder to Provide
	ii. Manufacturer	Bidder to Provide
	iii. Number of Hydro cyclone	Bidder to Provide
	iv. Diameter of Hydro cyclone	Bidder to Provide
	v. Diameter of Vortex Finder	Bidder to Provide
	vi. Diameter of Apex Valve	Bidder to Provide
	vii. Diameter of Feed Inlet	Bidder to Provide
	viii. Design Pressure	Bidder to Provide
	ix. Working Pressure	Bidder to Provide
	x. Feed Flow rate	Bidder to Provide
	xi. Overflow Rate	Bidder to Provide

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	xii.	Underflow Rate	Bidder to Provide
	xiii.	Mesh of separation (50% Removed)	Bidder to Provide
	xiv.	Solid content of feed slurry	Bidder to Provide
	xv.	Solid content in underflow of Hydrocyclone	Bidder to Provide
	xvi.	Solid content in Overflow of Hydrocyclone	Bidder to Provide
	xvii.	Type of cyclone	Bidder to Provide
	a)	Cyclone Dia/ Height (mm)	Bidder to Provide
	b)	Required Liquid Feed Pressure	Bidder to Provide
	c)	Cyclone Connection Number/ Dia. (mm)	Bidder to Provide
	d)	Feed	Bidder to Provide
	e)	Overflow	Bidder to Provide
	f)	Underflow	Bidder to Provide
	g)	Rf Value (Underflow Slurry (m ³ /hr/Feed	Bidder to Provide
	h)	Material	Bidder to Provide
	i)	Shell	Bidder to Provide
	j)	Internal Structure Part	Bidder to Provide
	k)	Lining	Bidder to Provide
	l)	Particle Size Distribution	Bidder to Provide
	m)	Weight	Bidder to Provide
4.1.1	SECONDARY HYDRO-CYCLONE		
	xvii.	Stage	Bidder to Provide
	xviii.	Manufacturer	Bidder to Provide
	xix.	Number of Hydro cyclone	Bidder to Provide
	xx.	Diameter of Hydro cyclone	Bidder to Provide
	xxi.	Diameter of Vortex Finder	Bidder to Provide
	xxii.	Diameter of Apex Valve	Bidder to Provide
	xxiii.	Diameter of Feed Inlet	Bidder to Provide
	xxiv.	Design Pressure	Bidder to Provide

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	xxv.	Working Pressure	Bidder to Provide
	xxvi.	Feed Flow rate	Bidder to Provide
	xxvii.	Overflow Rate	Bidder to Provide
	xxviii.	Underflow Rate	Bidder to Provide
	xxix.	Mesh of separation (50% Removed)	Bidder to Provide
	xxx.	Solid content of feed slurry	Bidder to Provide
	xxxi.	Solid content in underflow of Hydrocyclone	Bidder to Provide
	xxxii.	Solid content in Overflow of Hydrocyclone	Bidder to Provide
	xvii.	Type of cyclone	Bidder to Provide
	n)	Cyclone Dia/ Height (mm)	Bidder to Provide
	o)	Required Liquid Feed Pressure	Bidder to Provide
	p)	Cyclone Connection Number/ Dia. (mm)	Bidder to Provide
	q)	Feed	Bidder to Provide
	r)	Overflow	Bidder to Provide
	s)	Underflow	Bidder to Provide
	t)	Rf Value (Underflow Slurry (m ³ /hr/ Feed	Bidder to Provide
	u)	Material	Bidder to Provide
	v)	Shell	Bidder to Provide
	w)	Internal Structure Part	Bidder to Provide
	x)	Lining	Bidder to Provide
	y)	Particle Size Distribution	Bidder to Provide
	z)	Weight	Bidder to Provide
4.2	VACUUM BELT FILTERS (VBF)		
	a.	Manufacturer	: Bidder to Provide
	b.	Model No.	: Bidder to Provide
	c.	Dimensions (W x L x H) (m x m x m)	: Bidder to Provide
	d.	Cloth Width m	: Bidder to Provide
	e.	Cloth Length m	: Bidder to Provide

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	f. No. Working / Stand-by	:	Bidder to Provide
	g. Capacity (Guaranteed) Gypsum (Dry)	:	Bidder to Provide
	h. Inlet Flow Volume	:	Bidder to Provide
	i. Gypsum Flow (Dry) Kg/hr	:	Bidder to Provide
	j. Residual Moisture in gypsum %	:	Bidder to Provide
	k. No. of stages of cake washing / water flow m3/h	:	Bidder to Provide
	l. No. of stages of cloth washing / water flow m3/h	:	Bidder to Provide
	m. Design Pressure of Vacuum Chamber	:	Bidder to Provide
	n. Operating Pressure of Vacuum Chamber	:	Bidder to Provide
	o. Material / Thickness mm	:	Bidder to Provide
	i. Casing	:	Bidder to Provide
	ii. Cloth	:	Bidder to Provide
	iii. Gypsum Discharge Hopper	:	Bidder to Provide
	iv. Vacuum Box	:	Bidder to Provide
	p. Life of Cloth hrs	:	Bidder to Provide
	q. Type / Material of Carrying Belt	:	Bidder to Provide
	r. Type / Material of Sealing Belt	:	Bidder to Provide
	s. Life of Carrying Belt hrs	:	Bidder to Provide
	t. Life of Sealing Belt hrs	:	Bidder to Provide
	u. Automatic Cloth Tensioning Mechanism Provided	:	Yes / No - Bidder to confirm
4.3	VACUUM RECEIVER TANK		
a.	No. of Tank for each VBF	:	Bidder to Provide
b.	Capacity (m3)	:	Bidder to Provide
c.	Dimensions (Dia x Height) (mm x mm)	:	Bidder to Provide
d.	Material / Thickness (mm)	:	Bidder to Provide
e.	Lining Material / Thickness mm	:	Bidder to Provide
4.4	Vacuum Pumps		
a.	Manufacturer	:	Bidder to Provide

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b.	Make/ Model	:	
c.	Type	:	Bidder to Provide
d.	No. of Pumps for each Vacuum Belt Filter	:	Bidder to Provide
e.	Rated Capacity Flow (m ³ /hr)	:	Bidder to Provide
	Rated Capacity Head (mWCI)	:	Bidder to Provide
	Rated Capacity Power (KW)	:	Bidder to Provide
f.	Power consumption (KW)	:	Bidder to Provide
g.	Pump Speed (rpm)	:	Bidder to Provide
h.	Motor Rating (KW)	:	Bidder to Provide
i.	Motor Speed (rpm)	:	Bidder to Provide
j.	Margins (Flow/ Head) (%/ %)	:	Bidder to Provide
k.	Operation Pressure	:	Bidder to Provide
l.	Design Pressure	:	Bidder to Provide
m.	Material/ Thickness (mm) of	:	Bidder to Provide
	Base/ Lining	:	Bidder to Provide
	Casing	:	Bidder to Provide
	Shaft	:	Bidder to Provide
	Impeller	:	Bidder to Provide
n.	Type of seal	:	Bidder to Provide
o.	Sealing Water Flow (m ³ /hr)	:	Bidder to Provide
p.	Bearing	:	Bidder to Provide
	No. of Bearings	:	Bidder to Provide
	Type Of Bearings	:	Bidder to Provide
q.	Type of coupling	:	Bidder to Provide
r.	Whether silencer provided at outlet	:	Yes/No
4.5	SLURRY PIPES	:	
a.	Pipe size (mm)	:	Bidder to Provide
b.	Type of Joints	:	Bidder to Provide
	Pipe to Pipe/ Pipe to Fittings	:	Bidder to Provide
	Fittings	:	Bidder to Provide

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c.	Material / Thickness (mm) of Pipe	:	Bidder to Provide
d.	Material Thickness of lining	:	Bidder to Provide
e.	Estimated Life of liners (hrs.)	:	Bidder to Provide
f.	Slurry Solid concentration (w/w %)	:	Bidder to Provide
g.	Slurry Settling Velocity (m/s)		Bidder to Provide
h.	Pipe Velocity (m/s)		Bidder to Provide
4.6	BELT FILTER WASH PUMPS		
a.	No. for each VBF		Bidder to Provide
b.	No. of stand-by pumps for each VBF		Bidder to Provide
c.	Make / Model		Bidder to Provide
d.	Impeller Type		Bidder to Provide
e.	Material / Thickness (mm) of Impeller and lining		Bidder to Provide
f.	Casing Type		Bidder to Provide
g.	Material/ Thickness of Casing/ Lining		Bidder to Provide
h.	Rated Flow/ Head (m ³ /hr./mWCI)		Bidder to Provide
4.7	VOID		
4.8	BELT ACCESSORIES		
4.8.1	Bearing		
a.	Carrying	:	Bidder to Provide
b.	Return	:	Bidder to Provide
4.8.2	Material		
a.	Roller	:	Bidder to Provide
b.	Spindle	:	Bidder to Provide
4.8.3	Pulleys		
i)	General (for all types of Pulleys)	:	Bidder to Provide
a.	Pulley Shaft Diameter	:	Bidder to Provide
ii)	Drive Pulleys		
a.	Lagging	:	Bidder to Provide
b.	Lagging thickness	:	Bidder to Provide
c.	Minimum angle of wrap	:	Bidder to Provide

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d.	Maximum out of roundness	:	Bidder to Provide
iii)	Other Pulleys		
a.	Lagging	:	Bidder to Provide
b.	Lagging thickness	:	Bidder to Provide
iv)	Rubber for lagging		
a.	Type	:	Bidder to Provide
b.	Hardness	:	Bidder to Provide
c.	Elongation	:	Bidder to Provide
d.	Strength	:	Bidder to Provide
e.	Abrasion Loss	:	Bidder to Provide
f.	Specific Gravity	:	Bidder to Provide
g.	Adhesion Strength	:	Bidder to Provide
v)	Bearings for Pulleys		
a.	Type	:	Bidder to Provide
b.	Casing	:	Bidder to Provide
c.	Sealing	:	Bidder to Provide
d.	Lubrication	:	Bidder to Provide
e.	Pulley Material	:	Bidder to Provide
f.	Shaft Material	:	Bidder to Provide
4.9	Chutes and Hoppers		
a.	Minimum Valley Angle	:	Bidder to Provide
b.	Material :	:	Bidder to Provide
	i) Chute work	:	Bidder to Provide
	ii) Sliding zones & adjacent sides	:	Bidder to Provide
	iii) No striking/ Non sliding zones	:	Bidder to Provide
	iv) Chute with valley angle 80 degree and above	:	Bidder to Provide
	v) In the zone of magnetic field	:	Bidder to Provide
	vi) In the zone of flap gates	:	Bidder to Provide
	vii) Discharge Hoods overhead pulleys	:	Bidder to Provide
c.	Inspection Doors	:	Bidder to Provide

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d.	Chute Construction	:	Bidder to Provide
	i) Corners	:	Bidder to Provide
	ii) Joints Bolted	:	Bidder to Provide
	iii) Bolt size	:	Bidder to Provide
	iv) Bolts spacing	:	Bidder to Provide
	v) Fixing Arrangement	:	Bidder to Provide
4.10	Skirt Boards		
a.	Length	:	Bidder to Provide
b.	Height	:	Bidder to Provide
c.	Width	:	Bidder to Provide

SIGNATURE OF BIDDER _____
NAME _____
DESIGNATION _____

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ANNEXURE III- SCHEDULE OF GUARANTEES

Sl. No	Description	Data
1.	Rated capacity of Vacuum Belt Filter TPH	: Bidder to Provide
2.	Guaranteed power consumption of kW Gypsum Dewatering System at rated capacity	: Bidder to Provide
3.	Chloride content in output gypsum cake ppm	: Bidder to Provide
4.	Moisture in output gypsum cake %	: Bidder to Provide
5.	Output gypsum purity %	: Bidder to Provide
6.	Quantity of Process water for Cake m3/hr washing m3/hr	: Bidder to Provide
7.	Total quantity of utility water consumed m3/hr during VBF in operation	: ≤ 28
8.	Equipment Availability in % (avg. target % 98%) Continuous for 120 days	Bidder to Provide
9.	In the event PG test is unsuccessful, bidder shall take necessary remedial action at his cost & PG test shall be repeated	Bidder to Confirm

SIGNATURE OF BIDDER

NAME

DESIGNATION

	Form No:	 PE&SD	TECHNICAL SPECIFICATION FOR	PY 51769
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ANNEXURE – IV

REFERENCE LIST as per format shown below. (Atleast two reference plant details)

S.no	Project Name Customer & Plant capacity	Coal fired Yes/ No	Wet Limestone Based FGD Yes/ No	Model	Capacity of Vacuum belt filter TPH	Year of Coming	Qty
1.							
2.							

SIGNATURE OF BIDDER

NAME

DESIGNATION

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ANNEXURE – V- LIST OF DEVIATIONS/ EXCEPTIONS TO THE ENQUIRY DOCUMENT

Sl No	Clause No	Page No	Description of Deviation

Note: Enlarge the table to incorporate items

SIGNATURE OF BIDDER -----

NAME -----

DESIGNATION -----

Form No:	 PE& SD	TECHNICAL SPECIFICATION FOR	PY 51769
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ANNEXURE-VI DOCUMENTATION

A) DOCUMENTS TO BE SUBMITTED ALONG WITH THE OFFER:

Sl. No.	Description	No of copies
		With proposal
1.	Enquiry Specification (signed)	1
2.	Price Sheet	1
3.	Anchor Plan & Civil foundation Loading details	1
4.	Data Sheet	1
5.	Performance curve	1
6.	P & I Diagram	
7.	Terminal point details.	
8.	Annexure to qualification requirement-	1
9.	Proforma Packing List	1
10.	Shortest Manufacturing Time	1
11.	Approximate weight of each skid	1
12.	Required Electric power & other Utility List	1
13.	Deviation List	1
14.	General Assembly Drawing indicating dimension and civil loading details	1
15.	Gypsum dewatering building GA	1
16.	VBFSizing Calculation	1
17.	Cross-sectional Drawing	1
18.	Scope of Supply	1
19.	Spare List (Recommended)	1
20.	Start-up & Commissioning Spares	1
21.	List of Special Tools	1
22.	Test Arrangement & Test procedure	1
23.	Rotor GD2 (kg-m2)	
24.	T-Scurve	1
25.	Hoist/ Crane requirement	1
26.	Catalogue	1
27.	Calculation of Motor rating, Bearing capacity and selection of coupling	1
28.	Bill of material along with material and code	1

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29.	Overall space and headroom requirement with details of handling during Erection, operation & maintenance of the equipment.	1
30.	Erection, Operation & Maintenance manual with lubrication schedule	1
31.	Procedure for shop / site performance tests	1
32.	Time schedule for delivery.	1
33.	Quality Assurance Plan.	1
34.	Make of all bought out items.	1
35.	Deviation list	1
36.	Spares list.	1
37.	Hoist / Crane requirement.	1
38.	Reference list of similar projects executed.	1
39.	List of proposed makes and vendors	1
40.	Training program and schedule for BHEL/ END CUSTOMER C personnel	1
41.	Equipment maintenance schedules	1

Form No:	 PE& SD	TECHNICAL SPECIFICATION FOR	PY 51769
		GYPSUM DEWATERING SYSTEM PACKAGE	Rev. No. 00
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B) DOCUMENTS TO BE SUBMITTED AFTER CONTRACT:

S. No.	Description	No of copies After award of contract(tentative)	Delivery Time
1.	Utility Consumption	10	2 weeks after contract
2.	Foundation Data including Anchor plan	10	2 weeks after contract
3.	Performance curve	10	2 weeks after contract
4.	Assembly drawings of each equipment	10	1 month after contract
5.	Cross section detail drawing	10	1 month after contract
6.	Data Sheet	10	2 weeks after contract
7.	Documents in support of qualification requirement	10	2 weeks after contract
8.	Lubricating oil list	10	2 months after contract
9.	Special tools list	10	2 months after contract
10.	Installation and assembly procedure	10	4 months after contract
11.	Inspection and Test Procedure	10	1 month after contract
12.	Inspection & Test record	10	In 2 weeks after test
13.	Inspection Certificate	10	In 2 weeks after test
14.	Sub vendors List	10	2 weeks after contract
15.	Manufacturing Schedule	10	2 weeks after contract
16.	Progress report	10	Every month
17.	Proforma Packing List	10	2 months prior to shipping
18.	Approximate weight of each skid	10	2 months after contract
19.	Required Electric power	10	2 weeks after contract
20.	VBF Sizing Calculation	10	2 weeks after contract
21.	Material Test Certificates	10	In 2 weeks after test
22.	Pre Commissioning Check List	10	4 months after contract
23.	Scope of Supply	10	2 weeks after contract
24.	Quality Plan	10	1 month after contract
25.	Operation and Maintenance Manual	5 hardcopies and 4 electronic copies in English	4 months after contract
26.	Erection Manual	5 hardcopies and 3 electronic copies in	4 months after contract
27.	Commissioning Manual	5 hardcopies and 4 electronic copies in	4 months after contract

Form No:	 PE& SD	TECHNICAL SPECIFICATION FOR	PY 51769
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S. No.	Description	No of copies After award of contract(tentative)	Delivery Time
28.	Spare List (Mandatory, Recommended)	10	1 month after contract
29.	Start-up & Commissioning Spares	10	1 month after contract
30.	List of Special Tools	10	1 month after contract
31.	Delivery Schedule	10	2 weeks after contract
32.	Test Arrangement & Test procedure	10	1 month after contract
33.	T-Scurve	10	2 weeks after contract
34.	P & I Diagram	10	2 weeks after contract
35.	Catalogue	10	2 weeks after contract
36.	Gypsum Dewatering Building GA	10	1 month after contract
37.	Motor Data	10	1 month after contract
38.	Recommended repair procedure etc.	10	1 month after contract
39.	Any unique installation instructions shall be noted on the submitted drawings or be provided as a separate document prior to the submission of the Operation and Maintenance Manual	10	1 month after contract
40.	Erection schedule and component list.	10	1 month after contract
41.	Equipment		
42.			

SIGNATURE OF BIDDER

NAME

DESIGNATION

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Annexure-VII Piping & Instrumentation Diagram

Bidder to confirm to the P&ID enclosed.

SIGNATURE OF BIDDER

NAME

DESIGNATION

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Annexure-VIII -Sea worthy packing (applicable for supplies from outside India)

Refer to Specification No: PE-TS-888-100-A001 for detailed specification on Seaworthy packing.

SIGNATURE OF BIDDER -----

NAME -----

DESIGNATION -----

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Annexure-IX Inspection and testing requirements

Refer to various clauses of Inspection and Testing Requirements

SIGNATURE OF BIDDER

NAME

DESIGNATION

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Annexure-X Electrical specification

(Refer to NTPL-Vol-II-F electrical specification)

SIGNATURE OF BIDDER -----

NAME -----

DESIGNATION -----

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Annexure-XI INSTRUMENTS SPECIFICATION

(Refer to the NTPL-Vol-II-E control and instrumentation)

SIGNATURE OF BIDDER -----

NAME -----

DESIGNATION -----

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Annexure-XII Material specification

(Refer to NTPL-Vol-II-D piping & valve specification).

SIGNATURE OF BIDDER -----

NAME -----

DESIGNATION -----

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Annexure-XIII GA drawing of gypsum dewatering building

Refer to the GA drawing of GDSbuilding enclosed.

SIGNATURE OF BIDDER -----

NAME -----

DESIGNATION -----

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Annexure-XIV Paint schedule

(Refer to the NTPL-Vol-II-PAINTING).

SIGNATURE OF BIDDER -----

NAME -----

DESIGNATION -----

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Annexure-XV Vendor List

Refer to the Vendor List enclosed.

SIGNATURE OF BIDDER -----

NAME -----

DESIGNATION -----

	Form No:	 PE&SD	TECHNICAL SPECIFICATION FOR	PY 51769
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Annexure-XVI

(SELECTION PARAMETERS FOR GYPSUM DEWATERING SYSTEM).

SIGNATURE OF BIDDER -----

NAME -----

DESIGNATION -----



SELECTION PARAMETERS FOR GYPSUM DEWATERING SYSTEM

1.0 GYPSUM DEWATERING SYSTEM SELECTION DATA

1.1 PROCESS PARAMETERS FOR PRIMARY HYDROCYCLONE				
S.no	Parameters	Primary Hydro Cyclone Feed Slurry	Primary Hydro Cyclone Over Flow	Primary Hydro Cyclone Under Flow
a.	Total Flow (m ³ /hr.)	94.84	54.76 *1)	40.08 *1)
b.	Total Flow (t/hr.)	115.37	60.93 *1)	54.44 *1)
c.	Operating Temp (°C)	49.8	49.8	49.8
d.	Design Temp (°C)	70	70	70
e.	Solid (wt. %)	30	16.6 *1)	> 45 *2)
f.	Density (Kg/m ³)	1216	1113 *1)	1358 *1)
g.	pH	4 – 7	4 - 7	4 – 7
h.	Cl ⁻ (mg/l)	<26000	<26000	<26000
i.	Number of hydrocyclones : 2 numbers (1 W + 1 S)			
j.	Back pressure of Primary hydro cyclones inlet shall be maintained <20 m L.C			
k.	Primary hydrocyclone to be sized for : 104.4 m3/hr.(including 10 % margin)			
l.	Each set of primary hydrocyclone shall be provided with 10% spare hydro-cyclones as per clause 5.12.01 in Vol-IIB, Section –I, pg 12/57			
1.2 PROCESS PARAMETERS FOR SECONDARY HYDROCYCLONE				
S.no	Parameters	Secondary Hydro cyclone Feed Slurry	Secondary Hydro cyclone Overflow	Secondary Hydro cyclone Under flow
a.	Total flow (m ³ /hr)	54.76	34.22 *1)	20.54 *1)
b.	Total flow (t/hr)	60.93	35.04*1)	25.90 *1)
c.	Operating Temp (° C)	49.8	49.8	49.8
d.	Design Temp (°C)	70	70	70
e.	Solid (wt %)	16.6	3 *2)	35 *1)
f.	Density (kg/m ³)	1113	1024	1260
g.	pH	4 – 7	4 - 7	4 - 7
h.	Cl ⁻ (mg/l)	<20000	<20000	<20000
i.	Number of hydrocyclones : 2 numbers (1 W + 1 S)			
j.	Back pressure of Secondary hydro cyclones inlet shall be maintained <20 m L.C			
k.	Secondary hydrocyclone to be sized for : 60.3 m3/hr.			
l.	10% spare hydrocyclones shall be provided in each secondary hydrocyclone set as per clause 5.12.01 in Vol-IIB, Section –I, pg 12/57			

Project: NTPL 2x500MW Projects at TUTICORIN, FGD System Package							
Cont No: G515 & G516		Rev 00		Rev 01		Rev 02	
		Sign	Date	Sign	Date	Sign	Date
Engineer	MVR	-sd-	17.09.2020	-sd-	01.11.2021		
Reviewer	PNR	-sd-	17.09.2020	-sd-	01.11.2021		
Approver	ACR	-sd-	17.09.2020	-sd-	01.11.2021		



SELECTION PARAMETERS FOR GYPSUM DEWATERING SYSTEM

1.3 PROCESS PARAMETERS FOR VACUUM BELT FILTER					
S.no	Parameters	Belt Filter Feed Slurry	Product Gypsum	Filtrate	Washing Water *2)
a.	Total Flow (m ³ /hr)	40.08 *1)			Vendor to furnish process water requirement for cake wash.
b.	Total Flow (t/hr)-Wet	54.44 *1)	27.1		
c.	Design Temp(deg C)	70			
d.	Solid(% wt)	>45 *2)	>90 *2)	<0.2	
e.	Density kg/m ³	1358*1)			
f.	pH	4~7	5~8		
g.	Cl	<26000	<100 ppm *2)		
h.	Belt filter and the peripherals design capacity = 29.8 t/h (wet cake)				
i.	Number of vacuum belt filters : 2 numbers (1 W + 1 S)				

Note:

- Quantity of water shall be finalized by the vendor. Property of Process water given in section 2.0
- *1) shall be finalized by vendor
- *2) Shall be guaranteed by vendor
- Inputs furnished for vacuum belt filter in Section 1.0 are based on document 4-FW-000-01077 which are approved in Cat II.

Project: NTPL 2x500MW Projects at TUTICORIN, FGD System Package							
Cont No: G515 & G516		Rev 00		Rev 01		Rev 02	
		Sign	Date	Sign	Date	Sign	Date
Engineer	MVR	-sd-	17.09.2020	-sd-	01.11.2021		
Reviewer	PNR	-sd-	17.09.2020	-sd-	01.11.2021		
Approver	ACR	-sd-	17.09.2020	-sd-	01.11.2021		



SELECTION PARAMETERS FOR GYPSUM DEWATERING SYSTEM

2.0 WATER ANALYSIS

TREATED WATER/FGD PROCESS WATER (Used for belt and cake washing):



Tender Specification
for
FGD Package

NLC Tamil Nadu Power Ltd.
2x600 MW Project
Tuticorin, Tamil Nadu

TABLE-II

TREATED WATER/ FGD PROCESS WATER QUALITY

Sr. Number	Item	Unit	Value
1.	<u>TDS of permeate from Desalination RO System</u>	ppm	<500
2.	Total Suspended solids	ppm	Nil
3.	Iron as Fe	ppm as Fe	<0.1
4.	Reactive Silica as SiO ₂	ppm as SiO ₂	<1.0
5.	Chloride as Cl	ppm as Cl	<200
6.	Sodium	ppm as Na	<150
7.	pH at 25 deg C	---	6.0-7.0



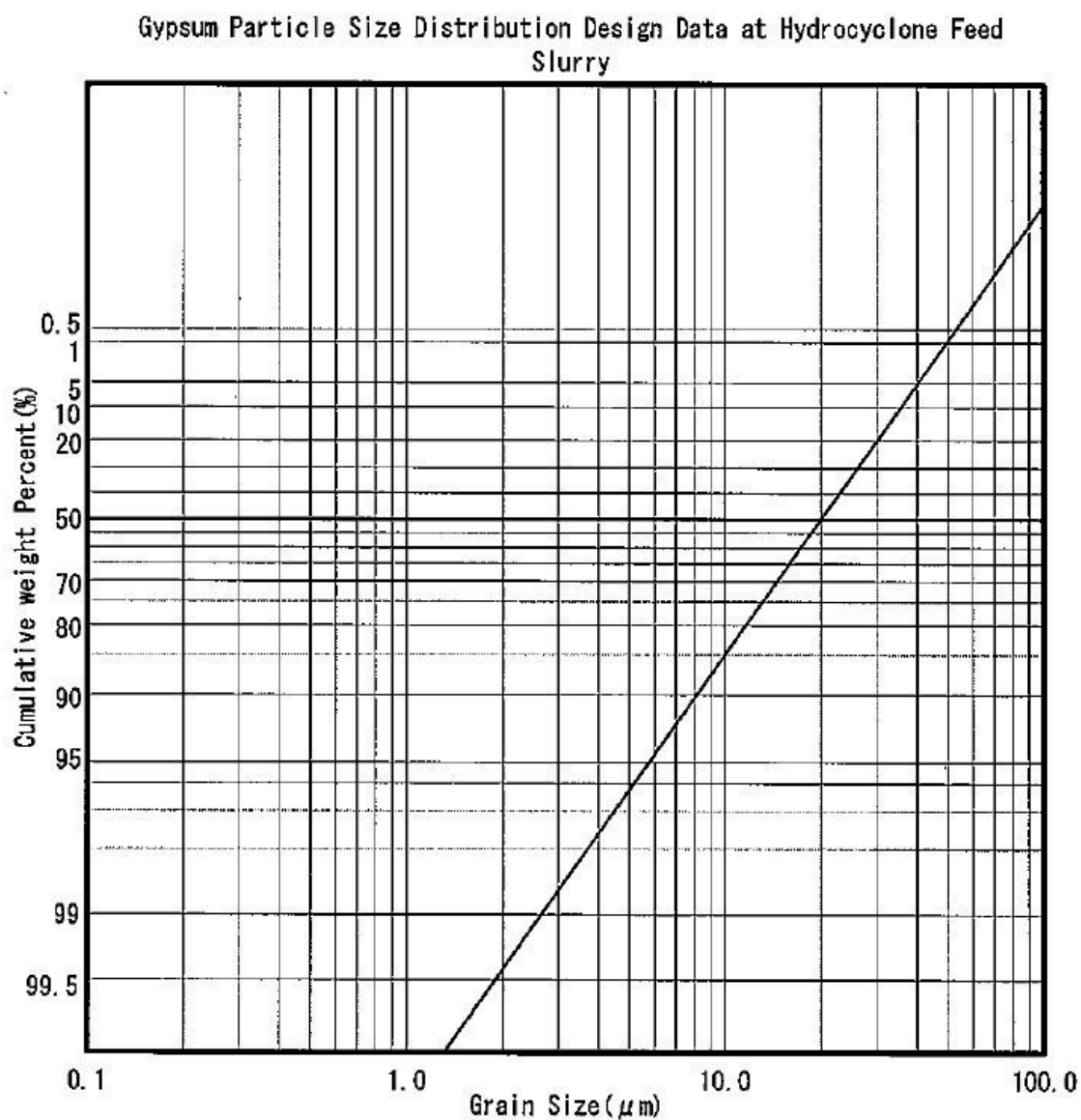
Development Consultants Pvt. Ltd.

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Vol. II-A/Section-IX
Salient Design Data

Project: NTPL 2x500MW Projects at TUTICORIN, FGD System Package							
Cont No: G515 & G516		Rev 00		Rev 01		Rev 02	
		Sign	Date	Sign	Date	Sign	Date
Engineer	MVR	-sd-	17.09.2020	-sd-	01.11.2021		
Reviewer	PNR	-sd-	17.09.2020	-sd-	01.11.2021		
Approver	ACR	-sd-	17.09.2020	-sd-	01.11.2021		

3.0 PARTICLE SIZE DISTRIBUTION



Note:

Vendor to submit the PSD based on their design for PHC & SHC underflow and overflow.

Project: NTPL 2x500MW Projects at TUTICORIN, FGD System Package							
Cont No: G515 & G516		Rev 00		Rev 01		Rev 02	
		Sign	Date	Sign	Date	Sign	Date
Engineer	MVR	-sd-	17.09.2020	-sd-	01.11.2021		
Reviewer	PNR	-sd-	17.09.2020	-sd-	01.11.2021		
Approver	ACR	-sd-	17.09.2020	-sd-	01.11.2021		



SELECTION PARAMETERS FOR GYPSUM DEWATERING SYSTEM

4.0 SCHEDULE OF GUARANTEES

Sl. No	Description	Data
1.	Rated capacity of Vacuum Belt Filter (VBF) TPH	: 29.8 TPH (Wet Cake) for each belt filter (including margin of 10%) 26.8 TPH DRY CAKE
2.	Power consumption at rated capacity kW	: Bidder to Provide
3.	Chloride content in output gypsum cake ppm	: <100
4.	Moisture in output gypsum cake %	: <10
5.	Output gypsum purity %	: >90
6.	Quantity of Process water for Cake washing m3/hr	: Bidder to Provide
7.	Total quantity of utility water consumed during VBF in operation m3/hr	: ≤ 28
8.	Equipment Availability in % (avg. target 98%) Continuous for 120 days	: Bidder to Provide
9.	In the event PG test is unsuccessful, bidder shall take necessary remedial action at his cost & PG test shall be repeated	: Bidder to Confirm

5.0 GENERAL NOTES

- Power consumption to be guaranteed as per Vol-IA, SCHEDULE – F1, Table -8, Sl.No. A. 3. ix & x. Maximum aux power (for vacuum belt filter, vent fan, vacuum pump, cake wash pump, belt filter wash pump) corresponding to rated capacity of 26.8 tph dry cake shall not exceed



210 kW.

- Scope of supply for gypsum dewatering system includes all equipments associated with gypsum dewatering system except primary hydrocyclone feed pumps; secondary hydrocyclone feed pumps, wastewater pumps and filtrate water pumps which are in BAP's scope of supply.

Rev 01: Auxiliary power consumption revised in line with Vol-IA, SCHEDULE – F1, Table -8, Sl.No. A. 3. ix & x.

Project: NTPL 2x500MW Projects at TUTICORIN, FGD System Package							
Cont No: G515 & G516		Rev 00		Rev 01		Rev 02	
		Sign	Date	Sign	Date	Sign	Date
Engineer	MVR	-sd-	17.09.2020	-sd-	01.11.2021		
Reviewer	PNR	-sd-	17.09.2020	-sd-	01.11.2021		
Approver	ACR	-sd-	17.09.2020	-sd-	01.11.2021		

 DEVELOPMENT CONSULTANTS PVT. LIMITED. Reviewed only for general conformance with contract drawings and specifications. Contractor to be responsible for any errors and for fulfillment of detailed requirements of contract documents	
ACTION 2	DATE 08/07/2021
DISTRIBUTED BY: MR/AT	
1 Approved	3 Returned with Comments. Please Resubmit.
2 Approved except as noted. Forward final drawings	4 For information only
SEE COVERING LETTER	
LETTER REF NO.	DATE

04	18.06.2021	Revision 04	MVR	PNR	ACR
03	08.03.2021	Revision 03	MVR	PNR	ACR
02	18.02.2021	Revision 02	MVR	PNR	ACR
01	11.01.2021	Revision 01	MVR	PNR	ACR
00	20.10.2020	Fresh Issue	MVR	PNR	ACR
REV	DATE	DESCRIPTION / NOTE	PRD	CHD	APD

REVISIONS

TITLE:

P&ID - Primary & secondary Dewatering, Waste Water Discharge System

OWNER/PROJECT:



NLC TAMILNADU POWER LIMITED (NTPL)
2X500 MW COAL FIRED UNITS AT TUTICORIN
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	MVR	-sd-	STATUS : <i>FOR APPROVAL</i>
CHECKED BY	PNR	-sd-	BHEL CUST NO : G515,G516
APPROVED BY	ACR	-sd-	REV NO : 04
BHEL DRG./DOC NO. : 3-FW-000-01634			

LINE SYMBOLS

SYMBOLS	NAME
	PIPE LINE
	CAPILLARY TUBING
	ELECTRIC SIGNAL
	SOFTWARE LINK
	PRESSURE LEAD
	DUCT

PIPING VALVE SYMBOLS

SYMBOLS	NAME
	GATE VALVE (NOR.CLOSED)
	GLOBE VALVE (NOR.CLOSED)
	BALL VALVE (NOR.CLOSED)
	BUTTERFLY VALVE (NOR.CLOSED)
	DIAPHRAGM VALVE (NOR.CLOSED)
	PINCH VALVE (NOR.CLOSED)
	NEEDLE VALVE (NOR.CLOSED)
	CHECK VALVE
	CHECK VALVE (WAFER)
	PRESSURE RELIEF VALVE

INSTRUMENT VALVE SYMBOLS

SYMBOLS	NAME
	ACTUATED BY AIR
	ACTUATED BY MOTOR
	AIR CONTROL VALVE
	SOLENOID ACTUATOR
	SELF REGULATING VALVE
	SELF REGULATING VALVE

TRENCH SYMBOLS

SYMBOLS	NAME
	TO ABSORBER AREA DRAIN SUMP
	TO GYPSUM AREA DRAIN SUMP
	TO LIMESTONE AREA DRAIN SUMP

SYMBOLS FOR PIPING PARTS & INSTRUMENT PARTS

SYMBOLS	NAME
	STEAM TRAP
	AIR TRAP
	Y-STRAINER
	T-STRAINER
	TEMPORARY STRAINER
	REDUCER
	EXPANSION JOINT
	DUCT EXPANSION JOINT
	FLEXIBLE HOSE
	SPOOL PIECE
	VENT
	HOSE CONNECTION
	BLIND FLANGE
	REDUCING FLANGE
	CAP (BW)
	CAP (SCR)
	TRENCH
	SIGHT GLASS
	SILENCER
	ORIFICE
	DIAPHRAGM
	MAGNETIC FLOW METER
	VORTEX FLOW METER
	PH METER
	FILTER
	MANHOLE
	PITOT TUBE
	SAMPLING POT
	SAMPLING NOZZLE
	ROTOMETER TYPE FLOW METER

SYMBOLS FOR VALVE OPERATION

SYMBOLS	NAME
	FAILURE OPEN (THE VALVE OPENS WHEN AIR OR ELECTRICITY FOR ACTUATOR FAILS.)
	FAILURE CLOSE (THE VALVE CLOSES WHEN AIR OR ELECTRICITY FOR ACTUATOR FAILS.)

INSULATION SYMBOLS

SYMBOLS	DESCRIPTION
H10	THERMAL INSULATION (100°C & LOWER)
H15	THERMAL INSULATION (101°C ~ 150°C)
H20	THERMAL INSULATION (151°C ~ 200°C)
H25	THERMAL INSULATION (201°C ~ 250°C)
H30	THERMAL INSULATION (251°C ~ 300°C)
H35	THERMAL INSULATION (301°C ~ 350°C)
HF	INSULATION FOR ANTI FREEZING
ET	ELECTRIC TRACE
ST	STEAM TRACE (LOW PRESSURE STEAM)
P10	PERSONAL PROTECTION (100°C & LOWER)
P15	PERSONAL PROTECTION (101°C ~ 150°C)
P20	PERSONAL PROTECTION (151°C ~ 200°C)
P25	PERSONAL PROTECTION (201°C ~ 250°C)
P30	PERSONAL PROTECTION (251°C ~ 300°C)
P35	PERSONAL PROTECTION (350°C ~ 400°C)

DELIVERY LIMITS

SYMBOLS	NAME
	BETWEEN NTPL AND CONTRACTOR
	BETWEEN SUB CONTRACTOR AND VENDOR

SYSTEM

NUMBER	NAME
1	FLUE GAS SYSTEM
2	SO ₂ ABSORPTION OXIDATION SYSTEM
3	REHEATING SYSTEM
4	GYPSUM DEWATERING HANDLING SYSTEM
5	LIMESTONE PREPARATION SYSTEM
6	BLANK
7	SUMP SYSTEM
8	UTILITY SYSTEM

FLUID NAME

FLUID SYMBOL	FLUID NAME	FLUID SYMBOL	FLUID NAME
AC	COMPRESSED AIR	WCS	DM COOLING WATER SUPPLY
AF	FLUIDIZER AIR	WCR	DM COOLING WATER RETURN
AI	INSTRUMENT AIR	WD	DRINKING WATER
AO	OXIDATION AIR	WP	PROCESS WATER
AS	SEAL AIR	WR	RAW WATER
DD	DUCT DRAIN	WC	Ca(OH) ₂ WATER
FS	FILTRATE SLURRY	WW	WASTE WATER
GS	GYPSUM SLURRY	VG	VACUUM PUMP VENT
LS	LIMESTONE SLURRY	VBG	BELT FILTER VENT GAS
		LD	LIME/LIMESTONE DEDUSTING
		LOL	LUBE OIL (LOW PRESSURE)
		LOH	LUBE OIL (HIGH PRESSURE)
		CW	CLARIFIED WATER

SERVICE CLASS

SERVICE CLASS	MATERIAL	FLUID SYMBOL
AA40	IIR RUBBER LINED PIPING	LS, WP, WC
AA60	IIR RUBBER LINED PIPING	GS,FS,WW,DD
BA01	Gr.304 STAINLESS STEEL PIPING	AI, LOL
BA02	Gr.304 STAINLESS STEEL PIPING	LOH
BA03	Gr.316L STAINLESS STEEL PIPING	WP, AO
CA01	CARBON STEEL GENERAL PIPING	AS,AO,AC,AF,LD
CC01	CARBON STEEL PRESSURE PIPING	WP,WR,WCS,WCR, VG, AA, CW
DA60	FRP PIPING (PIPE DIA UPTO 80 NB)	GS,FS,WW,DD
DA40	FRP PIPING (PIPE DIA UPTO 80 NB)	LS, WP, WC
UPVC	UPVC PIPING (PIPE DIA UPTO 25 NB)	LS, WP, GS
HDPE	HDPE PIPING (PIPE DIA UPTO 100 NB)	DD, WP

UNIT CODE

SYMBOLS	UNIT IDENTIFICATION
99	COMMON
10	UNIT-1 FGD SYSTEM AND AUXILIARIES
20	UNIT-2 FGD SYSTEM AND AUXILIARIES

EXPRESSION OF PIPING LINE

10	-	200	-	GS	-	2	00	1	-	AA60	-	HF
UNIT CODE		NOMINAL PIPE SIZE (mm)		FLUID SYMBOL		SYSTEM	SERIAL NUMBER	SUFFIX NUMBER		PIPING SERVICE CLASS		INSULATION CLASS

CUSTOMER NOS: G515 & G516

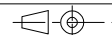
CUSTOMER: NLC TAMILNADU POWER LIMITED.
PROJECT: NTPL 2x500MW PROJECTS AT TUTICORIN
FGD SYSTEM PACKAGE

CONSULTANT:
M/s DEVELOPMENT CONSULTANTS PVT LTD

DEPT CODE	NAME (BHEL)	DATE
DRN	J SAKTHI	05.02.21
M	CHD	VENKATA RAMAN M
APPD	P NAVEEN REDDY	05.02.21

P & ID - LEGENDS AND NOTES
TITLE:

SCALE : NTS



SH 01 of 02

BHEL DRG NO	FILE NO	REV NO
	B240 - 00001	02

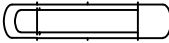
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BHARAT HEAVY ELECTRICALS LIMITED,
UNIT: BOILER AUXILIARIES PLANT,
RANIPET-632 406.

CONFIDENTIAL & PROPRIETARY INFORMATION



DRIVER SYMBOLS

SYMBOLS	NAME
	BAG FILTER
	SILO
	SLIDE GATE
	TANDEM LOUVER DAMPER (MULTIVANE)
	SINGLE STAGE LOUVER DAMPER (MULTIVANE)
	LOUWER DAMPER (SINGLE VANE)
	DISTRIBUTION BOX (3WAY)
	DISTRIBUTION BOX (2WAY)
	SUMP
	HEAT EXCHANGER
	SHELL AND TUBE HEAT EXCHANGER
	AIR DRYER
	FILTER
	SPRAY NOZZLE

OTHER SYMBOLS

INSTRUMENT SYMBOLS

PNEUMATIC VALVE ACTUATOR

CODE NO.	ACTUATION
FLXXWA-D	DOUBLE SOLENOID NO LIMIT SWITCH
FLXXWA-DL	DOUBLE SOLENOID WITH LIMIT SWITCH
FLXXWA-S	SINGLE SOLENOID NO LIMIT SWITCH
FLXXWA-SL	SINGLE SOLENOID WITH LIMIT SWITCH

CUSTOMER NOS: G515 & G516

CUSTOMER: NLC TAMILNADU POWER LIMITED.
PROJECT: NTPL 2x500MW PROJECTS AT TUTICORIN
FGD SYSTEM PACKAGE

CONSULTANT:
M/s DEVELOPMENT CONSULTANTS PVT LTD

SAID COMPANY.  BHARAT HEAVY ELECTRICALS LIMITED, UNIT: BOILER AUXILIARIES PLANT, RANIPET-632 406.	DEPT		NAME (BHEL)	DATE
	CODE	DRN	J SAKTHI	05.02
	M	CHD	YENKATA RAMAN M	05.02
		APPD	P NAVEEN REDDY	05.02

P & ID – LEGENDS AND NOTES

TITLE:

SCALE : NTS

SH 02 of 02

BHEL DRG NO

FILE NO

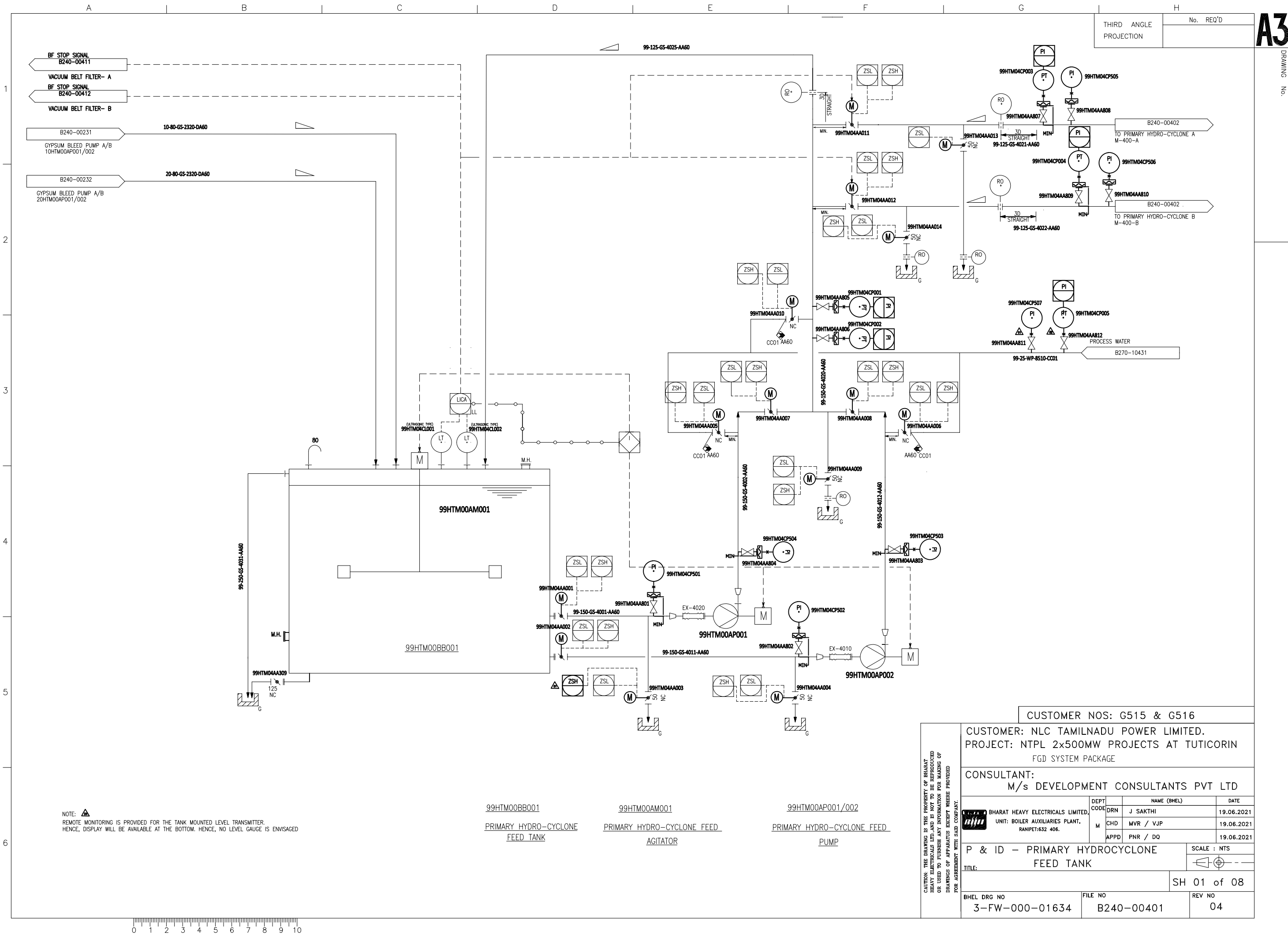
REV NO	

B240 - 00002

02

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NOTE: REMOTE MONITORING IS PROVIDED FOR THE TANK MOUNTED LEVEL TRANSMITTER. HENCE, DISPLAY WILL BE AVAILABLE AT THE BOTTOM. HENCE, NO LEVEL GAUGE IS ENVISAGED

99HTM00BB001

PRIMARY HYDRO-CYCLONE
FEED TANK

99HTM00AM001

PRIMARY HYDRO-CYCLONE FEED
AGITATOR

99HTM00AP001/002

PRIMARY HYDRO-CYCLONE FEED
PUMP

CUSTOMER NOS: G515 & G516

CUSTOMER: NLC TAMILNADU POWER LIMITED.
PROJECT: NTPL 2x500MW PROJECTS AT TUTICORIN
FGD SYSTEM PACKAGE

CONSULTANT:
M/s DEVELOPMENT CONSULTANTS PVT LTD

DEPT CODE	NAME (BHEL)	DATE
DRN	J SAKTHI	19.06.2021
M CHD	MVR / VJP	19.06.2021
APPD	PNR / DQ	19.06.2021

P & ID - PRIMARY HYDROCYCLONE
FEED TANK

SCALE : NTS

TITLE:

SH 01 of 08

BHEL DRG NO
3-FW-000-01634

FILE NO
B240-00401

REV NO
04

THIRD ANGLE
PROJECTION

No. REQ'D

A3

DRAWING No.

WRITEUP ON PRIMARY HYDROCYCLONE FEED TANK AND PUMPS

Purpose: This write up describes the Primary hydrocyclone feed tank and Pumps and associated control system.

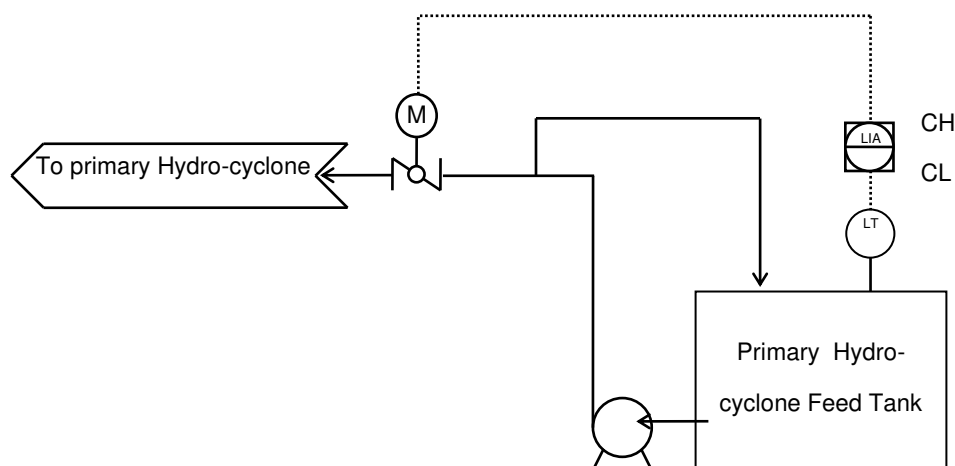
Equipment List for NTPL (2x500MW) Tuticorin FGD Package:

S. No.	Description	Item No.	Qty
1.	Primary hydro cyclone feed tank	99 HTM 00 BB 001	1
2.	Primary hydro cyclone feed tank Pump	99 HTM 00 AP 001/002	2 Nos (1W + 1S)
3.	Primary hydro cyclone feed tank agitator	99 HTM 00 AM 001	1

Operation Write Up:

Gypsum slurry from all the Absorbers are fed to a common primary hydro cyclone feed tank for first stage of dewatering by Gypsum Bleed Pumps. Gypsum bleed pumps will pump the gypsum slurry to Primary hydro cyclone by opening the bleed valve only when the density of slurry is reaches to 30 wt. %, and bleed valve kept open until the density of slurry reaches to 28 % wt. %.

Primary hydro cyclone feed tank pump feeds the slurry from the primary hydro cyclone feed tank to Primary hydro cyclone. Primary Hydro cyclone separates feed slurry into high concentration underflow and low concentration overflow. Primary hydro cyclone underflow is fed to vacuum belt filter for second stage dewatering. Primary hydro cyclone overflow is collected in Secondary Hydro cyclone feed tank.



Control Write Up:

When the Level in the tank reaches CH, the motorized control valve is opened to primary hydro cyclone. When the level reaches CL, the motorized valve closes. Meanwhile re circulation is carried out from the tank through the pump.

Primary hydro cyclone feed tank Pumps:

Start Command: When the Primary hydro cyclone feed tank Pump start command is given,

- 1) The drain valve closes. After the valve is closed completely,
- 2) The suction valve is opened & simultaneously the line drain valve is closed.
- 3) After a time delay T1, the Pump is started.
- 4) After a Time delay of T2 from the Pump start the discharge valve is opened.
- 5) After this, the Pump continuously runs till stop command is initiated.

Stop Command: When the hydro cyclone feed tank Pump stop command is given,

- 1) The discharge valve closes. After the valve is closed completely,
- 2) The pump is stopped and simultaneously the suction valve closes.
- 3) After the suction valve is closed completely, the suction drain valve starts to open & simultaneously the line drain valve is also opened and
- 4) With a time delay T3, the pump flushing valve is opened.
- 5) After a time delay T4, the Line drain valve and pump flushing valve is closed. And simultaneously line washing valve is opened.
- 6) After Time delay of T6 Line washing valve closes and simultaneously line drain valve opens.

T1 = 10sec

T2 = 0.2sec

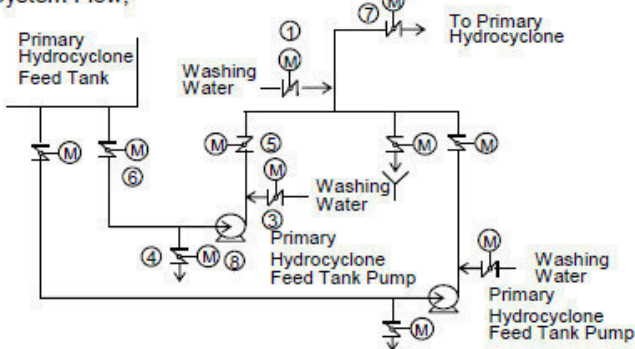
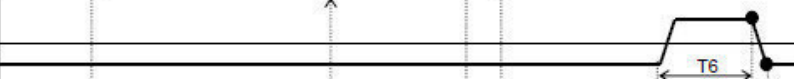
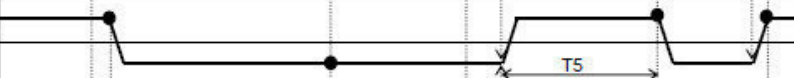
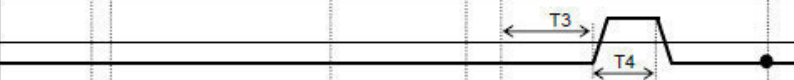
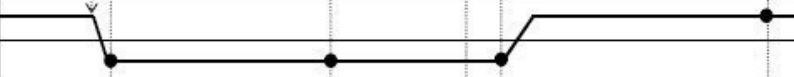
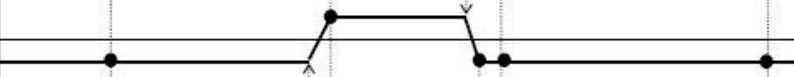
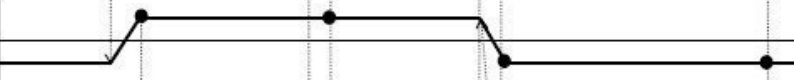
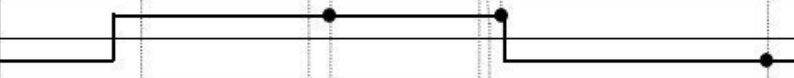
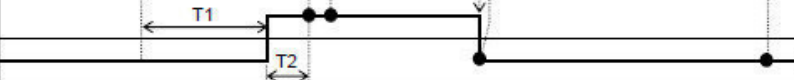
T3 = 60sec

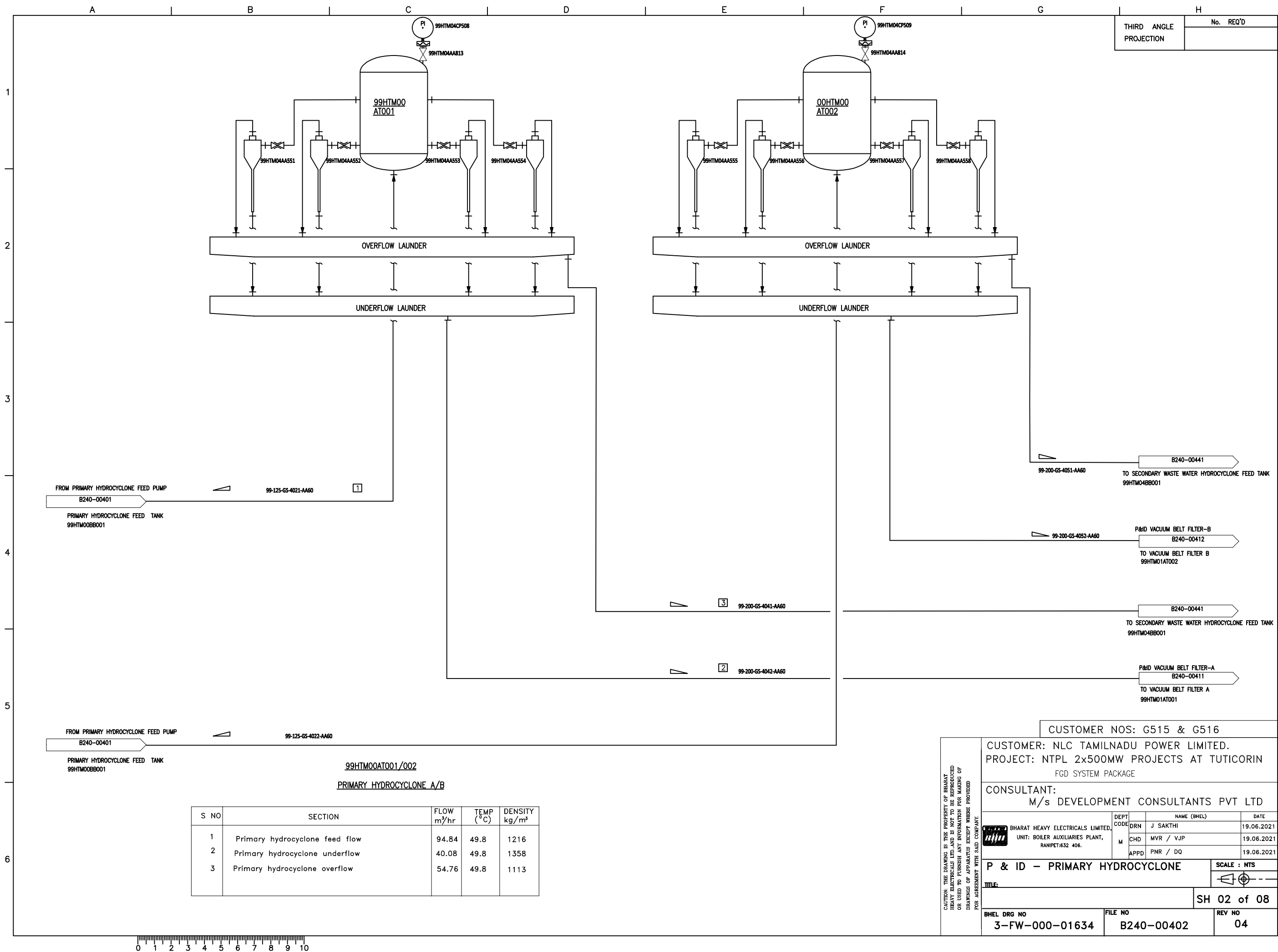
T4 = 60sec

T5 = 180sec

T6 = 180sec

These timing will be optimized during commissioning.

Item	00 HTM 00 AP 001/002	Service	Primary Hydrocyclone Feed Tank Pump A/B Sub Function Group	Stand-by Auto Mode (Back-up start)
System Flow;		Start Permission; ▪ Primary Hydrocyclone Feed Tank Level : Not LL		Stop Permission; ▪ N/A
		Start Interlock; ▪ Stand-by Auto Start due to Electric Fault		Stop Interlock; ▪ Electric Fault ▪ Primary Hydrocyclone Feed Tank Level : LL ▪ Related valves feed back signal missing
Start/Stop Sequence;		Emergency Stop;		
		Emergency Stop Completion		
① Line Washing Valve	Open			
	Close			
② Line Drain Valve	Open			
	Close			
③ Pump Flushing Valve	Open			
	Close			
④ Suction Drain Valve	Open			
	Close			
⑤ Discharge Valve	Open			
	Close			
⑥ Suction Valve	Open			
	Close			
⑦ Waste Water Hydrocyclone Feed Valve	Control			
	Close			
⑧ Pump	Start			
	Stop			
※ If the common header of pump suction is applied, water shall be fed to pump casing and inlet/outlet piping before pump operation.				



A3
DRAWING No.

Write Up on Primary Hydro Cyclone System

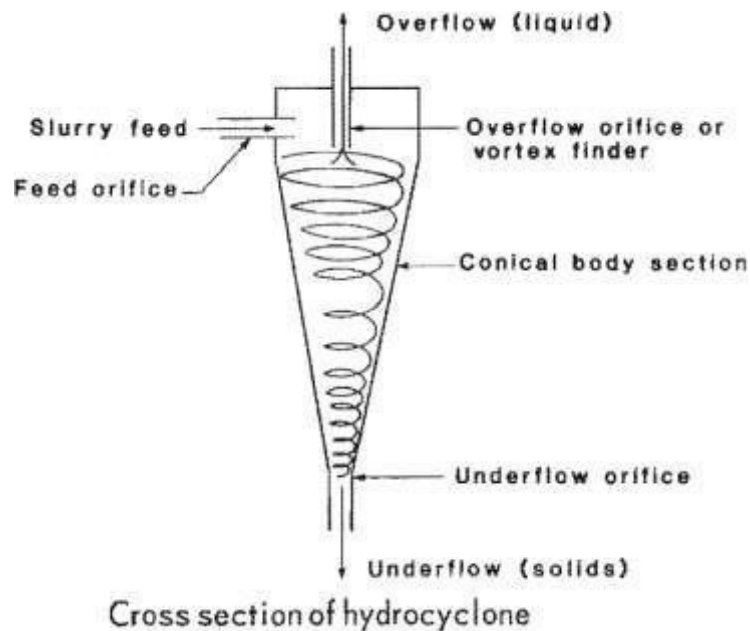
Purpose: This write up describes the Primary hydro cyclone system and defines the associated control system.

Equipment List for NTPL (2x500MW) Tuticorin FGD Package:

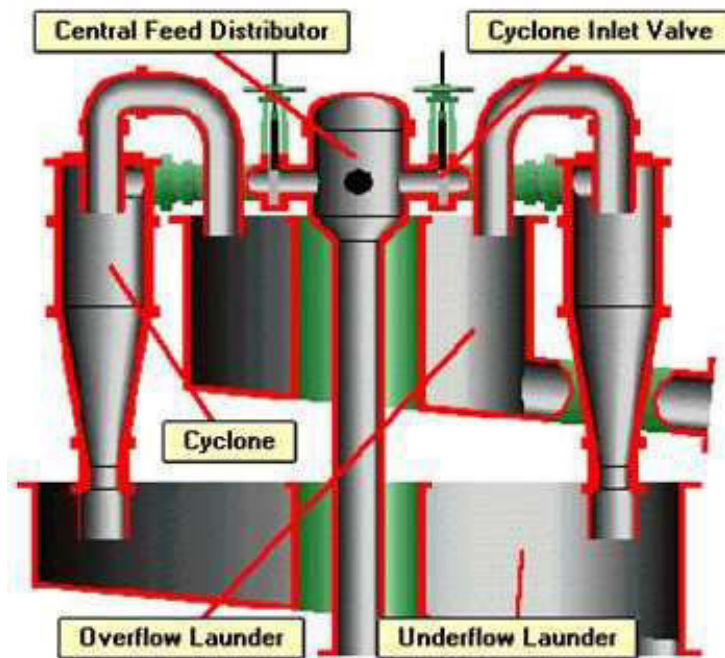
S. No.	Description	Item No.	Qty
1.	Primary Hydro Cyclone	99 HTM 00 AT 001/002	1W + 1S

Operation Write Up:

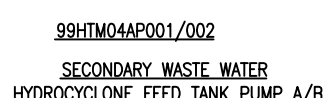
Primary hydro cyclone feed tank pump feeds the slurry from the tank to primary hydro cyclone for first stage of dewatering. Hydro cyclone separates feed gypsum slurry into high concentration underflow and low concentration overflow.



Central feed distributor directs and controls the flow to each hydro-cyclone by a pinch valve arrangement. Common under flow launder collects the under flow from all the individual hydro cyclones and common over flow launder collects the over flow from all the individual hydro cyclones



Primary hydro cyclone underflow from under flow launder is sent to vacuum belt filter for second stage of dewatering (to vacuum belt filter). Slurry from Primary hydro cyclone overflow from over flow launder is sent to secondary hydro cyclone feed tank for further classification.



REV NO	04

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WRITEUP ON SECONDARY HYDROCYCLONE FEED TANK AND PUMPS

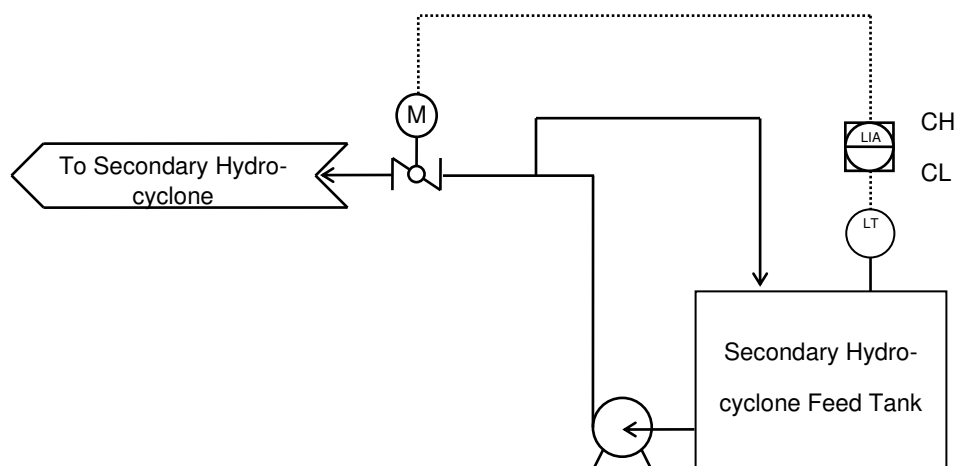
Purpose: This write up describes the Secondary Hydrocyclone feed tanks and pumps and associated control system.

Equipment List for NTPL (2x500MW) Tuticorin FGD Package:

S. No.	Description	Item No.	Qty
1.	Secondary hydro cyclone feed tank	99 HTM 04 BB 001	1
2.	Secondary hydro cyclone feed tank Pump	99 HTM 04 AP 001/002	1W + 1S
3.	Secondary hydro cyclone feed tank agitator	99 HTM 02 AM 001	1

Operation Write Up:

Secondary hydro cyclone feed tank pump feeds the slurry from the tank to secondary hydro cyclone. Hydro cyclone separates feed slurry into high concentration underflow and low concentration overflow. Secondary hydro cyclone underflow is collected in filtrate water tank from where it is recycled to absorber. Secondary hydro cyclone overflow is collected in waste water tank.



Control Write Up:

When the Level in the tank reaches CH, the motorized valve is opened to secondary hydro cyclone. When the level reaches CL, the motorized valve closed. Meanwhile re circulation is carried out from the tank through the pump.

Secondary hydro cyclone feed tank Pump:**Start Command:**

When the Secondary hydro cyclone feed tank Pump start command is given,

- 1) The drain valve closes. After the valve is closed completely,
- 2) The suction valve is opened & simultaneously the line drain valve is closed.
- 3) After a time delay T1, the Pump is started.
- 4) After a Time delay of T2 from the Pump start the discharge valve is opened.
- 5) After this, the Pump continuously runs till stop command is initiated.

Stop Command:

When the hydro cyclone feed tank Pump stop command is given,

- 1) The pump discharge valve closes. After the valve is closed completely,
- 2) The pump is stopped and simultaneously the suction valve and secondary hydro cyclone feed valves gets close.
- 3) After the suction valve is closed completely, the suction drain valve starts to open & simultaneously the line drain valve also starts open to drain the slurry from pump, suction line and discharge lines to nearby sump.
- 4) With a time delay of T3, the pump flushing valve starts opening to allow process water to flush the pump and suction lines.
- 5) With the time delay of T5 and T4, Line drain valve and pump flushing valve starts closing respectively.
- 6) Once the pump flushing valve and line drain valve closing is initiated, simultaneously line washing valve is opened.
- 7) With time delay of T6 Line washing valve closes and simultaneously line drain valve opens to drain the flushing water from the discharge lines.
- 8) Suction drain valve and discharge drain valves will be kept open till the pump start command is in initiated.

$T1 = 10\text{sec}$

$T2 = 0.2\text{sec}$

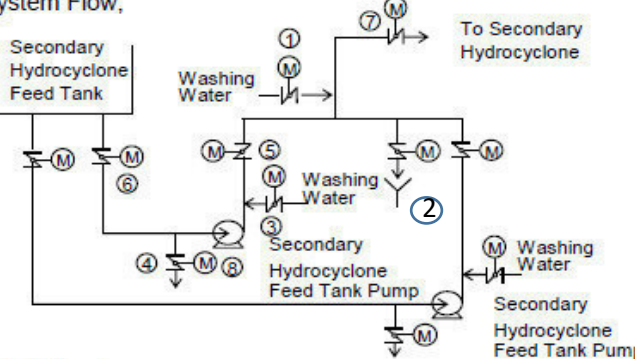
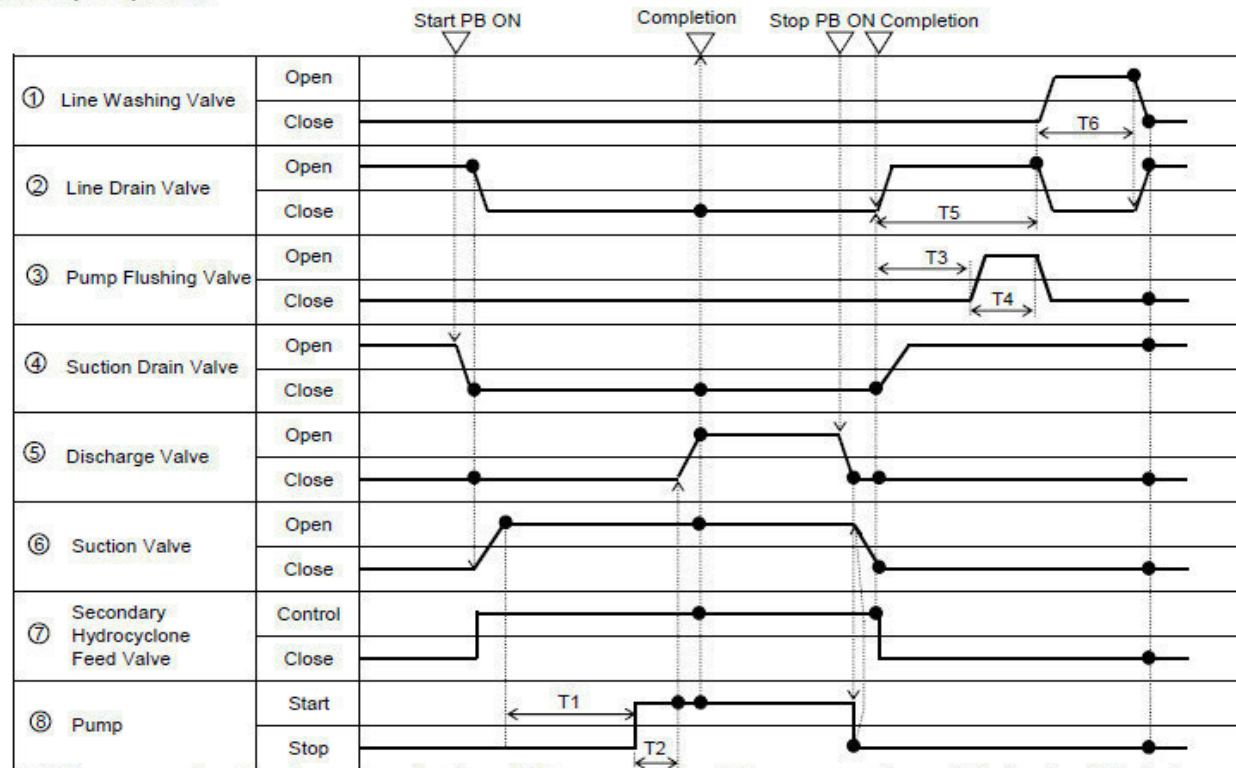
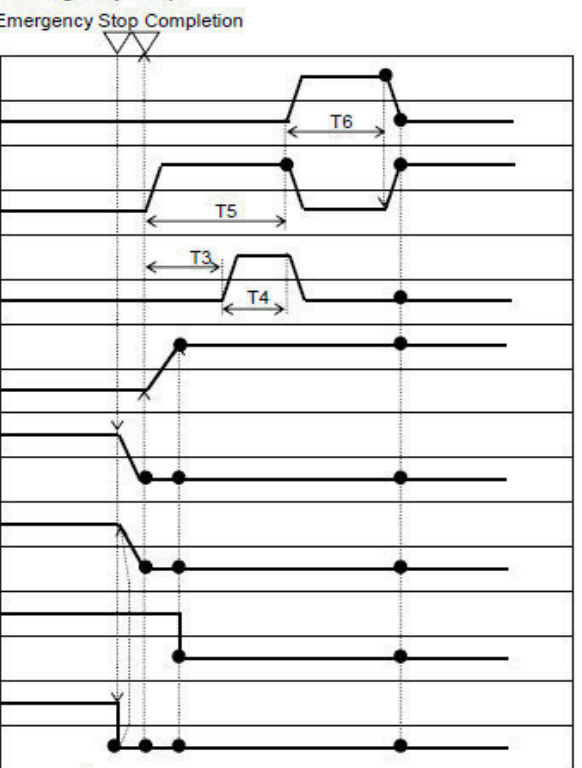
$T3 = 60\text{sec}$

$T4 = 60\text{sec}$

$T5 = 180\text{sec}$

$T6 = 180\text{sec}$

These timing will be optimized during commissioning of FGD.

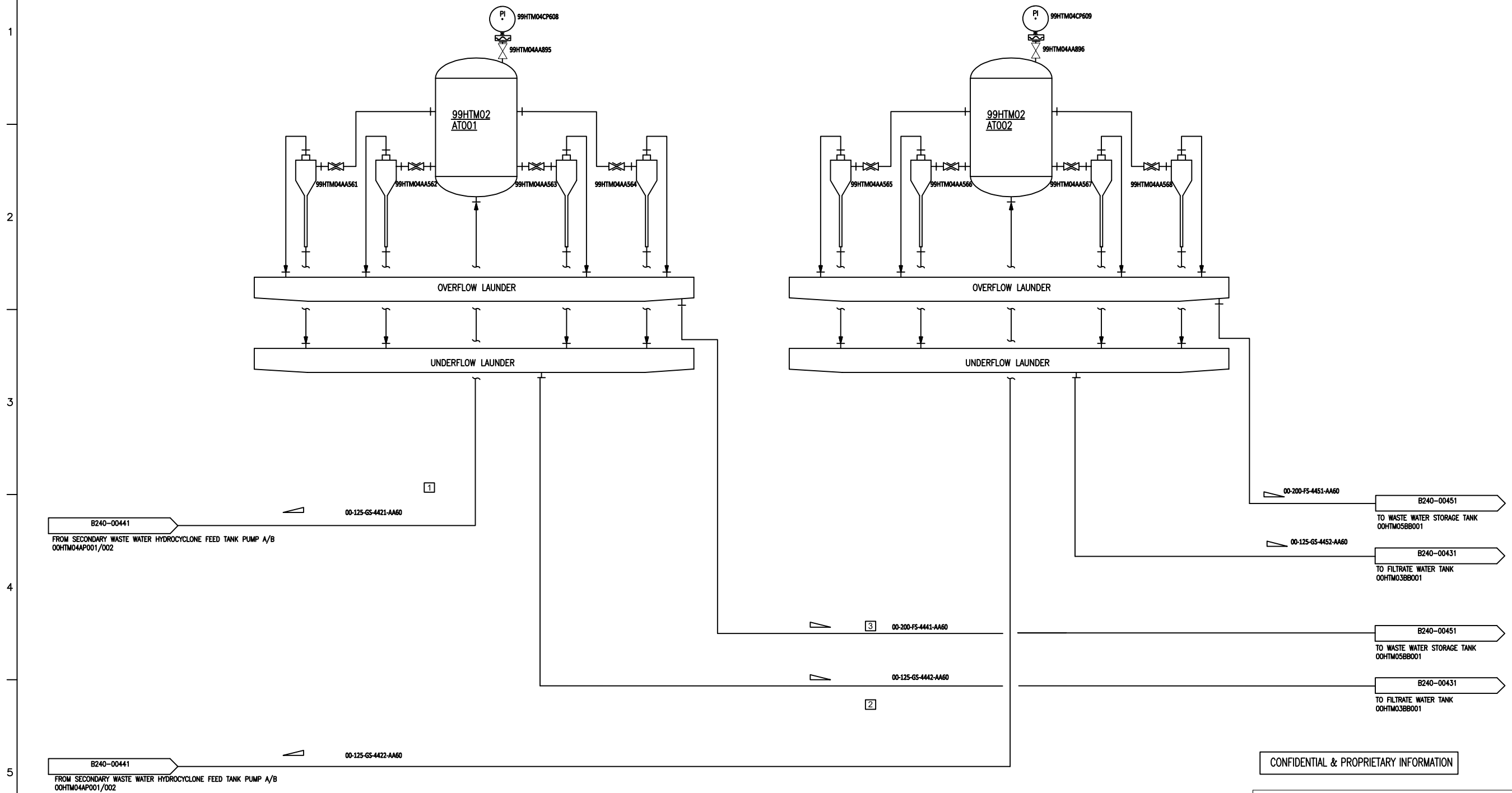
Item	00 HTM 04 AP 001/002	Service	Secondary Hydrocyclone Feed Tank Pump A/B Sub Function Group	Stand-by Auto Mode (Back-up start)
System Flow;		Start Permission; ▪ Secondary Hydrocyclone Feed Tank Level : Not LL		Stop Permission; ▪ N/A
		Start Interlock; ▪ Stand-by Auto Start due to Electric Fault		Stop Interlock; ▪ Electric Fault ▪ Secondary Hydrocyclone Feed Tank Level : LL ▪ Related valves feed back signal missing
Start/Stop Sequence;		Emergency Stop;		
				
※ If the common header of pump suction is applied, water shall be fed to pump casing and inlet/outlet piping before pump operation.				

THIRD ANGLE
PROJECTION

No. REQ'D

A3

DRAWING No.



99HTM02AT001/002
SECONDARY
HYDROCYCLONE A/B

S NO	SECTION	FLOW m/hr	TEMP (°C)	DENSITY kg/m ³
1	Secondary hydrocyclone feed flow	54.76	49.8	1113
2	Secondary hydrocyclone underflow	20.54	49.8	1260
3	Secondary hydrocyclone overflow	34.22	49.8	1024

CONFIDENTIAL & PROPRIETARY INFORMATION

CUSTOMER NOS: G515 & G516

CUSTOMER: NLC TAMILNADU POWER LIMITED.
PROJECT: NTPL 2x500MW PROJECTS AT TUTICORIN
FGD SYSTEM PACKAGE

CONSULTANT:
M/s DEVELOPMENT CONSULTANTS PVT LTD

DEPT CODE	NAME (BHEL)	DATE
DRN	J SAKTHI	19.06.2021
CHD	MVR / VJP	19.06.2021
APPD	PNR / DQ	19.06.2021

P & ID - SECONDARY HYDROCYCLONE

SCALE : NTS

TITLE:

SH 04 of 08

BHEL DRG NO
3-FW-000-01634

FILE NO
B240-00445

REV NO
04

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WRITE UP ON SECONDARY HYDRO CYCLONE SYSTEM

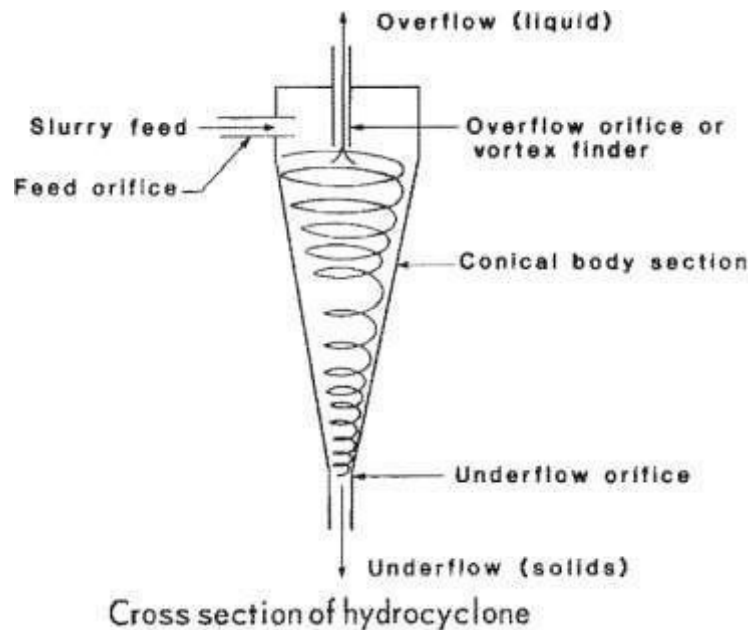
Purpose: This write up describes the Secondary hydro cyclone system and defines the associated control system.

Equipment List:

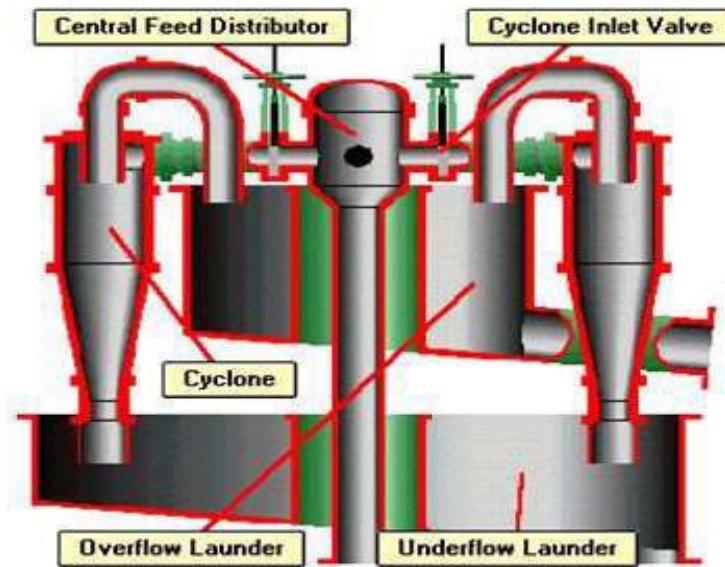
S. No.	Description	Item No.	Qty
1.	Secondary hydro cyclone feed tank	99 HTM 04 BB 001	1
2.	Secondary hydro cyclone feed tank Pumps	99 HTM 04 AP 001/002	1W + 1S
3.	Secondary hydro cyclone	99 HTM 02 AT 001/002	1W + 1S

Operation Write Up:

Secondary hydro cyclone feed tank pump feeds the slurry from the tank to Secondary hydro cyclone for further dewatering. Hydro cyclone separates feed gypsum slurry into high concentration underflow and low concentration overflow.



Central feed distributor directs and controls the flow to each hydrocyclone by a pinch valve arrangement. Common under flow launder collects the under flow from all the individual hydro cyclones and common over flow launder collects the over flow from all the individual hydro cyclones



Secondary hydro cyclone underflow from under flow launder is sent to filtrate water tank for recirculating back to absorber. Water with less concentration slurry collected in over flow launder is sent to Waste water tank for neutralizing and purging out of FGD system.

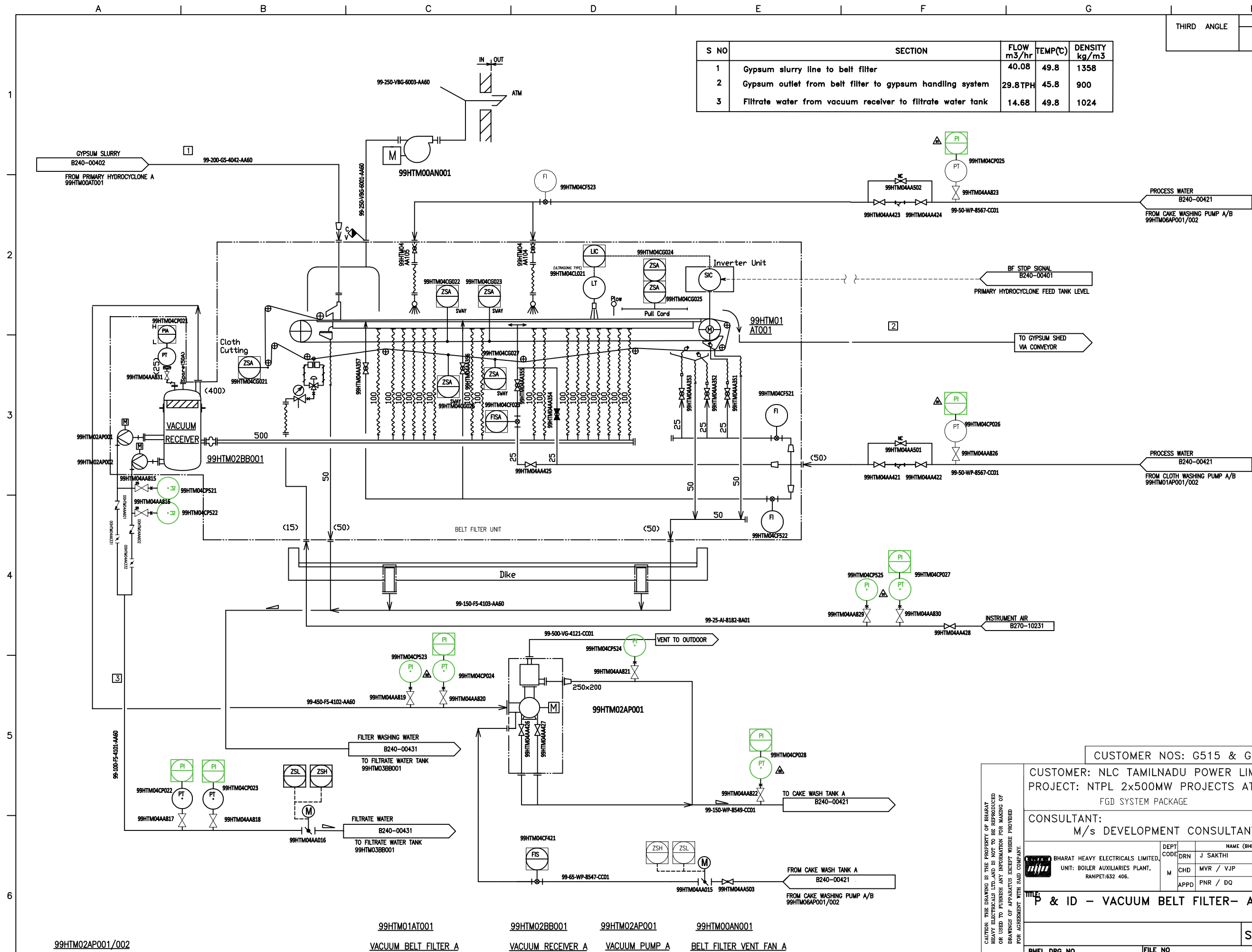
S NO	SECTION	FLOW m ³ /hr	TEMP(°C)	DENSITY kg/m ³
1	Gypsum slurry line to belt filter	40.08	49.8	1358
2	Gypsum outlet from belt filter to gypsum handling system	29.8TPH	45.8	900
3	Filtrate water from vacuum receiver to filtrate water tank	14.68	49.8	1024

THIRD ANGLE

No. REQ'D

A3

DRAWING No.



CUSTOMER NOS: G515 & G516

CUSTOMER: NLC TAMILNADU POWER LIMITED.
PROJECT: NTPL 2x500MW PROJECTS AT TUTICORIN
FGD SYSTEM PACKAGE

CONSULTANT:
M/s DEVELOPMENT CONSULTANTS PVT LTD

DEPT CODE	NAME (BHEL)	DATE
DRN	J SAKTHI	19.06.2021
CHD	MVR / VJP	19.06.2021
APPD	PNR / DQ	19.06.2021

TITLE: P & ID - VACUUM BELT FILTER- A

SCALE: NTS

SH 05 of 08

BHEL DRG NO	FILE NO	REV NO
3-FW-000-01634	B240-00411	04

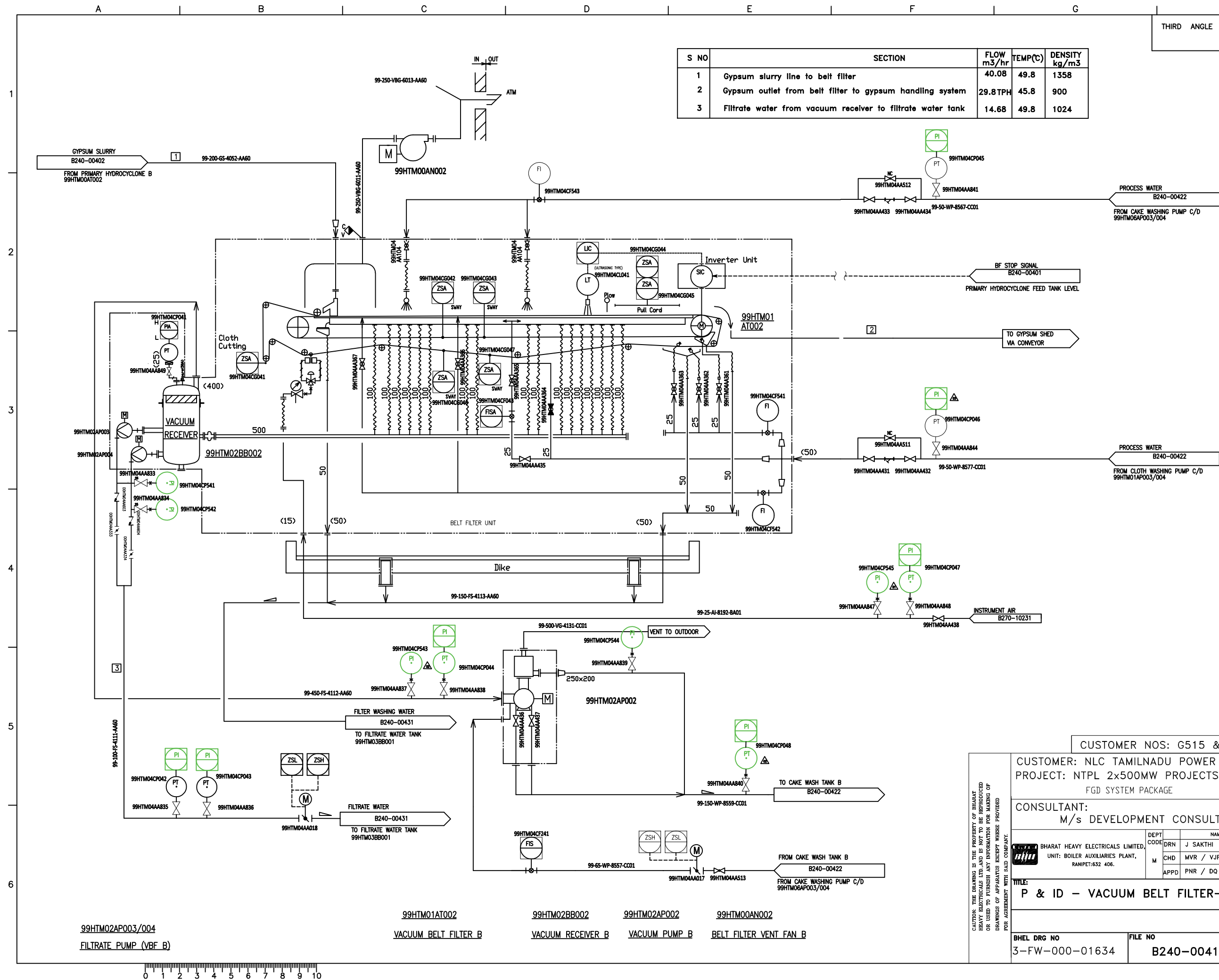
THIRD ANGLE

No. REQ'D

A3

DRAWING No.

S NO	SECTION	FLOW m ³ /hr	TEMP(°C)	DENSITY kg/m ³
1	Gypsum slurry line to belt filter	40.08	49.8	1358
2	Gypsum outlet from belt filter to gypsum handling system	29.8TPH	45.8	900
3	Filtrate water from vacuum receiver to filtrate water tank	14.68	49.8	1024



CUSTOMER NOS: G515 & G516

CUSTOMER: NLC TAMILNADU POWER LIMITED.
PROJECT: NTPL 2x500MW PROJECTS AT TUTICORIN
FGD SYSTEM PACKAGE

CONSULTANT:
M/s DEVELOPMENT CONSULTANTS PVT LTD

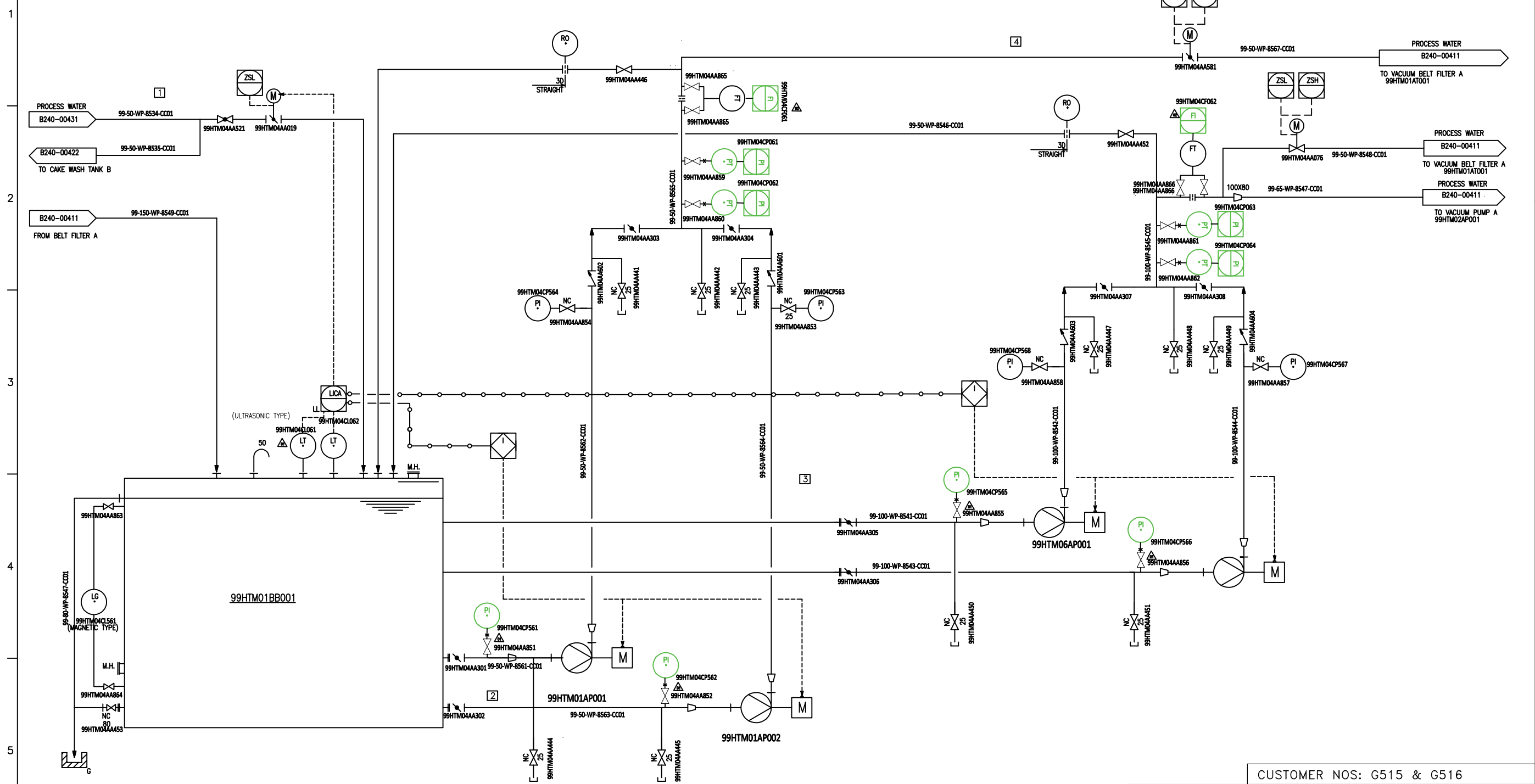
DEPT	NAME (BHEL)	DATE
DRN	J SAKTHI	19.06.2021
CHD	MVR / VJP	19.06.2021
APPD	PNR / DQ	19.06.2021

TITLE:
P & ID - VACUUM BELT FILTER- B

SCALE : NTS

SH 06 of 08

BHEL DRG NO	FILE NO	REV NO
3-FW-000-01634	B240-00412	04



S NO	SECTION	FLOW m ³ /hr	TEMP(°C)	DENSITY kg/m ³
1	Process water to cake wash tank	*VTF	45.0	990
2	At the suction of cloth wash pump	*VTF	45.0	990
3	At the discharge of cloth wash pump	*VTF	45.0	990
4	Wash water to belt filter	*VTF	45.0	990

*VTF – VENDOR TO FURNISH

99HTM01BB001
CAKE WASH TANK A

99HTM01AP001/002
CLOTH WASHING PUMP A/B

99HTM06AP001/002
CAKE WASHING PUMP A/B

CUSTOMER NOS: G515 & G516

CUSTOMER: NLC TAMILNADU POWER LIMITED.
PROJECT: NTPL 2x500MW PROJECTS AT TUTICORIN
FGD SYSTEM PACKAGE

CONSULTANT:
M/s DEVELOPMENT CONSULTANTS PVT LTD

DEPT	NAME (BHEL)	DATE
DRN	J SAKTHI	19.06.2021
CHD	MVR / VJP	19.06.2021
APPD	PNR / DQ	19.06.2021

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P & ID – VACUUM BELT FILTER
(CAKE WASH TANK A)

SH 07 of 08

BHEL DRG NO
3-FW-000-01634

FILE NO
B240-00421

REV NO
04



*VTF - VENDOR TO FURNISH

99HTM06AP003/004
CAKE WASHING PUMP C/D

CUSTOMER: NLC TAMILNADU POWER LIMITED.
PROJECT: NTPL 2x500MW PROJECTS AT TUTICORIN
FGD SYSTEM PACKAGE

SAID COMPANY.	 BHARAT HEAVY ELECTRICALS LIMITED UNIT: BOILER AUXILIARIES PLANT, RANIPET-632 406.	DEPT		NAME (BHEL)	DATE
		CODE	DRN	J SAKTHI	19.06.2
		M	CHD	MVR / VJP	19.06.2
			APPD	PNR / DQ	19.06.2

SCALE : NTS

SH 08 of 00

BHEL DRG NO	FILE NO	REV NO
3-FW-000-02069	B240-00422	04

		BHARAT HEAVY ELECTRICALS LIMITED R.C.PURAM, HYDERABAD-502032			
PROJECT ENGINEERING & SYSTEMS DIVISION					
PRICE FORMAT FOR GYPSUM DEWATERING PACKAGE (Rev-01)					
NTPL FGD					
Bidder's Name : <Bidder to indicate>					
Bidder's Offer No. & Dt. : <Bidder to indicate>					
Bidder's Ref No. & Dt. : <Bidder to indicate>					
BHEL Enq. No. & date : <Bidder to indicate>					
I MAIN OFFER [Prices for individual items to be quoted as indicated in the price bid format]					
SL NO	ITEM DESCRIPTION	QTY	UNIT	TOTAL PRICE (Rs.)	PRICE WEIGHTAGE IN PERCENTAGE
A MATERIAL SUPPLY-(MAIN)					
A.1	Gypsum Dewatering Package complete with all Accessories as per the Technical Specification including Commissioning Spares. (Commissioning spares as per manufacturer's recommendation. List to be enclosed.)	1	Set	not to be quoted separately	88% (FOR TOTAL A.1,A.2)
A.2	Special Tools & Tackles for Gypsum Dewatering Package (Special tools & tackles as per manufacturer's recommendations. 1 set stands for requirement for each VBF and other accessories. Bidder to furnish the list along with their offer)	1	Set	not to be quoted separately	
B MATERIAL SUPPLY-(SPARES)					
B.1	Gypsum Dewatering Package complete SPARES as per the Technical Specification (List of spares are as per annexure of technical specification)	1	Lump sum	not to be quoted separately	10% (FOR B)
C SUPERVISION CHARGES FOR ERECTION & COMMISSIONING AT SITE					
C.1	Includes supervision of erection & commissioning, supervision of trial operation, PG test, training of customer's O&M Personnel and handing over to customer. Supervision charges of Engineer(s) shall include all the expenses like boarding, lodging, travel, insurance, Visa fees etc. Lump sum price for complete supervision activities as defined above shall be quoted by bidder, envisaging a minimum of 60 Man Days and 2 Visits to site.	1	Set	not to be quoted separately	2% (FOR C)
TOTAL LUMP SUM PRICE					A + B+C
Notes:	i) The word "Set" means the quantity required for full replacement of that part in one machine. ii) Bidder shall quote ONLY Lumpsum Total Price (A+B+C). Individual Price not to be quoted. iii) Line Item Rates of the individual items shall be derived by multiplying the "Price Weightage Factor" with the Lumpsum Price quoted. Unit Rates of the Individual items thus arrived, shall be firm and binding on the bidder till the execution of contract. iv) For Training of customer's O&M Personnel and handing over to customer, no additional claim shall be made and shall be included in these two visits only.				
II OPTIONAL ITEMS					
SL NO	ITEM DESCRIPTION	QTY	UNIT	UNIT PRICE (Rs.)	
D SUPERVISION CHARGES FOR ERECTION & COMMISSIONING AT SITE					
D.1	Per day supervision charges of an Engineer including all other expenses like boarding, lodging, local travel, insurance etc.	1	Day		
D.2	Travel expenses (inclusive of all other charges like visa fee (if applicable), insurance etc) from / to vendor works to / from site per Engineer per Visit for supervision of erection & commissioning .	1	Visit		
E 3 YEARS RECOMMENDED SPARES					
E.1	Recommended spares list for 3 years normal operation for complete GDW Package along with the accessories. (List with price break up to be enclosed)	1	Set		
NOTES:					
1) Bidder to quote strictly as per BHEL's NIT requirements.					
2) Bidder to note that this is a LUMP SUM Turn-Key Order. Any additional claim after placement of order will not be entertained under any circumstances.					



BHARAT HEAVY ELECTRICALS LIMITED
R.C.PURAM, HYDERABAD-502032

PROJECT ENGINEERING & SYSTEMS DIVISION

PRICE FORMAT FOR GYPSUM DEWATERING PACKAGE (Rev-01)

NTPL FGD

3) **MAIN OFFER** consists of those items which will be part of main order after successful bidder is identified. **OPTIONAL ITEMS** consists of those items which need to be quoted by bidder but may or may not be ordered by BHEL. Bidders are instructed to provide the pricing details listed under **Main offer** and **Optional items** as per the prescribed format.

4) The Lumpsum Price quoted by the bidders for items under main offer : Sl. No. I [A to C] will be considered for evaluation of lowest bidder.

However, BHEL reserves the right,

(a) **To include any of the optional items in scope of supply (as per customer contract requirements) and accordingly consider the same in evaluation.** Any such scope increase and change in evaluation will be intimated to vendor during technical evaluation (before price bid opening).

(b) **To place PO for any of the Optional items with in the contract period.**

Hence bidders need to mandatorily quote reasonable prices for all optional items considering such requirement and keep the validity of the prices till the end of contract period.

5.a) For all items including Optional items, prices to be furnished in this prescribed price bid format only for each individual item. No combined prices, common prices or any other format will be accepted and such bids may be liable for rejection.

5.b) Bidder must not change the indicated item description, quantity & units in the price bid format. Bidder should only fill the unit rates & total price.

5.c) Bidder to quote for all the items as per price bid format. Incomplete/partial offer may be liable for rejection.

6) Bidder to quote the base rates only for items under I & II. **The Total Lumpsum price quoted shall be INCLUSIVE of Freight, Packing & Forwarding and Testing Charges etc.**

7.a) Commissioning spares are those spares which are required at the time of commissioning and shall be recommended (as per bidders experience) and quoted by bidder.

7.b) Commissioning spare consumed over and above the recommended commissioning spares, during commissioning shall be supplied free of cost by the equipment vendor.

8) Reference document: BHEL Tender Specification (PY51769) & all its annexures.

9) Unpriced price bid format indicating as "QUOTED" against each applicable item shall be submitted duly signed & stamped along with technical offer by bidder as a token of concurrence that prices are submitted in this format only. The offer shall be liable for rejection in case if un-priced price bid format is not submitted or any modification is carried out in price bid format.

10) **In case the systems are being supplied from outside India**, reputed Third Party Inspection like Llyods or equivalent has to be considered and the charges should be included in the Main offer. For those bidders who are supplying from India, such third party inspection charges need not be considered and same will be arranged by BHEL/BHEL nominated inspection agency.

11) Separate Purchase Orders will be issued for scope of work of this tender as follows:

a) The Purchase Order for Supply of Main Items (I-A & I-B) will be issued by BHEL-PE&SD Hyderabad.

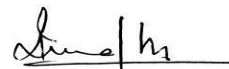
b) The Purchase Order for Supervision of E&C (I-C) will be issued by BHEL-PE&SD Hyderabad **(or)** BHEL-PSSR (BHEL's Construction Management Division for this project).

12) In case of inspection is Abroad (i.e other than INDIA), The local conveyance of end customer or his representative shall be arranged by the bidder . This Has to be considered by the bidder in his price estimates.

 Ranipet		MANUFACTURER'S NAME AND ADDRESS M/S BHEL: BAP: RANIPET 632 406 TAMIL NADU		STANDARD QUALITY PLAN										
				ITEM: VACCUM BELT FILTER SYSTEM: FGD						QP NO		FGS:725		
										REV. NO:		00		
										DATE:		12.02.2019		
								PAGE NO:		Page 1 of 6				
SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C/N				D *	M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.	D *	** 10.			11.
1.0 RAW MATERIAL (*Material shall be as per Drawing)														
1.1	Vacuum Pump	Material TC (Physical & chemical) for impeller. Casing, Shaft	Major	Review of TC	100%		Approved drawing/data sheet	TC	√	P	V	V		
		NDT of impeller & Shaft	Major	UT	100%		ASTM A 388/ASME sec.V	TC	√	P	V	V	UT of shaft ≥ φ40mm	
		Capacity power, pressure efficiency noise, Vibration	Major	Measurement	100%		Approved drawing /data sheet	TC	√	P	W	V		
1.2	Speed reducer	Visual, dimension, Run test including of leakage, temp. rise, Noise level and vibration.	Major	Visual & Measurement	100%		Approved data sheet / Drawing	TC	√	P	V	V		
1.3	AC Drive	Type, Make, Rating, Routine test.	Major	Visual & measurement	100%		Approved Drawing/Data sheet	TC	√	P	V	V		

LEGEND: * RECORD, IDENTIFIED WITH "TICK" (√) UNDER COLUMN 'D' SHALL BE SUBMITTED TO CUSTOMER AS A QA DOCUMENTATION PACKAGE.
M: MANUFACTURER / SUB SUPPLIER, **C:** MAIN CONTRACTOR.
N: CUSTOMER/CONSULTANT **P:** PERFORM **W:** WITNESS **V:** REVIEW OF RECORDS
MA: MAJOR AND **MI:** MINOR

PREPARED BY



Rakesh Kumar Madhu, (SEr/QA)

REVIEWD & APPROVED BY

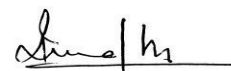


K C Gandhi Parimalam, (DGM/QA)

 MANUFACTURER'S NAME AND ADDRESS M/S BHEL: BAP: RANIPET 632 406 TAMIL NADU		STANDARD QUALITY PLAN												
		ITEM: VACCUM BELT FILTER SYSTEM: FGD						QP NO		FGS:725				
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								PAGE NO:		Page 2 of 6				
SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C/N				D *	M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.	D *	** 10.			11.
1.4	Belt	Visual & review of test certificate (tensile, Elongation, Thickness)	Major	Review of documents	100%		Approved data sheet/Drawing		TC	√	P	V	V	
1.5	Filter Cloth	Visual & Review of physical properties (Tensile, Elongation, Thickness, air permeability test. Etc.)	Major	Review of documents	100%		Approved data sheet/Drawing		TC	√	P	V	V	
1.6	Belt Wash Pump	Chem & mech Properties of Impeller, Casting, Shaft	Major	Review of documents	100%		Approved data sheet/Drawing		TC	√	P	V	V	UT of shaft ≥ φ40mm
		Balancing of Rotating Parts	Major	Static & Dynamic Balancing	100%		ISO 1940 Gr.6.3		TC	√	P	V	V	
		Hydro test of casing	Major	Static pressure testing	100%		Approved Data Sheet/Drawing		TC	√	P	V	V	Hydrostatic testing of casings for

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PREPARED BY



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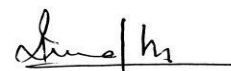


K C Gandhi Parimalam, (DGM/QA)

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					M	C/N				D *	M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.	D *	** 10.			11.
														30min at 1.5 times of shut-off head or 2 times pump rated head which ever higher
		Run test (Capacity, Head, efficiency, brake horse power, Noise and vibration)	Major	Measurement	100%		Approved Data Sheet/Drawing	TC	√	P	W	V		
1.7	Hydro cyclone	Visual & Dimension	Major	Visual & Measurement	100%		Approved Data Sheet/Drawing	TC	√	P	W	V		
1.7 (a)	Rubber Composition	Material content	Major	Measurement	1/Batch		Manufacturer standard	COC	√	P	V	V		
1.7 (b)	Rubber lining	Spark test at accessible area	Major	Inspection check	100%		Technical Spec/Relevant standard	IR	√	P	W	V		Spark test 10-12.5KV min

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PREPARED BY

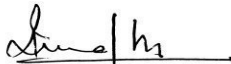


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REVIEWD & APPROVED BY

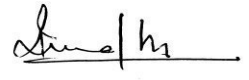


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SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS	
					M	C/N				M	C	N		
1.	2.	3.	4.	5.	6.		7.	8.	9.	D *	** 10.			11.
1.8	LT Motor	Make, Rating, Type, Routine test, Paint	Major	Measurement	100%		Approved Data sheet		TC	√	P	V	V	For Motor up to 30KW COC Above 30KW up to 50KW motor routine test shall be witnessed my BHEL. 50KW & Above separate QP to be submitted. Applicable for all MQP will be submitted.
1.9	Instruments	COC/Functional Check	Major	Measurement	100%		Approved Data Sheet/Drawing		TC	√	P	V	V	
2.0 FINAL INSPECTION														
2.1	Vacuum belt filter assembly	Visual, Dimensional	Major	Dimensional	100%		Approved Drawing			√	P	W	W	
2.2		Run test (for 30 minutes)	Major	Visual, Measurement	100%		Approved Drawing			√	P	W	W	
2.3	All components required paints.	Visual, DFT	Major		100%		Approved Painting Scheme			√	P	W	V	
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 Ranipet	MANUFACTURER'S NAME AND ADDRESS M/S BHEL: BAP: RANIPET 632 406 TAMIL NADU		STANDARD QUALITY PLAN											
			ITEM: VACCUM BELT FILTER SYSTEM: FGD					QP NO		FGS:725				
								REV. NO:		00				
								DATE:		12.02.2019				
					PAGE NO:		Page 5 of 6							
SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C/N				D *	M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.	D *	** 10.			11.

1	VACCUM TANK (RAW MATERIAL INSPECTION)												
1.1	Plates for shell and dished ends & structural	Chemical & Physical	Major	Chemical & Physical	1/ Heat	Approved Data Sheet/ Drawing		TC	√	P	V	V	
2.0	IN PROCESS CONTROLS												
2.1	Welding (As applicable)	WPS,PQR,WPQ	CR	Verification	100%	ASME Sec. IX/Relevant Standard		Repo rts	√	P	V	V	
2.2	Stress Relieving	Physical	Major	Review	100%	Relevant Standard / Manufacturer standard		HT chart	√	P	V	V	AS applicable
2.3	All Weld	Weld Quality	Major	DPT	10%	Relevant Standard / ASME Sec- VIII Div:1		IR	√	P	V	V	
2.4	Weld quality of circumferential & longitudinal seams	CR	UT	As Per Code	ASME Sec- V/ Appd.Drg	Relevant Standard / ASME Sec- VIII Div:1		IR	√	P	V	V	Only butted Welds
3.0	FINAL INSPECTION												
3.1	Complete Vessel	Dimensional	Major	Dimension	100%	Approved drawing		IR	√	P	V	V	
3.2		Nozzle Orientation	CR	Dimension	100%	Approved drawing		IR	√	P	V	V	
3.3		Hydro Test	CR	Hydro Test	100%	2X working PR or 1.5x design PR Whichever is higher for 30 minutes duration	NO Leakage	IR	√	P	V	V	

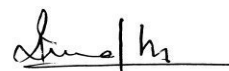
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 MANUFACTURER'S NAME AND ADDRESS M/S BHEL: BAP: RANIPET 632 406 TAMIL NADU		STANDARD QUALITY PLAN												
		ITEM: VACCUM BELT FILTER SYSTEM: FGD						QP NO		FGS:725				
								REV. NO:		00				
								DATE:		12.02.2019				
								PAGE NO:		Page 6 of 6				
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					M	C/N				M	C	N		
1.	2.	3.	4.	5.	6.		7.	8.	9.	D *	** 10.			11.
3.4		Pneumatic Test of RF pads (as applicable) for soundness/leakages	CR		100%		ASME SEC-VIII/appd. Drg/appd. Datasheet	No leakage	IR	√	P	V	V	
3.5 (a)	Rubber Lining of tank	Rubber lining	Major	Spark test	100%			Technical spec/Data sheet	IR	√	P	W	V	Spark test 10-12.5KV min
3.5 (b)	Rubber Lining of tank	Rubber lining	Major	Hardness testing	100%			Technical Spec/Data sheet	IR	√	P	W	V	Shore hardness value shall be within 60
3.6	Painting & Marking	Finish / DFT	Major	Visual	100%		Appd. Drg /Data Sheet		IR	√	P	V	V	
3.7	Quality Dossier	Document	Major	Review of document	100%		Compilation of all documents		Quality Dossier	√	P	V	V	

Note: Packing shall be witnessed by BHEL/BHEL's TPIA.

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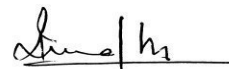


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					M	C/N				D *	M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.	D *	** 10.			11.
1.0 RAW MATERIAL (*Material shall be as per Drawing)														
1.1	Vacuum Pump	Material TC (Physical & chemical) for impeller. Casing, Shaft	Major	Review of TC	100%		Approved drawing/data sheet	TC	√	P	V	V		
		NDT of impeller & Shaft	Major	UT	100%		ASTM A 388/ASME sec.V	TC	√	P	V	V	UT of shaft ≥ φ40mm	
		Capacity power, pressure efficiency noise, Vibration	Major	Measurement	100%		Approved drawing /data sheet	TC	√	P	W	V		
1.2	Speed reducer	Visual, dimension, Run test including of leakage, temp. rise, Noise level and vibration.	Major	Visual & Measurement	100%		Approved data sheet / Drawing	TC	√	P	V	V		
1.3	AC Drive	Type, Make, Rating, Routine test.	Major	Visual & measurement	100%		Approved Drawing/Data sheet	TC	√	P	V	V		

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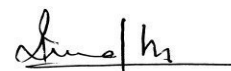


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					M	C/N				D *	M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.	D *	** 10.			11.
1.4	Belt	Visual & review of test certificate (tensile, Elongation, Thickness)	Major	Review of documents	100%		Approved data sheet/Drawing		TC	√	P	V	V	
1.5	Filter Cloth	Visual & Review of physical properties (Tensile, Elongation, Thickness, air permeability test. Etc.)	Major	Review of documents	100%		Approved data sheet/Drawing		TC	√	P	V	V	
1.6	Belt Wash Pump	Chem & mech Properties of Impeller, Casting, Shaft	Major	Review of documents	100%		Approved data sheet/Drawing		TC	√	P	V	V	UT of shaft ≥ φ40mm
		Balancing of Rotating Parts	Major	Static & Dynamic Balancing	100%		ISO 1940 Gr.6.3		TC	√	P	V	V	
		Hydro test of casing	Major	Static pressure testing	100%		Approved Data Sheet/Drawing		TC	√	P	V	V	Hydrostatic testing of casings for

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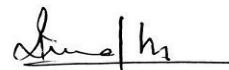


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					M	C/N				D *	M	C	N	
1.	2.	3.	4.	5.	6.	7.	8.	9.	D *	** 10.			11.	
														30min at 1.5 times of shut-off head or 2 times pump rated head which ever higher
		Run test (Capacity, Head, efficiency, brake horse power, Noise and vibration)	Major	Measurement	100%	Approved Data Sheet/Drawing	TC	√	P	W	V			
1.7	Hydro cyclone	Visual & Dimension	Major	Visual & Measurement	100%	Approved Data Sheet/Drawing	TC	√	P	W	V			
1.7 (a)	Rubber Composition	Material content	Major	Measurement	1/Batch	Manufacturer standard	COC	√	P	V	V			
1.7 (b)	Rubber lining	Spark test at accessible area	Major	Inspection check	100%	Technical Spec/Relevant standard	IR	√	P	W	V			Spark test 10-12.5KV min

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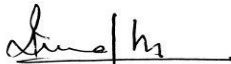


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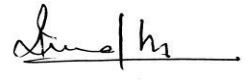


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					M	C/N				M	C	N		
1.	2.	3.	4.	5.	6.		7.	8.	9.	D *	** 10.			11.
1.8	LT Motor	Make, Rating, Type, Routine test, Paint	Major	Measurement	100%		Approved Data sheet		TC	√	P	V	V	For Motor up to 30KW COC Above 30KW up to 50KW motor routine test shall be witnessed my BHEL. 50KW & Above separate QP to be submitted. Applicable for all MQP will be submitted.
1.9	Instruments	COC/Functional Check	Major	Measurement	100%		Approved Data Sheet/Drawing		TC	√	P	V	V	
2.0 FINAL INSPECTION														
2.1	Vacuum belt filter assembly	Visual, Dimensional	Major	Dimensional	100%		Approved Drawing			√	P	W	W	
2.2		Run test (for 30 minutes)	Major	Visual, Measurement	100%		Approved Drawing			√	P	W	W	
2.3	All components required paints.	Visual, DFT	Major		100%		Approved Painting Scheme			√	P	W	V	
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					M	C/N				D *	M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.		** 10.			11.

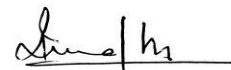
1	VACCUM TANK (RAW MATERIAL INSPECTION)												
1.1	Plates for shell and dished ends & structural	Chemical & Physical	Major	Chemical & Physical	1/ Heat	Approved Data Sheet/ Drawing		TC	√	P	V	V	
2.0	IN PROCESS CONTROLS												
2.1	Welding (As applicable)	WPS,PQR,WPQ	CR	Verification	100%	ASME Sec. IX/Relevant Standard		Repo rts	√	P	V	V	
2.2	Stress Relieving	Physical	Major	Review	100%	Relevant Standard / Manufacturer standard		HT chart	√	P	V	V	AS applicable
2.3	All Weld	Weld Quality	Major	DPT	10%	Relevant Standard / ASME Sec- VIII Div:1		IR	√	P	V	V	
2.4	Weld quality of circumferential & longitudinal seams	CR	UT	As Per Code	ASME Sec- V/ Appd.Drg	Relevant Standard / ASME Sec- VIII Div:1		IR	√	P	V	V	Only butted Welds
3.0	FINAL INSPECTION												
3.1	Complete Vessel	Dimensional	Major	Dimension	100%	Approved drawing		IR	√	P	V	V	
3.2		Nozzle Orientation	CR	Dimension	100%	Approved drawing		IR	√	P	V	V	
3.3		Hydro Test	CR	Hydro Test	100%	2X working PR or 1.5x design PR Whichever is higher for 30 minutes duration	NO Leakage	IR	√	P	V	V	

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					M	C/N				M	C	N		
1.	2.	3.	4.	5.	6.		7.	8.	9.	D *	** 10.			11.
3.4		Pneumatic Test of RF pads (as applicable) for soundness/leakages	CR		100%		ASME SEC-VIII/appd. Drg/appd. Datasheet	No leakage	IR	√	P	V	V	
3.5 (a)	Rubber Lining of tank	Rubber lining	Major	Spark test	100%			Technical spec/Data sheet	IR	√	P	W	V	Spark test 10-12.5KV min
3.5 (b)	Rubber Lining of tank	Rubber lining	Major	Hardness testing	100%			Technical Spec/Data sheet	IR	√	P	W	V	Shore hardness value shall be within 60
3.6	Painting & Marking	Finish / DFT	Major	Visual	100%		Appd. Drg /Data Sheet		IR	√	P	V	V	
3.7	Quality Dossier	Document	Major	Review of document	100%		Compilation of all documents		Quali ty Dossi er	√	P	V	V	

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PREPARED BY



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K C Gandhi Parimalam,(DGM/QA)

VOLUME IIB

**TECHNICAL SPECIFICATION
FOR
SEAWORTHY PACKING FOR EXPORT JOBS**

SPECIFICATION NO. PE-TS-888-100-A001



**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI, INDIA**

	TITLE TECHNICAL SPECIFICATION FOR SEAWORTHY PACKING FOR EXPORT JOBS	SPECIFICATION NO. PE-TS-888-100-A001	
		VOLUME II B	
		SECTION D	
		REV. NO. 0	DATE 10/08/2010
		SHEET 1	OF 52

1.0 Purpose

The purpose of this specification is to describe minimum packing requirements for the different items/equipment for all export Project and also to define marking and shipping requirements during transportation by ship, road and air for all export jobs.

2.0 SCOPE

For export jobs, sea worthy packing capable of performing all necessary functions like prevention of damage to the contents, sufficient to support frequent handling and lengthy period of outdoor storage in adverse weather conditions are required. Workmanship and materials used shall be of high standard meeting the technical requirements and in accordance with best commercial export packing practices. Vendor shall be responsible for sea worthy export packing, however it shall meet the minimum requirements specified herein. Equivalent or better packing methods may be deployed subject to approval of the BHEL/Purchaser. Vendor shall submit the packing procedure for its equivalent for purchaser's approval during detailed engineering.

The scope this specification is to define VENDOR's responsibilities in terms of:

- Preservation of the GOODS/items/equipments before packing.
- Packing of the GOODS for road, rail, sea and/or air transportation to desired destination i.e. project site
- Making cases/crates
- Chemical Treatment/Fumigation before packing to prevent fungus, damage due to termite, borer, rats, etc.
- Marking of cases/crates.
- Other Services required.

3.0 Application

This specification is applicable to all the goods to be transported to project site and requires to be in transit for longer duration. *However, for "Misc cable erection items", "Fire sealing system" & "Exothermic welding material", the packing requirements shall be as per the procurement specification.*

4.0 Definitions

- "BHEL" : Main EPC vendor
- "OWNER" : Customer for a particular export project.
- "VENDOR" : Company(ies)/VENDOR(s) to whom the BHEL has placed Purchase Order for GOODS/ items/system/package.
- "GOODS": means all or part of the articles, material, equipment supplies including technical documentation, as described in the Purchase Order, to be supplied by VENDOR.
- "PACKER": Packaging Company to whom VENDOR intends to sub-contract the packing in case they do not have own packing capability/facilities .
- "FREIGHT FORWARDER" : Means the Company responsible for performing freight forwarding activities.

5. General Information

	TITLE TECHNICAL SPECIFICATION FOR SEAWORTHY PACKING FOR EXPORT JOBS	SPECIFICATION NO. PE-TS-888-100-A001	
		VOLUME II B	
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The following requirements are intended as minimum requirements, and compliance to these requirements in no way absolves or relieves VENDOR of any responsibility or obligation outlined in the Purchase Order. In all circumstances, the packing will be designed and constructed in order to support GOODS during transportation as well as to prevent the Goods from damage due to impact, extreme climatic conditions, sun and rain. It must be ensured that the delivery of the GOODS to the jobsite by sea, road or air, in good condition.

GOODS shall be export packed in compliance with the best-established practices for international projects, in accordance with the following instructions. In the event of any conflict between these specified requirement and the established practices, specification requirement shall govern.

Due to climatic conditions and the complex transport operation(s), it is essential that protection and packing is of the highest standard. Packing means to efficiently protect the GOODS during the total transport operation; from the moment they leave the factory until they are delivered to the jobsite, including handling operations (loading/unloading) and storage.

When VENDOR do not have packing capabilities/facilities of their own and therefore intends to sub-contract, VENDOR have to inform BHEL/Purchaser of the name and address of proposed PACKER(s) for approval.

6.0 Criteria for Selection of Packaging

Packages are to be made according to categories, described in articles 8.1 to 8.5, depending on the type of materials, their fragility and size.

These categories have been established for the protection of equipment and material during multi-mode transports, i.e.: combination of overland and sea transport; containerization, air transportation.

In a general manner, the GOODS have to be packed in such a way that crates, bundles, pallets can be stored into General Purpose containers, wherever possible.

If VENDOR has any doubt about the correct method of protection or packing, he should contact BHEL/Purchaser in order to mutually agree on the adequate type of packing to be used.

Materials can be classified in following categories

- Hazardous Material
- Non-Hazardous Material

Further to above categorisation, non-hazardous materials can be sub- categorised for selection of packing.

6.1 Hazardous Materials

Though handling of hazardous material may is not applicable in the scope of this specification. All hazardous material must be packed in adherence to the detailed requirement relating to packing, marking and labelling set out in the most recent report of the Board's Standard Advisory Committee on the Carriage of Dangerous Goods in Ships for sea freight, and the Restricted Articles Regulations, laid down by the International Air Transport Association for airfreight.

6.2 Non-Hazardous GOODS

The scope of this specification is to provide necessary guidelines for packing for power plant equipment, components, Pipings & Valves, Fittings, other structural items, electrical items, spare parts and erection materials. The procedure is defined in subsequent paragraphs in details in clause no. 8.0.

	TITLE TECHNICAL SPECIFICATION FOR SEAWORTHY PACKING FOR EXPORT JOBS	SPECIFICATION NO. PE-TS-888-100-A001	
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7.0 Marking Instructions & Despatch details, Storage Code

7.1 Marking Instructions & despatch details

Packages and crates will be marked with indelible black paint, resistant to seawater. Marking must be perfectly legible.

The shipping marks, which will be as per fig-13, shall be stencilled on two sides and one end in clear characters at least 5 centimetres high (where crate size permits, otherwise use optimum size for each package dimension).

When the GOODS are to be shipped in containers then marking may be stencilled on one end only. However, packages must be stowed in a manner that shows these marks.

Crates containing fragile articles must be packed with special precaution against risk of breakage and must be stencilled on all sides "FRAGILE - HANDLE WITH CARE". Where crates are not to be overturned, VENDOR must show on the crates, clear and readily visible identification as per fig-12, to ensure they are kept in the correct position.

Packages/equipment of 2,000 kg or more must be marked with slinging points on all sides, in addition to the centre of gravity marks.

Number packages consecutively i.e. 1 of 10, 2 of 10, etc. Do not duplicate package numbers. VENDOR is responsible for any loss or damage caused by incorrect marking.

All cases/crates shall also be marked with the appropriate international standard graphic symbols for handling as shown in Fig 12.

As a minimum, all cases/crates are to be marked clearly on all four sides with:

- "HANDLE WITH CARE"
- "RIGHT SIDE UP"
- "KEEP DRY"

In the case of packages with a single gross weight totalling 2,000 kg and/or a height of more than 1m, the centre of gravity shall be clearly marked with the symbol on two adjoining sides. For all items of equipment with an eccentric centre of gravity this symbol shall be marked at the bottom, side and top of the package.

The slinging and lashing points shall be marked with a chain symbol.

When packing in cases/crates, these packages shall also have metal corners at the slinging points. (Fig-11)

External front and rear sides of the boxes to be planed for writing instructions.

Dispatch details such as consigner/consignee address, contract and case details, country of origin, port of delivery, stacking instructions shall be written on one side of the boxes. An anodized aluminum plate as per details and specifications given in fig-13 shall be provided on one side of the boxes.

One copy of packing slip wrapped in polyethylene bag covered with aluminum packing slip holder to be nailed on the external surface of the box. One more copy of the packing slip wrapped in polyethylene bag is to be kept inside the box at the pertinent place.

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7.2 Storage Code

The type of storage required is required to be specified, it will be shown on each packaging in **RED** colour.

- X Crates or packages to be stored outdoor without covers
- XX Crates or packages to be stored under tarpaulin
- XXX Crates or packages to be stored in covered or enclosed premises
- XXXX Crates or packages which must be stored in air-conditioned premises

8.0 GUIDELINES FOR PACKING GOODS

8.1 In the subsequent paragraphs details of different types of packings for different types of GOODS are defined. Vendor shall make packing details/procedure based on the guidelines and submit for approval.

8.1.1 Packing for Pipe, Fittings, Flanges and Valves, Structural Steel

Particular attention should be brought to pipe, fittings, flanges, valves and structural steel. Packing categories for piping and fittings will differ according to the diameter and wall thickness of these products. VENDOR shall comply with the following established practice.

IMPORTANT NOTE:

Depending on the project schedule and availability of ocean vessels, the piping and structural steel may be shipped in containers. In this event, VENDOR has to arrange the packages in such a way it allows the stuffing into Open Top in gauge containers.

8.1.2 Pipe

Where practicable, pipe lengths shall be limited to 11.8 meters.

All pipes 2" included and below shall be packed in crates. All pipes to be capped and ends sealed with waterproof tape.

Pipes over 2" up to 6", shall be bundled and banded in bundles of uniform length. Bundling is carried out with U-IRON or traversal planks, joined with threaded connecting rods with locknuts. Quantities and strapping positions depend on the lengths, with a 120 cm spacing to prevent distortion. Bundle weight shall not exceed 2,000 kg. All pipes are to be capped and ends sealed with waterproof tape (tape is not necessary if end caps are of the pre-shrunk or self-sealing type).

Pipes larger than 6" shall be shipped as single lengths with the ends capped. End caps are to be of the recessed type to enable the use of soft faced hooks, but still completely sealing the end and also protecting the weld.

All stainless steel piping must be packed separately in wooden crates. Any banding of bundles is to be with the same material.

8.1.3 Pipe Fittings, Flanges and Valves

All pipe fittings, flanges and valves up to 6", are to be packed in cases/crates. For items over 6", these may be fixed securely to a pallet base and enclosed in a crate, for protection. Where valves have actuators attached, rigidity must be ensured for the valve and actuator. The vulnerable parts of the actuator are to be completely protected within a wooden crate.

All stainless steel fittings, flanges and valves of all sizes, must be packed separately in wooden crates. Any strapping is to be with the same material.

8.1.4 Structural Steel

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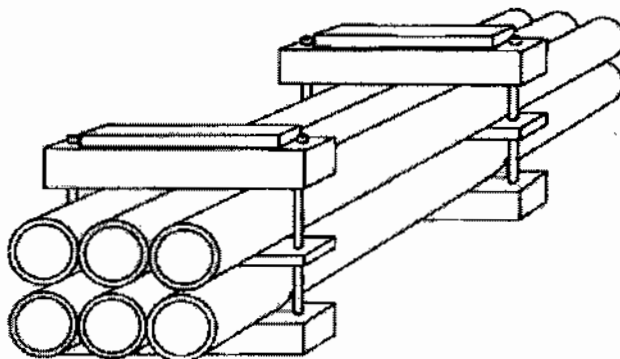
Structural Steel, reinforcing rods, bars, etc., should be packed in bundles of uniform length. Refer to articles 8.1.2, for strapping requirements. Bundle weight not normally to exceed 2,000 kg. Fabricated structures and structural steelwork, etc, should be bundled and packed using wooden beams and long bolting to secure the load.

8.2 Bundling – Packing Category I

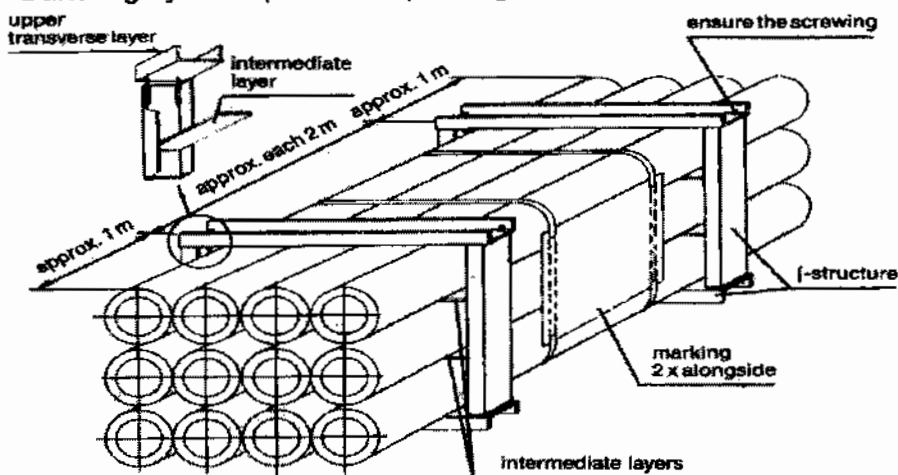
8.2.1 Type of Equipment

Equipment which is not subject to damage by corrosion or mechanical effect, i.e. pipes, piping, structural steel.

Packing category I



Bundling by U-shaped iron – packing category I A



8.2.2 Type of Construction

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- Bundling has to be effected
- By squared timber and threaded rods.
- With an intermediate layer (threaded on tightening bolts) according to the weight of the package.
- Wedge-shaped timbers must be added at the outer points of lower layer.
- Between the bolts a spacer must be nailed.
- The bolts must be secured (e.g. by locking nut).
- If single parts could protrude, an appropriate protection must be installed (flat iron or plates).
- Bundling with steel straps or PVC straps is not accepted.

8.3 Skids, Square Timber Constructions, Casings – Packing (Category II)

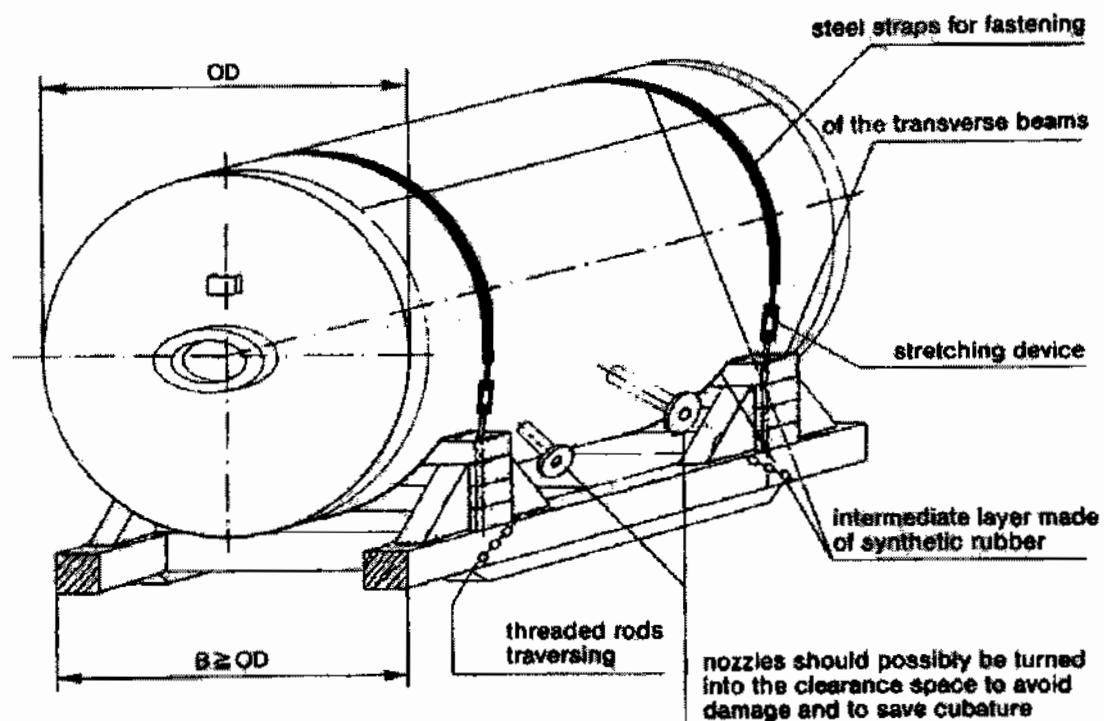
8.3.1 Type of Equipment

Voluminous apparatus, tanks and/or heavy pieces those are not vulnerable to mechanical or corrosive effects.

8.3.2 Type of Construction

- The construction skid can be made of wood or of metal.
- The fastening of the packages on the skid will be made by steel straps (flat iron) which have to be elastically lined, non-slip and securely bolted onto the skids.
- Flange openings have to be closed with gaskets and blind flanges or, if necessary, provided with cover.
- Skid constructions may not be less than the dimensions of the package in length or in width.
- Tanks and apparatus with their own support cradles must be supplied with an anti-slip lining.

PACKING CATEGORY-II



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8.4 Packing of GOODS in Wooden Crates/Cases/Boxes

The construction of wooden crate/cases/boxes shall be as per the details indicated in clause 9.0 & Fig 1 to 11. Details indicated in the sketches for different categories Packing crates/boxes are only for a typical equipment considered for illustration.

8.4.1 Packing Category III

8.4.1.1 Type of Equipment

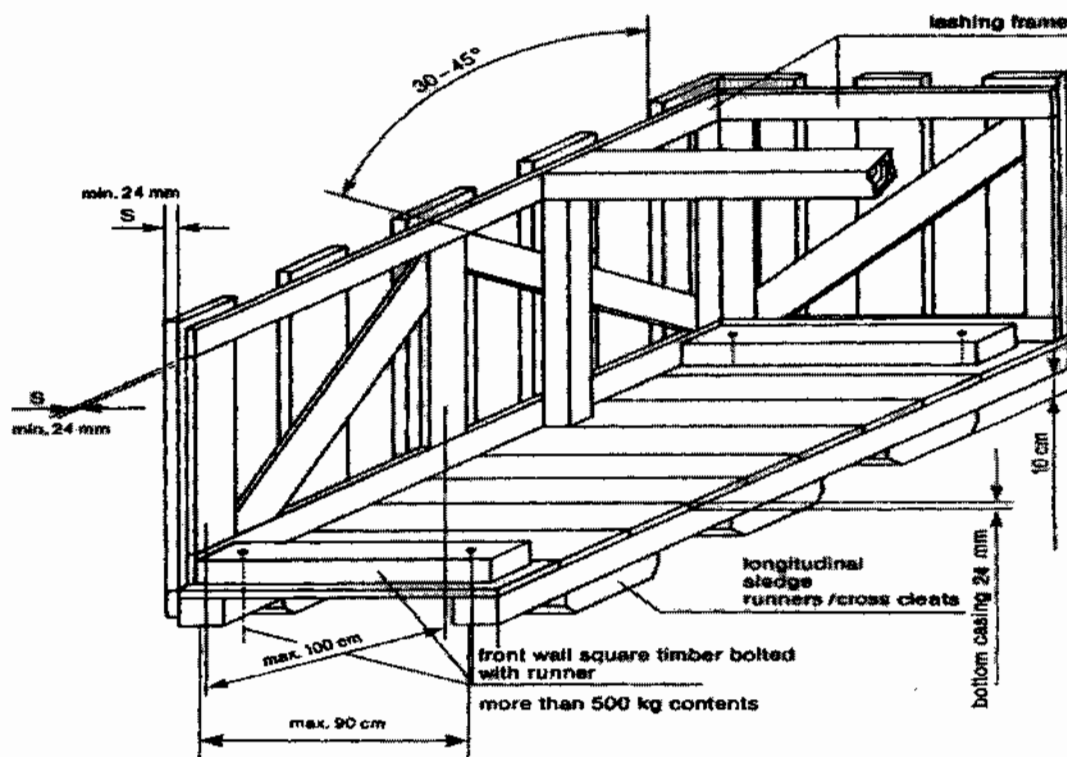
Fabricated equipment, which cannot be transported on cradles; frame-works, prefabricated piping and fittings, mechanical and electrical assemblies. *This type of packing is recommended where many parts of the equipment/component/assembly are not protruding out.*

8.4.1.2 Type of Construction

The equipment must be safely fastened to the bottom with bolts, possibly by the runners or to be spread in such a manner that no protruding parts are possible. For parts, sensitive to rainwater and/or debris, a protection has to be made by a foil cap.

If it is possible that single part could protrude through the front/back side wall, they shall be closed completely. The marking of the package shall be done on plywood plates at the prescribed sides.

Packing Category III



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8.4.2 Cases with Lining – Packing Category IV

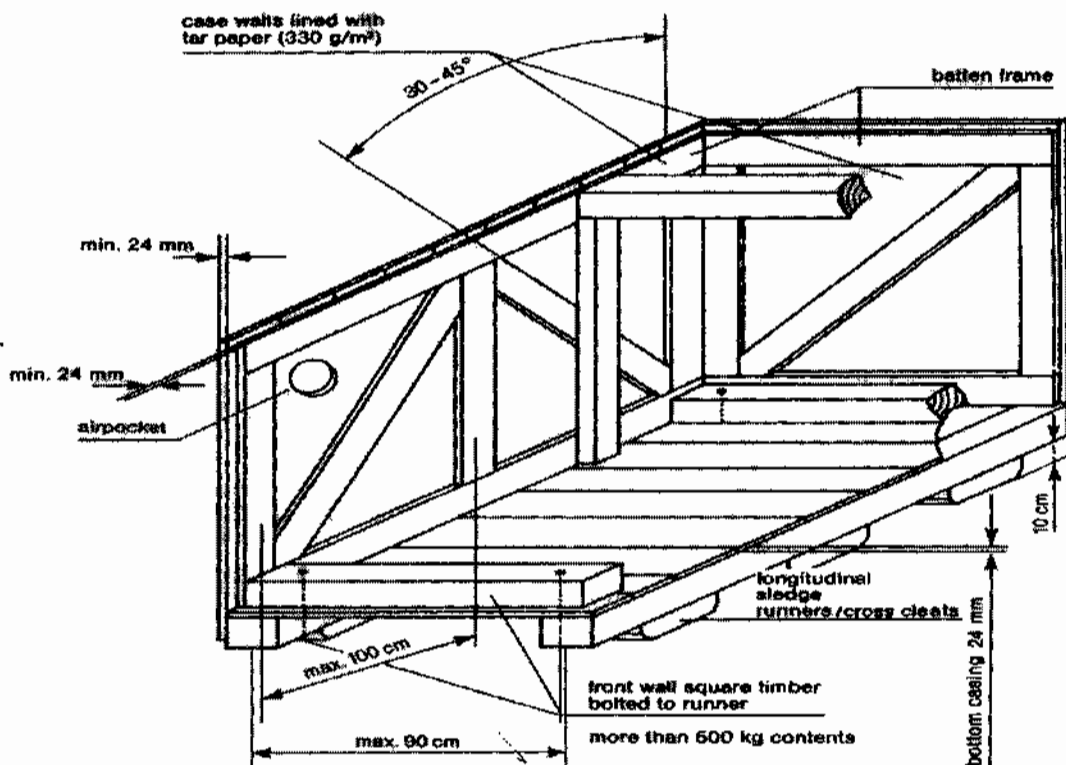
8.4.2.1 Type of Equipment

Recommended for equipment and mechanical parts Equipment sensitive to mechanical damage or parts and components that are particularly at risk of theft or loss; pumps, elbows, flanges, fittings, tools, erection materials, etc.

8.4.2.2 Type of Construction

The same type of construction as article 8.4.1.2, but with all sides completely boarded without space between the boards. Sides to be provided with waterproof lining; fabric-reinforced waterproof tar paper or polyethylene-foils resistant to ultraviolet rays can be used. Polyethylene-foil shall be fixed under the lid cover to avoid penetration of water. At weights of more than 500 kg the longitudinal runner must be bolted to the front all square timber. For ventilation inside the case, an opening in the waterproof lining must be placed between the diagonal battens and diagonal joists.

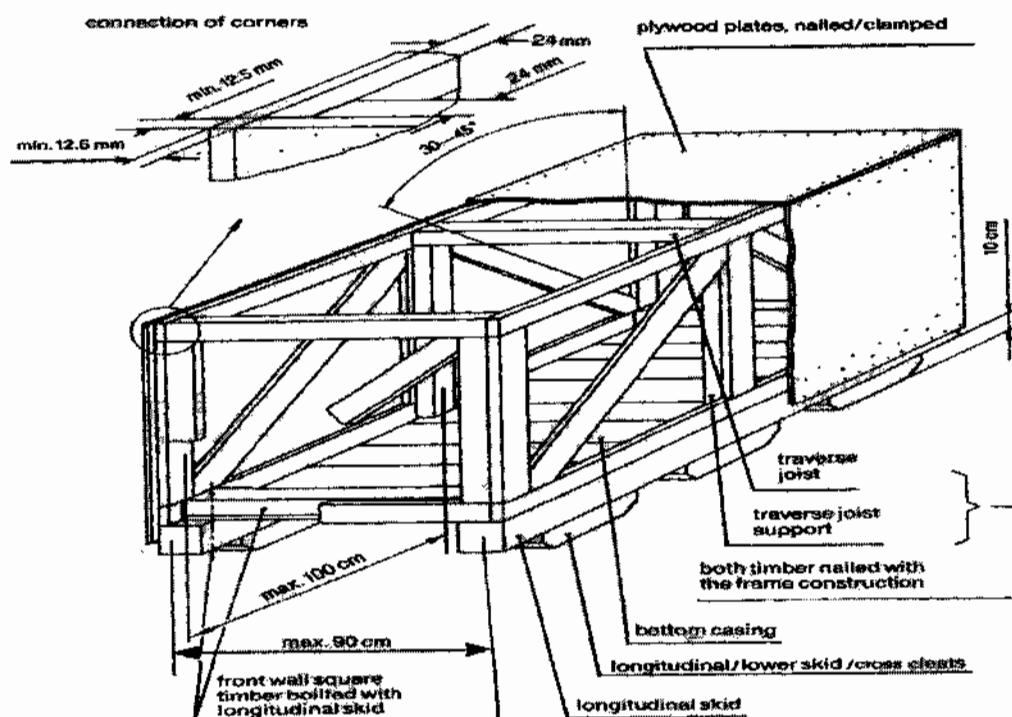
Packing Category IV



8.4.3 Cases with Alternative Surface Materials

8.4.3.1 Plywood Box – Packing Category IV A

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Case constructed of 5 layers of watertight, glued plywood with a total thickness of 12.5 mm. The frame must be constructed from minimum 24 mm timber or as per guide lines given above against clause 8.0, Fig 1 to 11 and must be suitable for the weight and nature of the parts to be packed. Planed square timber must be bolted with longitudinal skid and covered with diagonal joists. If applicable, construction of the cover and sides is to include diagonal bracing. Covers consisting of several layers of plywood are to be sealed with durable elastic putty or additional water-resistant sheets to be fixed.

8.4.4 Case with Barrier Material – Polyethylene Foil – Packing Category V

8.4.4.1 Type of Equipment

Sensitive equipment, simple electrical equipment, insulation materials, fire-resistant materials, with non-corrosion- guarantee for a period up to twelve (12) months.

8.4.4.2 Type of Construction

Preservation by welding in polyethylene-foil with addition of desiccants and if necessary, application of non-corrosive contact agents, otherwise, type of construction as indicated in article 8.4.2.2.

Additional marking:

- Case with desiccants.

8.4.5 Case with Barrier Material – Aluminium Compound Foil – Packing Category VI

8.4.5.1 Type of Equipment

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Electrical equipment such as, switchboards, electric motors, sensitive equipment, with non-corrosion guarantee, for a period up to twelve (12) months.

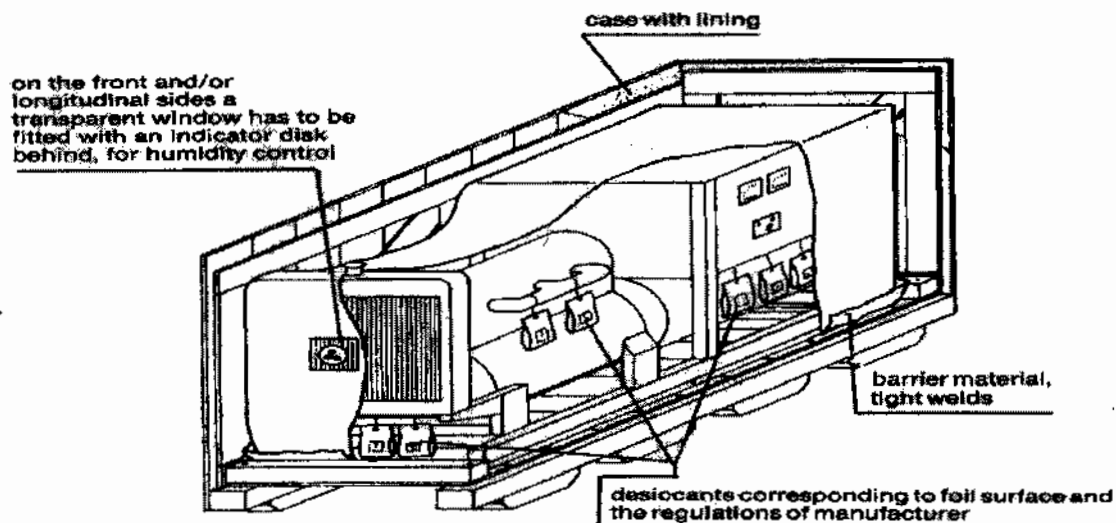
8.4.5.2 Type of Construction

Type of construction as indicated in article 8.4.2.2. Preservation by sealing an aluminium compound foil, with the addition of desiccants. Humidity indicators, if required and installed in the barrier wrapping, shall allow easy control from the outside.

Additional marking:

- Case with desiccants.

Packing Category V/VI



8.4.6 Double Case – Packing Category VII

8.4.6.1 Type of Equipment

GOODS which are of high sensitivity to shock, impact and vibration, for instance, special electrical equipment like computers, switchboards, laboratory instruments

8.4.6.2 Type of Construction

Case construction as indicated in article 8.4.2.2, with additional floating inner packing (case-in-case principle), padding corresponding to weight and sensitiveness. Preservation by sealing in aluminium compound foil with the addition of desiccants. The inner case has to be made of plywood or equivalent material with a thickness of 8-12 mm, depending on the weight of the GOODS to be packed. The inner buckles and/or frame borders have to be dimensioned so that the full stability of the inside case will be reached and no twisting is possible. The inner sides of the inside case will be lined with bituminous kraft paper on all sides (except bottom).

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8.4.7 Cable Drum – Packing Category VIII

8.4.7.1 Type of Equipment

All type of cables, wires, ropes, hoses.

8.4.7.2 Type of Construction

For all type of cables refer clause no. 11.1. For other items (wires, ropes, hoses) new or practically new drums are to be used. Planking of the e drums by use of boards, thickness minimum 20 mm, with additional double steel strapping, nailed, and carefully preserved/protected cable ends prior to packing.

8.4.8 Hazardous Materials – Packing Category IX

8.4.8.1 Type of Equipment

Hazardous materials according to the law are explosives, compressed gases, liquefied gases dissolved under pressure or deeply refrigerated, flammable liquids, flammable solids: substances liable to spontaneous combustion; substances which, on contact with water, emit flammable gases, oxidizing substances, organic peroxides, poisonous (toxic) and infectious substances; radioactive materials, corrosives, miscellaneous dangerous goods.

8.4.8.2 Type of Construction

Hazardous materials shall always be packed and documented separately from any other material. Selection of packaging materials, execution of packing and marking as well as documentation shall always be in compliance with the applicable laws and regulations. Any certificates required for transportation or for authorities to be supplied before shipment of the GOODS.

8.4.9 Wooden Floor as a Transport Support – Packing Category X

8.4.9.1 Type of Equipment

Any materials to be stuffed in containers or on flat racks and that are not stowed on standard pallets or otherwise suitably packed

8.4.9.2 Type of Construction

- Longitudinal internal square timbers bolted to the front wall runners, longitudinal skid.
- Maximum distance between longitudinal runners 90 cm (middle to middle of the runner).
- Full boarding of the floor.
- Attaching of lifting lugs and/or iron ropes for lifting/pulling the units off the transport equipment.
- If applicable, preservation of the equipment by sealing in polyethylene-foil or aluminium compound foil and the addition of desiccants.

8.5 Air Transport Packing

8.5.1 General

Certain types of material may have to be shipped by air from their country of origin. This means of transport will be exceptional, and will be used only:

- For GOODS, which are highly sensitive to shock or vibrations, such as computers, electronic instruments, or those of small dimensions and weight.
- For GOODS urgently required at the module yard(s) and/or jobsite.

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8.5.2 Type of Packing

Depending on the goods to be packed, VENDOR may use one of the following types:

- A triple-corrugated cardboard container made with waterproofed glue and a barrier layer of polyethylene on the outsides to keep out humidity.
- Wooden/cardboard packing cases: the wood being used for the framework and base of the cases, waterproofed triple-corrugated cardboard being used for the sides and top. These cases are of the "Bell" type, and used for material of small or medium dimensions.
- For larger dimensions, plywood cases are acceptable. The timber characteristics, cross-sections and thickness will be systematically determined by the nature of the loads to be packed.

8.5.3 Dimensions

In order to optimize the existing transport facilities (passenger or cargo aircraft), the dimensions of:

- Triple-corrugated containers.
 - Wooden/cardboard packing cases.
 - Plywood cases.
- Are to be adapted to pallets used for air transportation.

9.0 Detailed specification for Wooden Crates/Boxes/Cases and other packing materials

9.1 Technical specification for wood

The wood shall be Fir, Chir, Silver Oak (Gravillea Robusta), chemically treated mango and Pinewood with moisture content not exceeding 50%. The wood shall have flexural and compressive strength, stiffness, shock absorption and nail retention properties. The wood shall be free from common defects such as warp, bone, twist, knot, cracks, splits, end splits, bend, visible sign of infection and any kind of decay caused by insects or fungus, etc. Surface cracks with maximum depth of 3mm are permissible. A continuous crack of any depth all along the length is not allowed.

9.2 Chemical Treatment of Wood:

The wood shall be chemically treated to provide protection against deterioration due to fungi and attack by termites, borers, marine organism and any other kind of infection. It shall be treated only after final processing like cutting, planning, joint grooving, etc.

9.3 TYPE, DESIGN & DIMENSION OF WOODEN PACKING CASES:

9.3.1 PACKING OF EQUIPMENTS

Various mechanical, electrical and C&I equipment e.g. Pumps, motors, equipment skids, heat exchangers, control panels, switch gears, transformers, etc. shall be wrapped in weather proof packing and then secured in wooden packing cases. The construction of wooden packing cases/crates shall be as per details given below and also given in figure 1 to 11.

9.3.1.1 Bottom Frame

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The construction of bottom frame shall be as per Fig-2. The No. of slides/runners for bottom frames shall be selected depending upon the weight and overall dimensions of the load to be carried. The equipment shall be secured by fixing their base frame/plate with the help of bolt and nuts etc. to bottom frame of the wooden packing cases/crates. The equipment not provided with base frame/plate like cylindrical vessels, etc to be secured to the bottom frame of the wooden cases with "C" clamps fabricated from steel channels/ angle iron.

9.3.1.2 TOP FRAME

The construction of top frame shall be as per fig-3.

9.3.1.3 END PANELS

The dimension of the end and lateral panels shall be calculated according to overall dimensions of the items to be packed. Diagonal braces shall be used for packing cases having height exceeding 500mm. Details of bracings shall be as per fig 5 to 9.

9.3.1.4 Sling Plate

To facilitate lifting of cases, longitudinal under slide boards shall be fixed. To avoid damage to the box while lifting sling plates shall be provided. Refer fig-11.

9.3.1.5 Angle Iron Cleats

Angle iron cleats shall be used for strengthening the joints as indicated in fig-10

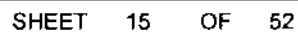
9.3.1.6 Other Requirements

- The thickness of planks for top, bottom, side and end panels shall be at least 25mm. Planks used for this purpose shall be joined with each other by tongue and groove joint. The groove dimension shall be such that tongue fits tightly into groove to make the joint.
- Runners/slides, traverse bars, etc shall be of single length i.e. without any joint. Planks for sheathing, diagonal bracing etc shall also be of single length up to 2400mm, proper jointing is permitted for planks for sheathing and diagonal bracings.
- Each equipment to be individually covered with double polyethylene petticoat. Sheet thickness of polythene sheet shall not be less than 0.175 mm (175 microns). The sealing shall be such so as not to allow moisture inside.
- The inner surface of 4 sides of shooks shall be nailed with bituminized water proof craft paper. Wherever 2 pieces of kraft paper are used, joint shall have an overlap of minimum 20 mm.
- All the inner sides of the box shall be nailed with bitumen coated HESSIAN POLYTHYLENE KRAFT PAPER. For top frame it shall project on all sides by 100mm and shall be nailed on sides. Wherever 2 pieces of kraft paper are used, joint shall have an overlap of minimum 20 mm.
- For delicate equipment like control panels and switchgears, lighting panels and lighting transformers, suitable cushioning material like rubberised coir (min. 50 mm thick and 100 mm wide) shall be provided on their bottom support and the gap between the panel and casing

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shall be filled with rubberized coir with distance between consecutive supports less than 500 mm (ref fig15). For other equipment suitable support from sides of the casing shall be provided.

- Switchgear cubicles, control panels and control desks shall be packed and shipped in separate convenient sections. The components e.g. circuit breakers relays and instruments etc. which are removed from panels for shipping purpose and shall be separately packed and shipped as per packing instructions in clause 10.4.
- Packing case for control panels and switchgear panels shall be finally covered with GI sheet of minimum thickness of 0.4mm.
- Packing cases shall be bound at edges by nailing MS clamps/brackets at sufficient intervals. Further heavier boxes shall be strapped with C clamps (ref fig-4) fabricated from steel channels/angles and lighter boxes shall be strapped with hoop iron strips.
- Silica gel is used for this purpose to protect contents over sufficiently long time from corrosion. Silica gel shall be indicating type confirming to IS-304 (1979) packed in cotton bags placed at different positions inside the packing for absorbing moisture and shall not come into directly contact with equipment/material inside the package. The quantity of silica gel shall be adequate for storage period of one year, however it shall not be less than 4 gm. per ltr. Volume of case subject to minimum 400 gm. Per case.





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BOTTOM FRAME ARRANGEMENTS

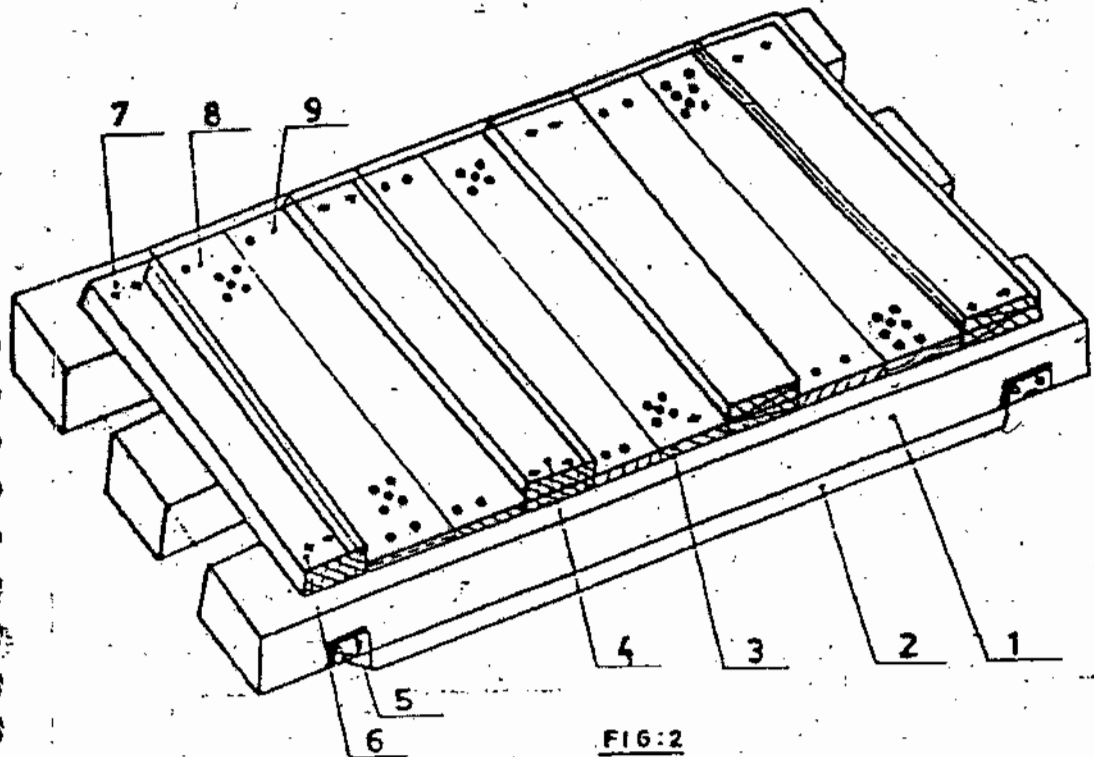


FIG:2

Nos. of slides: Minimum 2 Nos.
For length more than 1800 mm or
load more than 1000kg, Nos. of
slides shall be minimum 3 Nos.
For dimensions of slides, refer Table I
Cross section of end traverse bar; 100 X 100 mm.
(minimum)

1. SLIDE
2. UNDER SLIDE BOARD
3. BOTTOM BOARD
4. CARRIER TRAVERSE BAR
5. SLING PLATE
6. TRAVERSE BAR
7. BOLT, NUT & WASHER
8. DRAINAGE HOLES
9. NAILS

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TOP FRAME ARRANGEMENT

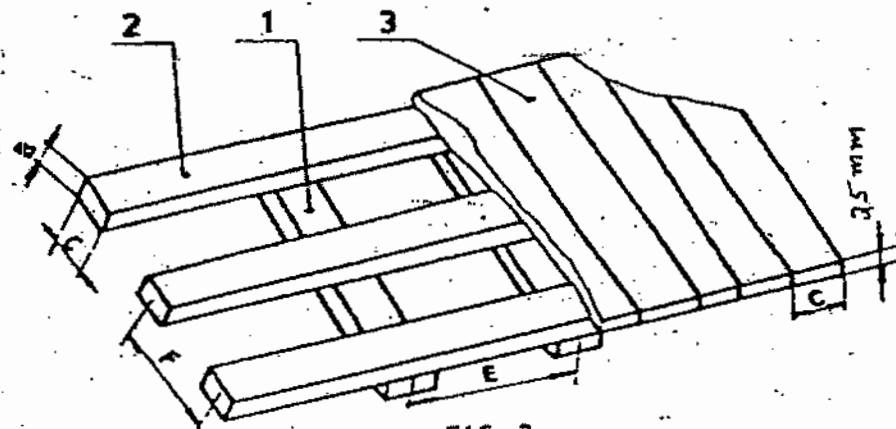
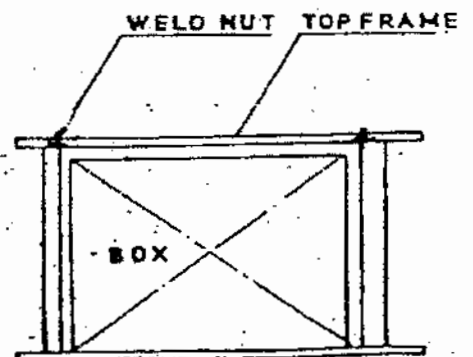
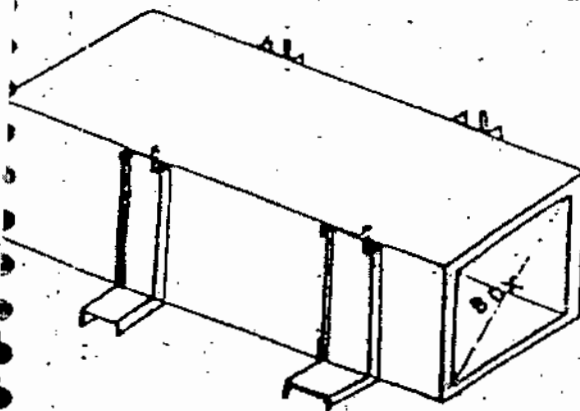


FIG-3

A : 700 to 1000 mm
B : 500 to 900 mm
C : 30 x 100 mm

- 1 - Traverse Bars
- 2 - Horizontal Soans
- 3 - Top Board

ARRANGEMENT OF C-CLAMPS AROUND CASES



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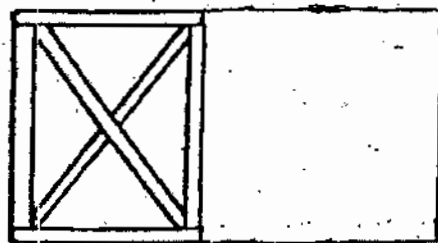
**ARRANGEMENT OF DIAGONAL BRACING AND
HORIZONTAL SUPPORT**

FIG:6

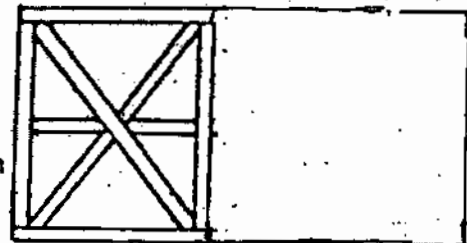


FIG:8

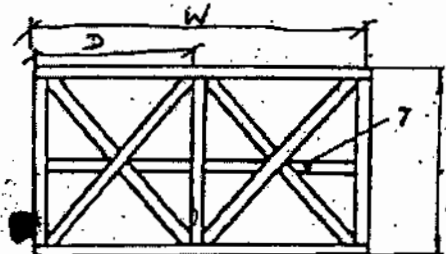


FIG:7

7- Middle Horizontal Support

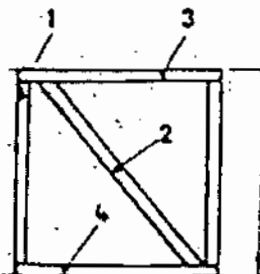


FIG:5

1- Vertical Support

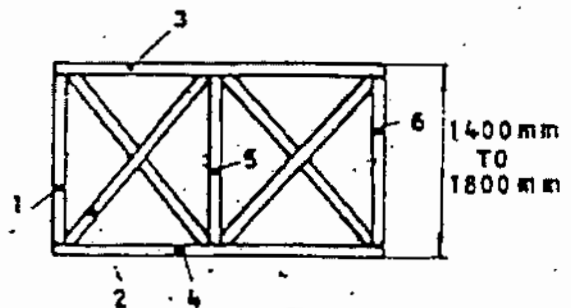


FIG:7

1, 5, 6 - Vertical Support

**TITLE**

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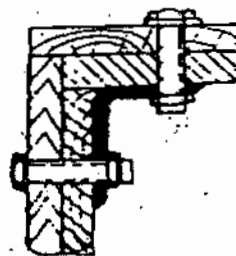
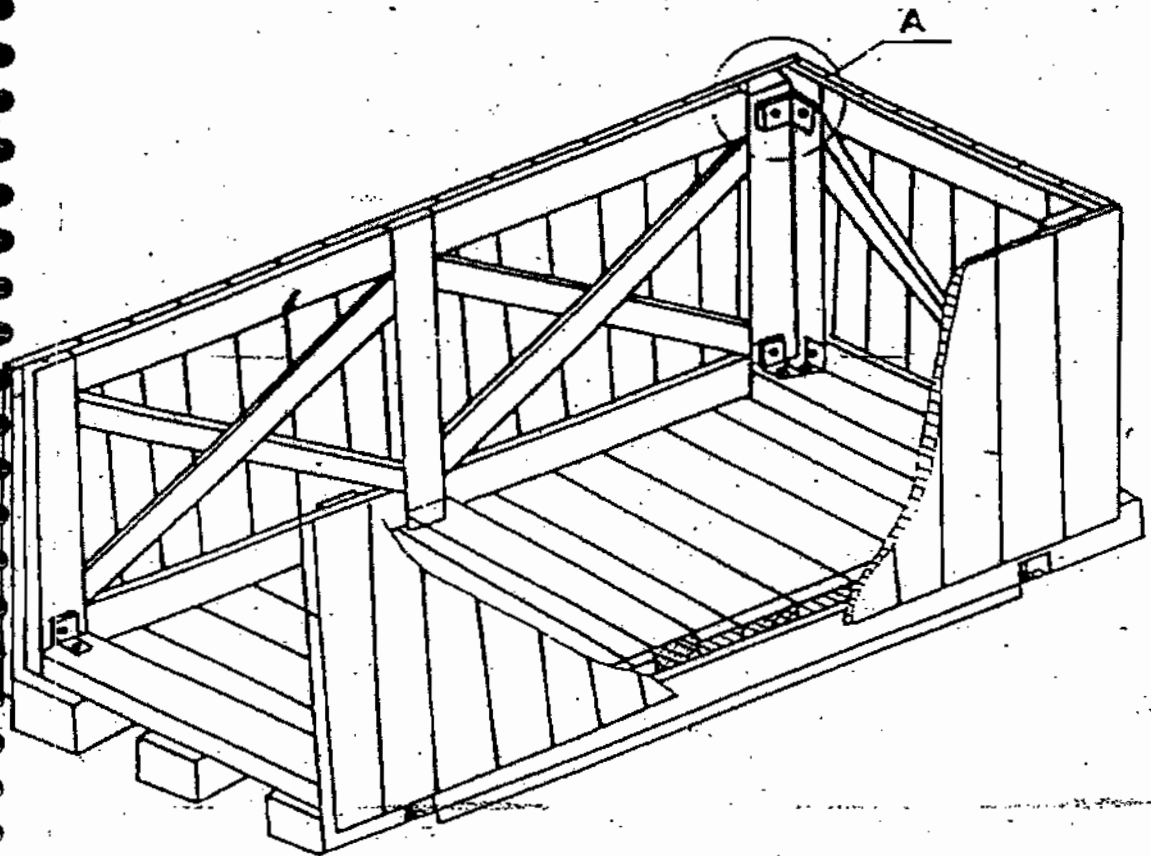
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ARRANGEMENT OF PACKING CASE



DETAIL-A

**HOLE DIAMETER
MUST CONFORM
TO BOLT DIA**

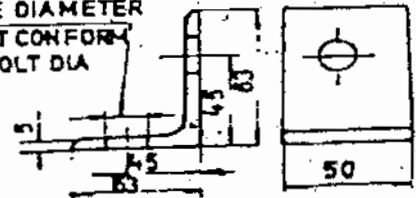


FIG 10

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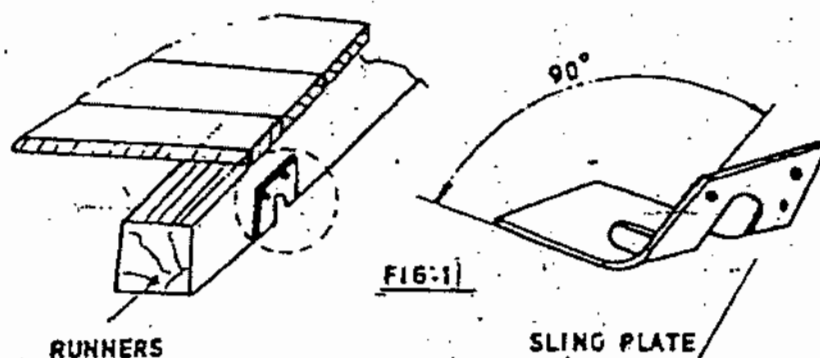
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**ARRANGEMENT OF SLING & PLATE ON
CASES**

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TABLE-1

LOADS	LENGTHS OF SLIDES						
	600	800	1000	1200	1300	1500	2000
	Cross section b x c				c b		
500	50 X 100	50 X 100	50 X 100	50 X 100	75 X 100	75 X 100	100 X 100
800	50 X 100	50 X 100	75 X 100	75 X 100	75 X 100	75 X 100	100 X 100
1000	75 X 100	75 X 100	75 X 100	100 X 100	100 X 100	100 X 110	100 X 150
1500	75 X 100	75 X 100	100 X 100	100 X 100	100 X 100	100 X 150	100 X 150
2000	75 X 100	100 X 100	100 X 100	100 X 150	100 X 150	100 X 150	150 X 150
2500	75 X 100	100 X 100	100 X 150	100 X 150	100 X 150	150 X 150	150 X 150
3000	100 X 100	100 X 150	150 X 150	150 X 150	150 X 150	150 X 150	150 X 150

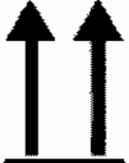
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Table-2

End and side panels	Width of the panel "W"	Distance between longitudinal support (Dimension "D")						
		600	800	1000	1200	1400	1600	1800
		Cross section b x c				Item 1 to 7		
Fig- 5 to Fig-9	600 to 1200	30	30	30	30	30	30	30
		X	X	X	X	X	X	X
		100	100	100	130	130	130	130
	1201 to 1600	30	30	30	30	30	30	30
		X	X	X	X	X	X	X
		130	130	130	130	130	130	130
	1601 to 2000	30	30	30	30	30	30	30
		X	X	X	X	X	X	X
		130	130	130	130	130	130	130
	2001 to 3000	30	30	30	30	30	30	40
X		X	X	X	X	X	X	
130		130	130	130	130	130	150	
3001 to 4000	40	40	40	40	40	40	40	
	X	X	X	X	X	X	X	
	150	150	150	150	150	150	150	

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INDICATION MARKS ON CASES/BOXES/CRATES

Designation	Symbol	Explanation
Fragile, Handle with care		The symbol should be applied to easily broken cargoes. Cargoes marked with this symbol should be handled carefully and should never be tipped over or slung.
Use no hooks		Any other kind of point load should also be avoided with cargoes marked with this symbol. The symbol does not automatically prohibit the use of the plate hooks used for handling bagged cargo.
Top		The package must always be transported, handled and stored in such a way that the arrows always point upwards. Rolling, swinging, severe tipping or tumbling or other such handling must be avoided.
Keep away from heat (solar radiation)		Compliance with the symbol is best achieved if the cargo is kept under the coolest possible conditions. In any event, it must be kept away from additional sources of heat. It may be appropriate to enquire whether prevailing or anticipated temperatures may be harmful.
Protect from heat and radioactive sources		Stowage as for the preceding symbol. The cargo must additionally be protected from radioactivity.
Sling here		The symbol indicates merely where the cargo should be slung, but not the method of lifting. If the symbols are applied equidistant from the middle or center of gravity, the package will hang level if the slings are of identical length. If this is not the case, the slinging equipment must be shortened on one side.
Keep dry		Cargo bearing this symbol must be protected from excessive humidity and must accordingly be stored under cover. If particularly large or bulky packages cannot be stored in warehouses or sheds, they must be carefully covered with tarpaulins.

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Center of gravity		This symbol is intended to provide a clear indication of the position of the center of gravity. To be meaningful, this symbol should only be used where the center of gravity is not central. The meaning is unambiguous if the symbol is applied onto two upright surfaces at right angles to each other.
No hand truck here		The absence of this symbol on packages amounts to permission to use a hand truck on them.
Stacking limitation		The maximum stacking load must be stated as "... kg max.". Since such marking is sensible only on packages with little loading capacity, cargo bearing this symbol should be stowed in the uppermost layer.
Clamp here		Stating that the package may be clamped at the indicated point is logically equivalent to a prohibition of clamping anywhere else.
Temperature limitations		According to regulations, the symbol should either be provided with the suffix "...°C" for a specific temperature or, in the case of a temperature range, with an upper ("...°C max.") and lower ("...°C min.") temperature limit. The corresponding temperatures or temperature limits should also be noted on the consignment note.
Do not use forklift truck here		This symbol should only be applied to the sides where the forklift truck cannot be used. Absence of the symbol on other sides of the package amounts to permission to use forklift trucks on these sides.
Electrostatic sensitive device		Contact with packages bearing this symbol should be avoided at low levels of relative humidity, especially if insulating footwear is being worn or the ground/floor is nonconductive. Low levels of relative humidity must in particular be expected on hot, dry summer days and very cold winter days.

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Do not destroy barrier		A barrier layer which is (virtually) impermeable to water vapor and contains desiccants for corrosion protection is located beneath the outer packaging. This protection will be ineffective if the barrier layer is damaged. Since the symbol has not yet been approved by the ISO, puncturing of the outer shell must in particular be avoided for any packages bearing the words "Packed with desiccants".
Tear off here		This symbol is intended only for the receiver.

FIG-12

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BHEL-PEM-DELHI-INDIA	
CONSIGNEE	
MATERIAL	
CUSTOMER REF.	MO. NO.
DESPATCH ADVICE NOTE NO.	CASE NO.
DIMENSIONS(MM) LXBXH	NET WT -KGS
	GROSS WT -KGS
SPECIAL INSTRUCTIONS	HANDLE WITH CARE -- KEEP DRY DO NOT DROP -- DO NOT TILT

FIG-13: MARKING PLATE



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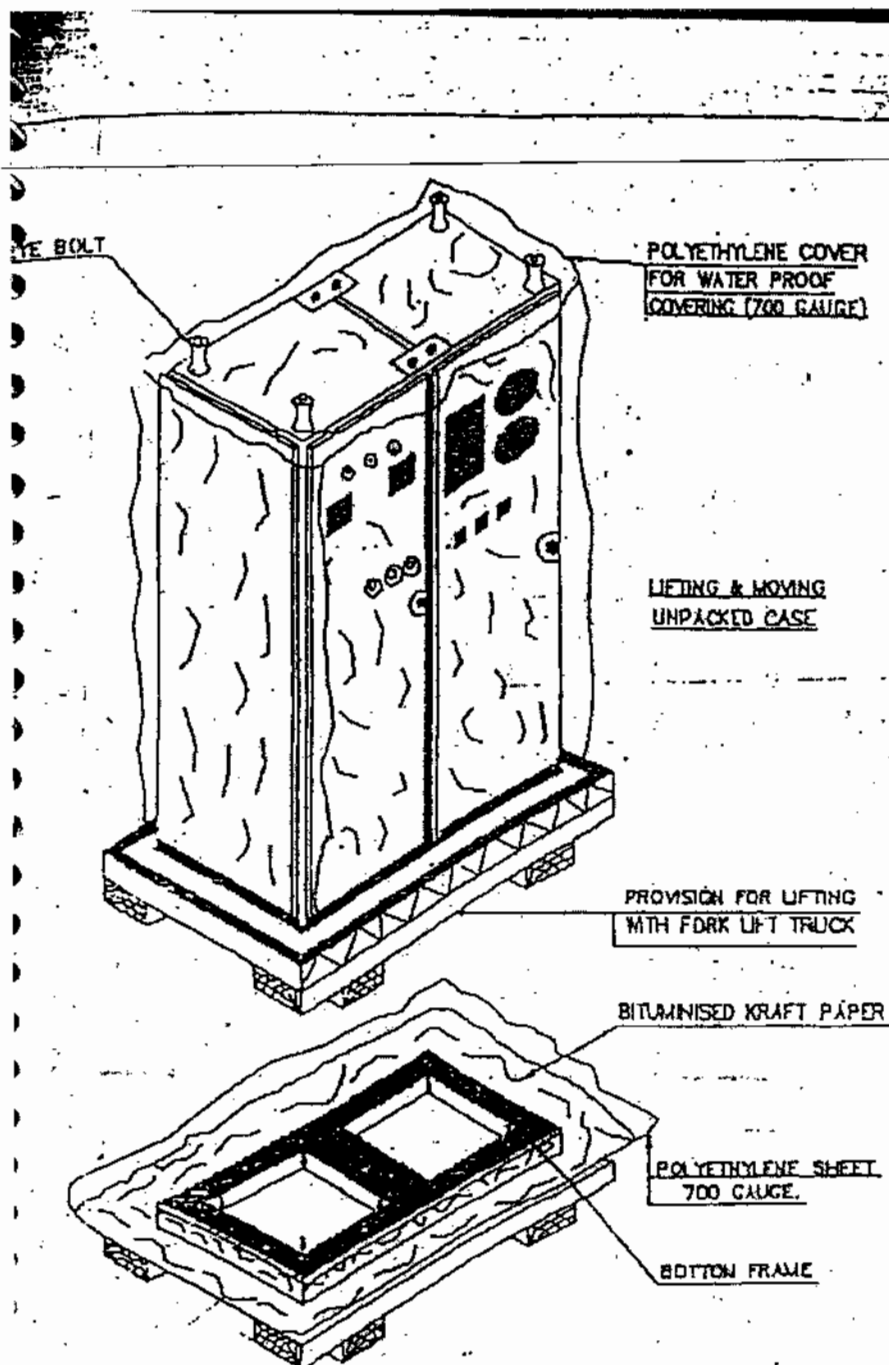


FIGURE-14

**TITLE****TECHNICAL SPECIFICATION
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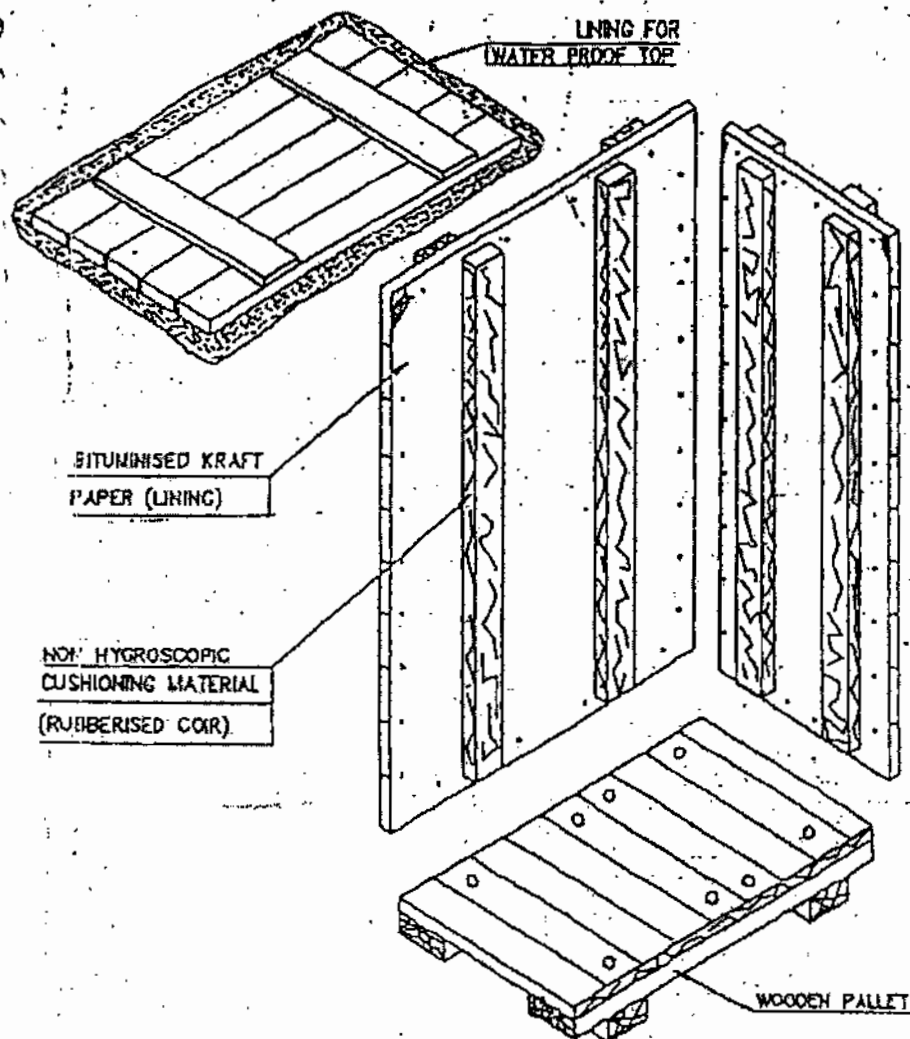
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**FIGURE-15**

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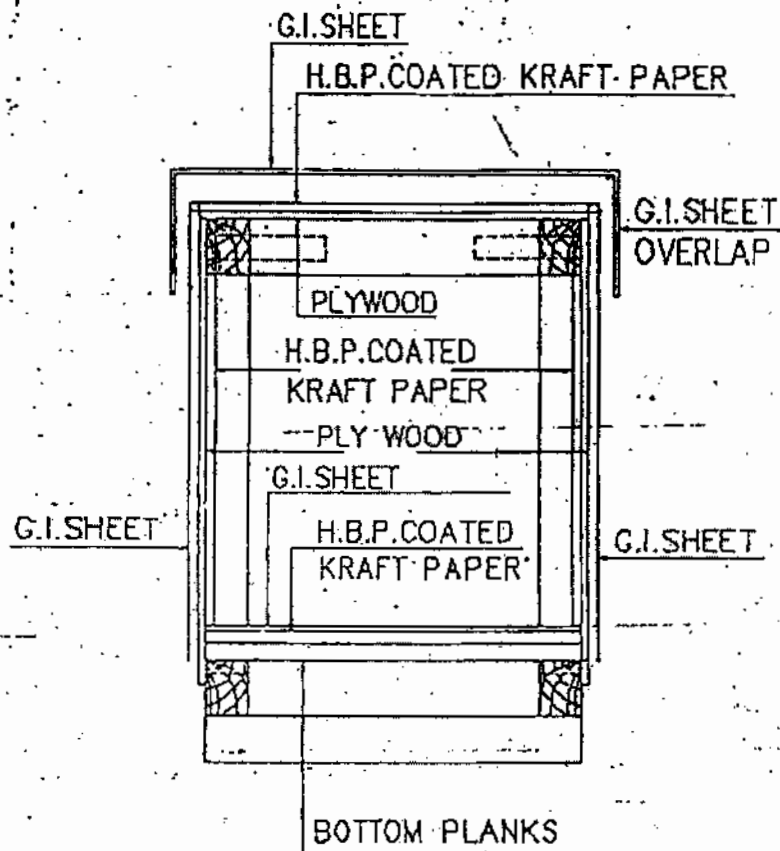


**FIG-16 : CLOSED PACKING CASE WITH G.I.SHEET
SHOWING LAYERS OF PACKING MATERIALS.**

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10.0 TYPICAL PACKING DETAILS/PROCEDURE FOR MECHANICAL ITEMS

10.1 INSULATION MATERIAL (MINERAL WOOL MATTRESSES)

This specification covers the requirements of seaworthy packing and marking for bonded mineral (rock) wool mattresses having metallic hexagonal wire netting as facing on one or both sides.

10.1.1 TYPE OF CONSTRUCTION

Mattress shall be packed in Polythene (of 0.2 mm thickness) all around and sealed to prevent moisture absorption during transit and storage. Further it shall be wrapped with Bitumen coated Polythene bonded/lined Hessian and stitched and then packed in 5 ply DFC carton box.

Silica gel is used for this purpose to protect contents over sufficiently long time from corrosion. Silica gel shall be of indicating type conforming to IS:304-1979 packed in cotton bags placed at different positions inside the packing for absorbing moisture and shall not come into direct contact with the material inside the package. The quantity of silica gel shall be enough for storage period of one year. However, it shall not be less than 4 gms per litre volume of case subject to minimum of 400 gms per case.

Each mattress as well as the packages shall be serial numbered. Also, printed sheets indicating the nominal thickness, density and wire netting details (i.e. material and size) shall be placed below the wire netting.

Following details shall be legibly written on the packages. The details shall also be typed on a sheet of paper & kept in a sealed Polythene cover, inside the packages

- Project Name
- Purchase Order No.
- Sl. No. of package
- Size of mattress (Thickness x Length x Width)
- Density
- Wire netting material and size
- Weight of the package

10.2 INSULATION MATERIAL (ALUMINIUM COIL)

Heavy Gauge Aluminium Coil Packaging are done by Eye-to-Sky packaging or by Eye to eye packaging as per the proven practice being followed by manufacturer of Aluminium sheets.

10.2.1 Type of construction for Eye to Sky packaging

- Strapping of coil with polyester strap around circumference at one place.
- Putting paper I. D. Edge protector.
- Wrapping the coil with VCI stretch film after putting silica gel bags (4 nos.) Inside the coil.
- Wrapping the coil with HDPE film.
- Covering the coil including its build up & bore with masonite / particle board.
- Putting metallic I. D on coil.
- Putting O.D edge protector (paper) on coil.

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- h. Putting circumferential polyester strap (3 nos.) & eye polyester strap (4 nos.).
- i. After placing the coil on coil tilter ply wood (10mm thick) of suitable size along with wooden pallet is to be put at the bottom side of the coil.
- j. Coil is to be tilted to eye-to-sky position.
- k. Final strapping with metallic strap to unit coil and skid at 2 places with top cover of plywood.
- l. Fixing the coil with wooden blocks at 4 corners.
- m. Labeling 2 nos.(one metallic & one adhesivetype) For specification, net wt. & gross wt.

10.2.2 Type of construction for Eye to Eye packaging

- a. Strapping of coil with polyester strap around circumference at one place.
 - b. Putting paper I. D. Edge protector.
 - c. Wrapping the coil with VCI stretch film after putting silica gel bags (4 nos.) Inside the coil.
 - d. Wrapping the coil with HDPE film.
 - e. Covering the coil including its build up & bore with masonite / particle board.
 - f. Putting metallic I. D on coil.
 - g. Putting O.D edge protector (paper) on coil.
 - h. Putting circumferential polyester strap (3 nos.) & eye polyester strap (4 nos.).
 - i. Placing of coil on wooden skid Coil is to be tilted to eye-to-sky position.
 - j. Final strapping of coil and skid at 2 places with steel strap. Fixing the coil with wooden blocks at 4 corners.
- Labeling 2 nos.(one metallic & one adhesive type) For specification net wt. & gross wt.

10.3 Packing Procedure for Online Tube Cleaning System and accessories

This procedure is applicable for the shipment of Onload Tube Cleaning System and accessories by sea.

10.3.1 Packing details:

- The Packing case shall be made of treated rubber wood. The design of the case shall be as per Annexure IIIA & IIIB.
- The Equipments shall be placed on the wooden base of the Packing case and fastened if required to arrest the movement of the same.
- Equipment shall be covered by Polythene sheet and inside wall surfaces of the wooden cases also shall be covered by polythene sheet.
- All Nozzles shall be closed with plywood dummies.
- All electrical components assembled or loose shall be covered with polythene sheets along with silica gel pack.
- Silica gel desiccants shall be kept inside each case in sufficient quantities in order to absorb the moisture.

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- Thermocol packing shall be made for glass items like Ball vessel sight glass, Vpiece
- sight glass & pressure gauge.
- Silica gel desiccants shall be kept inside of each case to absorb the moisture.
- A Packing list covered in a polythene envelope shall be fixed inside and outside of each packing case.
- Shipping marks and consignee address shall be painted on the outer surface of the case.
- All handling instruction required for the case like top, sling, rain, handle with care etc, shall be marked on the case as per the symbol attached.
- Machined surface will be applied with Anti rust oil and covered by polyurethane sheet to protect from external oxidation.
- All valves will be closed with dummies to protect the internals and placed in the wooden case which will covered by polyurethane sheet.

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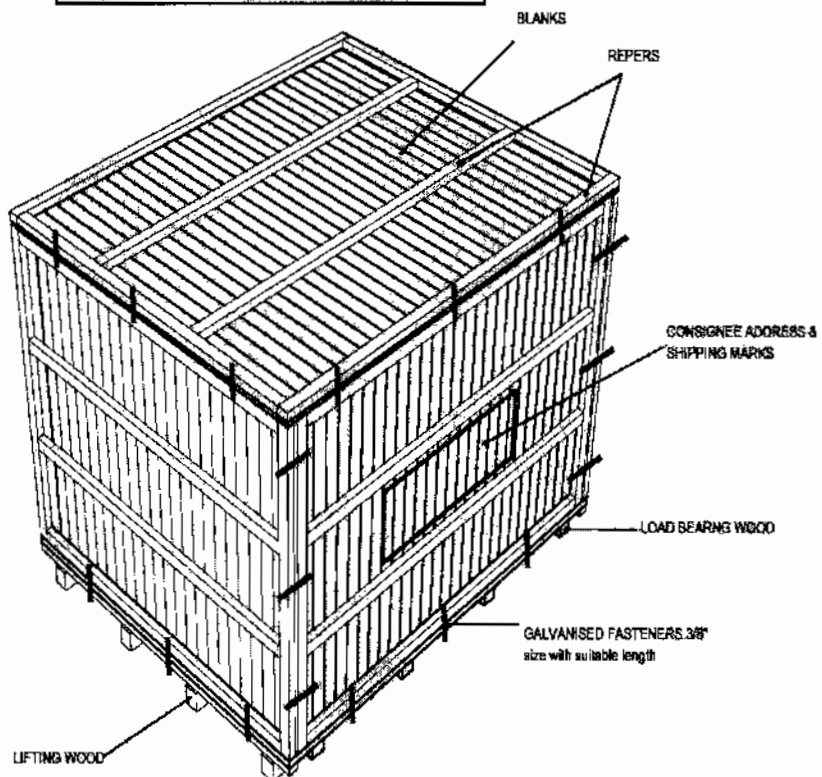
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**MODEL: FASTNERS TYPE (BASE, SIDE & TOP
ATTACHED WITH BOLT, NUT & WASHER)**

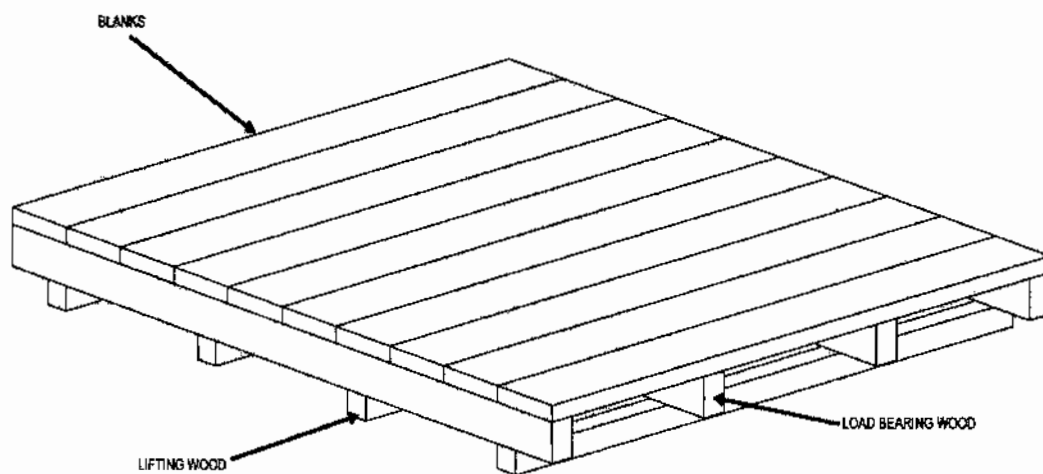
This Type of case to be used for
following items:

1. BALL SEPARATOR
2. BALL COLLECTOR SKID



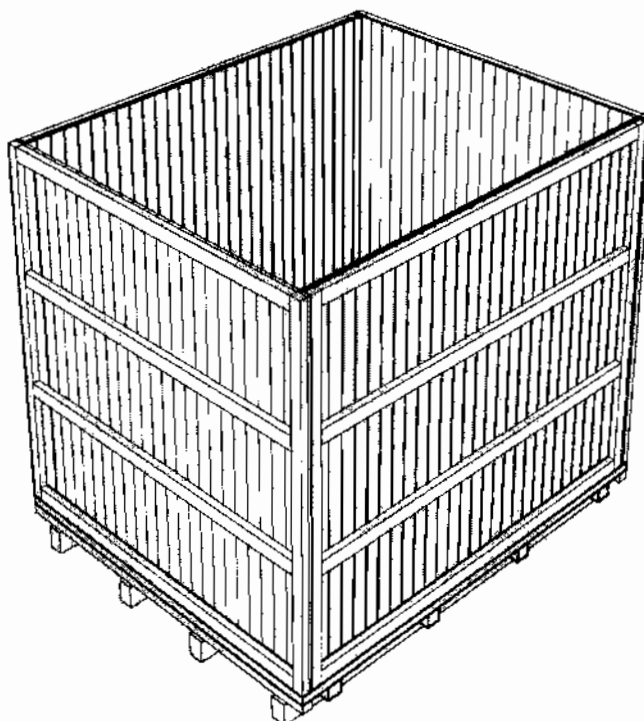
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BASE FRAME



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MODEL: FASTNERS TYPE - WITHOUT TOP





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MODEL: NAILING TYPE
FRAME & INSIDE REEFER NAILED

- THIS TYPE OF CASE TO BE USED FOR THE
FOLLOWING ITEMS:
1. PUMP SKID
 2. CONTROL PANEL
 3. EOODS ITEMS, TOOLS & TACKLES
 4. LIFTING GRM
 5. SPARES
 6. CLEANING BALLS
 7. CABLES & ACCESSORIES

Shipping marks & Consignee
Address

BLANKS

LIFTING WOOD

BLANKS

REEFERS

BLANKS

REEFERS

LOAD BEARING WOOD

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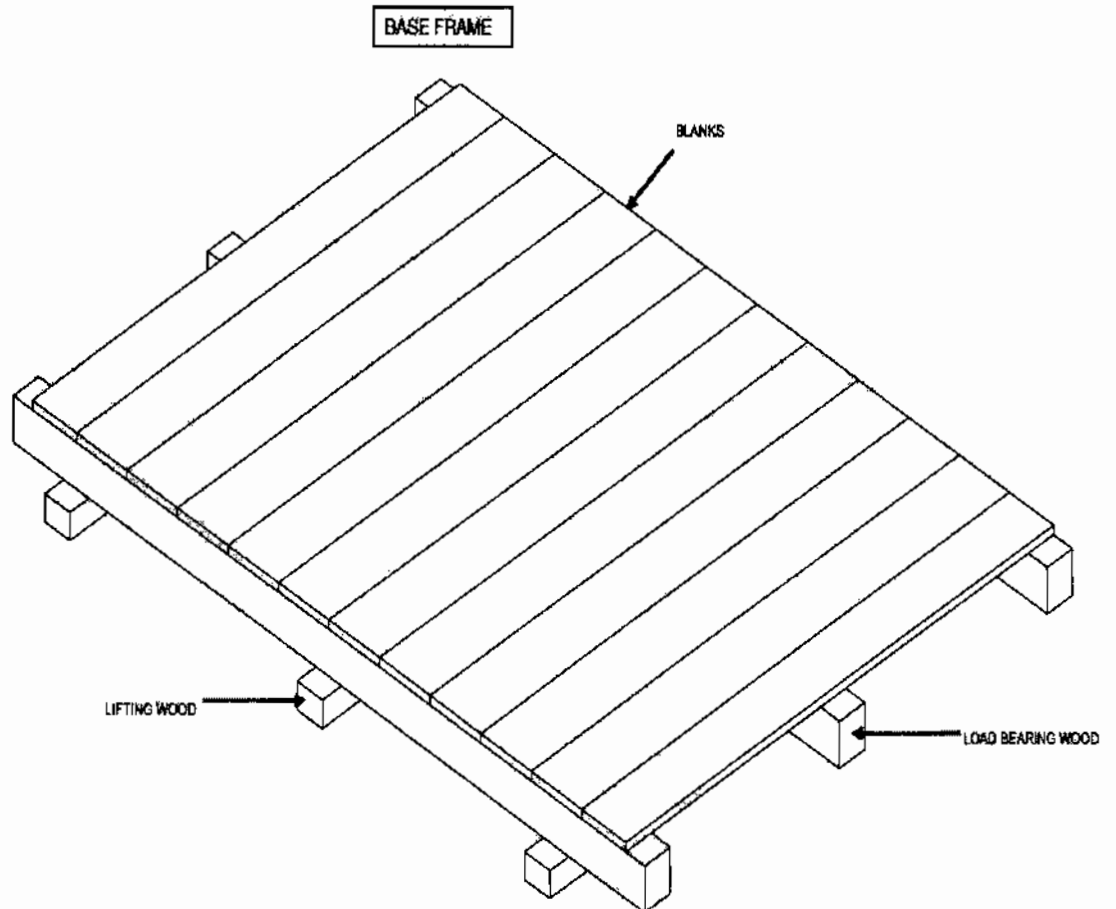
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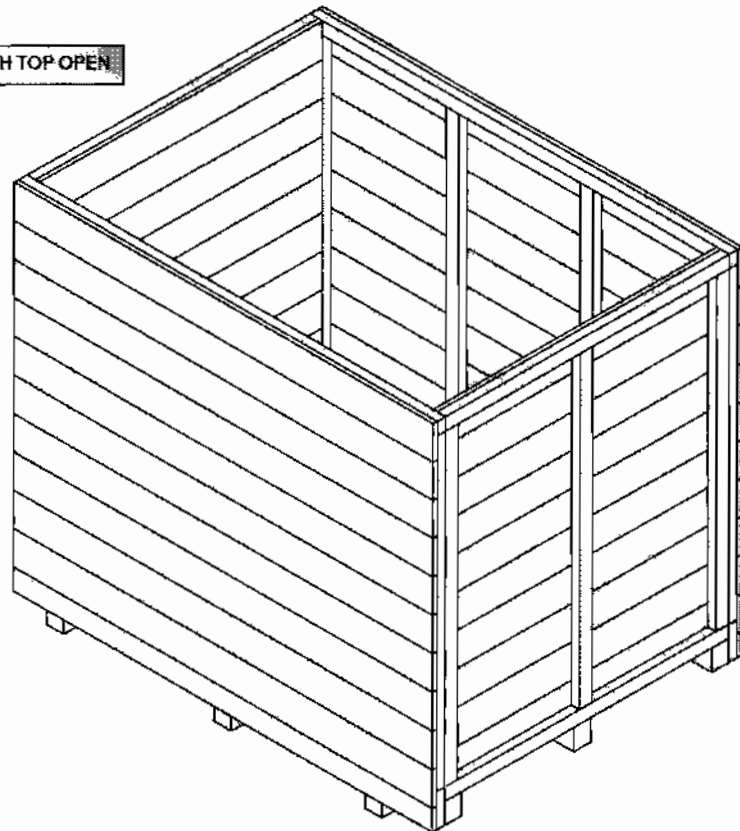
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NAILING TYPE MODEL WITH TOP OPEN

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10.4 PACKING OF LOOSE ITEMS

Loose mechanical, electrical and C&I items e.g. valves, fittings, pressure/temperature gauges/switches, circuit breakers, relays etc shall be individually wrapped using polyethylene sheets/U foam/ thermocol sheets/air bubble sheets depending upon the items and then packed in wooden boxes. The left out spaces and top of the boxes shall be filled with rubberized coir to get proper cushioning effect, Special attention shall be paid to relays, instruments etc for arresting the movements of their operating mechanism during transportation.

The construction of wooden packing cases shall be as per clause 9.3.1 retaining its all features concerning strength of the box. The construction of wooden packing case for electrical and C&I items shall be as per fig-16.

Inner surface of 6 sides of the box shall be lined with bitumen coated hessian polyethylene kraft paper. Rubberized coir of min. 25mm thickness and 100 mm width shall be nailed to inner surfaces of bottom and 4 sides of the boxes.

11.0 PACKING OF ELECTRICAL ITEMS

11.1 CABLES

11.1.1 Type of Equipment All type of cables..

11.1.2 Type of Construction

New or practically new cable drums made of steel and painted with epoxy resin paint are to be used. Cable ends are carefully protected before packing. Over the cables polyethylene sheet shall be wrapped and then sealed properly. Cable drum can be put in wooden crates for ease in transportation and handling. (Wooden cable drum is also acceptable, however vendor to furnish constructional details for approval).



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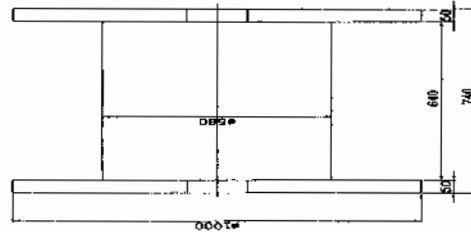
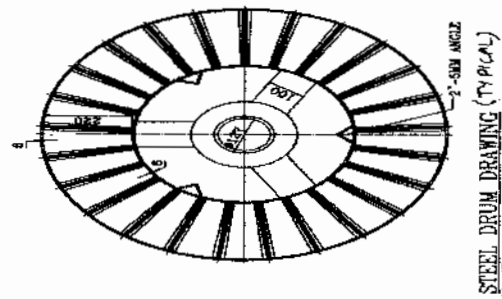
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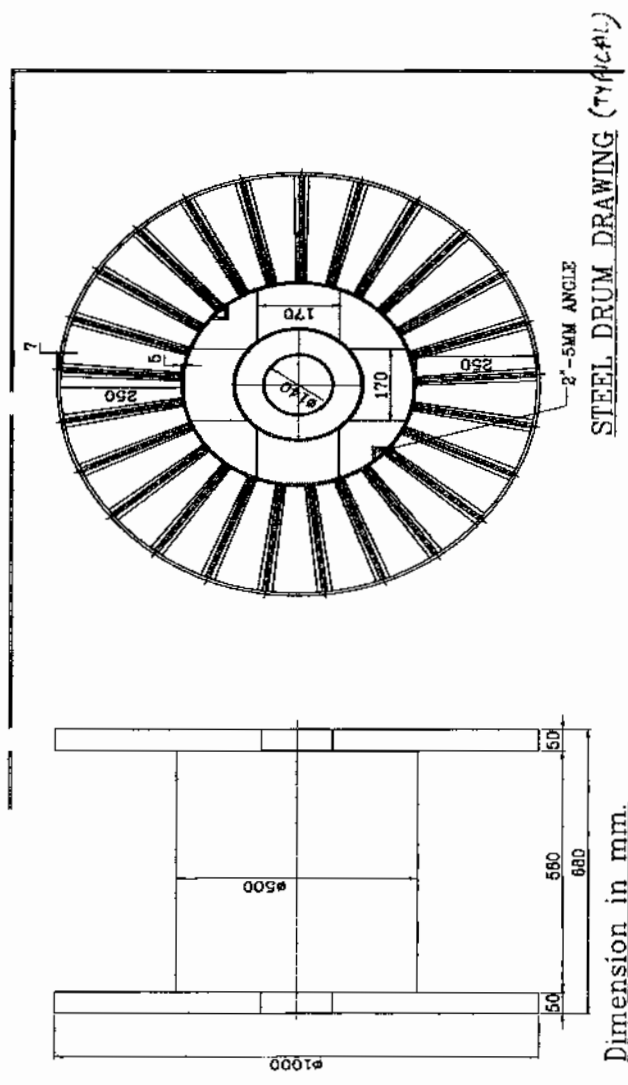
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Dimension in mm.

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11.2 PACKING OF CABLE TRAYS & ACCESSORIES AND CABLE TRAY SUPPORT MATERIAL

11.2.1 Cable trays can be packed in wooden boxes as per fig 1 to 11 or in steel boxes. Details of steel box construction is as indicated below.

- 1) All Dimensions are in "mm" unless otherwise stated.
- 2) Packing Box shall be fabricated using 50x50x6mm MS Angle, 50x3mm Flat, 2.5 mm thick C Channel, 1mm & 1.6mm Thick sheet.
- 3) Finish of Packing Box Shall be Galvanized.
- 4) Angle & Channel Section forming part of the Main frame shall be welded thoroughly with each other to give a rigid structure.
- 5) Sheet Section and Flat section shall be bolted/ Riveted/ Welded suitably to the Main frame stated in '4' above.

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- 6) Welding Portion on galvanized surfaces shall be painted with Zinc Rich Paint.
- 7) Dispatch details such as consignor/consignee address, contract and case details, 'country of origin, port of delivery, stacking instructions shall be written on one of the side of boxes. An anodized aluminium plate as per details and specifications given in page 3 of 5 shall be provided on the boxes
- 8) One copy of packing slip wrapped in polythylene bag covered with suitable aluminium .packing slip holder to be nailed on the external surface of the box. One more copy 9f the packing Slip wrapped in polythylene bag to be kept inside the box at the prominent place.
- 9) **INDICATION MARKS ON THE BOXES:** Markings shall be provided on the boxes indicating position of Boxes for handling, storage and nature of consignment. For guidelines referred page 4 of 5. The ink issued for this purpose as well as for marking dispatch instruction shall be indelible/non-washable marking ink.
- 10) Each item as mentioned in BOQ shall be packed & supplied as a set comprising of required numbers of associated fasteners & hardware etc



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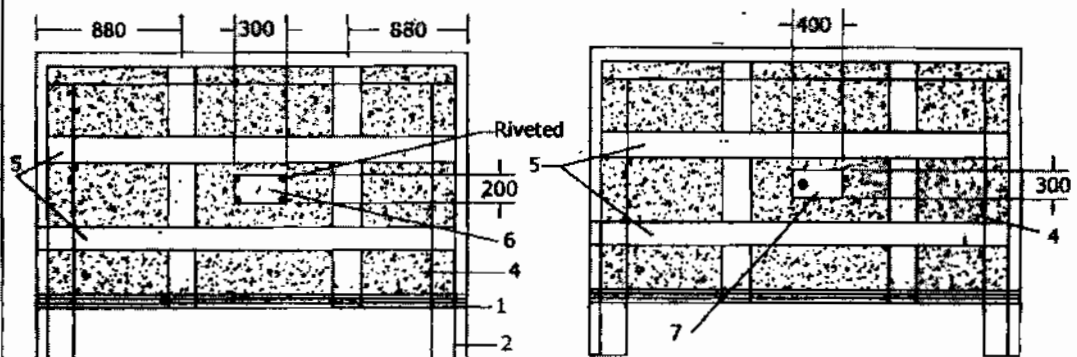
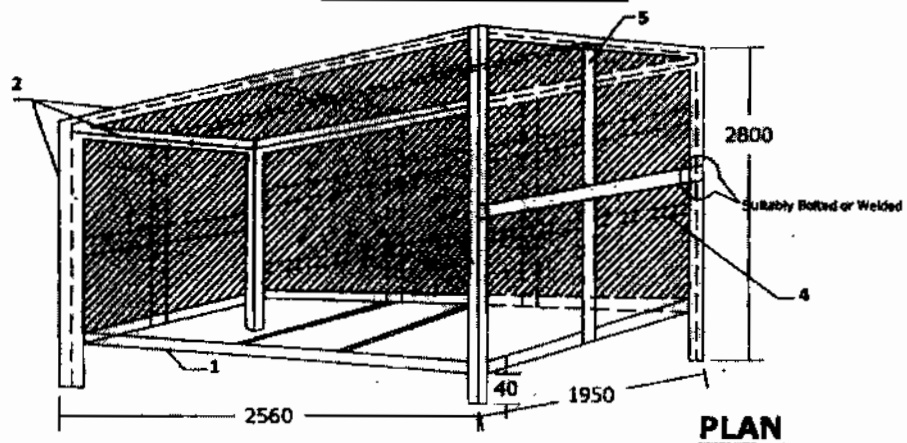
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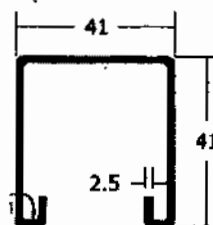
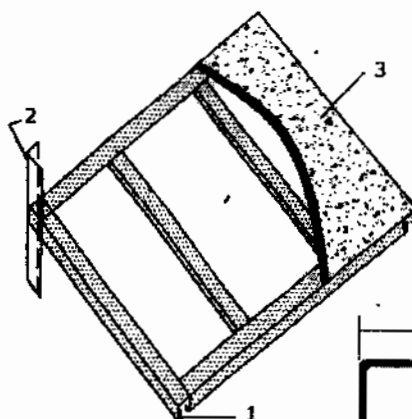
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STEEL PACKING (TYPICAL DETAILS)



Note:

1. "C" Channel to be used on Bottom Frame.
2. 50x50x6 Angle to be used Vertically on four sides of the Box and Horizontally on four sides on the top Frame.
3. 1.6mm thick sheet (plain) on Bottom Plate.
4. 1.0mm thick sheet to cover top & four sides of BOX.
5. 50x3 Flat as additional cross members to be used Horizontally & Vertically on top & Four Sides of Box.
6. Anodised Aluminium Plate for Marking.
7. Hinged Inspection Window.



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11.3 PACKING FOR STATION LIGHTING SYSTEM

Aspects of packing specific to equipments / items of station lighting system are given here. All other instructions / aspects as per the main specification of export packing which are not covered here shall also be applicable.

11.3.1 For LIGHTING TRANSFORMER, DISTRIBUTION BOARDS, LIGHTING PANELS,

- Construction of packing case for LIGHTING DISTRIBUTION BOARDS, LIGHTING PANELS, TRANSFORMER . shall be EITHER as per FIGURE 1,2,3,5,6,7,8,9,10,11 OR FIGURE 14,15,16.
- Each Panel/Transformer shall be individually covered with double polythene sheet of thickness 175 microns minimum.
- All the 6 inner surfaces of packing shall be nailed with bitumen coated hessian polythene craft paper. Wherever 2 pieces of craft paper are used, the joint shall have minimum overlap of 20mm.

For the top frame it shall be project on all sides by 100mm and shall be nailed on sides .

- The gap between the panels and packing case shall be filled with rubberized coir of thickness 50mm minimum and width 100mm. The distance between two consecutive supports of rubberized coir shall be less than 500mm.
- Silica get packed in cotton bags shall be placed at different positions inside the packing.
- Packing case shall be finally covered with GI sheet of thickness 0.4mm minimum.

11.3.2 For LUMINARIES, RECEPTACLES. EMERGENCY LIGHT, 240/24V TRANSFORMER, CEILING FAN, SWITCH BOARDS, FLEXIBLE CONDUIT, WIRES, EARTH WIRE. JUNCTION BOXES, ERECTION COMMISSIONING SPARES, RECOMMENDED SPARES , ERECTION MATERIAL AND CONSUMABLES

- Construction of packing case for THE ABOVE MATERIAL shall be as per FIGURE 1to11.
- Items placed inside the case shall be covered with double polythene sheet of thickness 175 microns minimum.
- All the 6 inner surfaces of packing shall be nailed with bitumen coated hessian craft paper. wherever 2 pieces of craft paper are used, the joint shall have minimum overlap of 20mm. For the top frame it shall be project on all sides by 100mm and shall be nailed on sides.
- Silica get packed in cotton bags shall be placed at different positions inside the packing.

11.3.3 For CONDUIT PIPE

As per international practice pipes are shipped in open bundles with metal strapping. Packing as per attached figure A shall be provided which is described as following:

- Each bundle shall be wrapped with 2 layers of 175 microns thick polythene sheet.
- Then bundle will be wrapped with bitumen coated hessian craft paper.
- Bundle shall be strapped with steel straps.
- An anodized aluminium packing description plate as per Figure No. 13 shall be provided.

11.3.4 For POLES

Poles will be wrapped with 2 layers of minimum 175 microns thick polythene sheet and then with bitumen coated hessian craft paper, packed as per Figure – C i.e. bundling.

11.3.5 For STRUCTURAL STEEL

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Structural steel will be different sizes and shapes. Hence it will be packed as per Figure No. B and described as following :

- a) Each bundle shall be wrapped with 2 layers of 175 microns thick polythene sheet.
- b) Then bundle will be wrapped with bitumen coated hessian craft paper.
- c) Bundle shall be strapped with steel straps.
- d) An anodized aluminium packing description plate as per Figure No. 13 shall be provided.

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PACKING PROCEDURE FOR CONDUIT PIPE

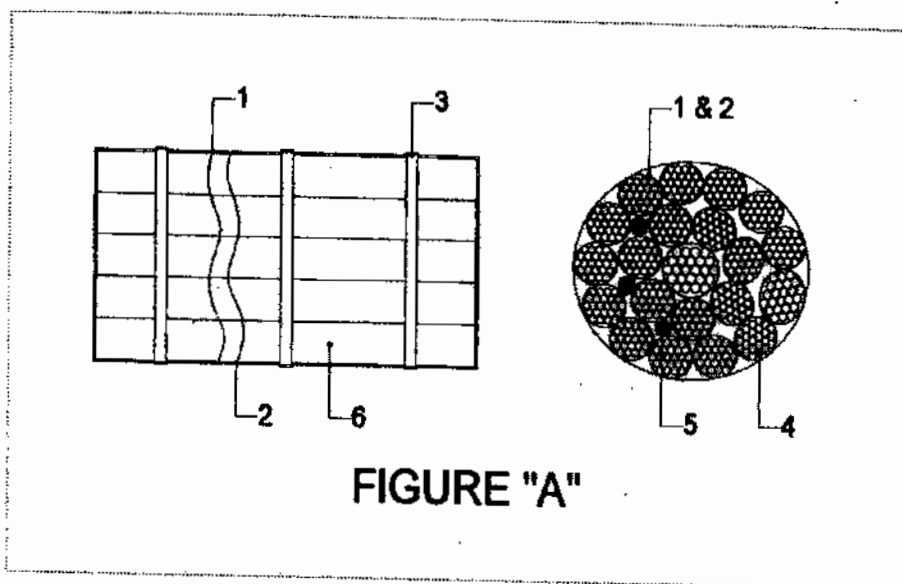


FIGURE "A"

- 1) LAYER OF BITUMEN COATED HESSIAN KRAFT PAPER.
- 2) LAYER OF POLYTHENE SHEET.
- 3) METAL STRAPPING.
- 4) CONDUIT PIPES.
- 5) SILICA GEL POUCHES.
- 6) BUNDLES OF CONDUIT PIPES.

**TITLE****TECHNICAL SPECIFICATION
FOR SEAWORTHY PACKING
FOR EXPORT JOBS**

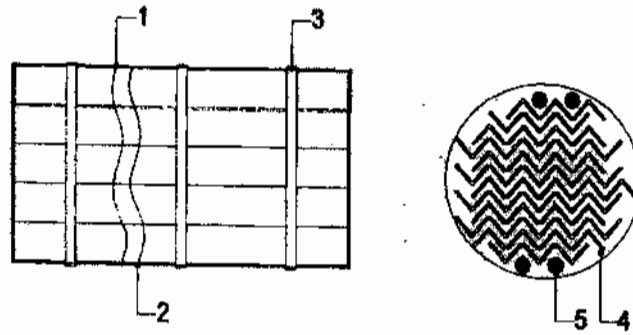
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PACKING PROCEDURE FOR STRUCTURAL STEEL**FIGURE "B"**

- 1) LAYER OF BITUMEN COATED HESSIAN KRAFT PAPER.
- 2) LAYER OF POLYTHENE SHEET.
- 3) METAL STRAPPING.
- 4) STRUCTURAL STEEL.
- 5) SILICA GEL POUCHES.



TITLE

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FOR SEAWORTHY PACKING
FOR EXPORT JOBS

SPECIFICATION NO. PE-TS-888-100-A001

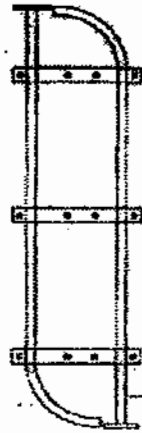
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packing procedure for poles



POLES WRAPPED WITH POLYETHYLENE SHEET &
STRAPPED WITH COATED HESSIAN CLOTH



TOP WOODEN BATTEN TO BE
FIXED WITH LOCKBOLTS MIN ON TOP
OF IT FOR TIGHTENING THE ROD
25 MM DIA



BOTTOM WOODEN BATTEN TO BE
FIXED ON UPWARD 90° ANGLE

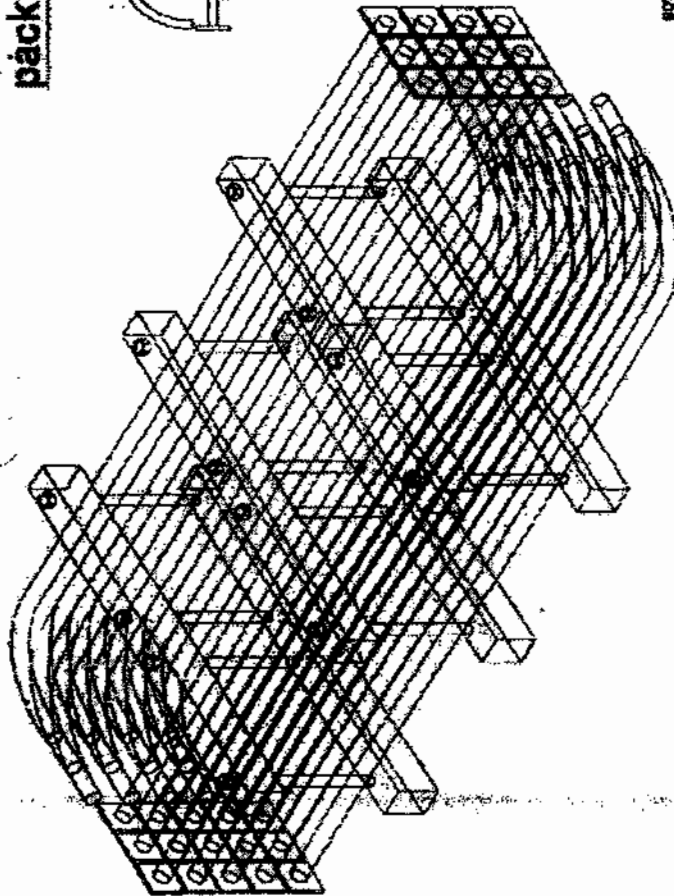


FIGURE "C"

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11.4 PACKING FOR DC BATTERY

The packing procedure for seaworthy packing of DC Battery is defined below, which is capable of withstanding impacts, compression, vibration, toppling, sea water spray, prevention against rust, temperature and extreme atmospheric conditions. Aspects of packing specific to equipments / items of DC Battery are given here. All other instructions / aspects as per the main specification of export packing which are not covered here shall also be applicable.

The packing procedure consists of various stages namely primary packing, cushioning, securing, desiccant, outside packing box, Runners/ sliders/ transverse bars of plywood, etc., provided for each movement.

- a) The packing boxes shall be made up of plywood boxes (thickness 9mm min.) with blocks at the bottom of the box for provision for handling the boxes using the forklift. The packing boxes sizes are generally standardized to half-euro size (capable of handling equipment's weight).
- b) Rubberized coir of 25mm thickness shall be provided as cushioning material at the bottom and thermocole of 20mm shall be provided inside on all four sides. Other than this polyethylene film wrap or cover also will be provided. Left out spaces to be filled with rubberized coir/ thermocol to get cushioning effect.
- c) Silica gel in dust free air permeable cotton/paper bag shall be placed in the packing boxes for storage period of 1 year as per IS 304 (1979)
- d) While packing the cells, transit caps (polypropylene) of red and blue shall be used for big size cells for ensuring that cells does not get damaged during the transport due to vibrations etc.
- e) The battery accessories shall be packed with suitable precautions as follows:
 - i) Copper connectors shall be packed after making bunches with lead wire seals to avoid misplacement.
 - ii) Hardware items shall be packed in polyethylene bags (Thickness $\geq 0.175\text{mm}$) with item slip
 - iii) Battery rack shall be packed in dismantled condition, wrapped with polyethylene sheet
 - iv) For Ni-Cd type battery, electrolyte in solid form for dry cells shall be packed in cans with KOH, LiOH being packed separately.
 - f) Galvanized Steel straps are provided for binding the packing box sides.
 - g) The handling instructions shall be marked in indelible/ non-washable ink, indicating the upright position.

11.5 PACKING OF SERVICE TRANSFORMERS(OIL FILLED) & ACCESSORIES

This instruction is applicable for packing of transformers (oil filled), its accessories and components so as to ensure safe delivery to end user. Aspects of packing specific to equipments / items of transformers(oil filled) are given here. All other instructions / aspects as per the main specification of export packing which are not covered here shall also be applicable.

11.5.01 PACKING DETAILS :

- a) Items shall be packed in case / crates as per the shipping list.
- b) All fragile items and small items shall be packed in cases and to be marked as "Fragile, handle with care Fragile items".
- c) Fragile accessories are to be first packed in their original boxes (VENDOR's packing). Very

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- d small / delicate items such as glass thermometer, door keys shall be packed in separate box.
- d In case original box is found damaged, suitable alternate box or packing method using felt or foam sheet and polythene wrap to be used.
- e These boxes are then placed in identified wooden boxes. Inside of such boxes are lined with a layer of polythene sheet, packing wool / grass and another layer of polythene sheet before placing the boxes. All boxes are then wrapped with this polythene sheet before closing the box. Fragile items shall not be placed loose, one above the other inside the case.
- f All wiring cables, connection flats of non-ferrous materials, CTs, valves bellows shall also be packed.
- g Items like CTs, Oil communicating bushings, insulators, wired equipments and housings such as RTCC Panel, M. Box, Drive Mechanism, thermometers, gauges shall be wrapped in polythene from all around.
- h Buchholz relay and OSR relay openings will be blanked using covers, before putting them in the box
- i Items shall be carefully lowered and arranged inside the crate / case and each item shall be locked from all sides in such a way to avoid its movement in any way. Wooden stoppers and separators shall be provided for this and nailed to the crate / case wood.
- j Wooden planks and batons in contact with fragile items shall be provided with kit foam at the locations of contact.
- k Oil communication bushings shall be packed in separate case on V or U shape wooden felted supports, as in case of condenser bushings.
- l While placing and arranging the items inside the crates / cases, these shall be verified for correctness and then the packing note shall be signed. The cover top of the crate / case shall then be closed.
- m The main equipment like transformer tank shall be packed suitably to prevent any damage during transit / storage. Support structures like frame, header supports etc. shall be crated. Conservator headers shall also be crated. Radiators pipe work and other instruments & components shall be packed in cases. All the cases shall be lined with polythene from inside.

11.6 ALTERNATIVE PACKING CASES FOR CONTROL PANELS AND SWITCH GEARS

For Control and switch gear panels, construction of wooden packing cases may be provided as per fig 14 & 15 and as detailed below.

Thickness of planks for all sides, binding and jointing battens shall be at least 25 mm. Width of the plank shall be at least 125mm and that of binding and jointing planks shall be at least 100mm.

Top frame shall be suitable so that it does not collapse due to sandwiching between slings while lifting. Longitudinal and traverse bars for the bottom wooden pallet to be suitably selected.

Diagonal bracings shall be as per cl 9.3.1.3 and all other requirements shall be as per clauses 9.3.1.4 to 9.3.1.6.

12.0 Containerization

As required by BHEL, the VENDOR shall stuff the GOODS into 20 or 40 foot containers (dry, open top, flat racks, etc.).

The maximum inside dimensions of containers are to be considered:

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- 40 foot containers: 11.80 m x 2.20 m x 2.05 m
- 20 foot containers: 5.80 m x 2.20 m x 2.05m
-

The present definition of containerization is valid for sea containers only. Vendor to check the size of containers before start of packing of equipment.

12.1 Protection of Cases/Crates

Since shipping containers are in general not water tight, packing in contact with the floor of the container shall be raised in order to prevent it from being damaged by the accumulation of water.

12.2 Mechanical Constraints

The mechanical constraints for "general use" closed containers are of a different nature (height of "stacking" being limited inside the containers), the packing for the GOODS may be of a lighter structure. However, it is necessary that the packing be appropriate so as to protect the GOODS on site during the storage period, as required after discharging of the GOOD'S from the containers.

Note:

It is the responsibility of the VENDOR to ensure that the cases/crates are stowed, secured and fastened inside the container. The VENDOR will take all necessary precautions to conform to the maximum weight allowed and the centre of gravity of the container. The securing and fastening of the cases/ crates can be carried out by nailing timbers on the bottom or on the vertical sides of the container.

13.0 Other Services to be provided by Vendor

In addition to the packing and shipping documents, VENDOR must also carry out the following services, which shall be included in his quotation:

Carriage of VENDOR's sub-contracted equipment and material, which must be re-grouped in VENDOR's or PACKER's workshops, whilst waiting for packaging.

BHEL reserves the right to postpone the shipping of the GOODS. In this event, any storage and insurance costs during the first ninety (90) days shall be borne by the VENDOR.

Loading, including lifting, securing, lashing, and stowing, of all cases, crates, or packages onto means of transportation such as, but not limited to, trailers, containers, etc.

14.0 Responsibilities and Guarantees

VENDOR is responsible for the choice of category for packing according to the transport facilities used, and on the basis of the present document. In case of doubt or disagreement regarding the choice, VENDOR must inform BHEL prior to packing and await BHEL's approval. All phases of packaging, marking, loading, etc. will be subject to BHEL inspection.

BHEL reserves the right to reject the packing when the packing does not conform to these instructions and/or when the packing does not ensure perfect protection of the GOODS. VENDOR is responsible for the weights and dimensions declared, and the marking of the packages.

The documents must be in strict conformity with the packing contents.

The packing specified in these "Packing, Marking and Shipping Instructions" is guaranteed for a twelve (12) months storage period after delivery on site.

VENDOR is responsible for providing storage recommendation adapted to the GOODS. According to this guarantee, VENDOR is held responsible in the event of goods becoming

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useless, damaged or broken, as a result of poor packing and/or stowing, or due to corrosion, subsequent to insufficient or inadequate protection. All direct or indirect costs resulting thereof, will be back-charged to VENDOR.

MANDATORY SPARES LIST FOR NTPL FGD PROJECT

INDEX No.	Sl. No.	Equipment/Package Name	Quantity to be supplied	REMARKS
187	25	Other Horizontal Centrifugal Pumps (for each type & size)		
188		i) Impeller	1 No.	As Applicable
189		ii) Casing	1 No.	As Applicable
190		iii) Shaft	1 No.	As Applicable
191		iv) Shaft sleeves	1 Set	As Applicable
192		v) Impeller/ casing liner	1 No.	As Applicable
193		vi) Seals	1 Set	As Applicable
194		vii) Pump & motor bearing	2 Set	As Applicable
195		viii) Gear box	1 No.	As Applicable
196		ix) Pump- motor coupling	1 No.	As Applicable
215	29	Hydro Cyclones (for each type & size)		
216		i) Hydrocyclones	1 Set	Applicable
217		ii) Feed vessel	1Set	Applicable
218		iii) Lining for vessel	1 Set	Applicable
219		iv) Complete vessel assembly	1 No.	Applicable
220		v) Valves	1 Nos. of each type & size	Applicable
221		vi) Pressure gauge	1 Nos.	Applicable
222		vii) Measuring nozzle	1 Set	Applicable
223		viii) Flanges for cycles	1 Set	Applicable
224		ix) Over flow & underflow pipes and	1 Set	Applicable
225		x) Filters	1 Set	Applicable
226		xi) Vortex finder and apex inserts	1 Set	Applicable
227	30	Vacuum Belt Filters		
228		i) Filter Cloth (Shall be for cumulative 8000 Hrs)	1Nos.	Applicable
229		ii) Belt (if applicable)	1 Sets.	Applicable
230		iii) Vacuum Box Seals	1 Nos.	Applicable
231		iv) Drive Motor (if applicable)	2 Sets.	Applicable
232	31	Vacuum Pumps		
233		Pump Impeller Assembly	1 no.	Applicable
234		Pump Bearings	1 Set	Applicable
235		Motor Bearings	1 Set	Applicable
236		Seals	1 Set	Applicable
237	32	Vacuum Breaker Valves		
238		Valve Assembly	1 no.	Applicable
239		Actuator	1 no.	Applicable
253	35	Other Valves		
254		i) Complete valves for each type and	2 Sets	Applicable
255		ii) Seat, disc, spindle with nut for each type	2 Sets	Seat Not applicable as it is welded to the body
256		iii) Diaphragms for each type and size of diaphragm type valves	5 Sets	Applicable
257		iv) Flats of each type and size of nonreturn valves	1 Set	Applicable
833	22	Local Control Station		
834	22.1	Local Control Station Complete Set for all type of drives	2 nos for each make, type and rating	As applicable
835	22.2	Push button complete set	5 nos for each make, type and rating	As applicable
1091	9	Local Control Panel and accessories		
1092	9.1	Selector switch & indicating lamps	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model	As Applicable
1093	9.2	Mosaic/Conventional Type Push button Station	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model.	As Applicable
1094	9.3	Mosaic Type Push button Station with LED Indication	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model.	As Applicable
1095	9.4	Mosaic Type LED Indication Station	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model.	As Applicable
1096	9.5	Indicator / Recorder (as applicable)	1(one) No. each	As Applicable



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME : II-D

SECTION - I

PIPING, VALVES AND SPECIALTIES



Development Consultants Pvt. Ltd.

**Vol. II-D/Section-I
Piping, Valves & Specialties**



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VOLUME : II-D

SECTION-I

PIPING, VALVES AND SPECIALTIES

1.00.00 INTRODUCTION

This section covers technical requirements of all piping, associated valves and specialties that include but is not limited to the following systems.

1.01.00 Slurry Piping – shall consist of all Slurry piping within the Flue Gas Desulphurisation system such as Limestone slurry, Gypsum slurry, etc

1.02.00 Process Piping – shall consist of various categories of piping as required for operation of the FGD Plant.

1.03.00 Service Air System - shall consist of distribution of Service air for general housekeeping terminated at hose valves at buildings/ facilities of the FGD Plant.

1.04.00 Instrument Air System - shall consist of distribution of instrument quality air to pneumatically operated instruments/ valves/dampers of the FGD Plant.

1.05.00 Service water system (clarified quality) from Terminal Points to Storage tank and subsequent distribution points for process use.

1.06.00 Drinking Water System - from Terminal Point to auxiliary buildings included under FGD package.

1.07.00 Fire water system - from Terminal Points to distribution points for emergency cooling.

1.08.00 Demineralised Closed Cycle Cooling Water System – from Terminal points to and from equipment coolers within FGD Plant.

1.09.00 Waste water – shall consist of waste water generated in the FGD Plant upto Terminal point.

1.10.00 Any other low pressure piping as found necessary during detail engineering stage shall also be included.

2.00.00 CODES AND STANDARDS

2.01.00 In addition to the requirements spelt out in Volume IIA (Lead Specification), Section-V, of this specification, the design, manufacture, inspection and testing of the piping, fittings, valves and specialties covered under this specification shall conform, in general, to the standards and codes (latest edition) mentioned below :

2.01.01 IS-1239 : Mild steel tubes, tubular and other wrought steel fittings.
[Part-I & II]



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

2.01.02	IS-3589	:	Electrically welded steel pipes for water, gas and sewage (150 to 2000 mm nominal diameter).
2.01.03	IS-554	:	Dimensions for pipe threads where pressure tight joints are required on the threads.
2.01.04	IS-1363 [Part-I & II]	:	Hexagonal head bolts, screws and nuts (size range M5 M36)
2.01.05	IS-1364	:	Precision and Semi-precision hexagon bolts, screws, nuts and lock nuts (diameter range 6 to 39 mm).
2.01.06	IS-3138	:	Hexagon bolts & nuts (M42 to M150).
2.01.07	IS-5312	:	Swing check type reflux (non-return) valves.
2.01.08	IS-2379	:	Colour code for the identification of pipelines.
2.01.09	IS-2016	:	Plain washers.
2.01.10	IS-2712	:	Compressed asbestos fibre jointing.
2.01.11	ANSI B-16.5	:	Steel pipe flanges and flanged fittings.
2.01.12	ANSI B-16.9	:	Wrought steel Butt welding flanged.
2.01.13	ANSI B-16.11	:	Forged steel fittings, Socket-welding and Threaded.
2.01.14	ANSI B-16.34	:	Steel Valves - Flanged and Butt Welding Ends
2.01.15	ASME B-36-10	:	Welded & Seamless Wrought steel Pipe
2.01.16	ASME B 36-19	:	Stainless Steel Pipe
2.01.17	ANSI B-36.10	:	Steel pipes thickness.
2.01.18	ANSI B-31.1	:	Code for Pressure Piping - "Power Piping".
2.01.19	IBR	:	Indian Boiler Regulations, with latest amendment.
2.01.20	API-600	:	Steel gate valves.
2.01.21	BS-2633	:	Class I Arc welding of ferrite steel pipe work for carrying fluids.
2.01.22	BS-534	:	Specification for steel pipes and specials for water and sewage.
2.01.23	BS-5351	:	Specification for Ball valves.
2.01.24	AWWA-C-504	:	Specification for Butterfly valves.





- 2.01.25 AWWA-C-208 : Dimension for fabricated steel water pipe fittings.
- 2.02.00 Other international codes and standards may also be offered by bidder. However, same may be subject to acceptance by the Owner/Consultant.
- 3.00.00 **SCOPE OF SUPPLY AND SERVICES**
- 3.01.00 The equipment and materials to be supplied under this section shall include but not be limited to the following:
- a) Supply of all low pressure piping including bends, elbows, tees, branches, laterals, crosses, reducing union, couplings, caps, saddles, shoes, flanges, blank flanges, Y-pieces etc. as required for the piping system under the scope of this section.
 - b) Matching pipes, matching pieces like reducers/expanders etc., counter flanges with bolts, nuts, washers, temporary and permanent gaskets, threaded union etc. for all terminals of other packages as required.
 - c) Supply and machining work of flanges, pipe spools and matching pipes to connect flow measuring orifices/nozzles with the main pipe work.
 - d) All isolating and regulating valves, non-return valves, steam/air traps, relief/safety valves (wherever applicable), strainers, pressure reducing orifices etc. complete with the counter flanges and matching connecting pieces as required within the terminal points of entire low pressure piping system.
 - e) Anchors, hangers and supports, etc. as required. Any platform necessary for maintenance and operation of valve and equipment located 1.5 m above any permanent floor or platform with access ladders, supporting structures etc.
 - f) All secondary structural steel members required for pipe supports from building steel structures and from embedded steel wherever provided including pipe supports in trenches. However, trench piping should be avoided to the extent possible.
 - g) Funnels, tundishes for drips and drains including all miscellaneous drain piping and drain piping from tundish outlet up to drain points. All drain and vent lines shall be conveniently terminated to floor drain points/permanent drain trenches.
 - h) Flanges, counter flanges, blank flanges, bolts, nuts, washers, temporary and permanent gaskets, fasteners caps etc. as required for interconnecting piping, valves & fittings as well as for terminal points.
 - i) Cleaning and Painting of all piping, valves & specialties at manufacturer's shop.
- 3.02.00 Following general requirements shall however be included:



- a) Instrument Connections including instruments, root valves, sensing lines etc.
- b) Pipe stubs and blanking plates etc. required for chemical cleaning and hydro testing.

For conducting acceptance test, the required pressure, temperature, flow measurement points shall be provided.

3.03.00 All miscellaneous instruments as per approved P &ID during detail engineering stage.

3.04.00 For details regarding Scope of Services and works, Lead Specification Volume-IIA of this specification shall be referred.

3.05.00 **Terminal Points**

For terminal points, refer Volume-IIA (Lead Specification), Section-IV, of this specification.

4.00.00 **DESIGN AND CONSTRUCTION**

4.01.00 **General Considerations**

4.01.01 The piping systems included in this section shall be designed to operate continuously without replacement during the plant service life of 30 years.

4.01.02 The piping system shall be complete in every respect and in accordance with the highest standard of workmanship. Any item of the section on which the Bidder is in doubt shall be referred to the Owner for clarification.

4.01.03 All design and fabrication shall be in accordance with Codes / standards as specified.

4.01.04 No pipe work shall be run in trenches carrying electrical cables.

4.01.05 Pipe size above 50 NB shall be shop fabricated and of size 50 NB and below shall be field run.

4.01.06 All piping shall be identified by means of colour strips and by adequate lettering, conveniently spaced and located. Identification colours and lettering shall be as approved.

4.01.07 Air release and drain branches shall be provided wherever necessary depending upon the layout and arrangement so that the drains and air release valves are located for easy operation.

4.01.08 Unless otherwise specified, all pipe work shall be suitable for a minimum pressure of 10.0 kg/sq. cm(g) at 80°C or as required by the design of the different piping system, if higher.



4.01.09 **Drain Pipe work**

- a) Low pressure drains shall have an isolating valve at the point of take-off from the pipe or vessel to be drained, or as near as possible for conventional operation.
- b) Unless otherwise stated, all drain piping shall be of 25 mm NB minimum and all vent pipings shall be of 15 mm NB size minimum. For pipes up to 50mm NB, pipe wall thickness shall be as per schedule 80 of ANSI B36.10.
- c) Unless otherwise stated, wherever a main or branch of any pipeline is terminated with a valve, such terminal valve shall be provided with a blank flange/blanking cap at the free end.

4.01.10 Specification of pipes used in different services included in the L.P piping section has been detailed in Annexure-I of this section.

4.02.00 **Material Specification**

4.02.01 Materials for pipes and fittings shall be as stipulated in Annexure-I of this section. In case bidder wants to offer alternative piping material, same may be accepted by the Owner/Consultant provided the offered material is superior than the material specified for the intended service.

4.02.02 Pipe attachments for supports, anchors and restraints, which are coming in direct contact with pipes shall have similar materials as the piping concerned. All other materials of supports, anchors and restraints shall be of tested quality and as per manufacturer's standards.

4.03.00 **Fabrication**

All pipes above 50 NB shall have butt-welded connections as per ANSI B 16.25 with a minimum of flanged joints necessary for maintenance. Piping of sizes 50 NB and below shall have socket welded connections as per ANSI B 16.11. Where flanges are adjacent to welded fittings, weld neck flanges shall be used.

Branches shall, in general, be formed by welding. Standard fittings may be used in positions and for sizes where approval has been given in detail drawings. Pipe bends and tees shall be truly cylindrical and of uniform section. all welded branches shall be reinforced where needed as per the applicable codes/regulations.

4.03.01 Piping shall be fabricated in the shop in the largest transportable sections to minimise the number of field weld joints. The choice of field weld joints locations shall be based on the traverse of the pipe through walls, floors, sleeves or other restrictive areas. Support attachments for major piping shall be done at shop.

4.03.02 All pipe bends shall be made true to angle with no negative tolerance and shall have a smooth surface free of flat spots, crease and corrugations. A cross section through any bent portion of the pipe shall be true in diameter, within



plus or minus 3% of the pipe diameter. Pipe bends shall be made from straight pipe pieces of sufficiently higher thickness so that after thinning, the minimum thickness of bends shall not be less than the minimum thickness required for the straight pipe. Thinning allowance shall be considered as per the relevant Code.

4.03.03 For bends in pipes straight piece of pipes shall be bent by the Bidder to required bend radius. However, forged bends (Bend radius = $1.5 \times$ pipe diameter) wherever required shall be provided at no extra cost.

4.03.04 The ends of Pipe and welded fittings shall be beveled according to details shown in the relevant piping code. All welding shall be made in such a manner that complete fusion and penetration are obtained without an excessive amount of filler metal beyond root area. The reinforcement shall be applied in such a manner that it shall have a smooth contour merging gradually with the surface of adjacent pipe and welded fittings. Backing rings shall not be used on any pipe welds, unless otherwise approved by the Owner.

4.03.05 **Cutting and Beveling**

a) Carbon steel piping - End preparation for butt welding shall be done by machining/flame cutting.

b) Socket welding - Socket weld and preparation shall be done by saw or machine cutting.

4.04.00 **Hangers, Supports, Anchors**

Normally pipe supports and anchors shall be selected at those points in the buildings where provision has been made for the loads imposed. The cutting of floor/roof beams or the reinforcement in slabs will not be permitted. Piping attached to a plant item shall be supported in such a way that the weight of the piping is not taken by the plant item.

4.04.01 Support spacing shall be as per good engineering practice. However in no case it shall be less than support spacing stipulated in ANSI B31.1.

4.04.02 Accurate weight balance calculations shall be made to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection.

4.04.03 All large pipes and all long pipes shall have at least two supports each arranged so that any length of pipe or valve may be removed without any additional supports being required.

4.04.04 Support steel shall be of structural quality. Perforated strap, wire or chain shall not be used. Support components shall be connected to support steel by welding, by bolting or by beam clamps. Bolt holes shall be drilled, not burned. Support components may be bolted to concrete using approved concrete anchors.

4.05.00 **Valves and Accessories**





4.05.01

General Requirements

- a) All valves shall be of approved make and type and shall have cast/forged bodies with covers and glands of approved construction and materials as specified in Annexures-II & III of this section. The valves shall be provided with electric motors/solenoids and actuators as required.
- b) Valves and specialties to be supplied under this section will be used for various air and water services and will be located indoor/outdoor and on horizontal/vertical runs of the pipelines. However, mounting of valves in vertical pipe runs should be avoided as far as possible.
- c) All valves shall, unless otherwise stated, have the internal diameter same as the internal diameter of the pipes to be joined.
- d) Material, design, manufacture, testing etc. for all valves and specialties along with the accessories shall conform to the latest editions of codes
- e) Gate valve and Ball valve have been specified with the intention of achieving isolation and tight shut-off. In full open condition, these valves should offer minimum of resistance to fluid flow.
- f) Globe valves have been specified with the intention of achieving good control of fluid passing. The plug and seat will have therefore suitable profiles for obtaining such controlling action.
- g) Check valves have been specified in order to prevent reverse flow through them.
- h) All valves shall function smoothly without sticking, rubbing or vibration on opening or closing and shall be suitable for most stringent service conditions i.e. flow, temperature and pressure under which they may be required to operate.
- i) By pass valves shall be provided for larger size valves as per standards followed and as felt necessary for smooth and easy operation, even though not specifically mentioned in the specification.
- j) All flanged valves and specialties to be supplied under this section shall be provided with two (2) counter flanges, bolts, nuts, washers, gaskets etc.
- k) All valves shall be of proven design and manufacture. Where valves are of similar size and type they shall be interchangeable with one another. Valves shall have welded or flanged connections subject to the Owner's approval.
- l) All valves shall have outside screwed spindles and screwed thread of spindle shall not pass through or into the stuffing box. Where valves are



exposed to the weather, protective covers shall be provided for the spindles, which shall be subject to approval.

- m) Gate, Globe and Ball valves shall be provided with the following accessories in addition to other standard items:
 - i) Hand wheel with embossed open and shut directions.
 - ii) Local position indicator.
 - iii) Motorised operation as specified by Owner/Consultant.
- n) Gate valves, in addition shall be provided with following extra features :
 - i) Bypass valve for larger valves.
 - ii) Draining arrangement.
 - iii) Gear operators for valves 300 mm size and above for ease in operation.
 - iv) Motorised operation as specified by Owner/Consultant.
- o) All gate and globe valves shall be rising stem type.
- p) All valves shall be provided with hand-wheels, chain, operator, extended spindle and floor stand wherever required so that they can be operated manually by a single operator from the nearest operating floor either at a lower or higher elevation as the case may be. If such a valve is provided with integral bypass then similar arrangement shall be done for the bypass valve also.
- q) All valves and specialties shall be provided with brass Tag Discs indicating Tag numbers and nomenclature of the valve including duty or service intended and the function of the valves specialties.
- r) Stems shall preferably be arranged vertically with gland at the top, however, in no circumstances must the stem be inclined downward from horizontal or gland be at the bottom. Globe valves shall be installed with the pressure under the disc. Valves shall not be fitted in inverted position.
- s) Where necessary, for accessibility, grease nipples shall be fitted at the end of extension piping and where possible these shall be grouped together and mounted on a common panel situated at a convenient position. A separate nipple shall be provided to lubricate each point. The Bidder shall supply the first fill of oil or grease for these parts. The Bidder shall supply a suitable manually operated grease gun for the standard type of nipple provided.
- t) The spindles for all valves for use outside the building shall have weatherproof protection covers of approved construction.
- u) All valves shall be fitted with indicators so that it may be readily seen whether the valves are open or shut. In the case of those valves fitted



with extended spindles, indicators shall be fitted both to the extended spindles and to the valve spindles.

- v) Plastic or bakelite valve hand wheels will not be accepted.
- w) All valves shall be closed by rotating the hand wheel in a clockwise direction when looking at the faces of the hand wheel. The face of each hand wheel shall be clearly marked with the words 'Open' and 'Shut' with arrows adjacent to indicate the direction of rotation to which each refers.
- x) Wherever practicable heavy valves of total weight including actuator, drive motor, integral by-pass etc., equal to or greater than 500 kg. shall be provided with suitable lugs to permit direct suspension by hanger rod or direct resting on bottom support, as applicable.
- y) Special attention shall be given to the operating mechanism for large size valves in order that quick and easy operation is obtained and maintenance is kept to a minimum.
- z) Eyebolts shall be provided where necessary to facilitate handling heavy valves or parts of valves.
- aa) The Bidder shall supply with his bid and in addition during the course of the Contract, comprehensive drawings showing the design of valves, test pressure and working pressure/temperatures. They should include a parts list referring to the various materials used in the valve construction.
- bb) All sampling and root valves shall be of integral body bonnet type.

4.05.02 For Design Requirements for different valves please refer Annexure-II & III of this section.

4.06.00 **Safety/Relief Valves**

Safety/Relief valves shall be of direct spring loaded type and shall have a tight, positive and precision closing.

All safety valves shall be provided with manual lifting lever.

Valves used for air and any other compressive fluid shall be of pop type.

Safety/Relief valves shall be constructed and adjusted to permit the fluid to escape without increasing the pressure beyond 10% above the set blow off pressure. Valve shall reset at a pressure not less than 2.5% and more than 5% of the set pressure.

Releasing capacity of the safety/relief valves shall be as per the applicable codes and standards and shall be subject to the approval of the Owner/Consultant.



The seat and disk of safety valves shall be of suitable material to resist erosion. The seat of valve shall be fastened to the body of the valve in such a way that there is no possibility of the seat lifting.

4.07.00 Hose pipe and Accessories

4.07.01 Hose valves for service water system shall be Gate valves and service air system shall be Globe valves.

4.07.02 Hose pipes with fittings for Service Water System:

- a) The water hose shall be as per IS-444 (Type-3).
- b) Length of each hose shall be 15 metres.
- c) For each hose, one end shall be fitted with M.S. female coupling with swiveling nuts and soft seating ring suitable for connection to male end of hose valve and other end shall be made threaded for joining with the swiveling nut of a second hose whereby two hose lengths may be joined.

4.07.03 Hose pipes with fittings for Compressed air System

- a) The compressed air hose shall be as per IS-911 (Type 2).
- b) The length and type of each end shall be similar to as specified in above clause no. (b & c) above.

5.00.00 INSTALLATION

5.01.00 All fittings like "T" pieces, flanges, reducers etc. shall be suitably matched with pipes for welding. The valves will have to be checked, cleaned or overhauled in full or in part before erection, after chemical cleaning and during commissioning.

5.02.00 Adjustments like removal of oval ties in pipes and opening or closing the fabricated bends of high pressure piping to suit the layout shall be considered part of work and the Erection Bidder is required to carry out such work as per instruction of Bidder/Owner, which shall include specified heat-treatment procedures, etc. also wherever required.

5.03.00 Certain adjustments in length may be necessary while erecting high pressure pipelines and the Contractor should remove the extra lengths to suit the final layout after preparing edges afresh and adopting specified heat treatment procedures.

5.04.00 Suspension for piping, pressure parts, etc., will be supplied in running lengths, which shall be cut to suitable sizes and adjusted as required.

5.05.00 All the valves, lifting equipments, actuators, power cylinders, etc., shall be serviced and lubricated to the satisfaction of Owner before erecting the same and also during pre- commissioning. Even after commissioning, the equipments, if there are problems in the operation, they have to be attended to by the Bidder



during the tenure of the contract. Welding or jointing of extension spindle for valves to suit the site conditions and operational flexibility shall be part of erection work.

- 5.06.00 All tubes and pipes shall be cleaned and blown with compressed air and shown to the Owner before lifting. Bigger size pipes should be cleaned with flexible wire brush, wherever necessary. After cleaning is over the end caps shall be put back in tube openings till such time they are welded to other tubes.
- 5.07.00 Fine fittings, drain piping, oil systems & other small bore piping have to be routed according to site conditions and hence shall be done only in position. As such, layout of small-bore piping shall be done as per site requirement. There is a possibility of slight change in routing the above pipelines even after completion of erection, which shall be carried out by the Bidder without any extra cost to the Owner. Work shall also include fabrication of small bends at site from straight lengths to suit the site conditions.
- 5.08.00 Welding of temporary supports, cleats, etc., on the building columns shall also be avoided. In case of absolute necessity, Erection Bidder shall take prior approval from Bidder/Owner. Further, any cutting or alteration of member of the structure or platform or other equipments shall not be done without specific prior approval of Owner.
- 5.09.00 Wherever piping erected by the Erection Bidder is connected to piping or equipment erected by some other agencies the joint at the connecting point shall be considered under this specification.
- 5.10.00
- a) All piping shall be grouped wherever practicable and shall be routed to present a neat appearance.
 - b) The piping shall be arranged to provide clearance for the removal of equipment for maintenance and for easy access to valves, instruments and other piping accessories required for operational maintenance.
 - c) Piping shall be routed above ground unless otherwise specifically indicated/ approved by the Owner. In such special case, the piping may be arranged in trenches, or buried and properly protected as per AWWA Standards.
 - d) Overhead piping shall have a minimum overhead clearance of 2.5 meters above walkways and working areas and 8 meters above roadways unless otherwise approved by the Owner.
 - e) Drains shall be provided at all low points and vents at high points as per actual layout regardless of whether some have been shown in respective Tenders drawings or not. The pipelines shall be sloped towards the drain points.
- 5.11.00 All drips and drains for piping and equipment whether shown in the Tender drawings or not shall terminate on the ground floor up to station drain unless otherwise specified. Leading such drains up to station drainage is also the responsibility of the Bidder.

6.00.00 **DRAWING, DATA AND INFORMATION REQUIRED**





- 6.01.00 Drawings, data, Information to be furnished by the Bidder besides those already mentioned in Volume-IIA (Lead Specification) with the offer.
- 6.01.01 A complete list of all piping and fittings of various sizes with their quantities and details e.g. nominal size, O.D., I.D. (as applicable) thickness, design pressure, design temperature, material of construction/code/standards etc.
- 6.01.02 A complete list of all valves with their type, quantities & ratings.
- 6.01.03 Manufacturer's catalogue indicating complete range of available size and rating of pipes & fittings.
- 6.01.04 Descriptive literature on the manufacturing process and quality control procedures highlighting the manufacturing, fabricating and testing facilities available in the shop.
- 6.02.00 After Award of Contract**
- Detail drawings including fabrication drawings of all shop fabricated piping system indicating design parameters and complete bill of material (Relevant Standards and grades to be indicated) and information/data pertaining to the hydrostatic and non-destructive test requirements to be submitted progressively.
- 6.02.01 Detail dimensioned drawing of each valve, specialties, indicating tag no., pressure rating, manufacturing standard, the bill of materials and hydrostatic test pressures. The drawing shall include the end preparation details and shall indicate the position of the hand wheel/operator. Technical particulars of motor operators wherever applicable shall also be indicated.
- 6.02.02 General arrangement drawing for each hanger/support/anchor etc. indicating identification number, auxiliary supporting structural details, other details & information as required in the specification.
- 6.02.03 Wiring diagram for all limit switches of motor operated valves.
- 6.02.04 The loading data required for design of structures shall be furnished well in advance to suit Owner's project schedule.



Tender Specification
for
FGD Package

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

ANNEXURE-I

SPECIFICATION OF PIPES & FITTINGS

Sl. No.	Services	Slurry Piping	Service Water and Demineralised Cooling Water	Drinking Water (chlorinated)	Service and Instrument Air	Auxiliary Steam
1.0	Material of Pipe					
a)	Above 150 mm NB	IS-3589 with minimum pipe thickness of 6 mm and 5 mm thick rubber lining.	IS-3589 with minimum pipe thickness of 6 mm	IS-3589 with minimum pipe thickness of 6 mm, galvanized as per IS-4736	Stainless steel as per ASTM A-312 Gr. 304 as per schedule 10S, ANSI B-36.19.	Carbon Steel, ASTM A-106, Gr. B or C.
b)	80 to 150 mm NB	IS-1239 Heavy Grade with 5 mm thick rubber lining	IS-1239 Heavy Grade	IS-1239 Heavy Grade, galvanized as per IS-4736		
c)	Below 80 mm NB	FRP			Stainless Steel as per ASTM A-312 Gr. 304 as per schedule 40S ANSI B36.19	
2.0	Construction	ERW / Seamless	ERW / Seamless	ERW / Seamless	Seamless	Seamless
3.0	Joints			Pipe to pipe joint shall be with union as per IS:1239, Part-II.		
a)	65 mm NB and above	Flanged	Slip on Flange / butt weld	Screwed flange	Slip on Flange / butt weld	Slip on Flange / butt weld
b)	size 50 mm NB and below.		Socket weld	Screwed socket	Socket weld	Socket weld
4.0	Fittings					
4.1	Materials					





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ANNEXURE-I

Sl. No.	Services	Slurry Piping	Service Water and Deminerlised Cooling Water	Drinking Water (chlorinated)	Service and Instrument Air	Auxiliary Steam
a)	Pipe Sizes $\geq$ 65 mm NB	ASTM-A-234 Gr. WPB with 5 mm thick rubber lining.	ASTM-A-234 Gr. WPB	ASTM-A-234 Gr. WPB galvanized as per IS-4736	ASTM-A-351-CF8 or ASTM-A-403 WP304	ASTM-A-234 Gr. WPB
b)	Pipe Sizes $\leq$ 50 mm NB	FRP	ASTM-A-105 or as compatible with IS:1239	ASTM-A-105 or as compatible with IS:1239 and galvanised as per IS-4736	ASTM-A-182 F304	ASTM-A-105
4.2	Construction	Welded/ Seamless				
a)	Pipe Sizes $\geq$ 65 mm NB		Welded/ Seamless	Welded/ Seamless	Welded/ Seamless	Welded/ Seamless
b)	Pipe Sizes $\leq$ 50 mm NB		Forged	Forged	Forged	Forged
4.3	Standard					
a)	Above 150 mm NB	ANSI-B-16.9/ For fabricated fitting AWWA-C-208	ANSI-B-16.9 / For fabricated fitting AWWA-C-208	ANSI-B-16.9	MSS-SP-43	ANSI-B-16.9
b)	80 to 150 mm NB	ANSI-B-16.11 or IS:1239, Part-II	ANSI-B-16.11 or IS:1239, Part-II	ANSI-B-16.11 or IS:1239, Part-II		
c)	Below 80 mm NB	As per applicable manufacturer's standard.				ANSI-B-16.11
4.4	End details					
a)	Pipe Sizes $\geq$ 65 mm NB	Flanged	Butt welded as per ANSI-B-16.25	Screwed Flanged.	Slip - on flanges as per ANSI B16.5. Butt welded for Pipe fittings	Butt welded as per ANSI-B-16.25





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ANNEXURE-I

Sl. No.	Services	Slurry Piping	Service Water and Demineralised Cooling Water	Drinking Water (chlorinated)	Service and Instrument Air	Auxiliary Steam
					and flanged for valves and equipments.	
b)	Pipe Sizes $\leq$ 50 mm NB		Socket welded as per ANSI-B-16.11	Screwed socketed as per ANSI-B-16.11 or IS:1239, Part-II	Socket welded as per ANSE B16.11	Socket welded as per ANSI-B-16.11
5.0	Flanges	Applicable class as per ANSI-B-16.5 complete with nuts, bolts and gaskets	150 lb class as per ANSI-B-16.5 complete with nuts, bolts and gaskets	As per ANSI-B-16.5 pressure class 150lbs - galvanised- complete with nuts, bolts and gaskets.	As per ANSI-B-16.5, 150lb pressure class complete with nuts, bolts and gaskets. Material as per class 4.01.00.	Applicable class as per ANSI-B-16.5 complete with nuts, bolts and gaskets
	Pipes shall be hydrostatically tested according to the said code, for other Codes please refer Volume-IIA (Lead Specification), Section-V of this specification.					

Note:

- 1) Piping system not covered in above table shall be as per Vendor's proven practice, subject to approval by Purchaser
- 2) For waste water handling system, all piping and fittings shall be HDPE material.





ANNEXURE-II

SERVICES OF VARIOUS CATEGORIES OF VALVES

Valve Classification		Service		
A.	Cast iron body Gate/Globe/Check Valve	i)	Service Water (Clarified).	For sizes 65 mm NB to 300 mm NB.
		ii)	Drinking Water.	
B.	Stainless steel body Ball/ Check Valve	i)	Service and Instrument Air.	For all sizes.
C.	Steel Body Gate/ Globe/ Check Valves	i)	Service Water (Clarified).	For sizes less than and equal to 50 mm NB.
		ii)	Drinking Water	
		iii)	Auxiliary Steam	For all sizes
		iv)	Inhibited Demineralised Water for DMCW system	
D.	Cast Iron body butterfly valve		Service Water (Clarified).	For sizes above 300 mm NB
E.	Cast Steel Knife Gate/ Butterfly valves with rubber lining		Limestone/ Gypsum Slurry	For all sizes



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ANNEXURE-III

SPECIFICATION OF GATE/GLOBE/CHECK/BALL VALVES

Sl. No.	Description	A. Cast Iron Body Gate/ Globe/Check Valve	B. Stainless steel Body Check/Ball Valve	C. Steel Body Gate/ Globe/Check Valve
1.0	Valve Classification	CIGC	SSGC	STGC
2.0	Basic Design Code			
2.1	Gate	i) IS 780 for 50 mm - 300 mm NB ii) IS2906 for 350 mm NB and above or as per MSS-SP-70		i) API 600 for 50mm NB and above /ANSI-B-16.34 ii) API 602 for size below 50mm NB/ANSI-B-16.34
2.2	Globe	MSS - SP - 85		BS-1873/ANSI-B-16.34
2.3	Check	IS-5312/MSS - SP -71	ANSI-B-16.34	BS-1868/ANSI B16.34
2.4	Ball		BS-5351	
3.0	Pressure Class	To be suitably chosen considering the pressure requirement. Refer Clause No. 4.01.08 in this regard.		
4.0	Construction	Cast body and bonnet / cover.	Forged body up to 50mm NB and Cast body above that.	
5.0	Material			
5.1	Body & Bonnet/ cover	IS 210 Gr. FG 260 or ASTM A216 Class B.	i) ASTM-A-182 F304 for Ball Valves ii) A351 CF8M for cast body check valves, iii) A 182 F304 for forged body check valves.	i) ASTM-A-216 Gr. WCB for cast body valves ii) ASTM-A-105 for forged body valves.
5.2	Trim / Disc.	IS-210 Gr. FG 260 or ASTM A216 Class B.	i) ASTM-A-182 F304 for Check valves ii) 351CF 8M for Ball valves.	i) 13% Cr Steel as per ASTM-A-182 Gr. F6 heat treated and hardened (min 250 HB) for cast body ii) ASTM-A-105 Hard faced





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ANNEXURE-III

Sl. No.	Description	A. Cast Iron Body Gate/ Globe/Check Valve	B. Stainless steel Body Check/Ball Valve	C. Steel Body Gate/ Globe/Check Valve
				with Stellite (min 350 HB) for forged body.
5.3	Seating surface	13% Cr steel as per IS 1570.	For Ball valves PTFE seats and seals.	13% Cr. Steel as per ASTM- A-182 Gr. F6
6.0	End Preparation	Socket welded for size equal to and below 50 mm NB and flanged with counter flanges for 65 mm NB and above.		
7.0	Testing			
	a) Gate	i) As per IS - 780 for 50 mm - 300 mm NB	As per ANSI B-16.34	API-598
		ii) IS-2906 for sizes equal to and above 350 mm NB		
	b) Globe	Hydrostatic Test as per MSS-SP- 85		BS-1873
	c) Check	IS-5312/MSS-SP-71		BS--1868

Note: For Waste water handling system, all valves shall be duplex stainless material.





ANNEXURE-IV

SPECIFICATION OF BUTTERFLY VALVE

1.0	Valve classification Code	: CIBF
2.0	Basic Design Code	: AWWA-C-504
3.0	Pressure	: To be suitably chosen by the Bidder according to requirement, but not less than class 75A as per AWWA-C-504.
4.0	Construction	: Cast Body and Disc
5.0	Material	
	a) Body	: 2% Ni Cast Iron as per IS-210 Gr. FG260 with 2% Ni.
	b) Valve Disc	: -Do-
	c) Valve Shaft	: Stainless Steel ASTM-A-479 type 304
	d) Seat ring	: Clamping ring Stainless Steel ASTM-A-479 type 304
	e) Shaft Bearing	: Ferrobestos LA-33
	f) Gland Packing	: Impregnated Teflon
	g) Seal	: Nitrile Rubber
6.0	End preparation	: Flanged, Drilled as per ANSI B16.1. Necessary counter flange nuts, bolts, gaskets are to be provided with each valve.
7.0	Testing	: As per AWWA-C-504. However valve disc strength for both forward reverse flow is to be carried out as per BS 5155. Certificate for proof of design test for similar type of valve is to be furnished.

Note:

- 1) For Slurry lines rubber lining/EPDM/equivalent protection to be provided.
- 2) For Waste water handling system, all valves shall be duplex stainless material.





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VOLUME: II-D

SECTION - II

THERMAL INSULATION



Development Consultants Pvt. Ltd.

**Vol. II-D/Section-II
Thermal Insulation**



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VOLUME : II-D

SECTION - II

THERMAL INSULATION

1.00.00 INTRODUCTION

1.01.00 This section covers technical requirements of thermal insulation, cladding sheet and other auxiliary materials required for thermal insulation on piping and equipment.

1.02.00 The thermal insulation shall be applied on the outer surface of equipment, piping, valves, fittings, having skin temperature more than 60°C, to conserve the thermal energy and also to maintain the outside surface temperature of the insulation below or at 60°C for personnel protection.

1.03.00 Insulation thickness shall be computed on the basis of the following data :

- a) Design ambient temperature: 45°C
- b) Surface temperature of insulation jacket: 60°C (max.)
- c) Emissivity of Aluminium sheet: 0.2
- d) Thermal conductivity of insulating material at different temperatures shall be as stipulated in IS:9842 and IS:8183 as applicable.
- e) Surface Wind velocity = 0.25 metre/sec
- f) Pipe/Equipment wall temperature=Maximum fluid design temperature
- g) Overall heat transfer coefficient and insulation thickness shall be calculated as per ASTM C 680-89.

1.04.00 The minimum insulation thickness, however, shall not be less than 50 mm.

1.05.00 Necessary hydrostatic pressure testing of piping, equipment shall be completed prior to the application of insulation.

1.06.00 All permanent and temporary covering necessary to protect insulation from the weather, shall be supplied and included in Bidder's scope.

1.07.00 Insulation shall not be applied over nameplates of equipment. A neat opening shall be left in the insulation and jacketing around nameplates and the opening suitably flushed to prevent the entrance of moisture.



2.00.00

CODES AND STANDARDS

In addition to the requirements spelt out in Vol-IIA (Lead Specification), all items covered under this section of specification shall conform to the latest edition of the following codes and standards:

1.	IS-8183	:	Specification for bonded mineral wool.
2.	IS-3144	:	Methods of test for mineral wool thermal insulation materials.
3.	IS-3346	:	Methods for the determination of thermal conductivity of thermal insulation materials (two slab, guarded hot plate method).
4.	IS-280	:	Mild Steel wire for general engineering purposes
5.	IS-6528	:	Stainless Steel wire.
6.	IS-3150	:	Specification for hexagonal wire netting for general purposes.
7.	IS-4826	:	Hot-dipped galvanised coatings on round steel wires.
8.	IS-737	:	Specification for sheet and strip of wrought Aluminium and Aluminium Alloys (for General Engineering purposes)
9.	IS-460	:	Specification for test sieves.
10.	IS-3677	:	Specification for unbonded rock & slag wool for thermal insulation.
11.	IS-9842	:	Specification for Preformed Fibrous Pipe Insulation.
12.	IS-5688	:	Specification for Methods of test for preformed block-type and pipe covering type thermal insulation.
13.	IS-14164	:	Code of practice for the Industrial Application and Finishing of Thermal insulation material at temperatures above -80°C and up to 700°C.
14.	ASTM B209	:	Standard specification for Aluminum and Aluminum alloy sheet and plate.



3.00.00 SCOPE OF SUPPLY AND SERVICES

The following materials in required quantities shall be supplied under this section:

- 3.01.00 Thermal insulating Materials -preformed bonded mineral wool sections, bonded mineral wool mattresses, loose mineral wool and lightly resin bonded glass wool.
- 3.02.00 Hexagonal wire netting of galvanised steel/stainless steel in the form of rolls.
- 3.03.00 Binding wires, stitching wires and lacing wires of galvanised steel/stainless steel in the form of coils.
- 3.04.00 Mild steel flats, lugs etc.
- 3.05.00 Joint sealing compound of self-setting paste type for making cladding joints vapour tight.
- 3.06.00 Cladding sheets.
- 3.07.00 Cadmium/zinc coated self-tapping type screws with washers for cladding sheet joints.
- 3.08.00 Heat resistant paints.
- 3.09.00 All other materials i.e. bolts, nuts, rivets, 3 mm thick mill board, aluminum pigment sealant, white glass cloth, insulating cement, neoprene washer etc.
- 3.10.00 For details regarding Scope of Services and works, Lead Specification Volume-IIA of this specification shall be referred.

4.00.00 MATERIAL SPECIFICATIONS

- 4.01.00 The insulating materials to be supplied under this specification shall be lightly resin bonded mineral wool of best grade conforming to IS:8183. Hand made mattresses is not acceptable. Material shall be rock wool only. Slag wool or slag wool inclusion shall not be accepted.
- 4.02.00 Resin bonded glass wool mattress, having density 150 Kg/m³ (min.), self stitched in shop can also be accepted for temperature less than 400°C.
- 4.03.00 The bonded mineral wool shall be secured by means of galvanised steel wire (as per IS:280 or equivalent) of at least 24 SWG in the form of hexagonal netting of 10 mm to 13 mm aperture.
- 4.04.00 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.
- (d) Not suffer any quality deterioration under specified service conditions (both cold/hot face temp.) of use.

4.05.00 The mattress insulation shall be machine made, stitched at factory and should retain their form under ordinary handling conditions.

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

4.07.00 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.

4.08.00 Binding and lacing wires shall be provided in line with following:

Temperature Range	Material	Thickness of wire
(a) Upto 400°C	Galvanised Steel	20 SWG
(b) Above 400°C	Stainless Steel	20 SWG

4.09.00 Sheathing material for all insulated surfaces, equipment, piping etc. confirming to ASTM B-209-1060 temper H-14 or IS:737 Gr 19000/H2, shall be provided as per following:

	With Lightly Bonded Mattress	With Preformed pipe sections
a. For dia of insulated surfaces of 450 mm & above and for flat surfaces	1.63 mm (16 SWG)	-
b. For dia of insulated surfaces upto 450 mm	0.914 mm (20 SWG)	0.914 mm (20 SWG)

4.10.00 Straps and bands shall conform to materials as under:





Temperature Range

Material

(a) Upto 400°C

Galvanized Steel.

(b) Above 400°C

Stainless Steel.

Bands shall be 20 mm wide and 0.6 mm thick. For securing Aluminum sheathing material, stainless steel or anodized aluminum bands shall be used.

4.11.00 Screws shall be of galvanized steel, check headed, self-tapping type. Above 400 degree Celsius temperature, screws shall be stainless steel.

4.12.00 Hexagonal wire mesh shall be conforming to following:

Temperature Range

Material

Mesh size

(a) Upto 400°C

Galvanized Steel

10-13 mm aperture
0.71 mm diameter

(b) Above 400°C

Stainless Steel

-do-

4.13.00 All other materials, e.g. insulation supports, expansion joints, washers, etc. shall be of standard design of the Bidder duly approved by the Owner and/or Consultant.

4.14.00 Insulating material shall be suitable for the pipe/equipment listed in attached Annexure. For bonded mineral wool insulation, the bonding substance shall retain its binding property upto 600°C.

4.15.00 The insulating material whether dry or wet shall:

- a) Be fresh, incombustible, rust proof, non hygroscopic and free from asbestos.
- 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.

5.00.00 **INSULATION APPLICATION PROCEDURE**

Bidder shall apply thermal insulation at site. Based on Bidder's proven practice and latest design, he will follow his own recommended thermal insulation application procedure. However, the details of method of application and finishing inclusive of all details of insulating materials and supporting arrangements shall be furnished for approval of Owner/ Consultant.



5.01.00 **General**

- 5.01.01 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.
- 5.01.02 Before applying the insulation the Bidder shall check that all instrument tapping, clamps, lugs and other connections on the surface to be insulated have been properly installed as per the relevant erection drawing.
- 5.01.03 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.
- 5.01.04 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.
- 5.01.05 Firm anchoring shall be welded onto the pads/strips already provided on the body of the casings/equipments. Pads/strips in addition to those already provided shall be attached only with the approval from Owner.

All flanged joints shall be insulated only after the final tightening and testing.

5.02.00 **Piping**

- 5.02.01 Pipe insulation shall be so arranged as to allow for expansion of pipe. Insulation expansion joints shall be provided on all pipelines to allow movements and expansion of the pipe without producing random cracking of the insulation. The recommended intervals of expansion joints are:

Pipe Temperature	Spacing of Insulation Expansion Joint
Upto 200°C	5.5 M
201 - 300°C	3.5 M
301 - 400°C	3.0 M
Above 400°C	2.0 M

Before application of any insulating material, it is important to ensure that the surface to be insulated is dry and free from rust, dirt and grease and extraneous matter.

- 5.02.02 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 (tie wires).
- 5.02.03 Longitudinal joints of insulation mattress sections of horizontal piping shall be on the bottom or at the sides of the pipe.



- 5.02.04 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.
- 5.02.05 The insulation shall be secured to pipes by means of circumferential tie wires of 1.6 mm to 1.0 mm (16 to 19 SWG) for insulation surface with diameter up to 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 tie 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.
- 5.02.06 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.
- 5.02.07 For multiple layer of insulation, the multiple layers shall be applied so that the circumferential joints on adjacent layers are staggered by at least 150 mm and longitudinal joints by at least 50 mm. At the joint of each layer of insulation, suitable packing material shall be firmly applied where necessary.
- 5.02.08 Insulation mattress/section ends shall be terminated at a sufficient distance from the flanges to facilitate removal of bolts.
- 5.02.09 The final layer of insulation shall be backed up by galvanised wire netting stitched with G.I. wire and this shall be anchored to the securing attachments by means of wire ties.
- 5.02.10 Preformed insulation on vertical or near vertical piping with a difference of elevation of 4 meters or above, must be supported in position by means of metal rings, part rings or studs at intervals not greater than 3.0 m and also immediately above each expansion break in the insulation. The support attachment may be welded or clamped to the pipe subject to approval of the Owner.
- 5.02.11 The mat insulation for vertical and near vertical piping shall also be suspended from above, and for this purpose securing attachments must be used which may be of metal rings or studs. The confining wire netting of the mattress shall be anchored to the securing attachments by means of wire ties.
- 5.02.12 Piping bends shall be insulated in the same way as the adjacent straight piping. Where preformed material is used, it should be cut lobster-back fashion and wired and strapped into position.
- 5.02.13 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, insulating cement shall be applied as required to obtain a smooth surface.



- 5.02.14 Protrusions through insulations, which themselves do not require insulations, such as pipe clamps, supports of small piping (except hanger rods), instrument take-offs, etc., shall be covered to the same thickness as the adjacent insulation.
- At outdoor locations and where necessary, the hanger rod protrusions shall be suitably shielded with metal flashing to deflect rain and protect the insulation from moisture while permitting the movement of the hanger rod.
- 5.02.15 Weather hoods shall be provided for insulated piping passing through floors/walls.
- 5.02.16 Upstream of all drain lines and the lines connected to steam traps, shall be insulated up to 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
- 5.02.17 All insulation shall be protected by means of an outer covering of aluminum sheathing. All insulation/cladding joints shall be sealed and made effectively weather and waterproof. All flat surfaces shall be given suitable slope to prevent collection of pools of water on the cladding surface. All sheathing shall be protected internally by the application of two coats of bitumastic paint.
- 5.02.18 Aluminum sheet jacketing on piping shall be screwed with self- tapping screws on longitudinal joints only. In case of insulating horizontal pipes, these joints shall be arranged approximately 30 Deg. below horizontal centre line to avoid water ingress. The sheets shall be overlapping by 50 mm on both longitudinal and circumferential joints.
- 5.02.19 Arrangement for securing the metal finish over the insulation shall ensure that direct metal contact between the insulating surface and outer metal cladding is reduced to minimum. All joints shall be vapour tight and shall be able to accommodate thermal movements.
- 5.02.20 All openings and joints in outdoor cladding for piping connections, supports of access shall be suitably flashed and weatherproofed. Where such flashing or weather-proofing cannot effectively control the entry of moisture, then such openings and joints shall be weather-proofed by application of aluminum pigmented sealer.
- 5.02.21 For bends, fittings etc. the cladding shall be provided in segments as to ensure a smooth finish of the cladding.
- 5.02.22 For cladding on vertical pipes/equipment, provision for load take up shall be made at every 2 to 4 meters along pipe/equipment axis.
- 5.02.23 Galvanic corrosion shall be prevented by carefully avoiding permanent contact of aluminum cladding with copper, copper alloys, tin, lead, nickel or nickel alloys including monel metal.



- 5.02.24 All joints shall be sealed with acrylic emulsion weather barrier.
- 5.03.00 **Dampers, Valves and Flanges**
- 5.03.01 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.
- 5.03.02 All dampers/ valves and flanges shall be provided with removable box type of insulation covered with box fabricated from aluminum sheets of thickness same as the connected pipe cladding. Adjoining pipe insulation shall be beveled back to permit removal bolts and nuts or bands.
- The portion of the damper/ valve, which cannot 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.
- 5.03.03 Removable box type cladding for valves and flanges shall be fitted on the connected pipe cladding, with bands.
- 5.03.04 Flanges on lines having temperature up to and including 150°C shall not be insulated.
- 5.03.05 Union shall not be insulated.
- 5.03.06 Expansion joints, metallic or rubber, shall not be insulated unless otherwise specifically indicated.
- 5.03.07 Safety valves shall be insulated.
- 5.03.08 All flanged joints shall be insulated only after the final tightening and testing.
- 5.04.00 **Equipment**
- 5.04.01 Equipment insulation supports shall be welded to the vessel to support vertical insulation. The material of the supports shall be similar to the vessel, as far as practicable. The supports shall be uniformly pitched at 500 mm (approx.). A support shall be located above each vessel flange at a sufficient distance above the flange bolts to allow for easy removal. The top and bottom supports shall be slotted suitably for attachment of straps or wire.
- 5.04.02 Dished ends of the related equipment shall be insulated by welding studs or cleats to the surface at approximately 300 mm intervals. Insulation application procedure shall be otherwise similar to that for piping.
- 5.04.03 All longitudinal joints shall have a minimum overlap of 50 mm and shall be located at 45 degree or more below the horizontal for horizontal equipment.



Joints shall be made with cheese headed self tapping galvanized steel screws at 150 mm centers.

5.04.04 All circumferential joints shall have a minimum overlap of 100 mm and shall be held in position by stainless steel or anodized aluminum bands, stretched and clamped.

5.04.05 Insulation to various areas shall be applied as under:

Insulation Area	Form of Insulation
(a) hot	Mineral wool block or air and gas ducts Mineral wool blankets.
(b) All other surfaces (not enclosed as per (a))	Calcium silicate block or above.

5.04.06 While applying mineral wool blanket insulation:

- (a) Expanded metal or hexagonal wire mesh shall be provided on both sides for single layer mattress and on first layer in case of multilayer insulation. Subsequent layers of multilayer insulation shall have only one side wire netting.
- (b) The edges of adjacent blankets shall be leased together, by appropriate lacing wire.
- (c) Any gap between joints between insulation layers shall be filled by loose mineral wool confirming to IS: 3677.
- (d) All insulation shall be secured by 1.63 mm diameter 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.

5.04.07 Aluminum cladding shall not come directly into contact with either the equipment surface or with the supporting arrangement on the equipment surface. To this end, adequate layers of 3 mm thick ceramic board shall be provided between the cladding and any supporting arrangement or equipment surface, and fitted with self tapping screws/metal bands, as applicable.

5.04.08 Weather proof flushing shall be installed where the panels intersect with columns and at other similar joints.

5.04.09 Removable insulated covers shall be provided over the Drum/Separator manholes.

5.04.10 Cladding on top surface of ductwork and equipments shall be suitably reinforced to prevent damage by personnel walking thereon.

5.04.11 All cladding for outdoor application shall be with neoprene washers.





- 5.04.12 Cladding shall have sufficient strength to withstand any force generated on the insulated surfaces, without any rupture or damage.
- 5.04.13 Hot Air or 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.
- 6.00.00 **INSPECTION AND TESTING**
- 6.01.00 The Bidder shall furnish test certificates from any one of the independent authorities listed below or any other reputed body subject to Owner's/ Consultant's prior approval for all the tests as mentioned later.
- a) National Test House - Calcutta/Bombay
 - b) Central Glass & Ceramic Research Institute, Calcutta
 - c) National Metallurgical Laboratory, Jamshedpur
 - d) Central Mechanical Engineering Research Institute, Durgapur
 - e) National Physical Laboratory, Delhi
 - f) Central Building Research Institute, Roorke, U.P.
 - g) Any other Internationally reputed Test House.
- 6.02.00 The Bidder shall carry out all the tests according to IS:8183/3144 or according to any other internationally accepted standards. The tests shall be done on representative samples drawn from the insulating material supplied under this section of specification. All the tests mentioned in IS:3144 shall be carried out for establishing various chemical and physical properties (as mentioned below) in accordance with the procedure laid down therein. Owner shall have the right to witness any or all of the tests conducted by the Bidder at the shop or laboratory.
- 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 | 100 Kg/m ³ (For use upto 400°C)
150 Kg/m ³ (For use above 400°C) |
| (c) Weight gain by moisture absorption | 2% (max.) |
| (d) Sulphur Content | Not exceeding 0.6% |
| (e) Alkalinity as Percentage of Na ₂ O | 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 IS:3144)
(i) Handability	Fully hand able, without any lump formation and disintegration of material
(j) Loss of weight after Combustibility test	Not exceeding 5% by weight

6.03.00 The Bidder shall furnish the following test reports along with the offer:

- a) Thermal conductivity of the insulating material at various mean temperature.
- b) Retention of binder at elevated temperature
- c) All other tests as per IS:9842 /8183.

6.04.00 The Bidder shall guarantee that if, on actual measurement, the specified maximum insulation surface temperatures are exceeded, the Bidder shall either replace the insulation with a superior material or provide additional insulation thickness at no extra cost.

7.00.00 DRAWING, DATA AND INFORMATION REQUIRED

7.01.00 Drawings, data, Information to be furnished by the Bidder besides those already mentioned in Volume-IIA (Lead Specification) with the offer.

7.01.01 Typical drawing showing application methodology

7.01.02 Manufacturer's descriptive literature and illustrative catalogues for the materials offered.

7.02.00 After Award of Contract

7.02.01 A comprehensive write-up on the tests to be conducted for thermal insulating, materials, inspection methods, testing facilities.

7.02.02 The certificates/reports for various properties of thermal insulation materials offered.

7.02.03 Comprehensive application methodology along with necessary drawings and datasheets required for the application of thermal insulation.

7.02.04 BOQ of insulation materials and other hardwires.

7.02.05 Calculation for establishing thickness of insulation

ANNEXURE-I

LIST OF EQUIPMENT, DUCTING AND PIPING TO BE INSULATED

Thermal insulation supply& application shall include, but not be limited to, the following Equipment, Ducting together with Dampers and piping together with fittings, valves & specialties, etc.:

1. Absorber.
2. All Hot Air and Flue gas ducting within the Terminal points.
3. All auxiliary steam piping from Terminal point to consumption points



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME-II-E

**TECHNICAL SPECIFICATIONS
FOR
CONTROL AND INSTRUMENTATION**



Development Consultants Pvt. Ltd.

**Vol. II-E / Control and
Instrumentation**



**Tender Specification
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**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

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SECTION-II	:	SCOPE OF WORK
SECTION-III	:	CONTROL AND INSTRUMENTATION SYSTEM
SECTION-IV	:	ERECTION, QUALITY ASSURANCE, TESTING AND COMMISSIONING





**Tender Specification
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2x500 MW Project
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VOLUME : II-E

SECTION - I

GENERAL TECHNICAL REQUIREMENTS



Development Consultants Pvt. Ltd.

**Vol. II-E/Section-I
General Technical Requirements**



**Tender Specification
for
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Tuticorin, Tamil Nadu**

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VOLUME: II-E

SECTION-I

GENERAL TECHNICAL REQUIREMENTS

1.00.00 INTENT OF SPECIFICATION

1.01.00 This part of the specification is intended to provide the technical guidelines for the Control & Instrumentation system with auxiliaries and accessories for Flue Gas De-sulphurization (FGD) package for 2 x 500 MW of M/s NLC Tamilnadu Power Limited (NTPL) at Tuticorin, in Tamil Nadu.

1.02.00 Bidder shall provide all material, equipment and deliverables so as to make a totally integrated Instrumentation and Control System together with all accessories, auxiliaries and associated equipment ensuring operability, maintainability and reliability. The Instrumentation and Control System shall be consistent with modern power plant practices and shall be in compliance with all applicable codes, standards, guides, statutory regulations and safety requirements in force.

1.03.00 Bidder shall also include in his proposal and shall furnish all equipment, devices and deliverables which may not be specifically stated in the specification but are needed for completeness of the equipment / systems furnished by the Bidder and for meeting the intent and requirements of the specification.

1.04.00 Wherever quantity is indicated, the same refers to only one set per generating unit to be furnished by the Bidder, unless specifically indicated otherwise.

1.05.00 It is not the intent to completely specify all details of design and construction features herein. Nevertheless, the instruments / equipment and their installation shall conform to high standards of engineering design and workmanship in all respects.

1.06.00 In the event of conflict between requirements of any two clauses of this specification / documents or requirements of different codes / standards specified, the more stringent requirements as per the interpretation of the Owner / Consultant shall apply.

2.00.00 FGD PLANT CONTROL PHILOSOPHY

2.01.00 FGD control system shall operate under all operating conditions from a dedicated PLC based Control system. The control system shall be unit wise. HMI Stations shall be located in FGD common Control Room.

One Remote Input/ Output Unit of the PLC shall be considered for each unit





for achieving data acquisition from the Station DCS in the CCR.

- 2.02.00 Hardwired interfacing shall be provided with Station DCS for time critical, interlock, control & protection signals. Further PLC based control system for FGD shall be connected to Station DCS through redundant soft communication link (OPC over Ethernet based TCP/IP) for the information exchange through Station wide LAN.
- 2.03.00 The FGD PLC shall be time synchronized with the GPS Master Clock System of the existing Main Plant.
- 2.04.00 Relay based local control panels may be required for a few sub-systems having interfaces with FGD PLC for limited control & monitoring of parameters. Local control panels will be provided at strategic points (including material unloading, all major equipment & sub-system) to allow for local operation of the plant.
- 2.05.00 Control & monitoring of electrical distribution system, namely PCC, bus coupler, incomer etc. for FGD system shall also be controlled from the PLC based control system for FGD as well as from respective switchgear unit.
- 2.06.00 Refer Drawing no. 17A14-DWG-I-001 (Control System Configuration Diagram for FGD Plant) for overall control system architecture for FGD plant.
- 2.07.00 The Local Control Room near chimney for FGD Plant System shall be partitioned to different rooms to house the following equipment in general.
- a) Control Desk for Operator Stations, Operator cum Engineering Stations, Printers and associated furniture in the Operation Area
 - b) System cabinets & Marshalling cabinets in the Electronic Cubicle Room adjacent to Operation Area
 - c) Uninterrupted Power Supply System (UPS) in UPS Room
 - d) Battery Room
- 3.00.00 **GENERAL PERFORMANCE REQUIREMENT**
- 3.01.00 All instruments and control equipment shall be guaranteed to meet the performance, functional and accuracy requirements enumerated in different sections of the specification.
- 3.02.00 Control & Instrumentation system shall be proven design and from the latest state of the art technology. Any predictable or planned deterioration and / or obsolescence of equipment shall be clearly brought out in the bid.
- 3.03.00 All instruments / equipment shall be capable of performing satisfactorily in continuous commercial operation conforming to all relevant codes and regulatory requirement under the specified environmental conditions and operating conditions described or implied in this specification without undue heating, vibration, wear, corrosion or other such operating troubles.



- 3.04.00 Instrumentation & Control system shall not impose any limitation or constraint on the operation of the main equipment. It shall be possible to utilize any in-built over capacity in design of any equipment with complete controllability and observability.
- 3.05.00 Mean Time Between Failure (MTBF) of the instruments shall be considerably higher than the equipment they shall cater to in order to avoid shutdown on account of instrumentation failure.
- 4.00.00 **PROVEN PRODUCT**
- 4.01.00 All equipment, systems and accessories furnished under this specification shall be from the latest proven product range of a reputed experienced manufacturer whose successful performance has been established by a considerable record of satisfactory operation in similar plants. Bidder shall furnish satisfactory evidence regarding successful operation and high reliability of the proposed equipment / systems in similar applications for meeting this requirement as specified elsewhere.
- 5.00.00 **WARRANTY**
- Refer Vol IIA of specification.
- 6.00.00 **DESIGN CRITERIA**
- This section lays down the general design criteria to be adapted in designing the instrumentation and control system of the FGD plant.
- 6.01.00 **General**
- 6.01.01 Instrumentation, control and automation shall be designed manufactured and installed taking into consideration the philosophy to satisfy the following requirements:
- a) State-of-the-art proven technology.
 - b) Maximum safety for plant personnel & equipment.
 - c) Reliable and efficient operation under all operating condition.
 - d) High system availability by introduction of adequate redundancies at various levels and low down time.
 - e) Diagnostics capability to pinpoint failure areas.
 - f) Use of public domain software and hardware for easy up gradation.
 - g) System flexibility and modular expansion capability. Modular System design shall be adopted to facilitate easy system expansion. The system shall have the capability and facility for hardware expansion through the



addition of controller modules, I/O cards, peripherals etc., while the existing system is fully operational.

- 6.01.02 Instrumentation, control and automation devices and accessories shall be designed with the following considerations:
- a) Stable in spite of temperature fluctuations.
 - b) Able to withstand high humidity.
 - c) Weather proof.
 - d) Dust proof.
 - e) Corrosion resistant.
 - f) Erosion resistant.
 - g) Able to withstand high vibration.
 - h) Easily accessible for operation & maintenance.
- 6.01.03 Latest version of hardware and software available at the time of system designing shall be provided. In case of future up-gradation of software, Bidder shall remain committed to upgrade the supplied system with the new version within the warranty period, without any additional cost.
- 6.01.04 Bidder shall ensure that supplied controls & instruments should be supported by the supplier such that spare parts are guaranteed to be available for purchase for a period of 15 (fifteen) years. Similarly the service shall also be guaranteed for a period of 15 (fifteen) years.
- 6.01.05 For the sake of completeness of the system for each application and in order to ensure desired performance & safety measures, any hardware or software item as required, shall be in the scope of Bidder irrespective of their explicit or implicit inclusion in the accompanying document. Bidder shall be responsible for proper functioning of the system as a whole or any part thereof and shall render guarantee for all addition/deletion.
- 6.01.06 Control systems shall have their independent redundant Electronic Earth pits for system grounding. These earth pits shall be separate from the Electrical earth pits and located away from the HT equipment. FGD control system (PLC based) shall have independent redundant Electronic & Electrical Earth pits.
- 6.02.00 **Standardization and Uniformity of Hardware**
- To ensure smooth and optimal maintenance, easy interchangeability and efficient spare parts management of various I&C instruments / equipment, the Bidder shall make reasonable efforts that all instruments / devices are of the same make, series and family of hardware. For example, all 4-20mA



electronic transmitters / transducers, control hardware, control valves, actuators and other instruments / local devices etc. being furnished by the Bidder for entire FGD Systems shall be of the same make and series for similar applications, except for the instrument integral to equipment such as Compressor etc. which may be manufacturer specific.

6.03.00 Reliability & Availability

6.03.01 All components and systems offered shall be of established reliability. The minimum target reliability of each component / module shall be established by taking into consideration its Mean time between failure (MTBF) and Mean time to repair (MTTR), such that the availability of the complete system is assured for 99.7%.

6.03.02 In order to establish the target reliability, Bidder shall perform necessary availability tests for major systems. Burn-in / Elevated Temperature test reports, not older than 5 (five) years shall be furnished for Owner / Consultant review. Surge protection for solid state systems, selection of proper materials, manufacturing processes, quality controlled components and parts, adequate derating of electronic components and parts shall be ensured to meet the reliability and life expectancy goals.

6.03.03 Redundancy and continuous self-checking features shall be incorporated in system design with automatic transfer to healthy redundant circuits to enhance the reliability of the complete system.

6.03.04 To ensure availability, adequate redundancy in system design shall be provided at hardware, software and sensor level to satisfy the availability criteria of 99.7%. For the protection system, independent sensing device shall be provided to ensure adequate safety of plant equipment.

6.04.00 Operability & Maintainability

6.04.01 The system shall be designed such that any 'single-failure' should not lead to loss of availability of the plant, modification in operating routine or degradation of performance. This shall be achieved by judicious introduction of redundancy at all critical levels like providing redundant power supply, hot-standby multi loop controllers, redundant IO modules (for all critical application), redundant IO network and data highways, redundant communication modules, duplicating console functions and servers and redundant field instruments. The plant operator remains totally transparent to 'single-failures'.

6.04.02 Control system shall be designed in a fail safe mode so that loss of signal, loss of excitation, loss of motive power or failure of any component shall not cause a hazardous condition for the plant & personnel and at the same time prevent occurrence of false trips. All modulating control valves shall be in stay put condition during any of the above failures.

6.04.03 Control consoles shall be designed for operation of the FGD system with

minimum operational manpower deployment. Bidder shall ensure proper operability and also take into account protections to minimize accidental mal-operations.

6.04.04 On-line testing, self-checking & diagnostic facility of control system shall be provided with indication for easy identification of the faulty module, while the unit is in operation. The system shall continuously check health of its modules including its redundant part and shall permit carrying out of the on-line dynamic test and self-diagnostic checks while maintaining safe condition without endangering the safety of equipment and without having any influence on the process being controlled.

6.04.05 Intercommunications in between sub-racks and system termination cabinets and in between sub racks and other panels shall be made by prefabricated connectors and cables with mechanical latch.

6.05.00 **Security and Failure Philosophy**

6.05.01 **General**

Control & instrumentation system shall meet the following requirements:

- a) No single failure shall cause the complete failure of the control.
- b) No single fault shall cause the protection system to spuriously operate or cause the protection system to become inoperative or / cause a trip or derate the unit.
- c) Due to control system failure if a final control element or plant item does not respond then that item or control element shall go into a fail-safe condition or in stay put condition as per the process requirement.
- d) Measure shall be taken on the action of IO due to loss and restoration of power. For example dual outputs such as separate start and stop outputs for motor starters / breakers etc. shall be provided.
- e) Fault on a cable does not cause loss of more than a minimum tolerable functionality of the system.

To meet the above requirement, control system shall incorporate redundancy with continuous self checking so that any internal fault can be detected prior to resulting any disturbance in the process. Protection and safety systems shall incorporate both channel redundancy and measurement redundancy with self checking and adequate test facilities.

Redundancy of components and systems shall be dictated by availability criteria to ensure the system availability target as well as safety considerations are fully met.

6.05.02 **Measurement & Channel Redundancy**

To meet the failure and self-checking criteria for the control system, measurement redundancy shall be provided for all the critical parameters.

Throughout the control system the security and validity of signals are to be ensured adhering to the following design principles.

- a) Where a plant measurement is to be duplicated or triplicated such signals shall be separately fed to the different input modules.
- b) Signals after the security and validity checking by means of voting, averaging, median, difference monitoring or similar technique shall be transmitted to the control functions of sequencing, modulating and protection.
- c) Where double measurements are used, provision shall be made for the selection of either measurement as the duty signal and continuous monitoring of difference between the signals.
- d) For binary and analog inputs, which are required for protection of more than one equipment as well as protection signals for HT drives, triple sensing devices / signals shall be provided.
- e) For binary and analog inputs required for other modulating control, protection and interlock conditions purpose of their equipment and other critical monitoring applications etc. minimum dual instruments/sensors shall be provided.
- f) Dual instruments / sensors shall be provided for instruments required for auto-starting of pumps or pump tripping due to discharge pressure very low.
- g) Measurement system, CLCS and OLCS shall all be configured with redundancy at processor modules, communication modules, data bus and power supply modules. All servers shall be dual redundant.
- h) Redundancy in input / output modules
 - i) Wherever redundant sensors are employed each sensor shall be wired to a separate input module so that even if one input module fails, the parameter shall be available from the other input module.
 - ii) Redundancy in input / output module shall be provided for all HT (11KV & 3.3 KV) drives, critical LT drives and critical modulating control drives so that any single failure of the input / output module shall not lead to the failure / disturbance of process. Critical LT drives/ modulating control drives shall be finalized by the Owner / Consultant at the time of Detail engineering.

i) **Data Highway Redundancy**

There shall be Redundancy in the system for high reliability of communication. The redundant buses shall work continuously. All communication modules, bus couplers, bus interfaces etc. shall also be hot redundant.

Communication between the operator station and the PLC control processors shall be by means of hot redundant data highways. Redundancy failure shall also be indicated in operating station.

All soft links amongst various PLC / proprietary control systems / Station DCS shall be redundant.



j) Redundancy for Power supply unit

All power supply feeders from UPS (in parallel mode having 50% load sharing) shall be redundant with auto changeover in each ACDB / DCDB panel. Any kind of bulk power supplies if used shall be redundant.

k) Redundancy in Operator Console

Operators' Consoles shall have fall back feature so that in case of failure of any console, its functions can be taken up in an adjacent console.

6.05.03 Each C&I cables shall have at least 20% or one no., whichever is maximum, spare wire capacity above the used cores for future maintenance.

6.06.00 **Instrument Accuracy, Standard Scales and Ranges**

6.06.01 **Instrument Accuracy**

- a) Accuracy of linear instruments shall meet the specified accuracy over its span.
- b) Flow meter shall meet the specified accuracy criteria when operating between 25 and 100 percent of full-scale flow value. The accuracy guarantee shall include the effect of errors in the differential head measuring device, square root converter and signal generator.
- c) Level measurement shall be linear with respect to the measured level based on a specific gravity of 1.00.
- d) Wherever the measured parameter like flow is influenced by process pressure & temperature, required correction against pressure and temperature shall be introduced for such measurement.
- e) Temperature compensation shall produce corrections over a flow range from 10 percent to 100 percent of maximum flow subject to a plus or minus tolerance of one-half of one percent of the maximum flow.

6.06.02 **Instrument Scale Displays**

- a) All displays shall be in engineering units. Instrument scales displayed on screen shall have graduations with scale divisions based on multiples of 10. The smallest division shall preferably be a whole number approximately 1% of the scale range if not otherwise impracticable.
- b) Pressure instrument shall have the unit suffixed with 'a' or 'g' to indicate absolute or gauge pressure, respectively.

- c) Scales and charts of all instruments shall have linear graduations

6.06.03 Instrument Ranges

Unless otherwise impractical, Instrument range shall be selected in such a way so that the normal reading lies within 50% to 70% of full scale for linear parameters and within 70% to 90% of full scale for flow measurements. Deviation indicators shall have the null position at mid-scale. The normal operating parameter shall be identified with a clear green mark.

6.07.00 Environmental Conditions

- 6.07.01 Control & Instrumentation system shall be suitable for continuous operation in the environmental condition as per the project metrological data provided elsewhere in the specification and shall meet the minimum design requirement of 50°C and 95% RH.

Equipment which cannot meet the stipulated environmental condition shall be installed in air conditioned environment..

- 6.07.02 Particulate contamination from fly ash and coal dust and gaseous contaminants such as SO₂ and other flue gas constituents in the plant can have deleterious effect on printed circuit board, connectors and components. This hazard shall be taken into design considerations.

- 6.07.03 Instruments, devices and equipment for location in outdoors/ indoor/ air-conditioned areas shall be designed to suit the environmental conditions indicated below and shall be suitable for continuous operation in the operating environment and also during periods of air conditioning failure without any loss of function, or departure from the specification.

SL. NO.	LOCATION	ENCLOSURE TYPE
1.	Indoor type non- ventilated enclosure in non-hazardous area	IP-54
2.	Indoor type ventilated enclosure in non-hazardous area	IP -42
3.	Enclosure in Air conditioned area	IP-32 with suitable canopy at top to prevent ingress of dripping water.
4.	Outdoor type in non-hazardous areas	IP-65 with anticorrosion coating.
5.	Outdoor in hazardous areas	As per requirements of the NEC Code for the location



6.08.00 Name plate

- 6.08.01 Each instrument / item of plant shall have nameplate, permanently attached to it in a prominent position, made of non-hygroscopic & non-corrosive material (generally stainless steel) upon which is to be engraved as per the existing philosophy.
- 6.08.02 Stainless steel tag plate shall be wired to the instrument. Inscription on equipment (labels) shall be in English.
- 6.08.03 Caution / Danger & Hazardous name plates shall be in English, Tamil & Hindi.

7.00.00 CODES AND STANDARDS

- 7.01.00 The design, construction and testing of all equipment, facilities, components and systems shall be in accordance with standards/ codes issued by Bureau of Indian Standards (BIS) and/or equivalent international standards/ codes. A non-exhaustive list of reputed international standards is given below:
- a) American National Standards Institute (ANSI)
 - b) American Petroleum Institute (API)
 - c) American Society of Mechanical Engineers (ASME)
 - d) American Society of Testing and Materials (ASTM)
 - e) American Water Works Association (AWWA)
 - f) American Welding Society (AWS)
 - g) British Standards (BS)
 - h) Deutsches Institut fur Normung (DIN), Germany
 - i) Heat Exchange Institute (HEI), USA
 - j) Hydraulic Institute Standards (HIS), USA
 - k) International Electro-technical Commission (IEC)
 - l) Institute of Electrical and Electronics Engineers (IEEE)
 - m) International Organisation for Standardization (ISO)
 - n) National Electric Code (NEC), USA
 - o) National Electrical Manufacturers Association (NEMA), USA
 - p) National Fire Protection Association (NFPA), USA
 - q) Tubular Exchanger Manufacturers Association (TEMA), USA
 - r) VDE association for Electrical, Electronic and Information Technologies (VDE), Germany

Other International Standards, equivalent or superior to the above Standards can also be adopted. However, in the event of any conflict between the requirements of the International standards / codes and the requirements of the BIS standards / codes, the latter shall prevail.

7.02.00 The following latest edition of codes and standards prevailing at the time of award of contract shall generally be applicable.

1) **Temperature Measurement**

- a) Instrument and apparatus for temperature measurement - ASME PTC 19.3 (1974).
- b) Temperature Measurement - Thermocouples - ANSI - MC 96.1 - 1982.
- c) Temperature Measurement by electrical resistance thermometers - IS: 2806
- d) Thermometer-element-Platinum resistance - IS: 2848 / DIN 43760.

2) **Pressure Measurement**

- a) Instrument and apparatus for pressure measurement - ASME PTC 19.2 (1964).
- b) Bourdon tube pressure and vacuum gauges - IS: 3624/1996.

3) **Flow Measurement**

- a) Instruments and apparatus for flow measurement - ASME PTC 19.5 (1972) Interim supplement, Part-II.
- b) Measurements of fluid flow in closed conduit - BS 1042.

4) **Electronic Measuring Instruments and Control Hardware**

- a) Automatic null balancing electrical measuring instruments -ANSI C 39.4 (Rev. 1973), IS 9319
- b) Safety requirements for electrical and electronic measuring and controlling instrumentation - ANSI C 39.5 / 1974.
- c) Compatibility of analog signals for electronic industrial process instruments - ISA-S 50.1: ANSI MC 12.1 / 1975.
- d) Dynamic response testing of process control instrumentation - ANSI MC 4.1 (1975) - ISA -S26 (1968).
- e) Surge withstand capability (SWC) tests - ANSI C 37.90A (1989), IEC / EN 61000-4-4 & IEC / EN 61000-4-5.



- f) Printed circuit boards – IPC-TM-650, IEC 326-2 & IEC 326-4.
 - g) General requirements and method of tests for printed wiring boards - IS-7405 (Part-I) /1994, IEC 326-2.
 - h) Edge socket connectors - IEC 130-11.
 - i) Requirements and methods of testing of wire wrap terminations-- DIN 41611 Part-2.
 - j) Dimensions of attachment plugs and receptacles- ANSI C73-1973.(Supplement ANSI C73a – 1980)
- 5) **Instrument Switches and Contacts**
- a) Contact Rating - AC services NEMA ICS Part-2 125, A-600
 - b) Contact Rating - DC services NEMA ICS Part-2 125, N-600
- 6) **Enclosures**
- a) Enclosures for Industrial Controls and Systems–NEMA ICS-6-110.15 through 110.22
 - b) Racks, panels and associated equipment -EIA: RS-310-B-1983 (ANSI C83.9 - 1972)
- 7) **Apparatus, Enclosures and Installation Practices in Hazardous Area**
- a) Classification of hazardous area - NEMA Article 500, Volume-6, 1978.
 - b) Electrical Instruments in hazardous dust locations - ISA-RP 12.11.
 - c) Intrinsically safe apparatus - NFPA Article 493 Volume-4 1978.
 - d) Purged and pressurized enclosure for electrical equipment in hazardous location - NFPA Article 496 Volume-4, 1978.
- 8) **Annunciators**
- a) Specifications and guides for the use of general-purpose annunciators - ISA 18.1- (1979) (R2004).
 - b) Surge withstands capability tests - ANSI C37.90 -1989 / IEC /EN 61000-4-4 & IEC /EN 61000-4-5.
- 9) **Interlocks, Protections**

- a) Relays and relay system associated with electric power apparatus - IEEE Standards 3.13.
- b) Surge withstands capability tests - ANSI C37.90 a - 1971 and IEEE Standard 472-1974.
- c) General requirements and tests for switching devices for control and auxiliary circuits including contactor relays - IS-6875 (Part-I)/1973.

10) **UPS System**

- a) Practice and requirements for semi-conductor power rectifiers - ANSI C34.2.
- b) Relays and relay systems associated with electrical power apparatus IEEE Standard - 3.13.
- c) Surge withstands capability tests - ANSI C 70.90 A/1971, IEC-255.4.
- d) Recommended practice for sizing large lead storage batteries for generating stations and sub-stations -IEEE-485.

11) **Control Valves**

- a) Control valve sizing (Incompressible fluids) - ISA-S39.1 / 1972.
- b) Control valve capacity test (Incompressible fluids) -ISA-S39.2 / 1972.
- c) Control valve sizing (Compressible fluids) - ISA-S39.3 / 1972.
- d) Control valve capacity test (Incompressible fluids) -ISA-S39.4 / 1972.
- e) Control Valve seat leakage – ANSI / FCI 70.2
- f) Face to face dimensions of Control Valves - ANSI B16.10
- g) Control Valve Capacity Test Procedure – ISA – 575.02

12) **Instrument Tubing**

- i) Seamless Carbon Steel Pipe - ASTM-A-106.
- ii) Forged carbon steel fittings - ASTM-A-105.
- iii) Dimensions of fittings - ANSI-B16.11.

- iv) Code for pressure piping, welding, hydrostatic testing - ANSI-B 31.1.
- v) Nomenclature for instrument tube fittings - ISA-RP 42.1 / 1982.
- vi) Seamless Stainless Steel Tube ASTM A-213 TP 316 / ASTM A-269 TP 316
- vii) Seamless Alloy Steel Pipe ASTM A 335 P22
- viii) Seamless Stainless Steel Pipe ASTM A-312 TP 316

13) **Cables**

- a) Thermocouple extension wires / cables - ANSI MC96.1.
- b) Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy-IPCEA S-61-402
- c) Guide for design and installation of cable system in power generating station (insulation, jacket materials)-IEEE Standard 422.
- d) Requirements of vertical tray flame test - IEEE 383
- e) Standard specification for tinned soft or annealed copper wire for electrical purpose - ASTM B33.
- f) Specification for PVC insulated (heavy duty) electric cables or (Latest revision) equivalent - IS-1554 Part-1
- g) Conductors for insulated electric cables and flexible cords or equivalent - IS-8130, 1984
- h) PVC insulation and sheath of electric cables or equivalent - IS-5831
- i) PVC insulated cables for working voltage upto and including 1100 volts or equivalent - IS-694 (Latest)
- j) Mild steel wires, formed wires and tapes for armouring of cable or equivalent - IS-3975
- k) Test on single vertical insulated wire or cable - IEC 332 (Part-1)
- l) Swedish Chimney Flame Test - SS 424-1475
- m) Test methods for insulations and sheaths of electric cables and cords - IEC 540



- n) Colour coding of instrumentation cables - VDE 0815
 - o) Minimum oxygen concentration to support candle-like combustion of plastics - ASTM D2863
 - p) Density of smoke from the burning of decomposition of plastics - ASTM D2843
 - q) Test on gases evolved during combustion of materials from cables - IEC 754
 - r) Determination of the amount of halogen acid gas - IEC 754 (Part-1)
 - s) Methods of test for cables - IS 10810
 - t) Drums for electric cables - IS: 10418
- 14) **Electronic Cards, Subassemblies and Components**
- a) **Unpackaged**
 - i) Vibration : IEC-68.2.6
 - ii) Shock : IEC-68.2.27
 - iii) Drop & Topple : IEC-68.2.31
 - b) **Packaged**

Vibration, Drop & Static Compression - NSTA.
 - c) **Electromagnetic Compatibility / Immunity**
 - i) Electrical Fast Transient immunity : IEC / EN 61000-4-4
 - ii) Surge Immunity : IEC /EN 61000-4-5
 - iii) Radiated Electromagnetic Field : EN 61000-4-3
 - iv) Electrostatic Discharge immunity : EN 61000-4-2
 - v) Electromagnetic Emissions : VDE 0871, Class-B
- 15) **Cable Trays, Conduits**
- a) Guide for the design and installation of cable system in power generating station (cable trays, support systems, conduits)- IEEE Standard 422, NEMA VE-1, NEC-1981. Test Standards NEMA VE-1-1979.
 - b) Galvanizing of carbon steel cable trays - ASTM A-386.



8.00.00 **GENERAL REQUIREMENTS**

- 8.01.00 Integrated Programmable Logic Controller (PLC) based closed loop control, open loop control and sequential control and bulk data acquisition system for FGD System in hierarchical levels has been envisaged for the plant.
- 8.02.00 Suggestive Control System Architecture for the FGD control system is schematically shown in Drawing No. 17A14-DWG-I-001. Bidder shall develop detail drawing based on this technical specification.
- 8.03.00 All field process transmitters shall be smart (HART based) type.
- 8.04.00 Final control device for regulating duty control shall have pneumatic actuator with HART based smart pneumatic positioners. Actuators for isolating and inching duty valves shall be, in general, electrical motor operated. Solenoid operated pneumatic actuator will be used for on-off duty control valves All the position limit switches employed in the pneumatic on-off valves shall be non-contact type.
- 8.05.00 Process switch (Pressure / Level switch) function shall generally be derived from analog process transmitters.
- 8.06.00 Process transmitter and valve positioner shall communicate with the PLC in the form of analog signal 4-20 mA DC along with superimposed digital signal through HART protocol. Separate handheld smart configurator shall be furnished for local and manual configuration / adjustment of all HART instrument / devices.
- 8.07.00 Power supply for Transmitters, contact interrogation, relay and solenoid shall be generally 24V DC. Power supplies for interrogation, relay and solenoid shall be provided from Bulk power supply modules separate from control system rack power supply. In all cases redundancy in power supplies & modules shall be considered.
- 8.08.00 Temperature measurement shall have upscale / down scale protection features to protect from process upset in case of sensor failure. Both the elements of duplex temperature sensors shall be brought to junction boxes.
- 8.09.00 Temperature transmitters shall be provided for all control applications. Transmitter shall be two wire type and current output of 4-20 mA DC with superimposed digital signal in HART protocol. For temperature monitoring functions, temperature elements (TC / RTD) shall be connected to their respective input module of PLC through instrumentation signal / Triad cable in case of RTD type element, extension / compensating cable for K type TC.
- 8.10.00 All alarm and trip signal shall be configured in NC mode of configuration so that any breakage in the wire can be identified with alarm.
- 8.11.00 Bidder shall be fully responsible for safe and efficient operation of the control



loops and interlock / protection logic even under all plant disturbances, disabilities, emergencies and component failures.

- 8.12.00 Critical maintenance purpose manual isolation valves of equipment, suction valves of critical pumps shall have open & close end position status indication at PLC.
- 8.13.00 All regulating duty control valves shall have mechanical position indicator and contact less position transmitter (4-20mA DC output) for monitoring the position from local and control room respectively. Air lock relays shall be provided with all regulating duty pneumatic drives to achieve stay put / fail safe condition on air failure. Hand wheel shall be provided for local operation. Pneumatic tubing for the control valve hook up including integral tubing of valve shall be of stainless steel material.
- 8.14.00 Motor winding temperature of HT motors and bearing temperature of HT motors & driven equipment shall be measured in all cases. In general bearing & winding temperature shall be measured with Duplex Resistance temperature detector (RTD).
- 8.15.00 Bearing temperatures of any equipment driven by H.T. motors shall be provided with direct mounted dial Temperature gauge at each bearing of driven equipment and motor.
- 8.16.00 All temperature-measuring elements (RTD / TC) shall be of duplex ungrounded type and both the elements shall be terminated at junction box. Extension / Compensating cable for TC and Triad cable for RTD shall be used for interfacing with PLC. Temperature elements shall be supplied with thermowell.
- 8.17.00 Flow Elements with Flow Transmitters & Flowmeter (Electro-magnetic type, Coriolis mass flow) for flow measurement of process medium like water, air, flue gas, slurry etc. shall be provided by Bidder based on application and as approved by Owner. Wherever DP type transmitter is used for flow measurement, square root extraction is to be performed in the PLC based system.
- 8.18.00 Pressure gauges, pressure switches and pressure / differential pressure transmitters shall be provided with diaphragm seal in case of dirty, corrosive & viscous fluid application. Diaphragm material shall be suitable for process fluid. Similarly the wetted part material for level transmitter / switches / gauges / analyzers in corrosive application shall have suitable grade material compatible with the corrosive fluid in contact. In all other cases material grade of the wetted part shall in no case be lower than stainless steel unless the process fluid calls for some other material.
- 8.19.00 Ergonomically & aesthetically designed furniture viz. control desks & chairs shall be provided at the local control room for various workstations. Similarly, furniture shall be provided for equipment like programming stations, PCs and various peripherals. Control desk and Video wall shall be from reputed



manufacturer/s. Local control room interior shall be designed with latest state of the art design prevailing in the modern power plant.

8.20.00 KKS identification system shall be adopted for the tagging. Bidder shall follow the KKS Tag numbering philosophy while preparing all instrumentation & control related documents.

8.21.00 The SI / MKS system of units shall be used for design, drawings, diagrams, instruments etc.

8.22.00 **Vibration Monitoring System**

Microprocessors based standalone online Vibration Monitoring System (VMS) shall be provided for rotating machine condition monitoring & diagnostic. On-line Vibration Monitoring System shall be provided for all HT drives (160 KW & above).

Each HT drive (160 KW & above) shall be provided with vibration sensors on the DE and NDE bearings of motors and fans / pumps. On each bearing there shall be two vibration sensors, one in X direction and other in Y direction along with key phasor for on line vibration monitoring and analysis.

Each vibration monitoring panel shall have local LCD display mounted on the panel.

8.23.00 **Process Connection & Instrument Hook Up (as applicable)**

Instruments	EQUIPMENT / PIPE SIDE	INSTRUMENT SIDE
Level Instruments		
Internal Displacer	4" – Flanged	4" - Flanged
External Displacer	2" – Flanged	2" - Flanged
Level gauge	¾" –Flanged	¾" - Flanged
DP Type	½" (min.)-welded 1" – welded for vessel like HP heaters, LP heaters, De-aerator etc. application	½"- NPT
External cage Level switch	1"- welded	1"- welded
Flow Instruments		

Instruments	EQUIPMENT / PIPE SIDE	INSTRUMENT SIDE
DP Type	$\frac{1}{2}$ " - welded in general 1" – welded for high pressure / temperature main steam, feed water, PRDS etc. application	$\frac{1}{2}$ " - NPT
Pressure Instruments		
Conventional	$\frac{1}{2}$ " (min.)-welded 1"- welded for high pressure/ temperature. application	$\frac{1}{2}$ " - NPT
Diaphragm type-HFO application	3"- Flanged	3"- Flanged
Temperature Instruments		
Thermowell	Generally - M 33 X 2 (M) $1\frac{1}{2}$ " Flanged- For air/FG path application	$\frac{1}{2}$ " NPT
Analyzer		
Liquid analyzer	$\frac{1}{2}$ " - 1" – welded	$\frac{1}{2}$ "

8.24.00 **Electrical Power Supply Systems**

240V AC Redundant Package UPS system with 60 minutes back-up to cater various C&I system loads in FGD control room including PLC, HMIs, field instruments / analyzers, Relay based Local Control Panel etc. and PLC / Proprietary control and monitoring system for package systems (if any), Vibration Monitoring System shall be provided by the bidder.

UPS Power supply (max. 1 kVA) required for the FGD C&I loads, located in main plant CCR, shall be made available to the bidder at purchaser's ACDB terminals as single redundant feeder. Cabling from the purchaser ACDB to FGD load points/ ACDB is under the scope of the bidder.

DC power distribution for PLC and loop-powered field instruments shall be derived from the UPS supply and the required DC distribution boards will be located within PLC cabinets. Any other DC power supply required for the plant will also be suitably derived and distributed. (UPS specification shall be covered

in Electrical Volume)

8.25.00 **Instrumentation & Control Cabling**

8.25.01 Instrumentation cables shall be copper, overall screened for binary signals and individual & overall screened for analog signals. All cables shall be FRLS type (inner & outer sheath) and armoured. Inter panel cables inside Control Rooms may be unarmoured. All the unarmoured cables shall run through conduits.

8.25.02 Fiber Optic cables in the field shall be laid through HDPE conduits for buried section and through dedicated encased perforated GI trays for over-ground section.

8.25.03 Bidder to follow the the following philosophy

- 1) DI & DO signal cannot be routed through the same cable.
- 2) Single pair or single triad cable is not acceptable. Minimum of 2 pairs or 2 triad cable shall be used.
- 3) Each multi-pair or multi-triad cable shall have 20% or minimum 1 pair / 1 triad cable whichever is maximum as spare.

8.25.04 Cable size & type shall be as below for different type of signals and control system shall be followed in general.

- 1) Cables for analog signals will be instrumentation paired cable of 0.5 sq. mm copper conductor size, with individual pair shielding & overall shielding.
- 2) Cables for binary signals will be instrumentation paired cable of 0.5 sq. mm copper conductor size with overall shielding only.
- 3) Conductor cross section for triad signal cables will not have individual conductor cross section below 1.5 sq. mm.
- 4) For interposing relay drive connection individual conductor cross section will not be below 1.5 sq. mm.
- 5) Cables for power supply to each solenoid valves will be control cable of 3C x 2.5 sq. mm copper conductor size for all voltage level.

9.00.00 **TYPE TEST**

9.01.00 **General Requirements**

- a) The Bidder shall furnish the type test reports of all type tests as per relevant standards and codes as well as other specific tests indicated in this specification. List of major tests are furnished below for solid state equipment. For the balance systems & instruments, which are not indicated here, type tests may be conducted as per manufactures

standard or if required by relevant standard.

- b) The Bidder / sub-vendor / manufacturer is required to conduct certain type tests specifically for this project as specified in respective sections and to be witnessed by Owner / Consultant or their authorized representative, even if the same had been conducted earlier. In case Owner / Consultant decides to waive any of the Type tests for any item based on tests conducted by Bidder in the last five years, Test certificates for same shall be provided for review / acceptance and the final decision rests with Owner / Consultant.
- c) Submission of type test results and certificate shall be acceptable provided:
 - i) The same has been carried out by the Bidder / sub-vendor on exactly the same model / rating of equipment.
 - ii) There has been no change in the components of offered equipment from tested equipment.
 - iii) The test has been carried out as per the latest standards along with amendments.
- d) In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the Bidder within the quoted price and no extra cost shall be payable by the Owner on this account.
- e) The schedule of conduction of type tests / submission of reports indicating the test standard shall be submitted and finalized during pre-award discussion for Owner / Consultant's review & approval.
- f) For the type tests to be conducted, Bidder shall submit detailed test procedure for approval by Owner / Consultant. This shall clearly specify test setup, instruments to be used, procedure, acceptance norms (wherever applicable), recording of different parameters, interval of recording, precautions to be taken etc. for the tests to be carried out.

9.02.00 **Special requirements for Solid State Equipments& Systems**

The type tests reports, as a minimum, over and above the requirements of above clause which are to be submitted for each of the major C&I system shall be as indicated below:

9.02.01 **Electromagnetic Immunity as per EN 61000-6-22**

- a) Equipment furnished by Bidder shall incorporate necessary techniques to eliminate measurement and control problems caused by electromagnetic interferences especially encountered in power plant

environment. Equipment, which is vulnerable to such interference, shall be suitably immunized to eliminate possible problems.

- b) Required shielding, input balancing, ripple amplitude and grounding for field signals and for the control systems to achieve an installation with minimum noise coupling from all sources.
- c) Any additional equipment, deliverables required for effectively eliminating the noise problems shall be identified and included.
- d) Electromagnetic emission as per EN 61000-6-43

9.02.02 **Surge-Protection For Solid State Equipment**

All solid state systems / equipment shall be immuned and able to withstand the electrical noise and surges as encountered in actual service conditions inherent in a power plant. All the solid state systems/ equipments shall be provided with all required protections that needs the surge withstand capability as defined in ANSI 37.90a-1989. Hence, all front end cards which receive external signals like analog input & output modules, binary input & output modules etc. including power supply, data highway, data links shall be provided with protections that meet the surge withstand capability as defined in ANSI 37.90a. Complete details of the features incorporated in electronics systems to meet this requirement, the relevant tests carried out, the test certificates etc. shall be submitted along with the proposal. As an alternative to above, IEC / EN 61000-4-4 & IEC / EN 61000-4-5 for Electrical fast transient / burst and Surge immunity may also be adopted for SWC test.

9.02.03 **Type Test Requirement for C&I Systems**

Sl. No.	Item	Test Requirement	Standard	Test to be specifically conducted	Approval required on Test Certificate	Remarks
1.	Transducers	As per Standard	IEC-688, IS-12784	NO	YES	
2.	Thermocouples	Degree of Protection Test	IS-2147	NO	NO	
3.	RTD	As per Standard	IEC-751	NO	NO	
4.	C.J.C. Box	Degree of Protection Test Ambient Temp. effect	IS-2147 Approved Procedure	NO NO	YES YES	
5.	Electronic Transmitter	As per Standard	BS-6447 / IEC-770	NO	YES	



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Sl. No.	Item	Test Requirement	Standard	Test to be specifically conducted	Approval required on Test Certificate	Remarks
6.	E/P Converter	As per Standard	Mfr. Standard	NO	YES	
7.	Dust Emission Monitor	Degree of Protection Test	IS-2147	NO	YES	
8.	Instrumentation Cables Twisted & Shielded			YES	YES	
	a) Conductor	- Resistance Test - Diameter Test - Tin Coating Test (drain wire)	VDE-0815 IS-10810			
	b) Insulation	- Loss of mass - Aging in air ovens - Tensile Strength and Elongation - Heat Shock - Hot Deformation - Shrinkage - Bleeding & Blooming	VDE-0472 0472 ** VDE 0472 ** VDE 0472 ** VDE 0472 VDE 0472 IS-5831			** As per VDE 0207 for Teflon insulated cables
	c) Inner Sheath	- Loss of mass - Heat Shock - Cold Bend / Cold Impact Test - Hot Deformation - Shrinkage	VDE-0472 VDE 0472 ** IS-5831 VDE 0472 VDE 0472			



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Sl. No.	Item	Test Requirement	Standard	Test to be specifically conducted	Approval required on Test Certificate	Remarks
	d) Outer Sheath	- Loss of mass - Aging in air ovens - Tensile Strength and Elongation Test before and after ageing - Heat Shock - Hot Deformation - Shrinkage - Bleeding & Blooming - Colour Fastness to Water - Cold Bend / Cold Impact Test - Oxygen Index Test - Smoke Density Test - Acid Gas Generation Test	VDE-0472 VDE 0472 ** VDE 0472 ** VDE 0472 ** VDE 0472 VDE 0472 IS-5831 IS-5831 IS-5831 ASTMD-2863 ASTMD-2843 IEC-754-I			
	e) Fillers	- Oxygen Index Test - Smoke Density Test - Acid Gas Generation Test	ASTMD-2863 ASTMD-2843 IEC-754-I			
	f) AL-MYLAR Shield	- Continuity Test - Shield Thickness - Overlap Test				
		Noise	IEEE			



Sl. No.	Item	Test Requirement	Standard	Test to be specifically conducted	Approval required on Test Certificate	Remarks
	g) Overall Cable	- Interference - Flammability - Noise Interference - Dimensional Checks - Cross talk - Mutual Capacitance - HV Test - Drain Wire Continuity	Transactions IEEE 383 IS 10810 VDE 0472 VDE 0472			
9.	Pressure Gauge	- Degree of Protection Test - Temperature Interference Test	IS-2147 IS-3624	NO NO	NO NO	
10	Temperature Gauge	Degree of Protection Test	IS-2147	NO	NO	
11	Pressure & Differential Pressure Switch	- Degree of Protection Test - As per Standard	IS-2147 BS 6134	NO NO	NO NO	
12	Level Switch	Degree of Protection Test	IS-2147	NO	NO	
13	Conductivity Level Switch	Degree of Protection Test	IS-2147	NO	YES	
14	Control Valves	CV Test	ISA 75.02	YES	NO	
15	Flow Nozzles & Orifice Plate	Calibration	ASME PTC, BS-1042	YES	NO	
16	PLCs	All tests as per IEC-1131	IEC-1131			
17	LIE / LIR / Junction Box	Degree of Protection Test	IS-2147	YES	YES	
18	Flue Gas O ₂	Degree of	IS-2147	NO	YES	



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Sl. No.	Item	Test Requirement	Standard	Test to be specifically conducted	Approval required on Test Certificate	Remarks
	Analyzer	Protection Test				
19	Flue Gas SO ₂ Analyzer	Degree of Protection Test	IS-2147	NO	YES	

10.00.00 TRAINING

10.01.00 Bidder's experienced personnel / engineers shall provide training courses on offered PLC, VMS or any other special instrument, to Owner's engineers in the following areas:

- a) Operator training
- b) Hardware maintenance training
- c) Software training
- d) Any other specialized training as required for system operation and maintenance

10.02.00 The maintenance training shall include lectures and hands on experience on a similar type of equipment / system at manufacturer's works and / or training simulator. The details of hardware and software training shall be finalized during detailed engineering and shall be subject to Owner's acceptance.



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VOLUME : II-E

SECTION-II

SCOPE OF WORK, TERMINAL POINTS & EXCLUSIONS



Development Consultants Pvt. Ltd.

**Vol. II-E/Section-II
Scope of Work, Terminal Points
& Exclusions**



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VOLUME : II-E

SECTION-II

**SCOPE OF WORK, TERMINAL POINTS & EXCLUSIONS
INSTRUMENTATION AND CONTROL**

1.00.00 INTRODUCTION

1.01.00 Bidder shall provide all material, equipment & services specified or otherwise required within the scope boundary to fulfill the intent of specification and to integrate into a fully functional Instrumentation and Control system ensuring operability, maintainability and reliability described in this specification.

1.02.00 Wherever quantity is indicated, the same refers to only one set per generating unit to be furnished by the Bidder, unless specifically indicated otherwise.

2.00.00 SCOPE OF SUPPLY

The brief scope of supply has been described in the following clauses of this section. Any other equipment / system required for ensuring the safe, reliable and trouble free operation of the FGD plants under the present scope of work shall be provided by Bidder.

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

2.01.00 FGD CONTROL SYSTEM

2.01.01 Programmable logic controller (PLC) based control system with hot redundant controller, redundant power supplies, I/O cards and redundant communication modules for FGD plant of each unit and common systems. The control room shall be common for both the units. The scope of supply shall include but not limited to following: (Control system shall be unit wise; however the workstations shall be common to both units)

- a) Three (3) sets of Redundant, Hot Standby PLC systems [one (1) set for Unit # 1, 1 set for Unit # 2 and one (1) set for common system like water and other raw material handling system].
- b) Two (2) nos. Engineering cum Operator Workstations, two (2) nos. Operator Workstations & one (1) no. colour A3 and one (1) no. black & white A4 sized LJP.
- c) One (1) no. Historian.
- d) One (1) no. Engineering laptop with master software.
- e) Two (2) nos 70" or higher LED display with PC.





- f) One (1) no. remote Operator Workstation at Central Control Room.
- g) One (1) Remote Input/ Output (RIO) Unit for each unit to be located in CCR for obtaining data of existing compressors and other existing systems required for FGD system control.
- h) All Eight (6 workstations plus 2 LED display) PC shall be capable of individual operation and have separate software license.

2.01.02 Local control panels shall be provided as per process requirement at strategic points (including material unloading, all major equipment & sub-system) to allow for local operation of the plant.

2.01.03 Relay based Control Systems in limestone unloading and feeding plant area for control of conveyors, vibrating feeders, crushers etc. shall be provided with interface to FGD PLC.

Relay based Control System(s) shall be provided with control desk and shall be complete with colored mimic, microprocessor based window type alarm Annunciator, Push Buttons, Indicators, Indicating Lamps & Ammeters.

2.02.00 **INTERFACE WITH STATION DCS**

2.02.01 Hardwired interfacing shall be provided with the existing Station DCS for time critical, interlock, control & protection signals. The quantity of Hardwired signals will be finalized during detailed engineering. The required cables, sub-trays etc, required for this hardwire interface is in the bidder's scope of supply.

2.02.02 FGD PLC shall also be connected to Station DCS through redundant communication link for the information exchange through Station wide LAN. FGD Bidder's scope shall include all cables and accessories required for connecting Bidder's FGD PLC up to Station DCS. One set of suitable interfaces and links for this connectivity shall be provided (Redundant OPC over Ethernet based TCP/IP) at both FGD PLC end & Station DCS end. Cubicles for mounting networking components and power supply distribution equipment shall be provided by Bidder on as required basis. The exact requirement shall be as finalized during detailed engineering.

2.02.03 Bidder shall provide all necessary interface hardware/software required for satisfactory operation of equipment covered under this specification. This shall include input / output modules, relays, isolators and other necessary hardware/ software for interfacing with station DCS and other C&I systems which are not in bidder's scope.

2.03.00 **VIBRATION MONITORING SYSTEM**

Vibration Monitoring System for HT motors & driven equipment for FGD plant





complete with all sensors, mounting pads, JB's, hardware, software, cable and accessories shall be provided by the Bidder.

2.04.00 **MEASURING INSTRUMENTS**

- (a) All primary instruments like process transmitters with HART Protocol, Temperature Elements (Thermocouple & RTD), Electro-Magnetic flowmeters, Ultrasonic / Radar type level transmitters, Pressure Transmitter, Differential Pressure Transmitter local indicators & gauges, thermowell, process switches, sensors, converters, totalizer, flow elements etc. required for control, operation and monitoring of the system / equipment being supplied by the Bidder in this package, shall be provided on as required basis meeting redundancy, availability & reliability requirements of the specification.
- (b) Sulphur-di-oxide (SO₂) at FGD inlet and outlet to control the treatment process.
- (c) Additionally, oxygen analyzer shall be provided to measure oxygen at the downstream of FGD system.
- (d) pH analyzer for solid lime or limestone (reagent) Feed control.
- (e) Density meters for Gypsum Solids / Density control
- (f) Belt protection / safety switches including pull cord switches, zero speed switches, belt sway switches, chute jam monitoring switches, Pull Chord & Belt Sway Monitoring System, Belt Weigher System etc.
- (g) Complete CEMS system at Chimney
- (h) All the instruments which are required but not specified, to implement the control philosophy as specified in corresponding Mechanical sections or as finalized during detailed engineering shall also be provided by the Bidder.
- (i) All instruments shall be supplied with valid calibration and test certificate provided by OEM.

2.05.00 **INSTRUMENTATION & CONTROL CABLE & ACCESSORIES**

- 2.05.01 All Instrumentation signal / triad cables twisted & shielded, PVC insulated & sheathed with FRLS properties, including thermocouple extension / compensating cables and prefabricated cables (with plug-in connectors, power supply distribution cables, optical fiber cables with accessories like LIU, patch cord / pigtail, FO converter, terminators and any other special cables for C&I systems under FGD area shall be supplied, terminated and





laid by the Bidder on as required basis.

2.05.02 Broadly, the philosophy for cabling scope shall be as follows:

- All cabling & interconnection required in-between Bidder's supplied instruments / cabinets / panels / enclosures / equipment / MCC / SWGR etc. shall be provided by the Bidder. All cables, accessories and associated works are under the scope of Bidder.
- When one end terminal is in the scope of Bidder and other end belongs to Owner's instruments / systems / cabinets / equipment etc., corresponding cable shall also be supplied and laid by the Bidder.

2.05.03 Pneumatic and motor operated Control valves / on-off valves and dampers along with actuators, smart positioners, limit & torque switches, hand-wheels, volume boosters, solenoid valves, position transmitters & accessories.

2.06.00 **POWER SUPPLY SYSTEM**

2.06.01 Isolation, conversion and distribution of UPS, DC and non-UPS (Utility) power supply to all instruments, system panels, consoles etc shall be in Bidder's scope.

2.06.02 UPS Power supply (max. 1 kVA) required for the FGD C&I loads, located in main plant CCR, shall be made available to the bidder at purchaser's ACDB terminals as single redundant feeder. Cabling from the purchaser ACDB to FGD load points/ ACDB is under the scope of the bidder.

2.06.03 Bidder shall provide power supply distribution panels / cabinets / boxes for sub-distribution of UPS / Utility feeders on as required basis. The power supply distribution box shall include change over circuitry, static switches, fuse units / MCBs, terminal blocks etc. suitable for application.

2.07.00 **FURNITURE**

Ergonomically designed control desks and furniture complete with all accessories and operator's chair in FGD local control room.

- a) Control Desk for Operator Workstations and LVS PC & Keyboard
- b) Computer Table for Operator cum Engineering Workstation and Historian.
- c) Printer Table (2 nos.)
- d) Locker Set (1 no.)
- e) Chair for all the work stations (OWS, EWS & Historian)

[Control Desk required for mounting FGD Remote Workstation located in the





Central Control Room shall be provided by owner.]

2.08.00 ERECTION HARDWARE

- 2.08.01 Process connection and piping materials comprising of stub, root valves, impulse pipes of different grades & stainless steel tubes, isolation & drain valves, valve manifolds, gauge valves, condensate pot, fittings, stands, brackets etc. as required for satisfactory installation of all field instruments like process transmitters, local switches, gauges etc.
- 2.08.02 Pneumatic hookup materials like stainless steel grade pneumatic tubes, fittings and isolating valves as required.
- 2.08.03 Erection hardware including junction boxes, canopies, structural steel etc. and consumables as required.
- 2.08.04 Conduit & accessories inclusive of all flexible & rigid conduits, perforated cable trays with top cover for main raceway and branches, pull boxes, inspection covers, bends, elbows, mounting brackets, clamps, nuts and bolts, glands, lugs, ferrules, connectors, markers, tray supports, tie wraps etc.
- 2.08.05 Rating Plates, Tag / Nameplates and Labels for all I&C items.
- 2.08.06 Complete Electronic & Electrical Earthing including Earth Pit for Bidder supplied I&C equipment / items shall be provided.
- 2.08.07 Consumables like printer cartridge, printer paper etc.
- 2.08.08 All other items as described in different sections of this specifications and any other C&I items required for safe & efficient operation of the plant.

3.00.00 SCOPE OF SERVICES

3.01.00 ENGINEERING AND OTHER SERVICES

- a) Bidder shall refer Lead Specification and Conditions of Contract for scope of services, in general.
- b) Participation of Bidder's personnel and experts as well as experts from their collaborator in discussion with Owner / Consultant and other equipment Vendors during various stages of contract implementation as required by Owner to achieve desired C&I system configuration and performance.

- 3.02.00 Bidder shall include all other necessary services as required like obtaining licenses, statutory clearances for pollution etc. in his scope.

3.03.00 SCOPE OF ERECTION





In general all items supplied by Bidder shall be erected by Bidder. Sound engineering practice of international standard shall be adopted throughout. Erection services shall be verified by the Owner site engineer / consultant on the basis of the approved Field Quality Plan (FQP) .Scope of works shall not be limited to the following:

- a) Installation of equipment, system, control room panels, desks, cabinets, junction boxes, instruments, gadgets and other accessories supplied as per this specification.
- b) Cable interconnection amongst different panels/cubicle/field instruments etc. including with third party systems.
- c) Installation of field mounted instruments and devices including primary elements along with impulse pipe laying and wiring etc. Installation of thermowells at the stubs provided at the tapping points.
- d) Installation of all transmitter racks & enclosure, cubicles, brackets, laying of impulse pipes and cable termination etc.
- e) Hook up of pneumatic tubes and interconnection between air supply point and all accessories of final control element as required.
- f) Laying of all cables including erection of sub-trays, G.I. conduits along with accessories, termination and ferruling at both ends of all cables laid.
- g) Termination & testing / checking of cable.
- h) Supply of the erection hardware, consumables, tools and tackle, test instruments and deployment of experienced personnel needed for completing the erection.
- i) Painting of site mounted structures and impulse lines after completion of erection.
- j) The JB / Instrument, numbers / KKS codes are to be written, with white paint on red background
- k) Providing a tentative programme of manufacture, erection, testing and commissioning.
- l) Erection activities shall comply with stipulated project schedule.
- m) Unloading, Storage of materials at site, transportation to site.
- n) Flanges in all process area (within their battery limit) both process & counter flanges shall be provided by the bidder.
- o) Excavation works for electronic earth pits, Installation of electronic grounding pits, Installation of risers, protection brickwork upto three (3) feet above ground, covering with MS chequer plates, painting of cover plate, laying & termination of grounding wires and grounding of panels, cabinets. Earth resistance shall be measured in presence of Owner's Engineer and shall be displayed next to the earthpit with date.

3.04.00

SCOPE OF TESTING, CALIBRATION & COMMISSIONING





Scope of works shall not be limited to the following:

- a) Testing / calibration / configuring / software development, loading, commissioning of instruments and systems as per the guidelines laid down in the specification.
- b) Setting up of site instrument laboratory equipped with testing equipment for running and maintenance of the plant and instruments needed to carry out the testing, calibration and commissioning
- c) Site modifications shall be documented and issued to Owner as design change notification and shall be signed by Owner. Subsequently, all such approved and agreed changes shall be incorporated in relevant design documents to elevate all documents to "As Built" status.

3.05.00 COMMERCIAL OPERATION, PERFORMANCE LIABILITIES, GUARANTEES

Major services to be rendered by Bidder on this account shall not be limited to the following:

- a) Trial operation, performing performance guarantee test, control system performance and system availability test, interfacing and co-ordination with other agencies, as indicated in relevant clauses of the specification.
- b) Satisfactory operation of the entire control and instrumentation system at varying loads .During this period, maintenance and supervision shall be in the scope of Bidder. Any defect or deficiency noted during this period shall be rectified by Bidder at no extra cost.
- c) Other requirements as indicated in the lead specification.

4.00.00 TERMINAL POINTS

- a) Station DCS Marshalling rack
- b) GPS Master & Slave Clock System.

Bidder to note that the terminal point for the Master Clock system shall be at Master Clock system (GPS Panel) located in main plant CCR. All the requirements for establishing connectivity with Master clock system are under the scope of the FGD bidder.

5.00.00 EXCLUSIONS

- a) Station DCS
- b) GPS Master & Slave Clock System

6.00.00 DRAWINGS AND DOCUMENTS

Bidder shall furnish system description, operational write-up, bill of materials,





drawings, data, information, technical catalogues, test certificates and other details to establish the proven-ness, capability and performance of the equipments and systems offered.

6.01.00 **DOCUMENT TO BE SUBMITTED WITH THE BID SHALL NOT BE LIMITED TO THE FOLLOWING:**

- a) FGD control system overview architecture with write up
- b) Bill of Materials of items indicating Make / Model
- c) Proposed GA of control panels, desks, system cabinets etc.
- d) Brief description of Type and Routine tests proposed to be carried out at shop and at site and write-up on the in-house quality assurance practice.
- e) List of reference of similar system in service with performance record.
- f) Sub-vendor's list.
- g) Details of training of Owner's personnel specifying duration of each course, number and category of personnel proposed to be trained in each course, location etc.
- h) Details of post-commissioning services
- i) Data / information as per "Bid Proposal Sheets (Technical Part)".
- j) Deviation list, if any.
- k) All other schemes, data, drawing, document required to establish product quality and completeness of supply.

6.02.00 **SUBMISSION OF DRAWINGS AND DOCUMENTS BY SUCCESSFUL BIDDER**

On award of the contract, the successful Bidder shall submit progressively, drawings and documents in multiple copies (as specified in Vol IA of Bid document) for approval of Owner / Consultant at different stages of the contract. Contractor shall obtain owner's approval in writing and manufacture the equipment as per these approved drawings and documents. Contractor shall revise the drawings in line with owner's comments and resubmit till approval is accorded. The drawings & documents shall not be limited to the following. After award of the contract contractor in association with owner will draw up a list of drawings, document / deliverables with corresponding submission schedule and will assign review status of either "A" (for approval) or "I" (for information) to each deliverable Also note that whether the review status is either "A" or "I", the bidder shall submit the same for approval. The review status "I" shall not deter the bidder from getting approval or revising the drawing/document in line with the owners comment.

A.	FGD PLC/ DCS		
1.	Overall configuration diagram of FGD control	:	I





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	system showing all components / modules, peripherals and network connections		
2.	Bill of Material FGD control system, System, mandatory spare quantities for each of the sub-systems of PLC indicating make, model no. etc.	:	I
3.	Design Philosophy for FGD control system	:	I
4.	Local Control Room Layout and Floor Opening requirements	:	I
5.	General Arrangement, Internal Arrangement of cabinets, control desk, furniture etc.	:	I
6.	Single Line Diagram for power supply requirements and distribution scheme of FGD control system (both UPS & 24V DC)	:	I
7.	Grounding Scheme of FGD control system	:	I
8.	Schematic / wiring drawings for all cabinets / systems.	:	I
9.	QAP / FAT / SAT Procedures for tests to be conducted	:	A
10.	Type Test result/ report/ certificate as applicable	:	A
11.	Input/ Output List	:	I
12.	Schedule of Alarms	:	I
13.	Sequence of Event Schedule	:	I
14.	Control loop & Control logic diagrams for control system and write-up	:	I
15.	Displays, Mimics, logs, reports etc. for HMI	:	I
16.	Hardware Design specification, Technical datasheet of all items including processors, modules, network components, peripherals etc.	:	Specification : A Vendor Final Datasheet: I
17.	System Software design manual including software listing	:	I
B.	MEASURING INSTRUMENTS		



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1.	Complete Bill of Material for all instruments including all necessary accessories etc. with mandatory spare quantities	:	I
2.	Technical datasheets for all instruments (transmitters, switches, gauges, analyzers, flow elements etc.) and other equipment like positioner, electrical transducer / meters / relays etc.	:	Specification : A Vendor Final Datasheet: I
3.	Control Valves (a) Datasheet / specification sheet of each control valve & its accessories (b) Sizing Calculation of each control valve (c) General arrangement, dimensional and edge preparation drawing (d) Complete Bill of Material of control valves & accessories with mandatory spare quantities (e) QAP and test reports as applicable (f) Piping & tubing diagram	:	Specification : A Vendor Final Datasheet / Other: I
4.	KKS codification of instruments	:	I
5.	Schedule of Instruments.	:	I
6.	Instrument Hook-up & Installation Drawing including Bill of Material and material specification of all accessories required for erection.	:	I
7.	Local Instrument Enclosures (a) Typical GA drawings (b) Outline and mounting drawings (c) Constructional details (d) Power Supply wiring (e) Grouping details	:	Specification : A Vendor Final Datasheet / Other: I
8.	QAP and test certificates of all instruments, wherever applicable.	:	A
9.	Sizing calculation of flow elements & thermowells	:	I
C	VIBRATION MONITORING SYSTEM		





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1.	Complete Bill of Material, Data sheets and technical details for each items such as sensors, JB, rack, cables etc. including Make / Model no. including Mandatory Spare quantities	:	Specification : A Vendor Final Datasheet / Other: I
2.	Vibration monitoring rack mounting drawing showing dimensional details	:	I
3.	Transducer mounting pad drawing, showing mounting hole and other mounting details	:	I
4.	Vibration monitoring system cabinets general arrangement drawing and floor cutout requirements	:	I
5.	Wiring Diagrams for vibration monitoring system	:	I
6.	Power Distribution Drawing including heat load & power supply requirement	:	I
7.	QAP and test certificate as applicable	:	A
D.	INSTRUMENTATION & CONTROL CABLE		
1.	Complete Bill of Material for all types of instrumentation cable and electrical accessories	:	I
2.	Technical datasheet of cables, junction box, terminal blocks and other electrical installation material furnished by Bidder	:	Specification : A Vendor Final Datasheet / Other: I
3.	Drive Interface Philosophy	:	I
4.	Cable Schedule & Interconnection Diagrams	:	I
5.	Junction Box Schedule	:	I
6.	I&C Grounding Scheme	:	I
7.	QAP and test certificate (as applicable)	:	A
E.	CONTROL DESK & PANEL		
1.	Complete Bill of Material for all control desk, panels, desk mounted items, LVS panel and local control panels. The bill of material shall include the accessories	:	I





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	associated with panel mounted items.		
2.	Design specification sheet of all panel / desk mounted items	:	Specification : A Vendor Final Datasheet : I
3.	Power supply requirements for all equipment	:	I
4.	General Arrangement & dimensional drawings and floor opening requirements	:	I
5.	Wiring Diagrams	:	I
6.	Furniture (a) Profile & dimensional drawing (b) Datasheet / catalogue	:	Specification : A Vendor Final Datasheet/ Other: I
G.	INTERFACE ENGINEERING DOCUMENTS		
1.	Interface with Master & Slave Clock System (a) Write-up on time synchronizing scheme and interface requirements with GPS Master Clock System	:	I
2.	Interfaces with Station DCS and other systems not in Bidder's scope	:	I
H	Operation & Maintenance Manual		I
I	As Built Drawings	:	I
J	Any other design data, drawings and documents prepared for this project but not specifically listed above.	:	I

For Drawing / Document to be submitted for Electrical Power Supply System, Plant Communication system relevant sections of the specification shall be referred.

6.03.00

FINAL DRAWINGS

- a) Bidder shall secure approval on the design drawings from Owner for the drawings that will be identified as approval category ("A"), in writing. Any





manufacture done prior to approval of the drawings shall be rectified in accordance with the approved drawings by Bidder at his own cost and the equipment shall be supplied within the stipulated period.

- b) Bidder shall furnish final drawings and documents in multiple hard and soft copies. Bidder shall furnish instruction manuals containing various components, sub-assemblies, method of installation, check-ups and tests to be carried out during erection and commissioning of the equipment. The manual shall also include instruction for step checking, trouble shooting and fault rectification for different components and sub-assemblies.
- c) Bidder shall incorporate all modifications in the drawings carried out at site during trial run, start-up performance and guarantee tests till hand over of the units to Owner and submit these final as-built drawings both in hard and soft copy.
- d) Final documents shall be submitted in proper bounded form. All catalogs and literature (including sub-suppliers' catalogs), datasheets, Instrument list, input output list, function control diagram, loop diagrams, configuration diagram, etc. shall be bounded together in indexed volumes. All O&M manuals shall be in handy size and neatly bound for carrying it to the work place.



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SECTION – III

TECHNICAL SPECIFICATION

INSTRUMENTATION AND CONTROL SYSTEM



Development Consultants Pvt. Ltd.

**Vol. II-E/Section-III
Instrumentation & Control
System**



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SECTION-III

INSTRUMENTATION AND CONTROL SYSTEM

1.00.00 FIELD INSTRUMENTS

This section provides general guidelines for field instruments, systems and equipment to be supplied under this specification, **as applicable for the Bidder's Scope of Work** for completeness of C&I system. All measuring instruments / equipment and systems / sub-systems offered by Bidder shall be from reputed experienced manufacturer of specified type and range of equipment, whose guaranteed and trouble free operation has been established. All instruments / equipment shall be of proven reliability, accuracy, repeatability requiring a minimum of maintenance and comply with the acceptable international standards. All instruments / equipment and accessories shall be supplied as per technical specifications, ranges, make as approved by Owner / Consultant.

All local gauges as well as transmitters, sensors, and switches for parameters like pressure, temperature, level, flow etc. and vibration transmitters as required shall be provided. In general, transmitters shall be provided for remote monitoring, alarm, interlock and control. Use of process actuated switches shall be avoided as far as possible unless the same is required as per manufacturer's standard & proven practice.

All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified.

For all instruments envisaged for corrosive liquid applications, they shall be provided with wetted parts made of Monel / Hastelloy C or any other material (if provenness experience of the proposed material for such applications is established by Contractor).

All instruments shall be provided with durable epoxy coating for housings and all exposed surfaces of the instruments. Anti-corrosive paint shall be applied to the field mounted enclosures / instruments.



1.01.00 **Pressure, Differential Pressure, Flow and Level Transmitter**

01.	Working Principle	:	Smart
02.	Type	:	2-Wire
03.	Output signal	:	Simultaneous transmission of digital and 4-20 mA DC signal. HART protocol.
04.	Signal Processing Unit	:	Silicon solid-state electronic circuitry
05.	Measuring element	:	Capsule/Diaphragm
06.	Element material	:	AISI-316 (Stainless Steel) or better
07.	Over Pressure	:	150% of maximum pressure
08.	Turn-down ratio	:	10:1 for vacuum / very low pressure application. 30:1 for other application
09.	Span and Zero	:	Continuous non-interacting tamper proof, remote as well as manual adjustable from instrument with zero suppression and elevation facility.
10.	Enclosure	:	Epoxy coated Die cast aluminium. IP-65 (Explosion proof for NEC Class-1, Division 1 area) with ½" NPT (F) cable entry.
11.	Output Indicator	:	LCD type
12.	Body	:	Forged Carbon Steel (SS for DM Water)
13.	Operating Voltage	:	24 V DC $\pm$ 10%
14.	Load	:	600 Ohms (min.) at 24 Volts DC
15.	Performance :-		
	a) Accuracy	:	$\pm$ 0.1 % of span or better
	b) Repeatability	:	$\pm$ 0.05 % of span or better
	c) Response time	:	250 msec or better



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- d) Zero & Span drift : 0.015% per Deg.C at max span
0.11% per Deg.C at min span
- e) Stability : 0.1% of calibrated span for six months
for ranges upto and including 70 Kg/
sq.cm.
0.25% of calibrated span for six months
for ranges more than 70 Kg/ sq.cm (g).
16. Process connection : ½" NPT (F)
17. Sealing / Isolation : Extended diaphragm with 5 meters SS
armoured capillary for corrosive, viscous
and dirty fluid applications. Material for
separator diaphragm, depending on
application.
18. Nameplate : Tag number and Service engraved in
stainless steel tag plate
19. Accessories : a) Installation accessories such as
mounting bracket, high tensile
carbon steel U-bolts suitable for
pipe mounting.
b) ½" NPT 2-valve stainless steel
manifold, constructed from
SS316 bar stock for pressure
transmitter.
c) ½" NPT 5-valve stainless steel
manifold, constructed from
SS316 bar stock for DP
transmitter. 3 valve manifold for
DP application in flue gas and
air.
d) Companion flange with nuts,
bolts and gaskets.
e) ½" NPT cable gland

1.02.00 Ultrasonic Level Transmitter

01. Principle of operation : Detection of reflected ultrasonic pulse





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02.	Signal processing	:	Microprocessor	Controlled	Signal Processing
03.	Type	:	Smart		
04.	Display	:	Large alpha-numeric back lit LCD/LED		
05.	Calibration & configuration:	:	Accessible from front of panel		
06.	Diagnostic	:	On-line		
07.	Status	:	For power, Hi / Lo / V. Hi / V. Lo-level indication, fault etc.		
08.	Construction	:	Plug-on board		
09.	Power supply	:	240 V AC 50 Hz / 24V DC		
10.	Signal Output	:	4-20 mA DC (isolated) - 600 Ohm load with HART protocol.		
11.	Hysteresis	:	Fully adjustable preferred		
12.	Output contacts	:	2SPDT Potential free changeover contacts @ 5A 230V AC.		
13.	Accuracy & Repeatability	:	0.25% of span or better		
14.	Resolution	:	0.1% of span		
15.	Operating temp.	:	Transmitter-55 o C and Sensor – 80 o C		
16.	MOC Sensor	:	SS 316 in general / PTFE, PP for corrosive application.		
17.	Humidity	:	1% to 95% non condensing.		
18.	Enclosure	:	IP-65 powder coated die cast aluminium		
19.	Cable connection	:	½" NPT with cable gland		
20.	Mounting	:	2" flanged for sensor and Transmitter on panel / surface.		
21.	Accessories	:	Cable gland, prefab cable, mounting accessories.		

Note : Sensors and transmitter shall be separately mounted.

1.03.00

Radar type Level Measurement





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01.	Type	:	Radar based on Time Domain Reflectometry / Pulse / FMCW as per application
02.	Antenna	:	Co axial / single rod type guided wave or Horn type as required for the application
03.	Communication	:	Two wire 4-20mA DC, HART protocol
04.	Enclosure	:	Explosion proof /IP 65 as per application
05.	Cable Entry	:	½" NPT
06.	Calibration	:	a) Self calibration with internal reference b) Zero & Span calibration
07.	Programming	:	Handheld programmer & Local keypad
08.	Process Connection	:	Flanged /screwed
09.	Electronic Housing	:	Epoxy painted Die-Cast aluminium alloy
10.	Antenna / Flange assembly:	:	316 SS or Hest alloy (as required)
11.	Output Indicator	:	Digital Integral Display
12.	Accuracy	:	5 mm or 0.1% of probe length
13.	Accessories	:	a) Programming tool kit, if required b) Gasket

1.04.00 Pressure Gauge and Differential Pressure Gauge

01.	Type	:	Bourdon/Bellows/Diaphragm
02.	MOC Sensing & Socket	:	AISI-316 SS
03.	Movement Material	:	AISI-304 SS
04.	Case Material	:	Stainless steel. Enclosure IP-65.
05.	Dial Size	:	Generally 150 mm (100 mm for SWAS gauges)
06.	Scale	:	Black lettering on white background in 270 Deg. arc.





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07.	Window	:	Shatterproof glass
08.	Range Selection	:	Normal process pressure – 50 ~ 70% of range (approximately).
09.	Over-range Protection	:	125% of maximum range by internal stop. External stop at zero.
10.	Adjustment	:	Micrometer screw for zero adjustment.
11.	Element Connection	:	Argon welding
12.	Process Connection	:	1/2" NPT (M) Bottom connection for local mounting, back connection for panel mounting.
13.	Performance	:	Accuracy of $\pm 1.0\%$ of span or better.
14.	Safety Feature	:	Blow out disc /diaphragm at the back
15.	Accessories	:	a) Snubbers and Glycerin filled for pulsating fluid applications. b) Stainless steel Diaphragm seals for corrosive, viscous and solid-bearing or slurry type process fluids. c) Gauge saver wherever required d) 3-Way stainless steel Gauge valve for pressure gauges. Process connection 1/2" NPT. e) 5-valve SS316 manifold constructed from barstock for differential pressure gauge. Process connection 1/2" NPT. f) Union, nut & tail piece and other Installation accessories as required.
16.	Applicable standard	:	IS-3624 / 1996
17.	Electrical Contact rating	:	Not applicable
18.	Nameplate	:	Tag number, service engraved in stainless steel tag plate





1.05.00

Pressure Switch and Differential Pressure Switch

01.	Type	:	a) Piston for high pressure application
			b) Bellow / Diaphragm for low pressure application
02.	Sensing element material	:	AISI SS-316. All other wetted part SS316.
03.	Case Material	:	Epoxy coated Die-cast aluminum alloy with neoprene gasket.
04.	Setter Scale	:	Required.
05.	Over range	:	150% of maximum pressure
06.	Adjustments	:	Internal Set Point adjustable over span
07.	Process Connection	:	1/2" NPT (M) bottom connected
08.	Switch configuration	:	One DPDT (Two SPDT)
09.	Switch Rating	:	240V, 5A AC/220V, 0.5A DC
10.	Switch Type	:	Snap acting, shock & vibration proof
11.	Terminal Block	:	Suitable for full ring lugs for cable connection.
12.	Cable connection	:	1/2" NPT conduit connection or compression gland.
13.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area).
14.	Performance	:	Repeat accuracy $\pm 1.0\%$
15.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
16.	Accessories	:	a) Remote diaphragm seal with SS-316 capillary for viscous & corrosive application. MOC of seal material shall be as per process fluid requirement.
			b) Retention ring and screws for surface mounting.





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- c) 1/2" NPT 2 Valve SS-316 manifold constructed from bar stock for pressure switch
- d) 1/2" NPT 3-Valve SS-316 manifold constructed from bar stock for DP switch
- e) 1/2" NPT cable gland

1.06.00 Level Switch

1.06.01 Type-1

- a) Type : External cage float operated, magnetically coupled
- b) Float material : AISI 316 stainless steel
- c) External cage &
other wetted part : AISI 316 stainless steel
- d) External cage mounting : Side Side, on standpipe
- e) External cage connection : 1" Flanged
- f) Switch housing : Epoxy coated die cast aluminum alloy with neoprene gasket conforming to IP-65.
- g) Enclosure class : IP 65
- h) Type of switch : Snap acting magnetically operated
- i) Switch configuration : 1DPDT
- j) Contact rating : 5A, 240VAC / 0.25A, 220V DC
- k) Accessories : Counter flange, nuts & bolts, suitable gasket etc.

Globe type Drain Valve.

1/2"NPT cable gland
- l) Application : Clean & non acidic fluid application in over ground tanks

1.06.02 Type-2

- a) Type : Float operated, magnetically coupled





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- b) Float material : Polypropylene
- c) Housing : Polypropylene
- d) Mounting : Side mounted.
- e) Process connection : 1/2" NPT (F) / Flanged
- f) Switch type : 1 DPDT
- g) Enclosure class : IP 65
- h) Contact rating : 5A, 240VAC/ 0.25A, 220V DC
- i) Cable meters (minimum) : Integral FRLS PVC stranded copper (5 meters (minimum))
- j) Application : Acid application in over ground tank

1.06.03

Type-3

- 01 Type : Capacitance type
- 02 Probe :
 - a) Rod or suspended electrode
 - b) Rope type probes may be used only where required probe length is greater than 1.5 meters.
 - c) Reference rod for non grounded tank.
- 03. Probe Mounting : 1-1/2" Flanged
- 04. Material of construction : 316 SS and to suit fluid type
- 05. Insulation : PTFE / PP / Kynar Part / Full as required
- 06. Enclosure : Powder coated Die cast aluminium with neoprene gasket conforming to IP-65.
(Explosion proof for NEC Class-1, Division 1 area).
- 07. Mounting : Probe on tap, switch unit separate on surface
- 08. Supply voltage : 240V AC $\pm 10\%$, 50Hz / 24V DC $\pm 10\%$,
- 09. Relay output : 2 SPDT
- 10. Contact rating : 5A min. at 240V AC on resistive load





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- 11. Response time : 100 msec or better
- 12. Cable connection : ½" NPT with cable gland
- 13. Accessories : Counter flange, cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.
Diagnostic & status LED on front of enclosure.

1.06.04

Type-4

- a) Type : Non-contact Ultrasonic type
- b) Signal processing : Microprocessor Controlled
- c) Display : Large alpha-numeric back lit LCD / LED
- d) Calibration & configuration : Accessible from front panel
- e) Diagnostic : On-line
- f) Status : For power, Hi / Lo / V. Hi / V. Lo-level indication, fault etc.
- g) Construction : Plug-on board
- h) Power supply : 240 V AC 50 Hz / 24V DC (UPS supply)
- i) Hysteresis : Fully adjustable
- j) Output contacts : Potential free changeover contacts @ 5A 230V AC.
- k) Repeatability : 0.25% of span or better
- l) Operating temp. : Transmitter-55° C and Sensor- 80° C
- m) MOC Sensor : SS 316 in general. PTFE, PP for corrosive application.
- n) Humidity : 95% non-condensing.
- o) Enclosure : IP-65 powder coated die cast aluminum
- p) Cable connection : ½" NPT with cable gland
- q) Mounting : 2" flanged





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- r) Accessories : Cable gland, mounting accessories.
- s) Application : Sludge pits and overhead tanks containing slurry, viscous and dirty fluid like slaked lime, lime preparation tank etc.

1.07.00 Gauge Glass

- 01. Type : Reflex or transparent. Resistant to mechanical shocks by steel armour.
- 02. Glass : Toughened borosilicate
- 03. Body material : forged Carbon steel / stainless steel as per process requirements
- 04. End connection : As per ASME PTC and drain /vent valve 15NB
- 05. Accuracy : $\pm 2\%$
- 06. Pressure rating : Twice the maximum working pressure
- 07. Scale : Linear vertical
- 08. Range selection : Covers 125% of max. of scale
- 09. Test Pressure : 1.5 times to the max. design pressure at 38°C
- 10. Housing : CS /304SS
- 11. Accessories : SS Ball check valves, gaskets, companion flange, SS drain and vent valve, nuts & bolts etc.

1.08.00 Sight Glass

- 01. Type : Flap-type
- 02. End connection : Screwed / Flanged
- 03. Material :
 - a) Body : SS-304
 - b) Cover Plate : SS-304
 - c) Indicator : SS-316
- 04. Sight Glass : Toughened Borosilicate





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- 05. Gasket : Neoprene
- 06. Bolts & Nuts : High tensile steel
- 07. Hydraulic Test Pressure : 1.5 times maximum working pressure
- 08. Accessories : As required

1.09.00 Temperature Gauge

- 01. Type : Bimetallic & all angle tiltable
- 02. Sensing Element Material: Bimetal strip helix
- 03. Stem Diameter : 1/4"
- 04. Stem Material : AISI 304
- 05. Thermometer connection to well : 1/2" NPT / SS 304
- 06. Case Material : Sturdy, corrosion resistant series 304 stainless steel case and bezel.
- 07. Dial Size : 5" in general
- 08. Scale : Anti parallax heavy gauge aluminum with white matte finish glare free. Black lettering on white background.
- 09. Pointer : Balanced, lightweight aluminum with matte black finish.
- 10. Dampener : Dampening pointer oscillation
- 11. Mounting : Surface with adjustable angle.
- 12. Over range Protection : 150% of range or more
- 13. Dial connection : Back connection with stem
- 14. Range : Normal temperature – 50 ~ 70% of range approximately.
- 15. Zero adjuster : Adjustable screw at back.
- 16. Window : Shatterproof glass.
- 17. Accuracy : ±1 % or better (Grade A / ASME B40.3)





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18. Enclosure Class : IP-65
19. Accessories : a) Forged/bar stock thermowell screwed as per ASME PTC code. Process connection M 33X2 (M).

Material of construction of Thermowell:

- SS 316: In general
- Inconel: For flue gas application
- Tungsten carbide: For lignite mill application.

Bidder shall provide Wake frequency calculation for thermowell as per ASME PTC 19.3 (latest edition).

- b) Installation accessories as required.

20. Nameplate : Tag number, service engraved in stainless steel tag plate

1.10.00 Thermocouples

01. Type : a) Type-K (Chromel-Alumel)
b) Duplex
c) Ungrounded
02. Wire gauge : 16 AWG for Type-K
03. Standard : ANSI-MC 96.1 for thermocouple
04. Protecting Tube :-
- a) O.D. : 8 mm
 - b) Material : 316-SS Seamless
 - c) Filling : Magnesium Oxide (Purity above 99.4%)





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05. Characteristics : Linear with respect to temperature within $\pm 1\frac{1}{2}\%$ of top range value
06. Accuracy : As per IEC 751 / ANSI MC 96.1 (special class)
07. Head :
- a) Type : IP-65 universal screwed type. (Explosion proof for NEC Class-1, Division 1 area)
- b) Material : Epoxy coated Die cast aluminum or better
- c) Terminal blocks : Nickel plated Brass - screw type/ silver plated
- d) Instrument connection to well : $\frac{1}{2}$ " NPT
- e) Cable connection : $\frac{1}{2}$ " NPT gland and grommet.
- f) Others : Terminal head cover with SS chain and suitable gasket
08. Accessories : a) Adjustable nipple-union-nipple [1/2" Sch 80 X $\frac{1}{2}$ " NPT (M)] with thermowell connection
- b) Compression fittings/unions
- c) Flanges etc. (for flanged connections only)
- d) Forged/bar stock thermowell as per ASME PTC 19.3 code. Process connection M 33X2 (M) in general or $1\frac{1}{2}$ " Flanged for Flue gas/ Air etc. application.
- e) Material of construction of Thermowell:
- SS 316: In general
 - Inconel: For flue gas application
- Bidder shall provide Wake frequency calculation for thermowell as per ASME PTC 19.3 (latest edition).





09. Nameplate : Tag number, service engraved in stainless steel tag plate

Notes:

1. Extension cable exposed to atmosphere in the conventional method melts away due to high temperature, at the top of mill or due to lignite burning. Hence the terminals of temperature sensors shall not be at the top of mills itself. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB.
2. Thermocouples provided for steam services like MS temp, HRH, CRH, Turbine metal temp, super heater / de super heater area, where the process pipe is inside the insulation of boiler penthouse, Thermowells are inaccessible and terminal head and connecting cable cannot withstand high temperature, for such services thermocouples shall be provided with flexible extension SS316 Sheath of 10-15 meters.

1.11.00 Resistance Temperature Detector

01. Type : Platinum (Duplex), Ungrounded
02. Resistance : 100 ohm at 0 degC
03. Base : Wound on ceramic (anti-inductive)
04. Wiring : 3 /4 Wire
05. Protecting Tube :
 - a) O.D. : 8 mm
 - b) Material : SS-316, Seamless
 - c) Filling : Magnesium oxide (Purity above 99.4%).
06. Calibration : DIN 43760 Class A
07. Characteristics : Linear with respect to temperature within $\pm 1/2\%$ of top range value
08. Head :
 - a) Type : IP-65 universal screwed type. (Explosion proof for NEC Class-1, Division 1 area)
 - b) Material : Epoxy coated Die cast aluminum or better
 - c) Terminal blocks : Nickel plated Brass-screw type / silver plated



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- d) Cable connection : ½" NPT gland and grommet.
- e) Instrument connection to well : ½" NPT
- f) Others : Terminal head cover with SS chain and suitable gasket
- 09. Accessories :
 - a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT (M)] with thermowell connection
 - b) Compression fittings/unions
 - c) Flanges etc. (for flanged connections only)
 - d) Forged/bar stock thermowell as per ASME PTC 19.3 code. Process connection M33X2 (M).
 - e) Material of construction of Thermowell:

SS 316: In general
- 10. Nameplate : Tag number, service engraved in stainless steel tag plate

Notes: The specifications for RTDs of winding/ bearings of motor/ pump can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However, the type of RTD shall be PT100.

1.12.00 Field Mounted Temperature Transmitters

- 01. Working Principle : Smart
- 02. Type : Two wire
- 03. Input : Thermocouple K and RTD (Pt 100)-3/4 wire
- 04. Isolation : 500V AC
- 05. Output Signal : Simultaneous transmission of digital and 4-20 mA DC signal. HART protocol.
- 06. Signal Processing Circuitry : Microprocessor based Solid State Electronic





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07. Span and Zero : Adjustable in field, Non-interacting facility for elevation and suppression of zero.
08. Enclosure Class : IP-65 (Explosion proof for NEC Class-1, Division 1 area)
09. Output Indicator : LCD type
10. Span Adjustability : Yes
11. Nameplate : Tag number to be engraved on metallic tag plate rigidly fixed to the body.
12. Body : Die Cast aluminum
13. Operating Voltage : 16-48 V dc
14. Load : 600 Ohms at 24V DC (Min.)
15. Performance
- a) Accuracy : 0.4% of span
 - b) Repeatability : $\pm 0.05\%$ of span
 - c) Cold Junction Compensation : Built-in
 - d) Calibration : As per N.I.S.T Monograph 125 for T/C and European Curve Alpha = 0.00385 for RTD
16. Accessories :
- a) Universal mounting bracket suitable for pipe and surface mounting.
 - b) Hi-tensile Carbon Steel U-bolts.
 - c) $\frac{1}{2}$ " NPT cable gland

1.13.00 Temperature Switch

01. Type : Bimetallic / gas filled-in
02. Stem /Bulb Material : AISI SS-316
03. Capillary : SS Capillary & Flexible armour





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04. Case material : Epoxy coated die-cast aluminum alloy with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
05. Over range Protection : 120%
06. Instrument connection : Bottom
07. Setter Scale : Black graduation on white linear scale. Graduation 0-100% with red pointer for set points.
08. Switch configuration : One DPDT (Two SPDT)
09. Switch rating : 240V, 5A AC/220V, 0.5A DC
10. Switch type : Snap acting, shock and vibration-proof.
11. Adjustability : Internal Set point adjustable over span
12. Cable connection : ½" NPT conduit connection or compression gland.
13. Compensation : a) Capillary compensation with invar wire throughout the capillary length.
b) Case compensation
14. Performance :
a) Repeatability : < 1 % of full range
15. Capillary length : 3 meters (minimum)
16. Nameplate : Tag number, service engraved in stainless steel tag plate
17. Accessories : a) Forged thermowell, Mounting accessories,
b) ½" NPT cable gland.
c) Material of construction of Thermowell:
SS 316 : In general
Standard : ASME PTC 19.3

1.14.00 Not used.





1.15.00 Instrument Air System

The instrument Air Supply System for various pneumatic Control & Instrumentation devices like pneumatic actuators, power cylinders, I/P converters, pneumatically operated valves etc. shall be complete in all respect with necessary Air Filter Regulators, valves, piping/tubing etc. Each pneumatic instrument shall have an individual air shut off valve. The pressure-regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built in filter-housing blow down valve.

Filter shall be of minimum 5-micron size & sintered bronze material.

1.15.01 Air Filter Regulator

01.	Filter Element	:	Sintered Bronze
02.	Filter Size	:	5 microns
03.	Input Air	:	10.0 Kg/Sq. cm (maximum)
04.	Output	:	Adjustable from 0-2.5 Kg / Sq. cm and 0-7.0 Kg / Sq. cm (continuous) as applicable.
05.	Effect of Supply	:	Maximum 0.02 Kg/Sq. cm for a change pressure variation in supply pressure of 4 Kg/Sq. cm
06.	Bowl Material	:	Metallic.
07.	Accessories	:	2" dial size output pressure gauge
08.	Feature	:	No perceptible drop of pressure on opening the drain port.

1.15.02 Power Cylinders (Pneumatic)

01.	Mounting Type	:	a) Fixed position mounting (End mounting). b) True union mounting
02.	Control Signal	:	4-20 mA DC for modulating purposes. 24V DC operated solenoid valve operating on pneumatic line for open & closing purpose of on & off drive.
03.	Supply Air	:	0-7 Kg / Cm ² .





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04. Selection : Based upon thrust / torque, stroke length, angular movement, full-scale travel time, repeatability, space factor etc. Provision for air-to-open and air-to-close operation.
05. Casing : IP-55.
06. Accessories : a) Air lock relay
b) Hand wheel.
c) Air filter regulator with gauge.
d) Volume Booster.
e) Limit Switches.
f) Smart Positioner with Input and Output pressure gauges, local keypad & display.
g) Solenoid Valve
h) Integral non contact type position Transmitter (4-20 mA DC linear output).
i) Junction box with cable gland
07. Fail-safe operation : For regulating duty- stay put / Fail safe position against power & air fail.
08. Repeatability : Better than 0.5% of full travel.
09. Hysteresis : Less than $\pm 1\%$ of full travel
10. Travel time : Better than 20 sec.
11. Operating Temp. limit : 80°C (min.)

1.15.03 Electric to Pneumatic (E/P) Converters

01. Air Supply : 1.5 kg/cm²
02. Max. supply Pressure : 7 kg/cm²
03. Input Signal : 4-20 mA DC (as required by the design of control system).
04. Output Signal : 0.2 to 1.0 kg/cm²





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05.	Control Action	:	Air to Close, Air to Open and Fail freeze-field selectable.
06.	Response Time	:	5 seconds for 0 to 90% output pressure
07.	Repeatability	:	+/- 0.1% span typical
08.	Accuracy	:	+/- 0.25% span typical
09.	Linearity	:	0.5% of span or better
10.	Hysteresis	:	0.1% of span or better
11.	Ambient Temp. effect	:	Less than 0.02% of span per °C between -20 °C to +60 °C
12.	Supply pressure effect	:	Less than 1%
13.	Span and zero adjustment:		Screw
14.	Mounting	:	Close to Actuator (but not on the actuator)
15.	Output Capacity	:	To suit the actuator
16.	Protection Class	:	IP 65
17.	Allowable Drift Rate	:	± 2% of set point / hour maximum

On loss of control signal, the last set point pressure shall be maintained so that the associated control valve remains in stay put condition.

1.15.04 Smart positioner

01.	Type	:	Universal design (linear or rotary application)
02.	Input Signal	:	4-20mA DC, 2 wire loop with 24V DC.
03.	Output Signal (position F/B)	:	i) 4-20mA with HART Protocol ii) Configurable end position switch
04.	Supply Pressure	:	Single acting 1.2 to 7.0 bar Double acting 1.2 to 10.5 bar
05.	Air Delivery	:	Single acting 10.0 SCFM at 2.1 bar supply





Double acting 7.2 SCFM at 2.1 bar supply

06. Housing : IP 65
07. Repeatability : +/- 0.3% of span or better
08. Accuracy : +/- 0.1% of span or better
09. Communication : Hart protocol
10. Power-up with position control : < 150 ms or better
11. Power interruption without Reset : < 100ms or better
12. Body Material : Aluminium
13. Response Time : Less than 10 sec
14. Features :
 - i) Noncontact position feedback sensor
 - ii) Integral Electro-Pneumatic convertor
 - iii) Self calibration with tunable response time
 - iv) Online diagnostics
 - v) Pressure gauges to be provided on positioner (I/P & O/P pressure)

1.15.05 **Solenoid Valve**

01. Operating Principle : Electromagnetic (noiseless)
02. Coil voltage rating : 24V DC (in general) other 220V DC /240V AC /110V AC as per manufacturer recommendation.
03. Ways : 3 ways in general other depending on requirement
04. Port size : 1/4" NPT all ports
05. Body : SS Bar Stock
06. Trim : AISI SS-316





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07.	Manual Operator	:	In built
08.	Duty	:	Suitable for continuous energization
09.	Sealing	:	Airtight and leak proof
10.	Fluid Temperature	:	0-150 O C (approx.)
11.	Coil Enclosure	:	Stainless Steel
12.	Insulation	:	Class-H
13.	Coil Casing	:	IP-65 (Explosion proof for NEC Class-1, Division-1 area)
14.	Mounting	:	On pipe or on panel
15.	Cable Connection	:	½" NPT cable gland
16.	Accessories	:	Mounting brackets, nuts and bolts as required.
17.	Special feature	:	a) LED indication b) Double coil type.

1.15.06 Air Lock Relay

01.	Type	:	Single acting with actuator (spring return) and double acting with double acting piston cylinder
02.	Max. supply Pressure	:	7 kg/cm ²
03.	Set Pressure	:	1.4 ~ 7 kg/cm ²
04.	Ambient Temperature	:	-5 to 60°C
05.	Port Size	:	¼" NPT(F)

1.15.07 Position Limit Switch

01.	Type	:	Proximity type
02.	Temperature Range	:	-25 to 85°C
03.	Protection Class	:	IP-65





- 04. Switch configuration : 2 SPDT
- 05. Contact rating : 5A min. at 240V AC on resistive load

1.16.00 **Flow Elements**

1.16.01 **Orifice Plate**

- 01. Application : Low fluid velocity flow measurement
- 02. Design Standard : Concentric as per ASME PTC 19.5 (part-II), ISA RP-3.2 or BS-1042, Part-I
- 03. Tapings : Flanged weld neck. No. as required plus one additional pair of taps
- 04. Diameter Ratio : Between 0.4 to 0.7
- 05. Plate material : Stainless steel or better
- 06. Thickness : 3 mm for main pipe diameter upto 250 mm, 6 mm for main pipe diameter above 250 mm and 10 mm for main pipe diameter of 500 mm and above.
- 07. Meter run pipe : Same as main pipe material
- 08. Root valve : Globe type, Body same as main pipe material, trim ss or better
- 09. Impulse pipe : Same material as main pipe upto root valve
- 10. Document : Beta ratio calculation, assembly drawing and Flow vs. DP curve.
- 11. Accessories : Flanges, gaskets, nuts & bolts, root valves jack screw, meter run pipe, Drain & vent hole as per application etc.

1.16.02 **Flow Nozzle**

- 01. Application : High fluid velocity flow measurement
- 02. Design Standard : Long radius, welded type as per ASME PTC 19.5 (Part-III) or BS – 1042
- 03. Number of Tapings : As required plus one additional pair of taps





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04. Diameter Ratio	:	Between 0.4 and 0.7
05. Material	:	Stainless steel or better
06. Thickness	:	Suitable for the application
07. Meter run pipe	:	Same as pipe material
08. Tapping	:	D and D/2
09. Root valve	:	Globe type, Body same as main pipe material, trim ss or better
10. Impulse pipe	:	Same material as main pipe upto root valve
11. Document	:	Beta ratio calculation, assembly drawing and Flow vs. DP curve.
12. Accessories	:	Meter run pipe, nipples and root valves. (Inspection port assembly for nozzles used in plant performance purpose)

Bidder shall submit certified flow calculation and differential pressure vs. flow curves for each element for Owner's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Owner's approval. One Flow element of each type shall be calibrated in the test laboratory for validation of commutated flow calculations.

1.17.00 FGD System related Special Instruments

1.17.01 Conductivity Analyzer

A. Sensor

01. Type of Cell	:	Flow through type / removable type (withdrawable with sealing valve)
02. Conductivity Range	:	As per instrument schedule
03. Cell Constant	:	0.01 / 0.1 / 1.0 depending upon range
04. Temperature Compensation	:	Manual and Automatic (Integral) upto 0-100°C with PT-100 Sensor
05. Process Connection	:	Screwed
06. Wetted Parts	:	Electrodes SS 316L or better





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Insulators .KYNAR & VITON or better

07. Pressure Rating : 10 kg/cm²
08. Accessories : Vessel (SS 316) with ½" NPT connection.
09. Cable : Upto transmitter in flexible conduct

B. Transmitter

01. Type : Microprocessor based, Single stream with multi-range facility
02. Mounting : Flush Panel
03. Protection Class : IP-55 or better
04. Output : 4-20 mA DC (isolated) to a load of 600 ohms (min.)
05. Display
- i) Digital Display of process variable in Engineering Unit, Temperature, Alarm Status.
 - ii) Back lit LCD
 - iii) Character Height 12 mm
06. Zero / Span Adjustment : Front Panel Membrane type Keyboard.
07. Temperature Compensation : Manual or Automatic - selectable through keyboard
08. Diagnostic : Self diagnostic programme for electronics, measuring electrode, open wiring etc.
09. Alarm : Dual alarm set point (2 SPDT, high & low), hysteresis and time delay adjustable from membrane keyboard. Switch contact rating of 5 Amp, 240 VAC / 0.2 Amp, 220 VDC
10. Enclosure : Die cast aluminium epoxy coated
11. Cable Termination : Internal (cable entry through conduit)
12. Accuracy : ± 1.0 % of measured range





- 13. Response time : Less than 5 sec.
- 14. Stability : ± 1.0 % of full scale / month non-cumulative
- 15. Power Supply : 240 V AC, 50 Hz
- 16. Operating Temp. : 0 -50°C
- 17. Accessories : a) For cation conductivity analyzer Dual Ion-Exchange column, resin, etc. (minimum 12 months requirements).
b) Phenolic Nameplate, cable gland

1.17.02 pH Analyzer

A. **Sensor**

- 01. Type of Cell : Measuring and reference electrode combination with flow through type (polypropylene flow chambers).
- 02. Process Connection : Screwed
- 03. Type of measurement : Combination electrode
- 04. Temperature Compensation : Automatic (Integral) upto 0-100°C with PT-100 Sensor
- 05. Preamplifier : Integral or separate
- 06. Range : 0-14 pH
- 07. Measuring Electrode : Glass
- 08. Liquid Junction : Ceramic/Kyner or equivalent
- 09. Pressure Rating : 10 kg/cm²
- 10. Accessories : Vessel (SS 316) with ½" NPT connection
- 11. Cable : Upto transmitter in flexible conduct

B. **Transmitter**

- 01. Type : Microprocessor based, Single stream





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- with adjustable range facility
02. Mounting : Flush Panel
03. Protection Class : IP – 55 or better
04. Output : 4-20 mA DC (isolated) to a load of 600 ohms (min.)
05. Display
- i) Digital Display of process variable in Engineering Unit, Temperature, Alarm Status.
 - ii) Back lit LCD
 - iii) Character Height 12 mm
06. Calibration : Two-point calibration with standard buffer solutions.
07. Temperature Compensation : Manual or Automatic - selectable through keyboard
08. Diagnostic : Self diagnostic for “Calibration required”/ “Calibration O.K.”, electrode checking etc.
09. Alarm : Dual alarm set point (2 SPDT, high & low), hysteresis and time delay adjustable from membrane keyboard. Switch contact rating of 5 Amp, 240 VAC / 0.2 Amp, 220 VDC
10. Enclosure : Die cast aluminium epoxy coated
11. Cable Termination : Internal (cable entry through conduit)
12. Accuracy : ± 0.03 pH or better
13. Repeatability : ± 0.02 pH or better
14. Response Time : Less than 2 seconds or better
15. Stability : ± 0.001 pH / week
16. Power Supply : 240 V AC, 50 Hz
17. Operating Temp. : 0 - 50°C
18. Accessories : a) Ultrasonic Electrode Cleaner for





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uncleaned water.

- b) Phenolic nameplate giving tag number, service, cable gland etc.
- c) Pre-amplifier, special cable, ultrasonic cleaner, etc.
- d) Buffer tablets.

19. Preferred feature Self cleaning type sensor

1.17.03 Turbidity Analyzer

- 01. Type : Light reflection principle
- 02. Accuracy : 2 % Low range
5 % High range
- 03. Response Time : 5 Min (max) [90% of Full Scale]
- 04. Range : 0-100, 0-200 NTU programmable
- 05. No. of streams : Single
- 06. Output signal :-
 - a) Analog : 4-20 mA DC (isolated) into 600 ohms
 - b) Binary : Field adjustable High and low PF contacts.
- 07. Zero & span adjustment : Yes
- 08. Ambient temperature : 50°C
- 09. Indication : Digital
- 10. Enclosure Type/ Material : Weather & dust proof (IP 55) Die cast aluminum
- 11. Type of electronics : Microprocessor based
- 12. Calibration : Auto & manual
- 13. Error / Diagnostic : To be provided
- 14. Mounting arrangement : Panel mounted
- 15. Power supply : 240V AC, 50 Hz, 1 Phase UPS





16. Other requirement : All chemical reagents

1.17.04 **Non - Nucleonic (Vibration) Type Density Meter:-**

A Application : Liquid Density measurement

Detector

1. Orientation : As per requirement
2. Case Material : SS 316L/ Cast Aluminum alloy
3. Wetted part material : SS 316L
4. Operating Principle : Vibration Density measurement

Convertor

1. Output : 4-20 mA DC isolated
2. Electrical Connection : ½" NPT3
3. Enclosure Class : IP 65
4. Local Display : Digital 5 digit, density display with temp. compensation
5. Accuracy : +/- 1%
6. Response time : < 1 minute
7. Power Supply : 230 V AC, +/- 10%, 50 Hz. From UPS

1.17.05 **Density Indicator**

01. Type : Hydrometer
02. Wetted part material : Polypropylene or better
03. Body material : Polypropylene or better
04. Sight Glass chamber : Borosilicate
05. Accessories : Protection guard, assembly fixing nuts & bolts, needle valves, vent plug etc..



1.18.00 **Material Handling System related special instruments**

1.18.01 **Belt Protection / Safety Switches**

(a) **Zero Speed Switches**

It shall be provided for all belt drives or indirectly driven equipment and shall be two-wire, inductive, proximity type with local indication facility. Sensing distance range shall be 1 to 25 mm. The interconnecting cable length shall not be less than 3 meters. Following features shall be provided.

(a) Type	:	Microprocessor based
(b) Body	:	Cast Iron
(c) Type of enclosure	:	Die-Cast Aluminium
(d) Degree of protection	:	IP-65 Flame proof for NEC Class-2, Division-1 area
(e) Speed Setting Accuracy	:	Within $\pm 5\%$ of desired value
(f) Repeatability	:	Within $\pm 1\%$
(g) Differential	:	Within $\pm 5\%$ of set value
(h) Contacts	:	2 NO + 2 NC
(i) Contact Rating	:	Continuous 10Amp. (240V AC)
(j) Preferred Features	:	(i) Red LED for "Supply On" (ii) Green LED for "Relay On" (iii) Display of present speed (iv) Display of speed set (v) Alarm facility with indication (vi) Initial bypass time delay
(k) Reset facility	:	Manual



(l) Accessories : Canopy

(b) Belt Sway Switches

Auto reset type shall be provided (in pairs) for protecting all non-self-aligning conveyor belts and can be installed in vertical or horizontal position at no more than 30 Mtrs. Intervals. For any conveyor, however, minimum two pairs of switches shall be provided. These switches shall be placed not more than 15 M from either end of conveyor. Operating lever shall actuate micro switches with movement of 45° on either side. Contact roller support bearing shall be with high relative lubrication & low coefficient of friction. Local indicating lamp as a special feature is envisaged.

- (a) Type : Addressable type
- (b) Body : Cast Iron
- (c) Contacts : 2 NO+ 2 NC
- (d) Contact Rating : Continuous 10 Amp,
Breaking 2 Amp (240V AC)
- (e) Type of enclosure : Die-Cast Aluminium
- (f) Degree of protection : IP-65
Flame proof for NEC Class-
2, Division-1 area
- (g) Accessories :
 - (a) Canopy
 - (b) The Belt sway switches shall be provided with a common bridging push button which shall be kept pressed to bypass the limit switch before restarting the conveyor.

(c) Pull Cord Switches

Pull cord switches shall be provided for manual safety stopping of conveyors. Pull cord wire rope shall pass through cradle of switch. Movement of lever (45° on either side) shall actuate the pull cord switch. It shall be provided at every 30 Mtr. Distance on both sides along the belt conveyors and shall only be manually reset locally. The operating handle shall be fitted with spring steel rings at both ends.



From either end of conveyor pull cord switches shall not be more than 15 Mtr.

Area alarm horns/ hooters shall be provided at various strategic plant locations, which shall sound first, continuously for sufficient time to alert personnel nearby to move clear, before the device or sequence can be started.

i.	Type	:	Addressable type
ii.	Body	:	Cast Iron
iii.	Contacts	:	2 NO+ 2 NC
iv.	Contact Rating	:	Continuous 10 Amp, Breaking 2 Amp (240V AC)
v.	Type of enclosure	:	Die-Cast Aluminium
vi.	Degree of protection	:	IP-65 Flame proof for NEC Class-2, Division-1 area
vii.	Accessories	:	(a) Canopy over lever of pull cord switch (b) Adequate length of PVC wire rope (c) Linking of switches through a single cable for each section. (d) Each pull cord switch shall be provided with red LED indication lamp for prominent visible indication of tripping.

(d) Pull Cords & Belt Sway Indication System

Pull cord and belt sway switches of all conveyors shall be continuously monitored through "Pull cord & belt Sway Indication System". System shall display the exact location and number of safety switches operated in a pull cord and belt sway loop of a conveyor. It shall also monitor the condition of field cable connecting the switches in series & generate signal if field cable is found broken or short. The indicator panel shall display the operated switch number. Units shall be installed at respective Control System location (PLC / DCS / RIO). There shall be analog 4~20 mA DC or soft communication link with the FGD DCS / PLC System for remote monitoring of the switch status in the operator station. Systems shall have the diagnostic to detect faulty switch and damaged cable.



(e) **Chute Block Switch**

i.	Type	:	RF based
ii.	Sensor Material	:	SS-316
iii.	Mounting	:	Flanged
iv.	Insulation Material	:	PTFE
v.	Contacts	:	2NO+2NC
vi.	Type of Enclosure	:	Die-Cast Aluminium
vii.	Degree of Protection	:	IP-65
viii.	Electrical Connection	:	¾" ET
ix.	Repeatability	:	0.05%
x.	Local Indication	:	To be provided
xi.	Accessories	:	a) Neoprene gasket and Stud bolt b) SS Tag plate, Nickel plated brass double compression type cable gland.

1.18.02 **RF Type Level Switch**

Sensing Probe	:	
01. Type	:	Rigid
02. Material	:	SS-316
03. Mounting	:	Threaded
04. Probe Head Housing	:	Cast Aluminium
05. Protection	:	IP-66
Electronic Controller	:	
01. Supply Voltage	:	240V AC (UPS)



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- 02. Relay Output : 2 nos. SPDT
- 03. Contact Rating : 240V AC, 5A/ 220V DC, 0.25A
- 04. Housing Material : Cast Aluminium
- 05. Protection : IP-65
- 06. Local LED Indication : Power On, Alarm Level, Probe Healthy
- 07. Switching Repeatability: $\pm 0.5\%$
- 08. Accessories : Coaxial cable probe connection to controller
1/2" NPT Cable Gland

1.19.00 FGD Emission Monitoring System

- 1.19.01 Complete CEMS package with all analyzers in the Chimney, for the measurement of Flue gas parameters (SO_x, NO_x, CO, CO₂, SPM, Hg, Gas flow) as per CEA guidelines shall be provided by the bidder. All analyzers shall be capable of online remote calibration requirement by CPCB. (CPCB Lr.No. C-12011/33/2017-17/Tech/514 dt. 16-04-2018)
- 1.19.02 Flue gas analyzers shall be provided for Flue Gas De-sulphurization System emission monitoring. FGD emission monitoring system shall comprise of Sulphur-di-oxide (SO₂) measurement at inlet and outlet of FGD System to control the treatment process. The reagent dosage shall be derived from these two values. Additionally oxygen shall be measured to detect leakage. Other CEMS monitoring as indicated above shall be provided as per CEA guideline.
- 1.19.03 The Bidder shall indicate system wise requirement of instrument air along with his proposal.
- 1.19.04 Monitoring system shall be extractive type comprising of the transceiver, the Sampling probe, Prefabricated heated sample lines, filters, coolers, the converter unit, analyzers, data logger and all special cables.
- 1.19.05 The measurement shall be completely independent of particulate, moisture, presence of other gases and temperature variation.
- 1.19.06 All output signals of all emission monitoring analyzers shall be hardwired and connected to FGD PLC as applicable for monitoring, archiving and report generation etc.
- 1.19.07 The Sampling probe shall be of suitable material of construction depending on the FGD classification & direct insertion into the FGD inlet & outlet. No sampling conditioning system shall be employed for the measurement.





1.19.08 The Complete system shall be installed in the analyzer shelter suitably located in the field. A permanent, environmentally controlled (air-conditioned) shelter/hut shall be provided to house all non on-line mounted components in the vicinity of the sampling location.

1.19.09 **Technical Specification**

1.19.09.1 SO_x, NO_x, CO, CO₂ Analyzer

01. Type	:	Extractive type analyzer, Microprocessor based.
02. Gases to be measured	:	SO _x , NO _x , CO, CO ₂ , and MOISTURE
03. Principle of measurement	:	Non-dispersive infrared absorption (NDIR)
04. Flue gas Temperature	:	As per process requirement
05. Probe material	:	Stainless Steel 316L
06. Mounting/Application	:	Flanged/ On chimney
07. Measurement range	:	Fully selectable as per process requirement
08. Units of measurement	:	PPM, mg / Nm ³ and %
09. Power Supply	:	240V, 50 Hz, 1 Phase UPS
10. Local Display	:	Back lit LCD / LED
11. Measurement of averaging	:	10 sec to 60 minutes (selectable)
12. Accuracy	:	1.0% of measured value
13. Repeatability	:	1.0% of full scale
14. zero & Span drift	:	2% per month
15. Calibration	:	Zero and Span calibration in manual and automatic mode. Automatic calibration interval shall be fully selectable.
16. Analog output	:	4-20 mA DC each channel (with superimposed HART signal) into 600 ohms / RS 485 MODBUS
17. Alarm output	:	(1NO + 1NC) for each measured parameter and self diagnostic failure. All contacts rated at 230V AC, 5A
18. Input normalisation	:	Required—online with pressure and





- temperature sensor and also provision for key pad entry of inputs
19. Enclosure : Corrosion resistant epoxy painted aluminium housing & enclosure rated to IP-65.
20. Accessories : a) Compressor/Blower unit, tubes & fittings for calibration and purging, purge fail alarm in CCR
- b) Calibration gas cylinders for SO₂, NO_x, CO₂ and CO filled in 10 Ltrs. of WC carbon cylinder with necessary SS regulators with pressure & flow gauges, solenoid valve & SS tubings and SS fittings etc. as required.
- c) Mounting flanges, gasket etc.
- d) control unit for interface with PC based data logger to be provided.

1.19.09.2 Smoke Density / Opacity Monitoring

01. Type : In-situ dry visible light (through LED)
02. Principle of measurement : Transmission & absorption (Dual beam type)
03. Sensor type : Luminescence
04. Display : Back Lit LCD
05. Measurement range : 0-999 mg/m³, 0-999 mg/Nm³, 0-100% opacity
06. Measurement averaging : Selectable 10 sec to 60 minutes
07. Accuracy : 0.2% of F.S
08. Resolution : 0.1% of F.S / 1mg/m³ whichever is better
09. Linearity : 1.0% of F.S
10. Repeatability : < 0.5% of Span
11. Response time (upto 90% of full scale) : 5 sec
12. Flue gas temperature : 90°C (When FGD in operation)



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- 135 °C (When FGD not in operation)
Max 600 °C (at APH outlet)
13. Ambient temperature : 0 - 60 °C
14. Operating temperature : Transmitter & receiver- 0-90 °C, Electronic unit – 0-70 °C
15. Mounting : Transceiver on opposite side of the duct
16. Analog output : 4-20mA DC (in 500 ohm resistance) to DCS
17. Alarm output : 2 SPCO potential free rated at 230 VAC, 5A
18. Power Supply : 240V AC, 50 Hz, 1 Phase UPS
19. Automatic misalignment detection : Required
20. Automatic compensation of lens contamination : Required
21. Purge air Failure : Purge air to be provided from Blower unit and to be monitored for failure.
22. Span and Zero Check : Automatic periodic with manual override
23. Housing : Corrosion resistant painted aluminium rated at IP-65
24. Fail safe shutter : Automatic fail safe shutter against power and air failure
25. Input normalisation : Correction for temperature, pressure, oxygen and water vapour to be provided.
26. Preferred Features : “Power Supply On” LED visible from front
27. Accessories : a) Mounting pads suitable for mounting projector and receiver units on duct, flanges, etc.
b) Blower unit (Purging System) with purge fail alarm at CCR
c) Enclosure for electronic units & indicators
28. Application : At chimney





1.19.09.03 Oxygen Analyzer

01. Type	:	In-situ, Zirconium sensor, micro-processor-based transmitter,
02. Range	:	0.1-10% / 0.25-25% by volume
03. Output	:	4-20 mA DC linear
04. Probe Length / Material	:	1800 mm (approximate depending on duct size) / SS 316
05. Process Temperature	:	As per Process Requirement.
06. Measurement Reference	:	Instrument Air
07. Accuracy	:	$\pm 1\%$ of F.S.
08. Response Time	:	Less than 5 (five) sec for 90% of full scale
09. Amplifier Housing	:	IP-65
10. Calibration	:	Manual or Automatic periodic-operator selectable
11. Power Supply	:	240V, 50 Hz, 1 Phase UPS
12. Material for Gas Carrying Components	:	Stainless Steel
13. Read Out	:	Backlit LED/LCD
14. Protection	:	Automatic cell protection against reducing atmosphere
15. Alarm Facility	:	1 HI and 1 LO independently adjustable over span. Contact rating 500 mA at 220 V DC (minimum).
16. Preferred Features	:	a) HI and LO alarm LED visible from front. b) Power Supply On/Failure LED visible from front
17. Accessories	:	a) Mounting flanges, adaptor plate and protection shield (protection/abrasive shield shall be SS 316) b) Gasket, nuts and bolts





- c) Cable with conduit from cell to amplifier (as required) and other special cables (if any)
- d) Automatic calibration kit (complete with all accessories and standard Gas Cylinders)
- e) Solenoid valve, Pressure regulator with Filter and Flow indicator

1.19.09.04 Mercury Analyzer

01. Operating Principle	:	Atomic absorption spectroscopy
02. Range	:	0-100 $\mu\text{g}/\text{Nm}^3$
03. Measuring Parameters	:	Spacious mercury, total mercury
04. Output	:	4~20 mA DC
05. Alarm/ Annunciation	:	Four Relay contacts, dual alarm set points (240V AC, 5A)
06. Indication	:	LCD Display
07. Sampling System	:	Extractive
08. Enclosure	:	IP-65
09. Power Supply	:	240V AC (UPS)
10. Accessories	:	Standalone system cabinet, interconnecting cables, mounting hardware as required.

1.19.09.05 Gas Flow Measurement (Ultrasonic Type)

01. Type	:	Transit time Ultrasonic meter,
02. Mounting style	:	Transducers on the duct/stack
03. Output	:	
Analog	:	Isolated 4-20 mA DC
Binary	:	RS 485/ Ethernet communication link with MODBUS / OPC protocol.





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04. Zero & Span adjustment : To be provided
05. Display : Flow meter with LCD screen backlight based local display and keypad. If required, transmitter shall be suitably located away from the sensor for better access and visibility.
06. Protection class : IP-65
07. Accuracy : Less than $\pm 2\%$ of F.S.
08. Accessories : All mounting hardware required like clamping fixtures, mechanism to remove the transducers online, interconnecting cables, flexible conduits, junction boxes etc.
- Purging arrangement for cleaning sensors to be provided. Material of all fittings shall be SS 316.





2.00.00 **CONTROL PANEL / DESK MOUNTED INSTRUMENTS AND ELECTRICAL
SYSTEM ACCESSORIES (As applicable)**

2.01.00 **Push Button**

01.	Type	:	Shrouded square format
02.	Face Dimension	:	32 x 32 mm (maximum)
03.	Contact Configuration	:	2 NO + 2 NC
04.	Contact Addition	:	Add-on block up to 4 each with 2 pairs of contacts
05.	Contact Material	:	Hard Silver Alloy
06.	Contact Rating	:	500V / 10 A
07.	Utilization Category	:	AC11 / DC11
08.	Insulation Voltage	:	2 KV for 1 minute between terminals and earth
09.	Mechanical Life	:	1 million operations
10.	Construction	:	Aluminum shrouding with plastic lens
11.	Colors	:	Red, Green, Yellow, Black, etc.
12.	Connection	:	Screw terminals
13.	Enclosure Class	:	IP-52
14.	Legend	:	Engraving

2.02.00 **Illuminated Push Button**

01.	Type	:	Square format
02.	Face Dimension	:	32 x 32 mm (maximum)
03.	Contact Configuration	:	2 NO + 2 NC (minimum)
04.	Contact Addition	:	Add-on-Block up to 4 each with 2 pairs of contacts
05.	Contact Material	:	Hard Silver Alloy
06.	Contact Rating	:	500 V/ 10A



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- 07. Utilization Category : A C11 / DC11
- 08. Insulation Voltage : 2 KV for 1 minute between terminals and earth
- 09. Mechanical Life : 1 Million Operations
- 10. Lamp : LED with built-in resistors as required
- 11. Lamp Rating :-
 - a) Voltage : 240 V AC /24V DC
 - b) Watt : 0.5 Watt (approx)
- 12. Lamp and Lens
 - Replacement : From front
- 13. Construction : Transparent Plastic Lens
- 14. Color : Red, Green, Amber, Yellow etc.
- 15. Connection : Screw terminals
- 16. Enclosure Class : IP-52
- 17. Legend : Engraving
- 18. MTBF lamp : 100000 hours

2.03.00

Selector Switch

- 01. Type : 2/3/4 position stay put type with rotary lever actuator.
- 02. Face Dimension : 32 x 32 mm (maximum)
- 03. Contact Configuration : 4 pair of contacts
- 04. Contact Addition : Add-on-Block up to 4 each with 2 pairs of contact
- 05. Contact Material : Hard silver Alloy
- 06. Contact Rating : 500 V/10 A
- 07. Utilization Category : AC11 / DC11
- 08. Insulation Voltage : 2 KV for 1 minute between terminals and earth





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- 09. Mechanical Life : 1 million operations
- 10. Construction : Aluminum shrouding
- 11. Connection : Screw terminals
- 12. Enclosure Class : IP-52

2.04.00 Indicating Lamp

- 01. Type : LED with built-in resistor
- 02. Face Dimension : 32 x 32 mm (maximum)
- 03. Voltage : 240 V AC / 24V DC
- 04. Watt : 0.5 Watt (approximate)
- 05. Lamp and Lens Replacement : From front
- 06. Construction : Transparent Plastic lens
- 07. Color : Red, Green, Amber, Yellow etc.
- 08. Connection : Screw terminals
- 09. Legend : Engraving
- 10. MTBF : 100000 hours

3.00.00 CONTROL VALVES, ACTUATORS & ACCESSORIES

3.01.00 General Requirements

3.01.01 Control Valves and accessories furnished by the Bidder shall be designed and tested in accordance with the latest applicable requirements of code for pressure piping ANSI B 31.1, ASME Boiler and pressure vessel code, Indian Boiler Regulation (IBR), ISA and other standards as specified elsewhere as well as in accordance with the applicable requirements of the "Federal Occupational Safety and Health Standards, USA" or acceptable equal standards.

All the control valves, their actuators and accessories to be furnished under this section shall be fully suitable and compatible with the services covered under the specification.

3.02.00 Control Valve Sizing and Construction





- 3.02.01 Design of all valve bodies shall meet the specification requirements and shall conform to the requirements of ANSI (USA) for dimensions, material thickness and material specification for their respective pressure classes.
- 3.02.02 Valve sizing shall be suitable for obtaining rated flow conditions with valve opening at approximately 80% of total valve stem travel and minimum flow conditions with valve stem travel not less than 10% of total valve stem travel. All the valves shall be capable of handling at least 120% of the required rated flow. Further, the valve stem travel range from minimum flow condition to rated flow condition shall not be less than 50% of the total valve stem travel. The sizing shall be in accordance with the latest edition of ISA on control valves. While deciding the size of valves, Bidder shall ensure that valves port outlet velocity does not exceed 8 m/sec for liquid services, 150 m/sec. for steam services and 50% of sonic velocity for flashing services. Bidder shall furnish the sizing calculations clearly indicating the outlet velocity achieved with the valve size selected by him as well as noise calculations, which shall be subject to Owner / Consultant's approval during detailed engineering stage.
- 3.02.03 Control valves of steam and water applications shall be designed to prevent cavitation, wire drawing, flashing on the downstream side of valve and downstream piping. Thus for cavitation / flashing service, only valve with anti-cavitation trim shall be provided.
- 3.02.04 All other control valves shall have leakage rate as per leakage Class-IV as minimum.
- 3.02.05 The control valve induced noise shall be limited to 85 dBA at 1 meter from the valve surface under actual operating conditions. The noise abatement shall be achieved by valve body and trim design and not by use of silencers.
- 3.03.00 **Valve Construction**
- 3.03.01 All valves shall be of globe body design & straightaway pattern with single or double port unless otherwise specified or recommended by the manufacturer to be of angle body type. Rotary valve may alternatively be offered when pressure drops permit.
- 3.03.02 For large flow conditions with low pressure drops, butterfly valves shall be used.
- 3.03.03 Valves with high lift cage guided plugs & quick change trims shall be supplied in case of globe type valves.
- 3.03.04 Cast iron valves are not acceptable.
- 3.03.05 Bonnet joints for all control valves shall be of the flanged and bolted type or other construction acceptable to the Owner / Consultant. Bonnet joints of the internal threaded or union type shall not be acceptable.



- 3.03.06 Plug shall be one-piece construction either cast, forged or machined from solid bar stock. Plug shall be screwed and pinned to valve stems or shall be integral with the valve stems.
- 3.03.07 All valves connected to vacuum on downstream side shall be provided with packing suitable for vacuum applications (e.g. double vee type chevron packing).
- 3.03.08 Valve characteristic shall match with the process characteristics.
- 3.03.09 Extension bonnets shall be provided when the maximum temperature of flowing fluid is greater than 280°C.
- 3.03.10 Flanged valves shall be rated at no less than ANSI pressure class of 300 lbs.
- 3.03.11 Gland material shall be chosen to suit the operating temperature. PTFE may be chosen for low temperature application and for high temperature application graphited asbestos glands are to be provided.
- 3.04.00 **Valve Materials**

Materials for Control Valves shall be equivalent/superior to the following:

Sl. No.	Service	Body Material	Trim Material
1	Non-corrosive, non-flashing and non-cavitation service below 275°C.	Compatible with piping material	SS-316 with stellite faced guide posts and bushings.
2	Severe flashing / cavitation services.	Alloy steel as per ASTM A 217 Gr. WC9	400 series SS or equivalent to suit the specific requirement
3	Low flashing / cavitation service.	Alloy steel as per ASTM A 217 Gr. WC6	400 series SS or equivalent to suit the specific requirement
4	Condensate service below 300°C.	SS-316	SS-316

Note: Valve body rating shall meet the process pressure and temperature requirements as per ANSI B16.34.

However, Bidder may offer valves with body and trim materials better than specified materials and in such cases Bidder shall furnish the comparison of properties including cavitation resistance, hardness, tensile strength, strain energy, corrosion resistance and erosion resistance etc. of the offered material vis-à-vis the specified material for Owner / Consultant's consideration and approval.



3.05.00 End Preparation

Valve body ends shall be either butt welded/socket welded, flanged (Rubber lined for condensate service) or screwed as finalized during detailed engineering and as per Owner / Consultant's approval. The welded ends wherever required shall be butt welded type as per ANSI B 16.25 for control valves of sizes 65 mm and above. For valves size 50 mm and below welded ends shall be socket welded as per ANSI B 16.11 Flanged ends wherever required shall be of ANSI pressure-temperature class equal to or greater than that of control valve body.

3.06.00 Valve Actuators

3.06.01 All control valves shall be furnished with pneumatic actuators. The Bidder shall be responsible for proper selection and sizing of valve actuators in accordance with the pressure drop and maximum shut off pressure and leakage class requirements. The valve actuators shall be capable of operating at 60 deg. C continuously.

3.06.02 Valve actuators and stems shall be adequate to handle the unbalanced forces occurring under the specified flow conditions or the maximum differential pressure specified. An adequate allowance for stem force, at least 0.15 kg/sq.cm. per linear millimeter of seating surface, shall be provided in the selection of the actuator to ensure tight seating unless otherwise specified.

3.06.03 Travel time of pneumatic actuators shall not exceed 10 seconds.

3.06.04 Spring-diaphragm type valve actuators shall be used in general applications. However piston type actuators shall be offered in case of high shut-off pressure & quick response requirement. Piston actuator shall be of double acting type for the regulating duty valves with long stem travel for better regulation and quick response.

3.06.05 Actuator shall be designed for 150% thrust required for the valve (at shut-off pressure) at an air line supply pressure of 5.5 Kg/Sq. cm.

3.06.06 All actuators shall be supplied mounted on the valve with all the accessories integrally mounted. The diaphragms shall be designed for 200% maximum operating pressure.

3.06.07 Nylon reinforced neoprene shall be used as diaphragm material.

3.06.08 Entire actuator assembly shall be painted with corrosion inhibiting paint.

3.06.09 Air connection size shall be 1/4" NPT (F) unless otherwise dictated by process response time. Integral tubing shall be of stainless steel construction.

3.06.10 Actuators shall be of failsafe design signifying that the spring direction will tend to move the valve (open or close) in a direction safe for the process. "Failure to Open" or "Failure to Close" shall be marked on the actuator.





3.07.00 **Control Valve Accessory Devices**

All pneumatic actuated control valve accessories such as air locks, hand wheels / hand-jacks, Non-contact type limit switches, microprocessor based smart electronic Positioners, diffusers, external volume chambers, position transmitters (capacitance or resistance type only), reversible pilot for Positioner, tubing and air sets, solenoid valves and junction boxes etc. shall be provided as per the requirements. For further details please refer clause no. 1.32.00 of this section of the specification.

3.08.00 **Tests**

All valves shall be tested in accordance with the Quality Assurance Programme (QAP). Bidder shall submit QAP for Owner's approval. The tests shall include but not be limited to the following :

- a) Non destructive test as per ANSI B 16.34.
- b) Hydrostatic shell test as per ANSI B 16.34 prior to seat leakage test.
- c) Valve closure test and seat leakage test as per ANSI B 16.34 and as per the leakage class
- d) Functional Tests: The fully assembled valves with actuator and all accessories shall be functionally tested to demonstrate from open to close position and vice versa. Valve lift shall be checked at 5 points at 0, 25, 50, 75 and 100% in both the directions with increasing and decreasing inputs. Performance of the valve with Positioner shall be as follows :
 - i) Linearity : +/- 1%
 - ii) Hysteresis : +/- 1%
 - iii) Sensitivity : +/- 0.5%
 - iv) Deadband : +/- 1%
 - v) Reproducibility : 0.3% of total stroke
 - vi) Overall accuracy : +/- 1%
- e) CV test: CV test shall be carried out as type test on each size, type and design of the valves as per ISA 75.02 standard and test report shall be submitted for Owner's approval.

4.00.00 **CONTROL DESK / PANEL / RACK / ENCLOSURE**

4.01.00 **General**





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- a) All control desks, panels, system cabinets, local panels and local instrument enclosures, racks shall be furnished fully wired with necessary provision for convenience outlets, internal lighting, grounding, ventilation, space heating, anti-vibration pads, internal piping, detachable lifting hook and accessories as per IS:5039-1969 as required for completeness of the system.
- b) Convenient and logical approach to operational interfaces and to enhance aesthetics in the overall view of the panel / desk shall be considered.
- c) All panels, desks, cabinets shall be free standing type and have bottom entry for cables unless otherwise specified. The bottom of desks, panels, cabinets, enclosures shall be sealed with bottom plate, compression cable glands and fire proof sealing material to prevent ingress of dust and propagation of fire. Thickness of gland plate shall not be less than 3 mm.
- d) Panels and cabinets shall be constructed from steel sheet reinforced as required to provide true surface and adequate support for devices mounted thereon. Thickness of the steel plate shall conform to the requirements of UL 50 or equivalent standard. Panels and cabinets shall be of adequate strength to support mounted components and to support a concentrated load of 100 Kilograms on their top after erection.
- e) For items susceptible to vibration, suitable rubber gaskets or padding shall be provided to prevent damage or malfunction.
- f) All electronic system cabinets shall be designed for 50°C operating under maximum ambient temperature without air conditioning system in service. Further cabinets, panels shall be so designed that temperature rise due to heat load does not exceed 10°C above ambient temperature under all operating conditions. Necessary louvers, fans, limited packing density, adequate spacing between instruments, devices etc. shall be provided to maintain temperature rise within permissible limits.
- g) Desk, panels, cabinets enclosures wiring and piping shall be arranged to enable the removal of instruments and devices without unduly disturbing them.
- h) All panels, desks, enclosures interiors shall be illuminated with rapid start fluorescent strip fixtures with door actuated switches. Door switch terminals shall be shrouded. All illuminated lights shall be provided with individual switch in parallel with door switch.
- i) Sufficient number of power receptacles with disconnect switches shall be installed within panels, desks, enclosure and racks.





- j) The local instrument enclosures / racks shall be provided locally for mounting of electronic transmitters and switches, etc.
- k) All panels, desks, cabinets shall be properly grounded. The grounding scheme shall be as approved by the Owner / Consultant.
- l) Exterior steel surface shall be sand blasted, ground smooth, filled, primed, sanded and smooth enamel painted to give a good finish subject to minimum paint thickness of 65-75 microns for sheet thickness of 3 mm and 50 microns for sheet thickness of 2mm. Minimum 2 coats of primer and two sprays of final finish colour shall be applied to all surfaces.
- m) The colour of the panels shall be glossy white with fire resistant paint in the panel interior. External colour of the panels shall be as light grey RAL 7032 for other system cabinets, etc.
- n) Panel / cabinet shall have detachable type eyebolt on top for lifting.
- o) Panel shall be provided with three point latch and lock.
- p) Pocket shall be provided on the inner side of panel doors for keeping drawings & documents.
- q) Nameplates on the panel and terminal blocks shall be provided.
- r) All items like MCB, Terminals, instruments, lamps etc. inside the panels / cabinets shall be neatly arranged with easy access/ maintenance approach to avoid undue disturbing the wiring.
- s) Power supply feeders shall be double so that a single failure shall not affect the operation of the system. Required isolation & protection through MCB shall be provided in all cases. Alarm shall be provided against failure of a single power supply.
- t) Crating of the panels and desks shall be suitable for protection against shock, vibration, inappropriate handling and inclement weather conditions during transportation and warehousing. All panel mounted equipment shall have adequate protection against damage during handling, transit and storage. Suitable desiccant shall be used inside the packing case.

4.02.00 Surface Preparation and Painting

All sheet metal panel/ desk exterior steel surfaces shall be sand blasted, ground smooth and painted as specified below:



- a) Suitable filler shall be applied to all pits, blemishes and voids in the surface. The filler shall be sanded so that surfaces are level and flat; corners are smooth and even. Exposed raw metal edges shall be ground burr-free. The entire surface shall be blast clean to remove rust and scale and all other residue due to the fabrication operation. Oil, grease and salts etc. shall be removed from the panels by one or more solvent cleaning methods prior to blasting.

Two spray coats of epoxy primer shall be applied to all exterior and interior surfaces, each coat of primer shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish color (Catalyzed epoxy or polyurethane) shall be applied to all surface of dry film thickness 2.0 Mil.

- b) Paint films, which show sags, cheeks, blisters, teardrops, fat edges or other painting imperfections, shall not be acceptable.
- c) Colour shade for the control desk shall be finalized during detailed engineering.

4.03.00

Wiring

All control and instrument wiring used within the panels shall conform to NEC standards and shall be factory installed and tested at the works. All interior wiring shall be installed neatly. Features shall not be limited to the following:

- a) All spare contacts of relays, switches and push buttons shall be wired up to the terminal blocks. All interconnections between sections of panels / desks shall be furnished.
- b) Each wire shall be identified at both ends with wire designation as per approved wiring diagram. Heat shrinkable type ferrules with indelible computerized print shall be used with cross- identification.
- c) All wire termination shall be made with insulated sleeve and crimping type lugs. All external connections shall be made with one wire per terminal. Wire shall not be spliced or tapped between terminals. Wires shall not be looped around the terminal screws or studs.
- d) Internal wiring should be terminated uniformly on one side of the terminal block leaving the other side available for termination of outgoing cables.
- e) Thermocouple lead wires, analyzer measuring lead wires, or any other lead wires carrying measuring signal of the order of low milli volt or micro volt or mA shall be electrically and physically isolated from other high voltage AC and DC wiring.



- f) Wires shall be dressed and run in trays or troughs with clamp-on type covers. Wirings may be neatly bunched in groups by non-metallic cleats or bands. Each group shall be adequately supported along its run to prevent sagging or strain on termination.
- g) Where pre-fabricated cables are used for direct connection to electronic cubicles plug-in type connectors shall be used.
- h) Shield wires of field signal cables shall be terminated on separate earthed terminals at panel end.
- i) Wiring to door mounted devices shall be provided with multi-strand wires of (49 strands minimum) adequate loop lengths of hinge-wire so that multiple door openings shall not cause fatigue failure of the conductor.
- j) Wiring shall be arranged to enable instruments or devices to be removed and/or serviced without unduly disturbing the wiring. No wire shall be routed across the face or rear of any device in a manner, which shall impede the opening of covers or obstruct access to leads, terminals or devices.
- k) Panel internal wiring shall follow distinct color-coding to segregate different voltage levels viz. 24V DC, 110V AC, 240V AC, 220V DC etc.
- l) Wire shall be multi-stranded annealed flexible high purity copper conductor with heat resistant FRLS PVC insulation and shall pass vertical flame test per IPCEAS-1981.
- m) Conductor sizes used for internal wiring shall not be lower than the followings:
 - i) Power supply / receptacle : 2.5 sq. mm or higher as per load.
/ illumination wiring
 - ii) 4-20mA DC current : 0.5 Sq. mm
and low voltage signal
upto 48V DC
- n) Identification of conductors shall be done by insulation color-coding identified on drawings or by printed wiring lists.
- o) 20% spare conductor shall be provided in the field cable for future use.

4.04.00

Grounding





- a) System cabinet AC and DC ground shall be electrically isolated from each other and also electrically isolated from the Instrumentation signal ground. All the above ground shall be individually connected to the single point on the ground pit. Dedicated redundant earth pit shall be provided which shall be away from the HV equipment. This earth pit shall not be shared with other electrical equipment ground and shall also be insulated from other electrical system ground to ensure single point grounding of the system. Grounding resistance shall be better than 1.0 ohm. IEEE guideline shall be followed while designing the grounding system.
- b) All panels and cabinets shall be provided with a continuous tinned copper ground bus bar of minimum 25 mm x 6 mm cross section, extending along the entire length of the panel / desk / cabinet assembly. This signal ground bus shall be bolted to the panel structure on the insulated post. All shield wires shall be connected to this bus for onward connection to the earth pit. System DC power ground shall also be connected to the earth pit in similar way.
- c) The panel /desk /enclosure /JB ground shall have two (2) bolt drilling with GI bolts and nuts at each end to connect to GI / copper flat ground riser or by means of insulated copper ground cable of required cross section with lug for protection ground.
- d) Each circuit requiring grounding shall be individually and directly connected to the panel ground bus.
- e) Signal cable shields shall be grounded at the panel end only and shall never be left open. The ground in between panels of a shipping section shall be firmly looped.
- f) Manufacturer recommendation and scheme shall be followed for all system panel grounding.
- g) Electrical transmitters and switching devices, operating at a voltage less than 50V shall be grounded through the steel structure.

4.05.00 **Miniature Circuit Breakers (MCB)**

MCB shall be used for protection and isolation of logic circuit and power distribution circuit.

4.06.00 **Fuse Blocks**

Where fuse blocks are required by the specifications or the manufacturer's design, they shall be modular type with bakelite frame and reinforced retaining clips. Blocks shall be class H.2 pole, screw terminal fuse blocks. Blocks for other current and voltage ratings shall be similar in construction.

4.07.00 **Fuses**



Where slow blow fuses are required for protection of instruments /devices they shall have ampere ratings of 1/4, 1/2, 1 or 2. Where fast acting fuses are required for protection of equipment they shall have ampere ratings of 1, 3, 6, 10, 15, 20 or 30. Indicating fuses or blocks to quickly identify a failed fuse shall be provided to the extent possible.

4.08.00**Terminal Blocks**

- a) Terminals shall be chromated galvanized DIN rail mounted screw less cage clamp type. Terminals shall have screwed connection for conductor cross-section above 2.5 mm². Terminal blocks shall conform to IEC 947-7-1.
- b) The characteristics of the terminal blocks shall be as follows.
 - i) High contact force, independent of conductor cross-section and large contact surface area.
 - ii) Integrated self-loosening protection to avoid shifting of contact surface that may allow contamination of connection point.
 - iii) Inspection and maintenance free (resistant to thermal aging and vibration)
 - iv) Low and constant voltage drop
- c) Material of the clamping yoke of screwed terminals shall be electroplated, chromated, case hardened steel with high strength clamping screw. For screw less terminals, the tension spring shall be made of high quality, non-rusting, acid-resistant steel. The current bar shall be of tin-lead plated copper or brass.
- d) Terminals shall be of non-flammable suitable thermoplastic material such as polyamide.
- e) Terminal blocks shall be mounted vertically in panels and cubicles with clearance for at least 100 mm between two sets and between wall and terminal block. Bottom of the terminal block shall be at least 200 mm above the cable gland plate for bottom entry type panels.
- f) Terminal blocks shall be provided with white marking strips / self-adhesive marker cards. Power terminals shall have protection covers.
- g) At least 20 percent spare unwired terminals shall be provided for all panels /cabinets /desks /junction box etc. This shall be in addition to spare wired terminals of spare IO channels and wired spare modules.
- h) For extending 24 V DC supply to panels, the size of the terminals shall be decided based on voltage drop and not based on current.

- i) The last terminal in a rail-mounted assembly shall be closed with an end plate and end bracket.
- j) For visual and electrical separation of terminal groups, partition plates shall be provided, which can be push fitted after forming an assembly.
- k) The terminals for DCS / PLC input /output connections to SWGR / MCC, actuator starter, solenoid valves etc. shall be provided with built in test and disconnect facilities to permit testing of incoming and outgoing signals by using suitable test plug and socket without disconnecting the cable connections. Technical detail for the same shall be finalized during detailed engineering.
- l) It shall also be possible to use jumper plugs through the above test plug socket to connect adjacent terminals. Adequate number of short circuit jumper plugs shall be provided for the purpose.
- m) Where more than one connection to a terminal block is required, two tier terminals shall be used.
- n) Terminal blocks shall preferably be assigned different colors depending upon voltage and current levels.

4.09.00 **Nameplates and Labels**

- a) Nameplate shall be furnished for each instrument or device mounted on the panel / desk.
- b) The material shall be laminated phenolic, 3 mm thick with white letters on black background.
- c) The nameplates for panels / consoles shall be provided both on the front and the rear.
- d) Nameplates for all devices shall be located adjacent to the respective devices.
- e) All such nameplates, instruction plates, lubrication charts etc. shall be with English inscriptions.

4.10.00 **Wiring Diagram**

Each panel & enclosure shall have drawing pockets to store the relevant drawings of the respective panels. For the junction box printed wiring schedule engraved in black on white bakelite sheet shall be suitably affixed inside the junction box.

4.11.00 **Control Desks**



- 4.11.01 All devices mounted on the panel / desks shall be flush type. Instruments / devices shall be so mounted that the removal and replacement can be accomplished individually without interruption of services to others.
- 4.11.02 Desk shall be ergonomically designed to suit the user / operators needs on a 24 x 7 basis. Aesthetic, ergonomics and lighting shall be considered while positioning of the desk, large video screen and panels in control room.
- 4.11.03 Control desk shall be free standing floor mounting type tabletop design with compartments for locating the computers and other hardware. Desk shall be of latest technology aesthetic design and constructed from aluminium extrusion with high pressure laminate 25 mm thick MDF board for work surface as per Owner / Consultant's approved colour. Aluminium structure shall be anodized or powder coated paint finish.
- 4.11.04 Desk should have concealed cable trays and wire management system, which shall be easily accessible for maintenance. The cable management should be designed to support vertical and horizontal cables with proper hardware and accessibility. Cable tray shall be designed from steel with powder coated paint finish.
- 4.11.05 Design shall include earthing bolts on left side end and right side end of the Desk.
- 4.11.06 Crating of the desks shall be suitable for protection against shock, vibration, inappropriate handling and inclement weather conditions during transportation and warehousing and all panel mounted equipment shall have adequate protection against damage during handling, transit and storage. Suitable desiccant shall be used inside the packing case.
- 4.11.07 OWS and other application terminals mounted on the control desk shall be powered from UPS feeders and each feeders shall be provided with MCB at the upstream of the permanent Power receptacles. A minimum of two set of Alarm Accept/Reset Push Button shall be provided on each Control Desk.
- 4.11.08 The desks shall be complete with vibration dampener and foot leveler.
- 4.11.09 **Technical Specification of Control Desk**

- i) The frame / structure should be minimum 2mm thick Powder Coated Extruded Aluminum profile.
- ii) The Table Top / Work Surface shall be 36mm thick, Medium Density Fiber (MDF) board with high pressure laminate or Acrylic Plastic Solid Surface (APSS). Top surface shall be finished with anti-scratch material.
- iii) Foot extension shall be of Cast Aluminum & painted.





- iv) Foot Leveler shall be injection molded glass filled nylon foot with steel insert.
- v) END Caps & Extruded PVC Caps shall be provided where required.
- vi) Front edge shall be extruded PVC or rounded post-formed laminate.
- vii) Concealed cable tray shall be powder coated steel.
- viii) Provision shall be made for keeping Multi-media speakers.
- ix) Design shall include Earthing bolts on left side end and right side end of the Workstation Desk / Rack.
- x) Design should include cutouts for Push buttons, Public Address System and Function Keyboard mounting on the Furniture.
- xi) Retractable keyboard tray in the control desk shall be provided.
- xii) Retractable tray with telescopic slide for CPU/PC block shall be provided.
- xiii) Front and Rear door shall be considered.

4.12.00 Not used.

4.13.00 **System Cabinets / Panels**

- 01. Material of construction : Cold rolled steel sheet
- 02. Thickness of Sheet : 2 mm thickness for load bearing and 1.6mm for non-load bearing.
- 03. Construction : Welded throughout as per (metallic parts) approved National Standards.
- 04. Panel height : 2300 mm (approx.)
- 05. Doors : Full height front & rear door, recessed, turned back edges. Double door for panel width more than 800 mm.
 - a) Thickness of Sheet : 2 mm
 - b) Hinges : Concealed stainless steel type





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- c) Door latches : Three point type
- d) Door gaskets : Neoprene rubber on fixed frame to result dust proof / weather proof enclosure.
- e) Opening of the doors : Outward
- f) Louvers : With removable wire mesh to ensure dust and vermin proof.
- 06. Colour of interior : Glossy white
- 07. Colour external : Light grey RAL 7032
- 08. Painting : Epoxy powder coated or better
- 09. Gland plates : Removable 3 mm thick (bottom)
- 10. Cable entry : Bottom
- 11. Hardware :
 - a) Anti vibration pad- 15 mm
 - b) Predrilled base channel ISMC - 100 or equivalent for all sides.
 - c) Stainless steel buff- finished 2 mm thick kick plate for all sides.
 - d) Stainless steel scratch strips along desk edges fixed with pan-head recessed screws.
 - e) Rubber strips to ensure air tightness between kick plate and finished floor.
 - f) Detachable lifting hook / Eye bolt
 - g) Drawing pocket at front & rear door
 - h) Door switch, lamps, thermostat, heaters and fans
 - i) Door lock with master key

4.14.00

Furniture

Bidder shall provide following industrial grade furniture items as a minimum from reputed manufacturers/suppliers meeting International Standards. The furniture shall be modular and latest with ease of operational features. The furniture shall be modern, aesthetically designed, modular, flexible, space saving and future safe.





4.14.01 **Workstation Furniture**

Modular work station furniture, suitable for mounting servers & historians, programmer stations, PC based systems, printers (A4/A3 color laserjet) etc. shall be provided.

4.14.02 **PC Rack**

PC Racks shall be provided to mount CPUs of workstations/ PCs of OWS/LVS etc. in control room. For each PC / workstation / monitor at least one chair shall be included.

4.14.03 **Chairs**

Industry standard revolving chairs with wheels and with provision for adjustment of height (hydraulically/gas lift) shall be provided for the operators, unit-in-charge & other personnel in control room area. These shall be designed for sitting for long duration such that these are comfortable for the back.

4.15.00 **Local Instrument Enclosure** (Closed type enclosure shall be provided in all areas)

4.15.01 Transmitters, switches and devices located in the field shall be grouped together and shall be installed in the Enclosure in case of outdoor area such as Boiler area etc. and in Open Type Rack in case of covered area. Racks and enclosure shall be factory prefabricated & painted and complete with internal piping, tubing, manifold valve, isolation valves, blow down valves, integral junction box, wiring, illumination etc. with outside access doors. Racks used for furnace, flue gas and air application shall be provided with intermittent & continuous air purging. No more than six instruments shall be grouped in a single rack /enclosure

4.15.02 The local instrument enclosures shall be constructed from 2.0 mm thick sheet plate and shall be of modular construction with one or more modules and two end assemblies bolted together to form an enclosure. Gaskets shall be used in between all mating sections to achieve protection class of IP-55. Enclosure doors shall have three point lock.

4.15.03 The local instrument racks shall be free standing type constructed from suitable 3 mm thick channel frame of steel and shall be provided with a canopy at top to protect the equipment mounted in racks from falling objects, water etc. The canopy shall not be less than 3 mm thick steel and extended beyond the ends of the rack.



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- 4.15.04 Bulk heads, especially designed to provide isolation from process line vibration shall be provided. Bulkhead plates shall be removable type and thickness of not less than 6 mm shall be employed.
- 4.15.05 2" NB galvanized pipes shall be laid horizontally and supported at two end channels to mount transmitters/ switches at accessible height. Adequate support for manifold, impulse pipe and cable tray shall be provided and the same shall be adjustable.
- 4.15.06 All internal wirings and / or data bus connections, if any, between the transmitters and terminal junction box shall run through flexible dust tight conduits connected to the terminal box hub. No exposed wirings within transmitter racks, both open and closed type, is admissible.
- 4.15.07 All racks shall have a common closed drain trough to connect transmitter drain points to a common header after suitable pressure breaking. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. The trough shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header. Individual Instrument blow down line shall be connected to the common blow down drain header through regulating globe type blow down valves. The common blow down drain header shall be 2" NB ASTM A106, Sch-80 Gr. C installed at a slope of 1:25.
- 4.15.08 The junction box for enclosure and racks shall conform to IP 65 protection class. Junction box shall be provided as an integral compartment at one side of the enclosure / rack with front opening type door. Junction box shall be complete with DIN rail mounted terminals, MCB, receptacles and earth bar. All wiring shall be laid in PVC cable tray. Cable gland plate shall be provided for cable entry from bottom. Earth bar shall be made of tinned copper continuous and of 25 X 6 MM size.
- 4.15.09 Each rack shall be provided with receptacle, light fixture with wire guard and lighting switch. Light fixtures shall be installed on the ceilings of rack / enclosure.
- 4.15.10 Type, size and material grade of the impulse pipes, fittings and valves are listed elsewhere in this specification
- 4.15.11 Bidder shall furnish the drawing and documents showing detail arrangement of racks and enclosure and hook up along with instrument grouping at detailing stage for Owner / Consultant's approval.

5.00.00 FGD CONTROL SYSTEM & CEMS

5.01.00 General Requirements

- 5.01.01 FGD system automation shall be realized in a dedicated hot redundant Programmable Logic Control (PLC) based control system.





- 5.01.02 The control system (PLC based) shall be latest state-of-the art and proven.
- System complete with all hardware, software & interfaces including controllers with system / marshalling / termination cabinets, data highways, operator stations, engineering stations with visual display units and control devices, printers, historical data storage & retrieval system, sequence of event recording system, necessary application, diagnostic and engineering software (including firewall & anti-virus software for all servers / workstations), interfacing with other plant control systems, operation, monitoring and controlling etc. for safe efficient operation / monitoring and control (both auto control and protection logic controls) shall be provided.
- 5.01.03 PLC based system shall be provided with the latest & proven system design and shall be supplied & engineered from original PLC manufacturer only PLC system supplied & engineered through system house shall not be acceptable.
- 5.01.04 The system shall be independent for each unit and connectivity with Station DCS has been envisaged. All Three (3) (one for each unit and one for common system) systems shall be capable of communicating with each other through soft-link.
- 5.01.05 Requirements for FGD control system are indicated on functional basis in this specification. Bidder shall be responsible for engineering, selection and connection of all components and sub-systems to form a complete system whose performance is in accordance with functional, hardware, parametric and other requirements of this specifications. It is not the intent or purpose of this specification to specify all individual system components since the Bidder has full responsibility for engineering and furnishing of a complete control system.
- 5.01.06 System shall be highly reliable with the availability of not less than 99.7% with adequate redundancy and fault tolerant configuration.
- 5.01.07 Proprietary microprocessor based control system (if any) shall also comply to the design criteria indicated for the PLC based system. Deviation (if any) shall be clearly intimated to Owner during finalization of Bid and shall depend on Owner's acceptability.
- 5.01.08 System Expandability
- Modular system design shall be adopted to facilitate easy system expansion. The system shall have the capability and facility for expansion through the addition of controller modules, process I/O cards, drives control modules, hand / auto stations, push button stations, peripherals like Large Video Screen (LED display), Operator Workstation (OWS), printers etc. while the existing system is fully operational. The system shall have the capability to add any new control loops groups / subgroups, in control system while the existing system is fully operational.



5.01.09 On Line Maintenance

It shall be possible to remove / replace online various modules (like I/O module, interface module etc.) from its slot for maintenance purpose without switching off power supply to the corresponding rack. The on-line removal/insertion of controller, I/O modules etc. shall in no way jeopardize safety of plant and personnel.

5.01.10 Fault Diagnostics

The PLC shall include on-line self-surveillance, monitoring and diagnostic facility so that a failure / malfunction can be diagnosed automatically down to the level of individual module giving the details of the fault on the programmer station monitor and printers. The faults to be reported shall include:

- (a) Module level faults of control system
- (b) Failure of HMIPIS bus / unit LAN, system bus, local / remote communication bus
- (c) Power supply faults (over voltage, under voltage, loss of input) for each feeder of power supply system / marshalling relay and HMIPIS cabinets.
- (d) Software faults

5.01.11 Response Time

Response time of the control system should be adequate to maintain control over the process under all regime of operation. Response time shall include the delay and dead time both internal and external to PLC. Response time pertaining to the process sensor shall be made optimum by selecting latest high sensitivity process instruments. Response time pertaining to PLC shall include the IO scan time, data communication time, processing time etc. As a guideline, the maximum permissible response time of PLC for various functions are shown as follows:

- a) The cycle time for CLCS, OLCS and Protective logic will be configured from 40 msec to 500 msec as per the process requirement and will be decided during detail engineering stage.
- b) DAS- 500 msec to 2 sec as per process dynamics
- c) SOE - 1 msec

Minimum 50 SOE points per unit (1 milli second resolution for all binary inputs used for SOE) shall be considered by the bidder for the FGD plant.

Faster response is required for some critical equipment and systems and for those systems, requirements for response time shall be guided by the respective equipment and systems dynamics.



5.01.12 System Spare Capacity

Over and above the equipment and accessories required to meet the fully implemented system as per specification requirements, PLC shall have spare capacity and necessary hardware / equipment / accessories to meet following requirement for future expansion at site:

- i) 10% spare channels in each of the functional groups for each type of input / output fully wired up to marshalling / termination TBs.
- ii) 20% hot spare I/O modules of each type of installed I/O module in the system, fully wired up to the marshalling/ termination TBs.
- iii) Wired-in "usable" space for 20% modules in each of the system cabinets for mounting electronic modules wired up to corresponding spare terminals in marshaling cabinets..
- iv) HMI shall be provided with capacity to handle 25% of tags

5.01.13 Following guidelines regarding the data loading of various components of PLC will determine the extent of functional distribution.

The maximum permissible loadings are as follows:

- Multi-loop Multifunction Controller – 60%.
- Input / Output - 80%
- Console – 80%
- Historical Storage - 75 %
- Data Highway / communication link – 60%
- Other computing modules – 60%



5.01.14 Wiring Scheme for Inputs / Outputs to Control system

- a) Each of the dual / triple redundant binary and analog inputs shall be wired to separate input modules. Implementation of multiple measurement schemes of these inputs shall be performed in the redundant hardware. Loss of one input module shall not affect the signal to other module and also other channels of these modules can be used by other inputs of the same functional group.
- b) No single failure in any component of the control system shall lead to unavailability of more than one of dual / triple redundant input signals to control system. Similarly, no single failure in any one component of the control system shall lead to unavailability of more than one of dual / triple redundant output signals of the control system.

5.01.15 Maximum number of inputs / outputs to be considered each type of module shall be as follows:

i)	Analog Input Module	:	16
ii)	Analog Output Module	:	16
iii)	Binary Input Module	:	32
iv)	Binary Output Module	:	32
v)	Analog Input & Output (combined)	:	16
vi)	Binary Input & Output (combined)	:	32

5.01.16 Remote Input output Modules and Cubicles

It is envisaged to use remote input output modules of FGD PLC and necessary racks / cubicles at the following location in the plant to minimize cabling. The exact areas where remote I/O modules are provided shall be decided during detailed engineering.

- One (1) Remote Input/ Output (RIO) Unit for each unit to be located in CCR

However, the modules used for the above application shall be designed in such a way to withstand the harsh environment expected to be encountered in respective plant areas.

All communication modules, links, cables and power supply modules shall be redundant.

5.01.17 It is proposed that the logics & control schemes for Booster fan, Booster fan IGV, I/L & O/L motorized isolation valve/ gate, Booster fan lube oil system,





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Absorber O/L valve, Bypass dampers etc. shall be implemented in FGD vendor supplied PLC.

However, provision shall be made for operation of these equipments from main plant DDCMIS also. The required command & feedback signals to operate and monitor these equipments from station DDCMIS shall be hardwired. The FGD bidder shall consider these IOs also in their PLC. The spare IO modules in the station DDCMIS shall be used for these Interface. The necessary hardwired cable, cabling & termination in both ends for these equipments shall be done by the FGD bidder.

5.01.18 Bidder to note that the terminal point for the OPC connectivity with main plant DDCMIS shall be the Purchasers DDCMIS located in main plant CCR. All the requirements for establishing connectivity with purchaser DDCMIS are under the scope of the FGD bidder.

5.01.19 Bidder to provide/ specify/ mention the following input/ information:

- The modification (both in hardware & software) if required in the main plant control system (in DDCMIS).
- The modification required if any, in the existing CLCS/OLCS of “draft control / furnace control”.
- The effect of ON/OFF Control of Booster Fan on the Furnace Draft as well as on its control logic etc., during the detail engineering stage.

However, the implementation of logics will be discussed and decided during detailed engineering in conjunction with the Boiler manufacturer.





5.02.00 **PLC Processors**

5.02.01 PLC unit shall be provided with redundant processors (Main processing unit, communication units and memories) one for normal operation and one as hot standby. The transfer from main processor to standby processor shall be totally bumpless and shall not cause any plant disturbance whatsoever.

5.02.02 Redundant CPUs in hot standby mode shall operate on fault tolerant mode with continuous self and cross monitoring facility. Redundant CPU/controllers shall be placed separately and shall not share the same motherboard. Failure of the active CPU shall not adversely affect the operation of the plant in any perceptible way. Failure of the active CPU will lead to transfer of the tasks being performed to the other healthy CPU within fastest possible transfer time (i.e. < 50 m sec.) without causing any output to drop during the Transfer period.

5.03.00 **Interface with Station DCS**

FGD PLC shall be interfaced with the Station DCS (OPC) for centralized monitoring and limited controls. Protocol for communication shall be finalized with the DCS vendor during detail engineering.

Bidder's scope shall include all cables and accessories including network components at both ends, required for interfacing FGD PLC with Station DCS.

5.04.00 **Operator Interface to the Control System**

- a) The operator interface of the HMI system shall consist of colour LED monitors / KBDs / mouse, LVS, colour laser printers, GUI etc. The operation shall employ powerful menu-driven and multi window supported input facilities.
- b) All OWS shall be fully interchangeable i.e. all operator functions including control, monitoring and operation of any plant area and drive shall be possible from any of the OWS / LVS at any point of time. Each OWS / LVS shall be able to access all control information related data under all operating conditions.
- c) The operators functions for control on each OWS shall as a minimum include control system operation, alarm acknowledge, call control displays, demand/printout of various displays, logs, summaries etc.
- d) The display selection process shall be optimized so that the desired display can be selected with minimum number of key strokes / steps by the operator.



- e) The control related displays on the monitor / LVS shall as a minimum include mimic displays, overview displays, area displays, individual loop / drive display, closed loop control displays, open loop control displays etc.
- f) The system shall have built-in safety features that shall allow / disallow certain functions and entry fields within a function to be under password control to protect against inadvertent and unauthorized use of these functions.

5.05.00 Plant Operational Displays

5.05.01 Standard plant operational and monitoring displays shall be offered by Bidder, which permits easy man machine interactions. The data presented shall be easily understandable, comprehensive and presented in soothing colors so that prolonged exposure to the screens do not lead to eye fatigue.

5.05.02 All consoles and control room furniture supplied shall be of ergonomic design so that no strain is caused to the operators & engineers.

5.05.03 Bidder shall generate typical control screen displays for operation and control. However, there shall be provision for customizing at least 20 additional screens by the Owner in future for specific operational convenience. All the displays shall be customizable by the owner in future, if required. The following typical screens are recommended. There shall be provision for multiple windows & pop- ups. Typical pop-up windows shall tentatively be as follows (i) display of some latest alarms, (ii) window to display messages for illegal key operation, (iii) HELP window to display user defined help messages. Over and above, all screens shall display a fixed header carrying salient information about the plant like MW generation, frequency, time & date, power factor, load demand etc, and an alarm footer to represent any major alarm in the plant.

5.05.04 Switching over from page-to-page or from display-to-display shall be by means of simple procedure like track ball operation and pull-down menus.

5.05.05 Control Overview Screen

Display of status & values of all analog control loops and open loop controls in one screen in color graphic form. The display shall present all the controlled parameters in color bar graph representing the value on a 100% span scale and/or the control deviation in a center-zero scale. The color of the scale shall indicate the alarm / healthy / control status of the variables. The point address code shall associate with each bar to enable the operator to select parameter display by direct addressing.

- a) Group display screen - group of related control loops, and or measurement parameters and / or related drives displayed in one screen. The display can be in controller face plate form showing the controlled variable, A/M status of the controller; engineering value of measurement parameter on a 100 %



span bar graph form; status of binary drives etc. Typically, a group screen shall be composed of 8 parameters or loops.

- b) Individual display screen - displaying one control loop, tag number of associated elements, schematic representation of the loop, trend of the controlled variable/s, alarm history, sectional plant sub-system display related to the loop, various settings including tuning parameters, alarm / trip settings etc., representing a complete data bank for the loop. Similarly, for binary drives, the representation shall include a sectional mimic for the drive area, control ladder, status of the drive, tag number, different delay and other settings etc.; all in one screen.
- c) Plant sub-system display - mimic diagrams meant for direct operation by vectoring cursor on the screen. The display shall have a fixed part representing the P&I diagram and a dynamic part refreshing parameter values and status of drives. There will be an overall plant sub-system display from which operator shall zoom into the specific area of interest. Additionally, operator shall be able to directly address specific displays by their area identification code. The displays shall be animated to represent changes. Extensive color coding shall be utilized to represent status of drives, alarm conditions, open / close status etc., together with the color coding for various lines carrying different fluids.
- d) Flow chart / logic / ladder screens - meant for sequence logic operations to represent the progress of the sequence, time-out conditions, forced or bypass conditions, hang-ups and prompts.
- e) Operator's guidance message screen - displaying process flags and prompts to the operator to assist in selecting course of action in the events of start-up and emergencies.
- f) Trend Display - The system shall be capable to display at least eight (8) numbers of real time trends with eight (8) different colors per page with selectable time frame to implement variation in resolution. The facility to magnify trend on Y-axis by 1, 2, 5 & 10 and scrolling within the range $\pm 100\%$ shall be provided. Also the facility to magnify X-axis by 1, 2, 4 or 8 and scrolling shall be provided.
- g) Screen Partitioning - The system shall be capable to implement screen partitioning to facilitate easy comparison of trending between two or more assigned screens and also display of X-T and X-Y trends on the same page and other combinations as per the requirement of operating personnel.
- h) Multi-windows - The system shall have facility of multi-windows & pop ups to allow related information to be displayed in different windows. The types of windows shall be tentatively as follows :-
 - i) Alarm window for display of all acknowledged & unacknowledged alarms in different colours. Alarm priority shall also be distinguished by colour.
 - ii) System help window for display of messages corresponding to illegal key operations.





- iii) Help windows for user defined help messages.
- iv) Trend window display with trend recording graphs.
- v) Faceplate window to display Instrument faceplate of called tag number.
- vi) Process window for display of process data.
- vii) MIMIC, System Diagnostic, Engineering menus etc.

However quantity of the above displays shall be finalized on as required basis during detail engineering.

5.06.00 **Historical Storage and Retrieval system (HSRS) (Historian)**

Complete HSRS shall be implemented in server / information workstation. The HSRS shall collect, store and process system data online on redundant hard disk. Provision shall be made to notify the operator when disk is certain percentage full. The disk capacity shall be sufficient to store at least seven days data.

The data to be stored in the above system shall include alarm and event list, periodic plant data, selected logs / reports such as event activated logs, sequence event log, trip analysis log, start-up log etc. The data/information to be stored and frequency of storage and retrieval shall be as finalized during detailed engineering.

5.07.00 **Programmer's Station**

- i. The structuring/ configuration/ modification of control loops/ logics in control system and program development/ in programming station shall be possible from fully graphic displays using familiar & conventional functional blocks.
- ii. The programming tools shall have inbuilt safety features which shall protect the system against inadvertent and unauthorized use of these tools. Necessary hard key locks and software locks, etc. shall be provided for this.
- iii. The system shall also have facility to permit the programmer to add test information at the beginning and end of each program, wherein programmer shall list out his name, time, date, the change which has been made, name of the person who has authorized the change, etc.

5.08.00 **Sequence of Event Recording / Alarm Annunciation Functions**

5.08.01 **SOE Function**

- a) The system shall monitor minimum Fifty (50) nos. sequence of Events (SOE) inputs with a resolution of one millisecond at all times for all SOE inputs including spare inputs. That is, all SOE points entering status change shall be reported and time tagged within 1 (one) millisecond of their occurrence. The start of data collection for SOE report shall be reported to OWS within 1 sec of SOE data collection initiation. The system shall also have provision of rejection of chattering inputs.
- b) The system shall also include provision for historical storage and retrieval of SOE reports for 3 months period.
- c) The SOE reports shall also include a list of major equipment trip in chronological order and include the points which initiated SOE collection.
- d) All the SOE inputs shall also be available for interlock / protection functions.
- e) The common requirements specified for all binary inputs shall also be applicable for SOE inputs.
- f) Software licenses as applicable shall be provided for SOE functionality.

5.08.02 **Annunciation System Function**



- a) The annunciation system shall be implemented as an inbuilt function of the PLC. The field contacts shall be acquired through PLC only. The annunciation sequence logic shall be implemented as a part of the PLC controllers. The annunciation logic shall include logic for presenting single alarms on a single window, logic for slow and fast flashing, logic for audible alarms including ring back, etc.
- b) The annunciation system shall have the facility of driving independent lamp box in the event of failure of HMIPIS or system bus in case the annunciation system is affected due to the same.
- c) The annunciation sequence shall conform to the following:

Designation	Visual	Audible (1)	Audible (2)
Normal	Off	Off	Off
Alarm	Fast flashing	On	Off
Return to normal before acknowledge	Slow flashing	On	On
Acknowledged	Steady on	Off	Off
Return to normal	Slow flashing	Off	On
Reset	Off	Off	Off
Test	Full functional / sequence test		

Redundant audible devices with adjustable pitch and sound level shall be provided. Audible tone of the alarms shall be settable depending upon the priority. The audible alarms shall be generated in the OWS as well as through external devices. Alarm & Trip tone shall be different.

5.09.00 **Power Supply**

5.09.01 Power supply system shall be designed to meet the total AC and DC electric power requirements of various C&I systems including PLC. In addition 20% spare capacity for future shall be provided.

5.09.02 Separate redundant bulk power supply units for powering relays and solenoids shall be provided.

5.09.03 Electrical power supply system (UPS / Utility supply / DC) for various loads for Bidder supplied system shall be provided by Bidder.

Bidder shall refer to the UPS specification mentioned in Electrical section.

5.10.00 **Grounding**





- 5.10.01 All panels, desks, cabinets shall be provided with a continuous bare copper ground bus. The ground bus shall be bolted / welded to the panel structure and shall efficiently ground the entire structure. All individual cabinet grounds shall be connected to separate earthing riser to be provided for C&I system signal grounding. The grounding requirements of various parts of the C&I system shall be properly co-ordinated by the Bidder with design of plant earthing system. The exact grounding scheme shall be as finalized during detailed engineering.
- 5.10.02 System cabinet's AC and DC ground shall be electrically isolated from each other and also electrically isolated from the Instrumentation signal ground. All the above grounds shall be individually connected to the single point on the ground pit. Dedicated redundant earth pit shall be provided which shall be away from the HV equipment and shall also be insulated from other electrical system ground to ensure single point grounding. Grounding resistance shall be better than 1.0 ohm. IEEE guideline shall be followed for the grounding requirement.
- 5.10.03 Separate redundant earth pit shall be envisaged for FGD PLC electrical & electronic earthing.
- 5.11.00 **System Software Requirements**
- 5.11.01 Bidder shall provide all software required by the system for meeting the intent and functional/ parametric requirements of the specification. The system shall utilize a readily upgradeable, software platform proven for real-time operation environment at the control and monitoring level overlaid with a relational database program. The general features shall not be limited to the following:
- i) The software system shall be fully modular.
 - ii) Support of multiprogramming and multi-user operation.
 - iii) Simple and easy-to-learn editing language for editing.
 - iv) Wide range of standard and non-standard peripheral support.
 - v) Effective task scheduling and support of multiple priority structure including event based interrupt etc.
 - vi) Effective debugging.
 - vii) Provision for on-line editing and program development without interrupting on-line functions.
 - viii) Self-diagnostic routines.
 - ix) Efficient memory management and effective utilization of system time.
 - x) Quick system start-up and program loading.



5.11.02 All system related software including real time operating system, file management software, screen editor, database management software, on line diagnostics / debug software, peripheral drivers software and high level language compilers shall be furnished. Latest version of standard PC based software for database handling, word processing, spreadsheet etc. and any other standard software as required shall be provided.

5.11.03 The Bidder shall provide software locks and passwords to authorized representative of Buyer at site for all operating & application software in order to prevent unauthorized access so that only Buyer's authorized representatives is able to do modifications at site.

5.11.04 **Software License**

Bidder shall provide software license for all software being used in PLC & Operator work stations. Software license shall be provided for the project (e.g. organization or site license) and shall not be hardware or machine specific. All software licenses should not have any expiry limitations and shall be valid for continuous service life of the plant. If the software license is dependent of no. of points / users then quantity to be considered 30% above finally implemented points. If licensing is based on tags / points, each point shall represent unique / distinct function and combining of tags in any form not permitted.

If licensing of software is based on number of displays, there shall be provision for adding 25% additional displays in future. Each display shall be made separately and no clubbing of similar displays and loading tags through external scripting is allowed

5.11.05 **Software Upgrade**

Bidder shall periodically inform the designated person of the Owner about the software upgrades / new release that would be taking place after the system is commissioned & handed over so that if required, the same can be procured and implemented at site.

5.12.00 **Hardware Specification**

5.12.01 Input Output Modules

a) HIGH LEVEL ANALOG INPUT MODULES

01. Number of inputs / module : 16 (Max)
02. Types of input (Linear) : 4-20 mA and 1-5 V
03. Accuracy : 0.1% or better
04. A/D Converter : Integrating, 15 bit + Sign or better





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- 05. Temperature effect : 0.01% / Deg.C or better
- 06. CMRR : 120 db (at 50 Hz) or better
- 07. NMRR : 60 db (at 50 Hz) or better
- 08. Stability : 0.03% / year or better
- 09. Features :
 - a) Diagnostic LED
 - b) Auto calibration
 - c) Auto start up
 - d) Status LED

b) LOW LEVEL ANALOG INPUT MODULES

- 01. Number of inputs / module : 16 (Max)
- 02. Types of input :
 - Thermocouples (K, R, etc.)
 - [Grounded & Ungrounded]
 - RTD (Pt -100 Ohm)
 - [Four wire, three wire]
- 03. Cold junction compensation : On module
- 04. Accuracy : 0.15% or better (Linearized)
- 05. A/D converter : Integrating, 15 bit + sign or better
- 06. Temperature effect : 0.01% / Deg.C or better
- 07. CMRR : 120 db (at 50 Hz) or better
- 08. NMRR : 60 db (at 50 Hz) or better
- 09. Stability : 0.03% year or better
- 10. Features :
 - a) Diagnostic LED
 - b) Auto calibration
 - c) Auto start up
 - d) Status LED
 - e) Auto CJC for TC input

c) BINARY INPUT MODULE (SLOW SCAN)

- 01. Number of inputs/module : 32 (Max)





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02. Types of input : 20/48V DC
NO/NC/Ch.over contacts
03. Contact bounce filtering : Hardware filter /soft adjustable
04. Resolution : 10 milli sec. or better
05. Features : a) Diagnostic LED
b) Wire break (as required)
c) LED status for inputs, power & communication
- d) BINARY INPUT MODULE (FAST SCAN SOE)
- Same as above but resolution 1 m sec.
- e) SMART TRANSMITTER INTERFACE MODULES
01. Number of inputs/module : 16
02. Types of input : From Smart Transmitters.
03. Protocol : HART or any proven compatible protocol.
04. Communication : Bidirectional
05. Accuracy : 0.1% or better
06. Function : a) Signal processing
b) EU conversion
c) Alarm, Diagnostic etc.
d) Configuration Tx. database
e) Re-ranging &Tx. calibration
07. Features : a) Diagnostic LED
b) Auto calibration
c) Auto start up
d) Status LED
- f) ANALOG OUTPUT MODULES
01. Number of points/module : 16 (Max)





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- 02. Types of output (Linear) : 4-20 mA DC
- 03. Resolution : 12 bit or better
- 04. Accuracy : 0.1% or better
- 05. Load : upto 800 Ohms
- 06. Features :
 - a) Diagnostic LED
 - b) Auto calibration
 - c) Auto start up
 - d) Status LED

g) BINARY OUTPUT MODULES

- 01. No. of points/module : 32 (Max)
- 02. Type of output : Relay with 1 change-over contact or voltage output
- 03. Contact rating : 60 VA
- 04. Contact voltage rating : 60 Volts
- 05. Switching frequency : 2 Hz
- 06. Contact life : 1 million operations
- 07. Output protection : Short ckt. Proof & Individual HRC fuse (as applicable)
- 08. Features :
 - a) Diagnostic LED
 - b) LED status for outputs, power & communication

5.12.02 Controller

- 01. Type : Microprocessor based, multi-loop and multi-function
- 02. Word length : 32 bits
- 03. Register add cycle time : 1 microsecond
- 04. Instruction cycle time : 75 microseconds (max.)
- 05. Memory : EPROM & EEPROM and RAM (battery backed up) as required.





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06.	Redundancy Supported	:	Yes
07.	Switch over time	:	5 milli sec. Instantaneous without any loss of data
08.	Mounting	:	Sub-rack
09.	Configuration	:	From LAPTOP through front plug and from Engineering Terminal through DCS / PLC data highway.
10.	Features	:	a) Power fail hold b) Automatic restoration on power c) Diagnostic display d) Status display LED

5.12.03 The Servers / Workstations / PCs / Laptop to be provided by the Bidder should be latest available in the market at the time of supply to prevent early obsolescence and shall be subject to Owner's approval. The software packages to be included with the server / OWS / PCs shall also be the latest version available at the time of supply. However for Servers and Historians / Programming station / Operating work station / PC / Laptops, the hardware shall conform to the following minimum requirements:

A. Operator's work Stations / Other's work Stations

01.	Processor	:	32 / 64 bit- On board Intel-Xeon quad core, 3.46 GHz processor with 1066 MHz bus with Hyper threading or higher.
02.	Memory	:	8 GB DDR4 RAM
03.	Hard drive	:	1 x 1000 GB Hard Disc Drive of 7200 RPM or higher.
04.	Monitor	:	LED based 24" or higher sized monitors with non-interfaced refresh rate min. 75 Hz. Full HD resolution 1920 x 1080, 256 colours with MRPII compliant, viewing angle 178 ° vertical & horizontal and fastest response time.
05.	DVD R/W	:	16x or higher
06.	Keyboard	:	ASCII





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07. Pointing Device : Optical Mouse
08. Software : Latest & proven version of Windows OS with Multimedia. Third party operating system, graphical users interface and software, if required. General MS Windows latest, MS-Office Professional, Adobe Acrobat, Anti-virus software with IPS, AutoCAD etc.
- Application engineering & HMI software to suite project specific requirement
09. Miscellaneous Requirements : System chipset: Intel Express
2 x RS-232 ports
1 x parallel port
4 nos. USB (3.0/2.0 ports (2 nos. on front side)
2 x Ethernet (10/100/1000 MB) cards (Industrial Grade)
One (1) Graphic card with minimum 2048 MB memory.
Sound Card & Internal speakers
Wireless internet & Bluetooth interface.
Redundant power supply (In-built)

B. Engineering Workstation

01. Processor : Intel Xeon 6 core 64 bit processor capable 3.6 GHz with 16 MB L3 cache memory per processor, dual independent 1333 MHz system bus (2 way SMF) or better.
02. Memory : 16 GB DD4 RAM (or latest)
03. Hard drive : 2 X 1000 GB





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04.	Monitor	:	LED based 24" or higher sized monitors with non interfaced refresh rate min. 75 Hz. Full HD resolutions 1920 x 1080, 256 colours with MRPII compliant, viewing angle 178 ° vertical & horizontal and fastest response time
05.	DVD R/W	:	16x or higher
06.	Keyboard	:	ASCII
07.	Pointing Device	:	Optical Mouse
08.	Software	:	Windows latest edition server version standard/ Enterprise Edition General MS Windows latest, MS-Office Professional, Adobe Acrobat, Anti-virus software with IPS, AutoCAD etc. Application engineering & HMI software to suite project specific requirement
09.	Additional general purpose software (for using over network by servers / workstations/ PCs)	:	Comprehensive disk maintenance utility for disk clean sweep / crash guard / anti-virus etc. (like "Norton System Works Latest Edition")
10.	Miscellaneous Requirements :		1 x parallel port 4 nos. USB (3.0/2.0 ports (2 nos. on front side) 4 x Ethernet (10/100/1000 MB) network ports 2 non-boards and 2 added One (1) Graphic card with minimum 2048 MB memory





2PCI Express slots (1x4 lane & 1x8 lane)

2 PCI x slots (64 bit/ 100 MHz)

2 PCI x slots (one 32 bit/ 33MHz, 5V & one 64 bit/66 MHz)

Back-up & Disaster Recovery Software.

5.12.04 **Specification of Laptop PC**

All the Laptop shall also be used as pluggable temporary programmer's station and operator station functionalities of the programming stations mentioned in the specifications shall be provided (including requisite license).

The Laptop shall meet following minimum requirements:

- Intel Centrino TM Mobile Technology.
- Intel Core – i7 Processor with 3.46 GHz, 4 MB L2 cache, 1066 MHz FSB or better.
- 15" WXGA LED Screen with wide angle viewing.
- 1000 GB 7200 rpm HDD with shock absorber.
- 8 GB 800 MHz DDR3 SDRAM (slot for 1no. additional RAM slot should be provided) (or DDR4 latest)
- 1024 MB Graphic Accelerator
- 1 x windows 10 or latest & proven version of Windows OS with
- Multimedia
- Slim type DVD-RW/DVD ROM combo drive.
- Internal 10/100/1000Mbps Ethernet card
- IEEE 802.11B connectivity port
- 2Nos. USB 3.0/2.0 ports & Wireless INTERNET & blue tooth interface
- External mouse connectivity and Optical mouse
- Minimum 5 hrs battery backup.
- Recovery software tools.
- Sound cards
- Internal speakers
- General MS Windows latest, MS-Office Professional, Microsoft
- Visual Studio, Adobe Acrobat, anti-virus McAfee or equivalent, etc.



- Application engineering & HMI software - to suit project specific requirement.
- Carry Bag.

5.12.05 Large Video Screen (LVS)

Large video screens, complete with projectors, screens, control units (graphical generators), Master controller & associated accessories shall be supplied as per the following specifications.

1. Size (diagonal) 70 inch or higher
2. Type LED
3. Resolution of each screen Minimum 1400 x 1050 pixels and should offer 16.7 million colors. (Bidder to ensure that the aspect ratio of OWS monitor is same as that of LVS being supplied.) The brightness uniformity should not be less than 95 % ANSI 9.
4. Configuration of LVS Single tier with Screens seamlessly combined with provision of expansion of one screen on each side.
5. Control Unit Same as operator work station without the LED monitor. Facility of projecting a particular display on a selectable area of the screen upon activation of a predefined event shall be provided.
6. Input signal interface Interfacing with Video signals, to receive & project pictures from CCTV, Owner's Live camera, VCP. This Video signal shall be connected to video wall through Master controller.

Signal types: PAL, NTSC or SECAM in S-VHS/VHS, Composite, Component, S-Video DVI, VGA, SCADA Each cube should be capable of taking two inputs.

No of Inputs:6
No. of Outputs: 6



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Remote unit/video switcher for switching between video signal & HMI signal, selecting the video signal channel (live minimum 16 camera nos./location typically) shall be provided.

7. Illumination level Minimum 170 cd/sq.mtr.
8. Degree of viewing Minimum Horizontal +/- 33 deg and Vertical +/- 27 deg
9. The LVS and its accessories shall be designed in such a way that the brightness in the centre of the screen and the edge of the screen is uniform and there is no perceivable difference in the quality of the picture on the centre and on the edges of the screen. If any extra hardware has to be provided for achieving the above feature, same shall be provided the bidder at no extra cost. The screens should have low inter screen gap of ≤ 0.2 mm for seamless viewing.
10. Auto brightness & colour adjustment between each screen. White point should be 3200k- 9600 K Custom.
11. The hardware / software of the control unit shall be such that the command execution time of any control command from the LVS shall be same or better than the execution time from the OWS as stipulated elsewhere in this specification. If during any stage of the contract, the command response times as stated in specifications are not achieved, the bidder shall upgrade the hardware/software of the control unit in order to achieve the same at no extra cost to the Owner.
12. Master controller unit shall be provided for controlling the entire video wall in LVS. It shall be capable of projecting HMI displays over a part of screen to multiple screens. Any configuration of windows shall be possible. Facility for overlays shall be provided. Specification of Master controller unit shall be same as specified for server.
13. Complete LVS analysis & diagnostic software shall be provided.
14. LVS annunciation functionalities shall be provided with salient features of the conventional hardware annunciations, while presenting more flexibility.
15. The projectors, screens, control units (graphical generators), Master controller and associated wall management software should be of same manufacture. OEM should have a manufacturing setup in India for Video Walls.





16. As no hardwired backup has been envisaged, the LVS should ensure operation of the plant in case of total failure of all operator stations. Hence Complete DCS / PLC HMI & operation software shall also be loaded on respective display controller.
17. LVS shall be designed for continuous viewing (24 hours in a day) under normal room ambient lighting without any need to darken the room. Suitable darkening of the projection screen for light absorption shall be provided for this purpose.
18. The system should be configured such that any of the operators sitting on the same network should be able to work on the Large Video Screen sitting at his own position with his local keyboard & mouse.

5.12.06 **Laser Printer**

01. Type : Colour laser, tabletop
02. Paper size : A3 / A4
03. Speed : 6 ppm (color) for A3/ 4 ppm (color) for A4
20 ppm (B&W) for A3 / 16 ppm (color) for A4
04. Resolution : 600 dpi
05. Duty cycle : Heavy duty
- at least 50000 pages / month for A3
- at least 30000 pages / month for A4
06. First page out time : =< 1 min for color
<45 sec for BW
07. Paper input capacity : 500 sheets
08. Additional Features : Automatic Duplex printing
09. Communication port : Ethernet Port in addition to standard parallel port
10. Accessories : a) Additional cartridge
b) Printer stand

6.00.00 **ON LINE VIBRATION MONITORING SYSTEM (VMS)**





- 6.01.00 **Vibration Monitoring System**
- 6.01.01 Microprocessor based vibration monitoring system shall be provided for all HT motor & their driven equipment (pumps / fans) rated 160 KW and above. System shall be proven and from latest product range of the manufacturer. The System shall be supplied for each unit. Bidder shall consider Vibration Monitoring system for the HT equipments in their scope of supply (Refer Section-II of this volume of this specification for detailed scope of supply).
- 6.01.02 Vibration sensors shall be provided on the DE and NDE bearings of motors and fans / pumps. On each bearing there shall be two vibration sensors, one in X direction and other in Y direction. For vertical pumps there shall be three bearing locations i.e. DE motor, NDE motor and pump thrust / DE bearing. Proximity type key phasor sensor/s shall be provided for the shaft speed signal for analysis of the vibration.
- 6.01.03 The vibration monitoring system shall be furnished on a system basis including vibration transducers with low noise flexible cables in flexible conduit, terminated in local terminal boxes, necessary pre-amplifier / electronics mounted in local weather proof boxes, vibration monitors, mounting racks and cabinets. The vibration monitoring system shall include all power supplies, interconnecting cabling, calibration equipment, indicators, signal conditioning & measuring devices and all other accessories required for monitoring of vibration at each point.
- 6.01.04 Bidder shall offer 2/4 channel vibration monitors for each measurement location catering for horizontal and vertical measurements. Offered vibration monitors shall be modular in construction, plug in type and suitable for 19" rack mounting.
- 6.01.05 Piezo electric transducer / Eddy current type proximity transducers shall be used. However, the finally selected sensor type shall also depend on recommendation of the equipment manufacturer & suitable for application requirement. Transducers shall be furnished in weatherproof housing suitable for field conditions.
- 6.01.06 Vibration monitoring system shall give buffered output of 4-20 mA DC for each point monitored. The signal shall be suitable for use as an input to Station DCS for indication and recording linear in proportion to vibration velocity as well as displacement. Monitor shall provide vibration indication calibrated in velocity units along with provisions of changing to displacement unit (field-programmable) for each measurement point in both horizontal & vertical planes. For each vibration monitor, two independent potential free contacts shall be made available for alarm & trip purposes.



6.01.07 The vibration monitor racks with power supplies shall be mounted in a separate self-standing cabinet to be located in FGD Local Control Room. The number of racks and power supplies shall be such that on failure of a single power supply / module, no more than four monitors shall be affected. The vibration monitoring cabinet shall be fed from redundant UPS feeders with auto changeover scheme.

Complete VMS shall be time synchronized from Master clock system.

6.01.08 The functional requirement for vibration monitoring system shall include but not be limited to the following:

- a) Vibration monitor front face status indications shall be available for indications of healthy conditions of pick up circuit, monitor circuit and power supply. Also set point indication with set point adjustment facility for setting alarm & trip levels shall be provided.
- b) The facility shall be available from front of mounting rack for functional checking of monitors with inhibition of alarm and trip contact outputs during test. Alarm inhibition shall also be provided during start-up.

6.01.09 All vibration monitoring equipment shall be functionally tested for circuit continuity and output response. All the components & interconnection cables shall be tested to ensure compliance with the specification requirements and all other applicable codes & standards.

6.01.10 Vibration analysis is not envisaged for this system, hence bidder can use loop powered vibration sensors.

7.00.00 POWER SUPPLY SYSTEM

7.01.00 240V AC Redundant Package UPS system with 60 minutes back-up to cater various C&I system loads in FGD control room including PLC, HMIs, field instruments / analyzers, Relay based Local Control Panel etc. and PLC / Proprietary control and monitoring system for package systems (if any), Vibration Monitoring System shall be provided by the bidder.

7.02.00 UPS Power supply (max. 1 kVA) required for the FGD C&I loads, located in main plant CCR, shall be made available to the bidder at purchasers ACDB terminals as single redundant feeder. Cabling from the purchaser ACDB to FGD load points/ ACDB is under the scope of the bidder.

7.03.00 24V DC power distribution for PLC and loop powered field instruments shall be derived from the UPS and the required DC distribution boards shall be located within the PLC cabinets. Any other DC power supply required for the plant shall also be suitably derived and distributed. (UPS specification shall be covered in Electrical Volume).



8.00.00 **INSTRUMENTATION & CONTROL CABLE**

8.01.00 **Cable Design Criteria**

8.01.01 Cables shall be suitable for the area through which they are routed. All cable shall be flame retardant low smoke (FRLS) type conforming to IEC 60332 standards. Hot zones shall have FS / PTFE cables.

8.01.02 Cables shall be so designed and manufactured that damage does not occur in handling, during transit, storage, installation and operation under any or all the climatic and operating conditions which they may be subjected to. Outer sheath of cables shall have rodent and termite repulsion property.

8.01.03 Cables shall be suitable for laying in conduits, ducts, trenches, trays or for direct burial in ground in both dry and wet locations.

8.01.04 Cables shall be capable of operating satisfactorily under the power supply voltage and frequency variations as specified in the specification. Current ratings and ratings factors of cables shall not be worse than the ones specified in IS: 3961.

8.01.05 Performance characteristics of cables shall be based on the following conditions of laying:

- All cables shall be laid in multilayer and touching each other.
- Cables shall be suitable for laying in duct or burying in ground upto a depth of 1.5 meters with uncontrolled back fill and chances of flooding by water.

8.01.06 Suitable distance shall be maintained in routing and laying instrumentation cables so that the interferences from electrical HT & LT cables are minimized. Cables carrying redundant instrument signals shall be separately routed. In hazardous areas cables of suitable R/L ratio shall be provided for intrinsic safety.

8.01.07 Fillers in multiple conductor cables shall be flame retardant and moisture resistant.

8.01.08 Durable marking shall be provided on the surface of the cable at intervals not exceeding 5 mtrs. Marking shall include Manufacturer's name, Year of manufacture, Voltage grade, Type of cables (Conductor size & no. of pairs / triads / type of extension /compensating cable), Insulation material, FRLS etc.

Sequential length marking shall also be provided at every meter interval on outer sheath of cable.



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- 8.01.09 All cables shall be suitable for continuous operation at 85°C except for high temperature heat resistant Teflon insulated cables, which shall be suitable for continuous operation at 205°C.
- 8.01.10 The allowable tolerance on overall diameter of cable shall be +/- 2 mm (maximum) over the declared value in data sheet.
- 8.01.11 The variation in diameter shall not be more than 1.0 mm throughout the length of the cable.
- 8.01.12 The ovality at any cross-section of cable shall be not more than 1.0 mm.
- 8.01.13 The cables shall be provided in non returnable wooden drums. The drum length shall be 1000 m + 5% up to & including 12 pair cables and 500 m + 5 % for above 12 paired cables. The drum length shall be 1000 m + 5% for optical fiber cables.
- Drum shall be anti rodent, anti termite and smooth finish. Both end of cable shall be capped by means of non hygroscopic sealing material
- 8.01.14 20% spare pairs or min 1 pair cable (whichever is more) shall be provided with all type of cables, except for pre-fabricated cables which shall be as per manufacturer's standard.
- 8.02.00 **Instrumentation Cable Specification**
- 8.02.01 **Instrumentation Multi Paired Signal Cable**
- | | | | |
|-----|----------------------------|---|---|
| 01. | Conductor type | : | Stranded (7) annealed tinned copper (as per IS 8130) |
| 02. | Conductor size | : | 0.5 / 1.5 Sq.mm (as applicable) |
| 03. | Conductor Insulation | : | Extruded HR PVC Type-C to IS-5831 |
| 05. | Operating Voltage | : | 300 / 500V RMS (Core to earth / core to core) |
| 06. | Twisting | : | Twin twisted with lay of 60 mm |
| 07. | Twisting Direction | : | All pairs in the same direction.
Lapped to form bunch with Mylar tape. |
| 08. | Screen
(Pair & Overall) | : | Aluminium Mylar tape with a thickness of 28 µm (min.) for individual pair screen and 60 µm (min.) for overall screen with 100% coverage and 25% overlapped edges. |





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Over the individual pair screening tape two laps of 0.05 mm thick (min.) polyester tape shall be applied with minimum overlap of 25%.

Metallic side of the screen shall be in contact with drain wire.

* Analog signals- Individual pair & overall shield to be considered.

* Binary signals- overall shield to be considered.

09.	Drain wire	:	Annealed tinned copper wire, stranded (7)
10.	Inner Sheath	:	FRLS HR PVC Type-ST-2 to IS-5831
			Colour- Black
11.	Rip Cord	:	Non metallic under sheath
12.	Armouring	:	Galvanized steel wire/strip to IS:3975& IS 1554 Part II
13.	Outer Sheath	:	FRLS HR PVC Type-ST-2 to IS-5831
			Colour- Grey
14.	Filler	:	Non hygroscopic with FRLS property.
15.	Temperature Range	:	85 °C
16.	Electrical Parameters :		

Conductor Loop Resistance at 20°C	73.2 Ohms/Km for 0.5 sq mm. Conductor size.

24.6 Ohms/Km for 1.5 sq mm. Conductor size

Insulation at 20°C	100 MOhms/ Km

Mutual Capacitance	120 nF/km (for Individual & Overall Shield)

between conductor at 0.8 KHz (Max.)	100 nF/km (For Overall Shield)

Cross Talk	60 dB

Attenuation at 1 KHz (Max.)	1.2 dB/Km





Above 4 Pairs, 4 Pairs making a unit shall have indelible printed colour coded bands like Pink for 1st unit, Orange for 2nd unit and Violet for 3rd unit and so on. In addition band marking, for example single band for 1st. unit, double band for 2nd. unit and so on, shall be provided on each conductor for identification of unit. Band marking on individual core shall be provided at regular intervals not exceeding 50 mm.

8.02.02 Thermocouple Extension &Compensating Cable (As applicable)

01.	Conductor	:	Solid conductor
02.	Conductor size	:	16 AWG (1.31 Sq. mm)
03.	Type	:	Single/ multi-pair twisted and shielded type as per ANSI MC96.1 KX (Extension) (Chromel - Alumel)
04.	Conductor Insulation	:	Extruded HR PVC Type-C to IS-5831
05.	Operating Voltage	:	225 V (peak value)
06.	Twisting	:	Pair twisted with lay of 60 mm (max)
07.	Twisting Direction	:	All pairs in the same direction. Lapped to form bunch with Mylar tape.
08.	Screen (Pair & Overall)	:	Aluminium Mylar tape with a thickness of 28 μm (min.) for individual pair screen and 60 μm (min.) for overall screen with 100% coverage and 25% overlapped edges. Over the individual pair screening tape two laps of 0.05 mm thick (min.) polyester tape shall be applied with minimum overlap of 25%. Metallic side of the screen shall be in contact with drain wire.
09.	Drain wire	:	Annealed tinned copper wire, stranded (7)
10.	Inner Sheath	:	FRLS HR PVC Type-ST-2 to IS-5831
11.	Rip Cord	:	Non metallic under sheath
12.	Armouring	:	Galvanized steel wire/strip to IS:3975& IS 1554 Part II



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13. Outer Sheath : FRLS HR PVC Type-ST-2 to IS-5831
14. Filler : Non hygroscopic with FRLS property
15. Temperature Range : Up to 85°C
16. Electrical Parameters :
- | | |
|--|---|
| Conductor Loop Resistance at 20°C | 760 (Typ.) for Kx Type
95 (Typ.) for Sx/Rx Type
390 (Typ.) for Tx Type |
| Insulation at 20°C | 100 MOhms/ Km |
| Mutual Capacitance between conductor at 0.8 KHz (Max.) | 200 nF/km |
| Cross Talk | 60 dB |
| Attenuation at 1 KHz (Max.) | 1.2 dB/Km |
| E.M.F at 100°C | 4.095 mV for Kx Type
0.646/ 0.647 mV for Sx/Rx Type
4.279 mV for Tx Type. |
| E.M.F at 200°C | 8.137 mV for Kx Type
1.441/ 1.469 mV for Sx/Rx Type
9.228 mV for Tx Type. |
17. Tests : a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863)
- b) Acid Gas Gen.: Max.20% by weight (IEC 754 Part-I)
- c) Temp Index : Min 250°C at 21 Oxy. Ind. (ASTM-D-2863)
- d) Smoke Density Rating : Max.60% (ASTM-D-2843).
- e) Flammability Test : (IEC 332 Part-B)





- f) Swedish Chimney Test : (SS-424-1475 F3)
- g) Halogen Content Measurement Test :
0.2% max. (ICEA T-33-655)
- h) Insulation Resistance Test : 100 M Ohm / Km Min
- i) High Voltage Test :
Core to core - 1.5 KV for 1 min.
Core to screen - 1.0 KV for 1 min.
Screen to armour - 1.0 KV for 1 min.
- j) Rodent & Termite repulsion test
(Presence of lead shall be confirmed)
- k) Thermo E.M.F (ANSI MC96.1)

18. Conductor material & sheath color for thermocouple cable as per ANSI MC 96.1 / IEC codes

Cable type	Overall Sheath Color	Wire	Sheath Color	Conductor Material
KX type	Yellow	Positive	Yellow	Nickel / Chromium
		Negative	Red	Nickel / Chromium

19. Durable printed or embossed numbering at regular interval of 50 mm shall be provided for identification of pairs.

8.02.03 Instrumentation Multi Triad Signal Cable

- 01. Conductor type : Stranded (7) annealed tinned copper (as per IS 8130)
- 02. Conductor size : 0.5 / 1.5 Sq.mm (as indicated under Section-I)
- 03. Conductor Insulation : Extruded HR PVC Type-C to IS-5831
- 04. Operating Voltage : 300 / 500V RMS (Core to earth / core to core)
- 05. Twisting : Triad twisted with lay of 50 mm
- 06. Twisting Direction : All triads in the same direction.





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- Lapped to form bunch with Mylar tape
07. Colour : Outer sheath colour shall be black for non-IS cable and light blue for IS cable. Individual triad colour code shall be Light Blue-Brown-Black
08. Individual triad & overall shield : Polyethylene coated aluminium foil with 100% coverage with 25% overlap (0.06)
09. Drain wire : Annealed tinned copper wire, stranded (7)
10. Inner Sheath : FRLS HR PVC Type-ST-2 to IS-5831
Colour- Black
11. Rip Cord : Non-metallic under sheath
12. Armouring : Galvanized steel wire/strip to IS:3975& IS 1554 Part II
13. Outer Sheath : FRLS HR PVC Type-ST-2 to IS-5831
14. Filler : Non hygroscopic with FRLS property.
15. Temperature Range : 85 °C
16. Electrical Parameters :
- | | |
|--|---|
| Conductor Loop Resistance at 20°C | 73.2 Ohms/Km for 0.5 sq mm. Conductor size. |
| | 24.6 Ohms/Km for 1.5 sq mm. Conductor size |
| Insulation at 20°C | 100 MOhms/ Km |
| Mutual Capacitance between conductor at 0.8 KHz (Max.) | 120 nF/km (for Individual & Overall Shield)
100 nF/km (For Overall Shield) |
| Cross Talk | 60 dB |
| Attenuation at 1 KHz (Max.) | 1.2 dB/Km |
| Characteristic Impedance at 0.8 KHz | 370 Ohms for 0.5 sq mm.
230 ohms for 1.5 sq mm. |
17. Tests : a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863)





- b) Acid Gas Gen.: Max.20% by weight (IEC 754 Part-I)
- c) Temp Index : Min 250 ° C at 21 Oxy. Ind. (ASTM-D-2863)
- d) Smoke Density Rating : Max.60% (ASTM-D-2843).
- e) Flammability Test : (IEC 332 Part-B)
- f) Swedish Chimney Test : (SS-424-1475 F3)
- g) Halogen Content Measurement Test : 0.2% max. (ICEA T-33-655)
- h) Insulation Resistance Test : 100 M Ohm / Km Min
- i) High Voltage Test :
Core to core - 1.5 KV for 1 min.
Core to screen - 1.0 KV for 1 min.
Screen to armour - 1.0 KV for 1 min.
- j) Rodent & Termite repulsion test
(Presence of lead shall be confirmed)

8.02.04 Cables near high temperature zone shall be capable of withstanding high temperature and terminated in junction box / panel in normal temperature zone. Teflon insulated and sheathed thermocouple extension cables and copper conductor cables shall be used in high temperature zone. Conductor and sheath shall be extruded FEP (Teflon) as per VDE 0207 Part 6 and ASTM D 2116. These cables shall be pair, multipair, triad, multitriad and twisted & shielded.

8.03.00 **Control & Power Cable**

8.03.01 **Control Cable (Core, Armoured)**

- 01. Conductor type : Stranded (7) circular high conductivity annealed plain copper generally conforming to IS 8130
- 02. Conductor size : 1.5 Sq.mm or above
- 03. Conductor resistance : 12.1 Ω/Km
- 04. Conductor Insulation : HR PVC Type-C (IS-5831,1984) 0.8 mm thick



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05. Voltage grade (U_0 / U) : 650 V / 1100 V AC RMS(Core to earth / core to core)
06. Service : For control signals with nominal voltage of 240 VAC / 220V DC
07. Inner Sheath : Extruded FRLS PVC (anti rodent, anti termite& moisture resistant properties)

HR PVC Type ST2 of IS-5831, 1984

Thickness as per IS-1554, Part-I 1976
08. Armour : Galvanized single round steel wire armouring as per IS 3975.
09. Outer Sheath : Extruded FRLS PVC (anti rodent, anti termite& moisture resistant properties)

HR PVC Type ST2 of IS-5831, 1984

Thickness as per IS-1554, Part-I 1976
10. Temperature Range : 85 °C
11. Insulation at 20°C : 100 Mega Ohms /Km [Min]
12. Codes & Standards : a) IPCEA-S-61-402
b) IEC 332-1
c) ASTM-B-33
d) IS-8130-1984
e) IS 1554 Part-1
f) IS 10810
13. Core Identification : As per IS 1554 (Part I)
14. Outer Sheath colour : Black
15. Tests : a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863)
b) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I
c) Temp Index : Min 250 °C at 21Oxy. Ind. (ASTM-D-2863)





- d) Smoke Density Rating : Max. 60% (ASTM-D-2843).
- e) Flammability Test : as per IEC 332 Part-I
- f) Swedish Chimney Test-SS-424-1475 F3
- g) Insulation Resistance 100 M Ohm / Km Min
- h) High voltage test (3 KV for 5 minutes)
- i) Rodent & Termite repulsion test (Presence of lead shall be confirmed)
- k) Routine Test
- l) Type Test

8.03.02 **Low Voltage Power Cable (Core, Armoured)**

01. Conductors	:	Stranded and compacted high conductivity annealed plain copper as per IS-8130
02. Conductor size	:	2.5 Sq.mm or above
03. Conductor Insulation	:	Extruded HR PVC insulation conforming to type C of IS-5831 or XLPE.
04. Internal sheath	:	Extruded PVC conforming to type ST2 of IS-5831
05. External Sheath	:	Extruded FRLS PVC conforming to type ST2 of IS-5831
06. Service	:	For instrumentation & Control power supply
07. Voltage grade (U_0 / U)	:	650V / 1100V AC RMS (Core to earth / core to core)
08. Maximum rated conductor temp. in normal operation	:	85 °C
09. Armour	:	Galvanized single round steel wire armouring as per IS 3975.





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10. Core Identification : As per IS 1554 (Part I)
11. Outer Sheath colour : Black
12. Tests : a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863)
- b) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I
- c) Temp Index : Min 250 °C at 21Oxy. Ind. (ASTM-D-2863)
- d) Smoke Density Rating : Max. 60% (ASTM-D-2843).
- e) Flammability Test : as per IEC 332 Part-I
- f) Swedish Chimney Test-SS-424-1475 F3
- g) Insulation Resistance 100 M Ohm / Km Min
- h) High voltage test (3 KV for 5 minutes)
- i) Rodent & Termite repulsion test (Presence of lead shall be confirmed)
- k) Routine Test
- l) Type Test

8.04.00 Optical Fiber Cable

8.04.01 This specification defines the minimum general requirements for the design, manufacture, supply, inspection, installation, testing & commissioning of multimode & mono-mode optical fiber cables and accessories, such as fiber distribution (patch) panels, adapters, connectors, joint boxes, pigtails and other components, as required to complete the system. Bidder shall consider all related activities, such as cable stripping, cable entry in boxes and panels, cable fiber splicing/fusion, cable performance testing and other deliverables, to achieve a properly documented and operational cable network.

8.04.02 Fiber Optic Cables shall be installed on cable tray, duct bank, cable trench installation as necessary. For outdoor applications the cable shall be armoured with Poly Ethylene sheathing. Cable shall be routed through suitable grade HDPE permanently lubricated protection pipe as per IS 4984, IS 12235 & TEC.G/CDS-08 /01 of suitable size @ 53% fill factor.





- 8.04.03 The Optical Fiber core shall be of ultra pure fused silica glass coated with UV-cured acrylate suitable to withstand temperature of about 80°C (continuous).
- 8.04.04 Fiber optic cable shall be of loose tube design. Typically, fibers shall be housed in-groups of 6 (minimum) within gel-filled buffer tubes to protect against ingress of moisture and vibration. The tubes shall be manufactured with industry standard material like Poly-Butelene Terathylate (PBT). They shall be colored for easy identification. Buffer tubes shall be approachable with industry standard tools and practices. The buffer tubes shall be stranded around the Central Strength Member utilizing Reverse Oscillating Lay (ROL). Blank fillers shall be used as necessary to maintain circular cable structure. Cable shall withstand water penetration when tested with a one meter static head or equivalent continuous pressure applied at one end of a one meter length of filled cable for one hour. No water shall leak through the open cable end.
- 8.04.05 The central strength member of the cable shall be Fiberglass Reinforced Plastic (FRP) or other material with equivalent mechanical strength to provide both tensile and anti buckling strength to the cable.
- 8.04.06 In addition to central strength member, additional strengthening substance like aramid yarns shall be helically applied over the cable core to provide additional tensile strength to the cable.
- 8.04.07 The cable shall be of dual jacket & armoured. Inner sheath consists of a medium density polyethylene (MDPE) jacket extruded over the cable core. Two highly visible ripcords are placed under the jacket to aid in sheath removal. A co-polymer coated steel tape is corrugated and wrapped around the inner jacket to provide additional cable compression strength and rodent protection. The armor is covered with an outer black FRLS MDPE jacket. A ripcord is also placed underneath the armor for easy outer jacket removal.
- 8.04.08 Minimum bending radius shall be equal or more to 15 D. A continuous strength member shall be provided for the entire length of the cables. Every tube and fiber shall be colour coded to provide easy identification. The outer sheath shall be marked to show fiber type and cable classification at suitable intervals.
- 8.04.09 Minimum 100% spare cores over the actual use shall be provided.
- 8.04.10 The entire length of each cable shall be marked with the following items:
- a) Manufacturer's Name
 - b) Month and year of manufacturer
 - c) Coded description of the cable based on Telcordia's (Bellcore) SR-2014 Suggested Optical Cable Code (SOCC).
 - d) Sheath Identification Number

- e) Sequential Length Marking in meter
- f) A Telephone Handset symbol to distinguish communication from power cable as per NESC section –35 G.

8.04.11 Fiber optic cable shall provide a long life expectancy of minimum 25 years and shall meet the industrial standard of continuous operation at temperature of 55°C and humidity to 100% without degradation to optical or mechanical performance.

8.04.12 Optical fiber used in the plant shall generally conform to the following specification.

Specification for ITU G.652 Monomode Fiber		
1.	Cladding Diameter	125 $\mu\text{m} \pm 1.0 \mu\text{m}$
2.	Nominal Core Diameter	8.3 $\mu\text{m} \pm 1.0 \mu\text{m}$
3.	Fiber core count	6 core (minimum)
4.	Cladding non-circularity	$\leq 0.8\%$
5.	Maximum attenuation at (a) 1310 nm (b) 1550 nm	< 0.5 dB/km < 0.5 dB/km
6.	Index of refraction (a) 1310 nm (b) 1550 nm	< 1.467 < 1.468
7.	Zero Dispersion (a) 1300 ~ 1324 nm	< 0.093 ps/Km/nm
8.	Proof Test	$\geq 1\%$
9.	Fiber Curl (ROC)	$\geq 4.0 \text{ m}$
10.	Macro-bend Test on Fiber	$\leq 0.1 \text{ dB}$

Specification for ITU G.651 multi mode Fiber		
1.	Cladding Diameter	125 $\mu\text{m} \pm 2.0 \mu\text{m}$
2.	Nominal Core Diameter	50 $\mu\text{m} \pm 3.0 \mu\text{m}$
3.	Fiber core count	6 core (minimum)
4.	Cladding non-circularity	$\leq 3.0\%$
5.	Maximum attenuation at (a) 850 nm (b) 1300 nm	< 3.5 dB/km < 1.0 dB/km

Specification for ITU G.651 multi mode Fiber		
6.	Group index of refraction	
	(a) 850 nm	< 1.483
	(b) 1300 nm	< 1.479
7.	Proof Test	≥1%
8.	Fiber Curl (ROC)	≥ 4.0 m
9.	Macro-bend Test on Fiber	≤ 0.1 dB

8.04.13

Cable Assembly

(a) Optical Fiber Environmental Splice Enclosure

Optical fiber environmental splice joint enclosures shall be re-enterrable and rack / wall mountable. The interior splice case shall be equipped to mechanically accommodate single-mode optical fibers connected by the fusion method. Splice case shall be equipped to organize the splice trays and the required service loops of buffered incoming optical fibers and outgoing 'pigtails' in such a way that allows each completed splice and associated optical fiber to be maintained in an unstrained configuration. Splice enclosure shall be dust and weather proof.

(b) Fiber Optic Distribution Patch Panel

Fiber optic distribution panels shall be provided as required. Fiber optic distribution panels shall be of a standard wall mounted sheet metal enclosure type. Fiber optic distribution panels shall be equipped to secure optical fiber patch cables and pigtails to prevent damage during all operation and maintenance functions. In general splice enclosure are envisaged. However, if no optical fiber splice enclosures are implemented, than the fiber optic distribution panels shall be equipped with splice trays for storage and protection of fusion splice connections of single-mode fiber optic cable and pigtails. Each fiber optic distribution panel shall be fully equipped with 'SC' type bulkhead connector sleeves or equivalent. Unused sleeve ports shall be equipped with reusable caps to prevent the intrusion of dust.

(c) Pigtail and Patch Cord

All pigtails shall be factory SC-connectorized, and satisfy specified performance for optical links. All unused pigtails (including spares) shall be terminated with the connector to a bulkhead connector sleeve, protected by a reusable cap on the opposite sleeve port, to prevent the intrusion of foreign material or dust. All necessary connectorized pigtails shall be provided in the lengths required.



9.00.00 **ERECTION HARDWARE**

This section provides the general technical guidelines for the erection materials for instruments. All erection materials shall be of good quality and conform to the operating environment of the corresponding instrument.

9.01.00 **Electrical Accessories**

9.01.01 Electrical conduit and associated materials shall conform to the requirements of the articles which follow:

a) **Rigid Steel Conduit**

- i) Conduits up to and including 25 mm shall be of 16 SWG and conduits above 25 mm shall be of 14 SWG. Minimum size of conduits shall be 19 mm.
- ii) Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushing at both ends.
- iii) All rigid conduit couplings and elbows shall be hot dip galvanized rigid mild steel in accordance with ANSI C 80.1 and UL6. The conduit interior and exterior surfaces shall have a continuous zinc coating with an over coat of transparent enamel or zinc chromate. Conduits shall be furnished in standard length of 3 meters, threaded at both ends.
- iv) All conduit fittings shall conform to the requirements of ANSI C 80.4 and UL-514 where these standards apply.

b) **Flexible Conduit**

- i) Flexible conduit shall be of three layer construction of very high quality of lead coated steel. Outside and inside layer shall be reinforced with heat resistant material.
- ii) Lead coating outside and inside of the conduit steel surface shall provide a non-corrosive characteristic particularly in acidic atmosphere. Besides flexibility, this shall be strong enough to stay at the desired profile without support and shall be durable and strong so as to offer sufficient mechanical protection. It shall also be fully liquid dust and air tight and shall withstand a continuous hydraulic pressure up to 2 Kg/Sq. cm and temperature up to 200 °C.

c) **Special Fittings**

- i) Conduit sealing and fittings shall be provided as required and shall be consistent with the area and equipment with which they are installed.



- ii) Double locknuts shall be provided on all conduit terminations not provided with threaded lugs and couplings. Locknuts shall be designed to securely bond the conduit to the enclosure when tightened. Locknuts shall not loosen due to vibration.
- iii) Conduit supports shall be furnished and installed in accordance with the specifications.

9.01.02 **Junction Box**

01.	Type of Enclosure	:	Dust tight & weatherproof conforming to IP 65
02.	Material	:	3 mm sheet steel/ fiberglass reinforced polyester (UV stabilized)
03.	Type of Cover	:	Solid unhinged with retention chain/ screwed at all four corners
04.	Paint	:	RAL 7032 – Siemens Grey
05.	Mounting	:	Surface/ 2" pipe stanchion (At a dry compartment at one side of the enclosure/ rack with front opening type door)
06.	Cable Entry	:	3 mm (min) Bottom / side Gland plate
07.	Gasket	:	Neoprene
08.	Grounding	:	Brass earth lug with green screw head External-two (2) nos., Internal – one (1) no.
09.	No. of Drain holes	:	Two at bottom capped
10.	Identification	:	Label for JB & tags for cable
11.	Accessories	:	a) Rail mounted cage clamp type screw less terminals (suitable for conductor size up to 2.5 sq. mm of suitable voltage grade) with markers and 20% spare terminals. b) Cable gland (Brass) & raceways

9.01.03 **Cable Gland**

01.	Type	:	Double compression





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- 02. Entry Thread : NPT
- 03. Material : Brass
- 04. Finish : Cadmium Plated.
- 05. Protection : IP 54 or better
- 06. Accessories : Neoprene gasket, locknuts, reducers etc.

9.01.04 Cable Tray

- 01. Material : Mild steel
- 02. Thickness : not less than 2.0 mm
- 03. Finish : Hot dip galvanized
- 04. Perforation : As per MFR standard.
- 05. Cover : Suitable for tray

9.02.00 Process Hook Up Accessories & Specification (as applicable)

Material and rating of the hook up items shall generally suit the piping and fluid condition. Bidder shall furnish hook up drawings and the drawings for open racks & closed racks for Owner / Consultant's approval. For the design guide line Bidder shall refer to Section-I of this Volume.

9.02.01 Specification for Process Hook Up Materials

Sr. No	System	Piping class	Impulse Pipe Material	Schedule	Materials for Valve / Fittings	Stem Material	Rating of Fitting	Pr. Class of valve
1.	Auxiliary steam	G	ASTM-A106 Gr. B	80 (½ inch)	ASTM-A 105	ASTM -A182 Gr. F-6a	3000 lb	800
2.	Air / Flue Gas Outside Furnace	K	ASTM-A106 Gr. B/C	80 (¾ inch)	ASTM-A 105	ASTM -A182 Gr. F-6a	3000 lb	800
3.	Air / Flue Gas Inside Furnace	L	ASTM-A335 Gr. P-22	80 (¾ inch)	ASTM-A 182 Gr. F-22	ASTM -A182 Gr. F-6a	3000 lb	800





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Sr. No	System	Piping class	Impulse Pipe Material	Schedule	Materials for Valve / Fittings	Stem Material	Rating of Fitting	Pr. Class of valve
4.	DM Cooling Water	M	ASTM A312 TP 316	40 (1/2 inch)	ASTM A182 F316	SS or better	3000 lb	800
5.	Cooling Water	N	ASTM-A106Gr . C	80 (1/2 inch)	ASTM-A 105	SS or better	3000 lb	800

Note:

- 1) Above requirements to be complied by Bidder as applicable for the FGD system. Rating of piping/ fittings / valves etc. is subjected to be approved by Owner as per the final design pressure & temperature finalized during the detail engineering as per ANSI B31.1.
- 2) Material shall be compatible with that of the impulse pipe material and design parameter.
- 3) For DM water services, complete erection hardware material shall be SS316 only.

9.02.02

Seamless Stainless Steel Pipe

01. Reference : ASTM A-312 TP 316
02. Material Grade : TP 316
03. Type : Seamless /Plain end
04. Size : 1/2" NB
05. Schedule : 40
06. Standard Length : 5 meter

9.02.03

Stainless Steel Pipe Fittings

01. Reference : ASTM A-182 F 316 / ANSI B16.11
02. Type : Forged
03. Rating : 3000 lbs / 6000 lbs / 9000 lbs
04. Size : 1/2" NB





05. End connection : Generally socket weld
06. Type of Fittings : Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

9.02.04 **Seamless Stainless Steel Tube**

01. Reference : ASTM A-213 TP 316
02. Material Grade : TP 316
03. Size : ½" OD X 2.1 MM Thick
04. Type : Cold drawn annealed, pickled, passivated, de-scaled, hydraulically cleaned seamless tube.
05. Properties : The tube shall be free from scratches and suitable for bending and capable of being flared by hardened and tapered steel pin. The expanded tube shall show no crack or rupture. Hardness shall be RB 80.
06. Test Pressure : 400 Kg/Sq. cm (minimum)
07. Tolerance : ± 0.13 mm for outside diameter
± 15 % for wall thickness
08. Standard Length : 5 meter
09. Test : Flare, Hardness, Ball and Bubble Test

9.02.05 **Stainless Steel Tube Fittings**

01. Reference : ASTM-A-182
02. Type : Double ferrule double compression
03. Material : 316 Stainless steel forged
04. Ferrule : 316 Stainless Steel
05. Type of Fittings : Male / female connector, elbow, cross / equal tee, straight connector, bulkhead union, ferrule etc. as required to suit installation.





06. Size : To suit SS tubing and NPT end connection
- 9.02.06 **C.S. Pipe**
01. Reference : ASTM-A 106 Gr. C
02. Material : Cold drawn seamless black C.S.
03. Type : Seamless / Plain ends
04. Size : ½" NB
05. Schedule : 80, 160, XXS as required
06. Standard Length : 5 meter
- 9.02.07 **C.S. Pipe Fittings**
01. Reference : ASTM-A 105 / ANSI B16.11
02. Type : Forged
03. Rating : 3000 lbs / 6000 lbs / 9000 lbs
04. Size : ½" NB
05. End connection : Generally socket weld
06. Type of Fittings : Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.
- 9.02.08 **A.S. Pipe**
01. Reference : ASTM-A 335 P22 AS PER ANSI B 36.10
02. Material : Cold drawn seamless A.S.
03. Type : Seamless / Plain ends
04. Size : ½" NB
05. Schedule : XXS
06. Standard Length : 5 meter



9.02.09

A.S. Pipe Fittings

01.	Reference	:	ASTM-A 182 F22 AS PER	ANSI	B
			16.11		
02.	Type	:	Forged		
03.	Rating	:	9000 lbs		
04.	Size	:	½" NB		
05.	End connection	:	Generally socket weld		
06.	Type of Fittings	:	Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.		

9.02.10

Carbon Steel Globe Valve

01.	Reference	:	ASTM A-105
02.	Type	:	Globe
03.	Construction	:	Forged Body Cadmium Plated
04.	End Connection	:	½" Socket Weld
05.	Rating	:	CL. 800 / CL. 2500
06.	Material	:	Body - Carbon steel Stem - Hardened Steel Plug - AISI 316 SS Seat- Stainless steel stellited
07.	Packing	:	Teflon / Grafoil as required
08.	Yoke	:	ASTM A105
09.	Handwheel	:	Carbon steel
10.	Design standard	:	As per ANSI B 16.34

9.02.11

Stainless Steel Globe Valve

01.	Reference	:	ASTM A-182 F316
02.	Type	:	Globe





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03.	Construction	:	Forged Body
04.	End Connection	:	Socket Weld
05.	Proof Pressure	:	400 Kg/cm ²
06.	Material	:	Body - Stainless steel Stem - Hardened Steel Plug - AISI 316 SS Seat- Stainless steel stellited
07.	Packing	:	Teflon as required
08.	Yoke	:	ASTM A182 F316
09.	Handwheel	:	Carbon steel
10.	Design standard	:	As per ANSI B 16.34

9.02.12 Alloy Steel Globe Valve

01.	Reference	:	ASTM A-182 F22
02.	Type	:	Globe
03.	Construction	:	Forged Body
04.	End Connection	:	½" Socket Weld
05.	Rating	:	CL. 2500
06.	Material	:	Body - Alloy steel Stem - Hardened Steel Plug - AISI 316 SS Seat- Stainless steel stellited
07.	Packing	:	Grafoil as required
08.	Yoke	:	ASTM A182 F22
09.	Handwheel	:	Carbon steel
10.	Design standard	:	As per ANSI B 16.34

9.02.13 Condensate Pot

01.	Reference	:	ASTM A182 F22 / ASTM A105





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02.	Material	:	Alloy steel / carbon steel as per application
03.	Construction	:	Drilled from barstock
04.	End connection	:	3 nos. 1/2" socket weld end
05.	Accessories	:	Vent valves

9.02.14 Instrument Valve Manifold

01.	Type	:	a) Two valve manifold b) Five valve manifold c) Three valve manifold
02.	Mounting	:	Remote 2" Pipe Mounting
03.	Construction	:	Single block (bar stock)
04.	Material	:	Forged body and bonnet AISI 316 stainless steel
05.	Ports	:	1/2 " NPT (F)
06.	Rating	:	420 Kg/Sq. cm at ambient
07.	Operating Temperature	:	(-)30 to (+)170°C
08.	Packing	:	PTFE Wafer
09.	Seat & Stem	:	AISI 316 SS
10.	Plug	:	AISI 316 SS free to turn on stem / 17-4 PH
11.	Handle Bar	:	AISI 316 SS
12.	Connection	:	Straight
13.	Accessories	:	a) Plugs for all ports b) Mounting Bracket, bolts, nuts

9.02.15 Air Header

			For Panel	For Field
01.	Material of Construction	:	Stainless steel	Stainless steel





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02.	Inlet Connection	:	2" NPT (M)	1" NPT (M)
03.	Header Take-off	:	Stainless Steel	Stainless Steel
04.	Take off Connection	:	1 / 2" NPT (M)	1/ 2" NPT (M)
05.	Take-off Valves	:	Stainless Steel	Stainless Steel
06.	Tube Take-off	:	Tube adapter on valve	Tube adapter on valve
07.	Drain	:	SS drain valve at lowest point	SS drain valves at lowest point

9.02.16 Seamless Stainless Steel Tube

01.	Reference	:	ASTM A-269 TP 316
02.	Material Grade	:	TP 316
03.	Size	:	¼" OD x 0.049" wall thickness
04.	Type	:	Cold drawn annealed, pickled, passivated, de-scaled, hydraulically cleaned seamless tube.
05.	Properties	:	The tube shall be free from scratches and suitable for bending and capable of being flared by hardened and tapered steel pin. The expanded tube shall show no crack or rupture. Hardness shall be RB 80.
06.	Test Pressure	:	400 Kg/Sq. cm
07.	Tolerance	:	± 0.13 mm for outside diameter ± 15 % for wall thickness
08.	Standard Length	:	5 meter
09.	Test	:	Flare, Hardness, Ball and Bubble Test

10.00.00 SPECIAL TOOLS & TACKLE AND TEST EQUIPMENT

10.01.00 Bidder shall supply a complete set of new, unused and reliable type of special tools and tackle and test equipment which are necessary or convenient for erection, commissioning, maintenance and overhaul of the plant and equipment provided under this specification.





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- 10.02.00 The tools & tackle and Test Equipment shall be shipped in separate container, clearly marked with names of the equipment for which they are intended.
- 10.03.00 Bidder shall furnish list of tools & tackle and test equipment proposed to be supplied along with the bid, if applicable. Minimum two (2) nos. antistatic wrist band in each control panels are mandatory and shall be included in the bid.





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SECTION - IV

**ERECTION, QUALITY ASSURANCE,
TESTING AND COMMISSIONING**



Development Consultants Pvt. Ltd.

**Vol. II-E/Section-IV
Erection, Quality Assurance,
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SECTION-VII

ERECTION, QUALITY ASSURANCE, TESTING AND COMMISSIONING

1.00.00 ERECTION TESTING & PRE-COMMISSIONING PRACTICES - GENERAL

1.00.01 This part of the specification is intended to provide a general guideline for the procedures to be followed for the erection, testing and commissioning of various Control & Instrumentation Systems, field instrumentation, final control elements and accessories.

1.00.02 Omission of any specific reference to any method, parts, accessories or material required for proper and efficient execution of the work shall not in any way relieve the Contractor from his responsibilities of providing such facilities and performing the successful erection, testing and commissioning.

1.01.00 Equipment, Materials & Services to be provided by Contractor

1.01.01 Contractor shall follow the stipulations of the contract enumerated elsewhere in the specification regarding Equipment, Materials & Services to be provided under this specification and shall include but not limited to the following:

- a) Shop testing and Factory Acceptance Test.
- b) Pre-calibration of instruments at site and maintaining record of the same.
- c) Pre-assembly at site, as required.
- d) Erection of items.
- e) Cleaning / flushing (as required), pre-commissioning checking to ensure correctness of erection.
- f) In-situ calibration, testing, loop checking etc. of instruments and accessories, as required and maintaining record of the same.
- g) Cleaning up of instruments, accessories and worksite during and after erection.
- h) Powering on and Commissioning of all the instruments and equipment and systems.

1.02.00 Site Acceptance Test

1.02.01 General

- a) The work under Control & Instrumentation shall include activities like placement of equipment on foundation/ support, leveling and alignment,



grouting on foundation, other miscellaneous civil work such as dressing / chipping of foundation / surfaces and also assembly and pre-assembly, minor rectification, welding, cutting, site adjustments and all other incidental activities, as applicable.

- b) Contractor shall arrange all testing, erection and commissioning tools and tackle like hydraulic jacks, precision levels including micro level, dial and other gauges, surface plates, straight edges, vacuum cleaners, blowers, pumps and other equipment / implements necessary for hydro testing, compressed air testing, calibration and all other necessary tests as may be required for timely and efficient execution of the Contract.
- c) Bidder shall furnish a detailed erection micro-plan consistent with the overall project schedule and keeping in view the various site facilities and constraints encountered during various phases of work.

2.00.00 SPECIFIC ERECTION PRACTICES AND GUIDELINES

The specification provides the general guidelines to be followed for the warehousing, handling, testing, erection, pre commissioning checks and commissioning of various types of instruments and accessories.

- a) The guidelines provided shall not be deemed as an effort to describe the entire work involved or to identify the steps and sequence to be adhered to in the erection of specific work items.
- b) The basic intent is to establish a sound engineering practice to be adopted throughout.
- c) Equipment manufacturers' recommendation, where available, shall prevail over the guidelines furnished in this section and in case of any contradiction between the stipulations.
- d) For special instruments viz. analyzers etc., the specification furnished are of general nature only and manufacturer's recommendation shall be strictly followed as guideline for erection and commissioning.
- e) The specification shall not be treated as comprehensive. Any activity, not specifically mentioned but felt essential or advisable from good engineering consideration shall be performed.

2.01.00 Field Instruments

Guidelines provided herein shall be adhered to while erecting an instrument or accessory in the plant beyond control room areas.

- a) Care should be taken to avoid damage to the instruments during handling and transportation. Special care shall be taken while handling breakable, spillable, fragile and delicate items.



- b) Before erection, all instruments shall be subjected to calibration and other functional checks at Contractor's site laboratory. The instruments shall be uncrated and unpacked with utmost care and as per instructions furnished on the respective packages, using appropriate tools and implements.
- c) All instruments, jigs, tools and tackle for the purpose of performing the tests shall be arranged by Contractor.
- d) All instruments shall be tagged with engraved aluminum / stainless steel tag plates and shall be secured to the instrument with metallic wire fasteners, during the test.
- e) For instruments found acceptable and conforming to the declared performance parameters of the manufacturer, the test report shall be prepared.
- f) Minor repairs and adjustments of the instruments shall be performed by Contractor. Once the defective instrument has been successfully repaired, it shall again be subjected to calibration and functional checks, as indicated above.
- g) A record of such repairs and adjustments shall be systematically maintained by Contractor.
- h) For instruments where the extent of damage is such that the same cannot be repaired at site, a failure report shall be generated by Contractor, enumerating the nature of fault/ damage. Cases where the damages are only superficial and which does not affect the appearance and performance of the instrument/s, the decision as to whether such instruments are fit for erection shall solely lie with Owner.
- i) In no case, erection work shall be taken-up in areas where heavy equipment movement is foreseen, major welding activity is under progress, heavy structural items are being erected or any other major activity is being carried out or is anticipated, which may cause damage to the erected instrument or its support.
- j) If any erected instrument or its accessories are found to be vulnerable to damage or to be fouling/interfering with progress of other activities in the area, same shall be dismantled/removed. During re-erection of such instruments, all the necessary steps as indicated in the specification for the erection of the instrument shall be carried out afresh.
- k) After erection, the instruments shall be covered with transparent polyethylene sheets to protect from unauthorized handling.
- l) Colored PVC adhesive tapes shall be put on the polyethylene cover to indicate various stages of activities. Red tape shall indicate erection under progress. Yellow tape shall indicate completeness of erection. Blue tape shall imply approval of erection and Green tape shall signify the commissioning of the instrument. Adhesive paper tapes shall be fixed on the respective tapes to inscribe the dates of completion of activities.

- m) Location of field instruments shall be consistent with tapping points on pipes and equipment.
- n) No field mounted instrument shall be installed in such a manner that it depends on rigidity of the impulse piping or the electrical connection to it for support.
- o) Handrails shall not be used for mounting or supporting instruments.
- p) The place where the instrument is to be installed must be easily accessible from nearest floor / platform level and there must have enough clear space to allow maintenance work and lay-down.
- q) The installed position must be such as not to cause any inconvenience to repair, removal, observation, inspection and maintenance of the installed equipment and other items nearby.
- r) The nearby high temperature equipment or process piping shall not give rise to any injurious effect to instruments.
- s) There will be no safety valve or effluent drain point which may cause injurious effect near the instrument. In general, no instrument shall be erected in areas prone to vibration.
- t) Instruments which are outside the building or shed and are not located within transmitter rack shall be provided with protective cover or canopy to provide effective protection against dust, rain, sun etc. The cover shall be provided immediately after mounting the instrument.
- u) All clamps, supports, stands etc. required for installation and erection of instruments and their accessories, shall be painted.
- v) No field mounted instruments shall be installed without simultaneously taking up impulse line work connected with the instrument.
- w) Proper precaution is to be taken to protect his installations, instruments, accessories, devices etc. by isolation/removal from possible damages during flashing, pressure testing of main pipe lines, air headers, vessels, equipments etc.
- x) Wherever practicable the height of the instrument from its working floor/ platform shall be between 1000-1400 mm. The illumination at the locations where instruments are located shall be adequate so that the scales can be read unassisted.
- y) Sub-trays, where required, shall be erected for proper routing of the cables and tubes and no cable shall be laid unsupported.
- z) The indicating meters shall be oriented properly so that the scale can be read unassisted and unobstructed from the approach floor / platform.

2.01.01 Pressure / Differential Pressure (D.P) Transmitters / Level Transmitters



Pressure and DP transmitters shall in general be on transmitter rack/enclosure mounted or shall be mounted locally on fabricated structures. Displacer type level transmitters shall, however, be mounted directly on the vessel / stand pipe attached to the vessel.

- a) All manifolds, cocks and valves shall be pressure tested at rated hydraulic test pressure. All air line and draft / vacuum service cocks and valves shall be leak tested.
- b) Manifolds / valves / Impulse pipes shall be mounted on / connected to transmitter at Contractor's workshop / site and the assembly shall be leak tested after completion of the plumbing. The leak test shall be performed with compressed air and soap solution at pressure not exceeding the maximum overload pressure of the transmitter.
- c) All tests on the transmitters shall be performed after mounting / connecting of the manifold / valve assembly.
- d) For transmitters located in transmitter racks, the erection activities shall normally include mounting of the transmitter with its manifold/valve assembly on appropriate support structures in the rack with proper fasteners, viz. U-clamps, bolts etc., proper leveling of the transmitter, all pipe connections from process to the transmitter, piping from transmitter to drain valve / vent valve, supporting/ clamping of the valve, pipe connections from transmitter / valve to drain pot/drain header/ nearest system drain, cabling from transmitter to the rack / external junction box using flexible conduits, termination of the cable with appropriate lugs, sleeves and markers; mounting and connecting all settling chambers / damper pots / siphons etc., as applicable.
- e) For transmitters mounted on stanchions, brackets etc., such supporting structures shall be designed properly to support all transmitter accessories.
- f) For displacer type level transmitters, the blanks provided on the vessel / stand pipe shall be removed and the transmitter shall be mounted with proper gaskets, bolts and nuts. All nut and bolt heads shall be properly greased before tightening.
- g) For external cage type level transmitters, additional supports to the transmitters in the form of bracings / pedestals, if felt necessary, shall be fabricated and erected. While supporting/mounting such structures due consideration shall be given to the movement/expansion of the main equipment.
- h) For transmitters mounted on local structures, cabling shall be done up to the nearest junction box through suitable flexible / rigid conduits / cable trays.
- i) Attention shall be paid to allow free space for the removal of transmitter cover.

- j) During installation of level instruments on vessels, if the nozzles on vessels are found to be out of alignment, necessary modification or addition of spool pieces as required, for proper installation, shall be carried out.

2.01.02 Temperature Instruments / Thermowells

- a) Welded thermowells shall be welded on pipes / vessels / equipment by certified welders only and all post-weld tests shall be performed as per main pipeline specification.
- b) All thermowells shall be thoroughly cleaned with air jet and wire brush before insertion of temperature gauges / element.
- c) The dial of temperature gauges and switches shall be oriented properly so that the scale can be read / set point can be adjusted unassisted from the approach floor/ platform.
- d) Capillary type instruments shall be mounted on appropriate support structure with clamps, bolts etc.
- e) Contractor shall fabricate structures for routing, supporting and protecting the capillary tubes. Capillaries shall be clamped at intervals not more than 1 meter. Capillaries shall not run unsupported.
- f) The cable take-off from temperature switches/elements shall be with flexible conduits up to the nearest sub-tray / junction box. Where appreciable movement of the pipelines are expected, adequate loop lengths shall be kept in the flexible conduits to allow the movement of the elements / switches without any strain.
- g) In the phase between erection and cabling work all cable entry points shall be kept plugged with PVC caps.
- h) Both the elements of duplex type elements shall be terminated at the junction box.
- i) All compensating cables shall be terminated with proper polarity.
- j) All cables shall cross ferruled at both the junction box and element head end.
- k) In case of thermowells with long immersion length and temperature elements having long and rigid extension neck, as in case of air or flue path measurements, mechanical supports shall be provided to avoid excessive suspension weight on the boss.

2.01.03 Pressure Gauges / Switches, Differential Pressure Gauges / Switches

Pressure gauges / switches and differential pressure gauges / switches shall either be directly mounted on the process pipeline or shall be mounted on local brackets, gauge boards or racks depending on accessibility and maintainability. Guidelines provided in clause 2.01.01 (a), (b), (c) & (d) above shall be generally followed for pressure and differential gauges and switches as well.



2.01.04 Stand Alone Field Mounted Electronic Controllers

Installation, supporting, cabling, calibrating, and commissioning of field mounted stand-alone electronic controllers (wherever used), fabrication of necessary supporting structures, pedestals, etc. shall be deemed as a part of the erection activity.

- a) Contractor shall fabricate protective enclosure of canopy wherever deemed required.
- b) The structure fabricated for installing the controller must have provision for mounting the associated accessories.
- c) All pneumatic tubing from the related I/P converter to the final control element shall be done in accordance with the specification laid down elsewhere in this specification.

2.01.05 Level Gauges / Switches

Level Gauges and Switches shall either be directly mounted on the vessel or on standpipe.

- a) Float and switching mechanism shall be installed only after welding and installing the cage in position.
- b) Contractor shall verify the following well in advance:
 - i) Necessary access platforms, ladders are provided.
 - ii) The center line of the tap-off valves are in plumb.
- c) Necessary support structures, if required for installation of external cages/gauges shall be fabricated.
- d) The erection activity of Level Gauges / Switches shall normally include mounting of the instrument, to vessel/stand pipe with necessary pipes, nipples, drain / vent valve, connection of drain to nearest system drain, cabling up to external junction box using flexible conduit, termination of cable with proper sleeves, conductor marker/ferrules and lugs etc.
- e) Necessary sub-trays, wherever required, shall be erected for proper routing of cable.
- f) The indicating side of gauge glasses shall be so oriented that it can be read unassisted and unobstructed from the approach floor / platform.
- g) Illumination in the areas where level gauges are mounted shall be adequate for the level to be visible without the help of flash light. Areas where this requirement can not be met, gauge glasses shall be provided with internal illumination.

2.02.00 Analyzers



Analyzers shall include flue gas analyzers or other analyzers, with all accessories, associated pipings / tubings and drain / purge line work/sampling system and necessary cabling.

- a) All necessary measures and precautions to be exercised for field mounted instruments shall be adhered to for field mounted analyzers, as well.
- b) Attention shall be paid to the accessibility of probe locations and withdrawal area for the probes. If Probe locations are found inaccessible, Contractor shall arrange for the construction of necessary access platforms. Also if any restriction is noted to the smooth withdrawal of the probes due to some interfering structures / railings etc., necessary modification work shall be performed by Contractor.
- c) Protective covers / canopies shall be fabricated and installed to protect the probe head / converter cabinet / calibration kit.

2.02.01 Oxygen Analyzers

- a) Suitable adapter plates with necessary openings on the duct properly stiffened and blanked with suitable blank flanges, shall be used for mounting Zirconia probe type Oxygen analyzers.
- b) Work shall include the erection of sub- trays or conduits for the cabling between probe head to the converter cabinet and the tubings for reference air and test gas, from calibration kit to the probe.
- c) While installing the converter cabinet, care shall be taken to locate the same within the specified distance from the probe.
- d) Activities shall also include the necessary sub-header work to extend reference air supply line from the nearest instrument air header to the reference air set, piping/tubing work between reference air purge meter to the reference air set and the probe, piping/tubing work between auto calibration kit to the probe and the necessary piping / tubing between the reference gas cylinders to the probe.
- e) All earthing continuity tests, insulation tests etc. shall be done as per manufacturer's recommendation.

2.02.02 Continuous Emission monitoring System (CEMS)

Contractor's scope of work shall include complete transportation, lifting, mounting, calibrating, testing and commissioning of stack emission monitoring system. Contractor's scope of work shall also include drawing of instrument air line up to platforms and subsequent distribution at Consumer points, laying of sampling lines from probe to analyser room as applicable etc. Necessary tubing, sub-tray work, cabling up to junction box on stack platform, conduiting etc. shall also be deemed to be a part of installation activity.

- a) Contractor's scope of work shall also include to arrange :



- i) Inserts and cutouts on stack wall with studs blanked-off temporarily by plates.
 - ii) Main cable tray/ladder up to the platform level and subsequent cable routine upto CEMS room.
 - iii) Instrument air take-off point near the analyzer location, if applicable.
- b) Adapter plate should be removed before installation and then bolted to the insert available on the stack or duct wall.
- c) The stack emission monitoring systems shall be mounted in the stack/CEMS room as per the layout drawing together with cubicle for housing the analyzers and all accessories like gas coolers, diaphragm pumps, test gas cylinders etc.
- d) Contractor's scope shall include; rigging, installation by bolting, necessary air piping up to the cubicle, cabling up to local junction box/CEMS room, testing, calibrating and commissioning of the system.
- e) The necessary precautions for probe mounting as detailed in the installation procedure of Oxygen analyzers shall be taken.
- f) Complete cabling from probe head to analyzers at platform or at CEMS room including laying of cable subtrays, conduits as required shall be in Contractor's scope of work.
- g) CEMS monitoring will consist of transmitter and receiver units, as applicable and electronic signal conditioning unit with necessary air purge units.

Contractor's scope of work shall include mounting of the transmitter and receiver units as per the approved layout drawings / documents.

- h) Contractor's scope of work shall also include cabling from trans-receiver units to local junction box/CEMS room, providing air purge connection and routing of air lines up to the required point with valves, air filter regulators, pneumatic lines etc.
- i) Field mounted electronic unit (if any) shall be installed on site fabricated stands/stanchions/enclosures.

2.03.00 Local Panels, Racks, Cubicles, Gauge Boards Enclosures and Structures

Local racks, panels, gauge boards, cubicles shall be installed at specified locations. Work shall also include fabrication and installation of gauge boards, stands, mounting brackets and frames, drain headers etc. with associated painting and civil work.

- a) Contractor shall erect panels / cubicles / enclosures etc. only after ensuring availability of work front.
- b) The panels shall be issued from warehouse or storage yard on the same day when the actual erection is performed.



- c) Panel, once uncrated, must be installed on the same day.
- d) Panels supplied in packed condition, will be properly slinged for lifting. When lifting unpacked panels eye-bolts shall be used. Unpacking should be done at store or installation site only.
- e) During slinging or lifting of the panel, care shall be taken not to damage the structure or any instrument/equipment mounted on the panel.
- f) Panels shall be slowly lowered on its foundations and shall not be subjected on unnecessary jerk or bounce.
- g) Prior to the installation of panels the foundation shall be inspected for presence of foreign matters and existence of possible defects or damage. Positions, shape and dimensions of the foundation shall be verified against corresponding drawing. Pockets for grouting shall normally be on the concrete base. Contractor shall arrange anchor bolts or grouting spikes and grout the same in the pocket.
- h) Accurate center lines and auxiliary lines shall be marked-off with due consideration of proper alignment and level. Base channel of panel shall be dismantled from the panel and shall be positioned and set by grouted anchor bolts. Before fixing the bolts, the panels must be properly aligned and plumbed. Only brass shims may be used for leveling of the panels. Leveling of panel should be done by the help of spirit level or similar device.
- i) Contractor shall arrange to provide suitable protective coverings for the panels since unpacking and after erection to avoid any damage due to movement of men and materials in the vicinity.
- j) Retouching work of painted surface of panels shall be carried out wherever required.
- k) During installation of panels and panel instruments the panels must be kept in perfectly clean condition.
- l) All panels shall be suitably earthed as per guidelines furnished in the specification.
- m) Only construction power shall be utilized during erection of panels. Under no circumstances power lines shall be tapped-off from the panels.

2.03.01 Junction Boxes and Pull Boxes

Contractor's scope of erection of junction boxes shall include mounting of junction boxes in appropriate locations indicated in the drawings, fabrication of necessary supports, pedestals, brackets, frameworks etc., for erection and final painting of the structures and the junction boxes.

- a) Junction boxes and pull boxes shall be provided for multi-pair / multi-core cables and compensating cables.



- b) Junction boxes shall be provided either with un-drilled removable gland plates or with knock-outs. Before installation gland plates shall be drilled/knock-outs shall be removed based on the cable schedule.
- c) The junction boxes shall be fixed to the nearest available structures as far as possible. In certain cases, special pedestals may have to be fabricated and grouted/bolted to nearest available structure.
- d) Before installation, junction boxes may have to be assembled by fixing terminal blocks, mounting rail etc. Any other connected job shall be a part of the junction box installation.
- e) Unused knock-outs in the junction boxes shall be left plugged to prevent dust and moisture entry.
- f) All necessary nuts, bolts, screws, foundation bolts etc. for mounting the junction boxes and their supporting structure shall be supplied by Contractor.
- g) Identification tags for the cables shall be provided both inside and outside the junction boxes close to the glanding point.
- h) Junction box mounting shall include the fabrication of steel supporting structures as well as other connected jobs.
- i) Contractor shall arrange to repaint junction box if the paint is damaged due to improper handling. Wherever required, Contractor shall arrange to perform retouching of paint on the junction boxes. Proper identification numbers shall be labeled on the junction boxes for ease of identification.
- j) After erection, junction boxes shall be covered with polyethylene sheets.
- k) Ideally the height of junction boxes shall be 1000-1400 mm from the approach floor level.

2.03.02 Transmitter Racks

- a) The location of transmitter racks shall normally be pre-assigned. However, depending on site conditions, some may have to be relocated at site.
- b) Guidelines provided for erection of panels shall apply for erection of transmitter racks, as well.
- c) Impulse lines shall normally terminate at a bulk head union at the top or back side of the closed type racks. In cases when bulk heads are not available, entry holes shall be drilled (not gas cut) and properly sealed after installation.
- d) Contractor shall avoid hot bending of impulse pipes inside the enclosures. All bending and forming activity should be performed outside before fixing in position.



- e) Contractor shall suitably support the drain/vent valves, manifolds etc. with the necessary clamps, bolts, washers etc.
- f) Contractor's scope of work shall also include terminating all rack mounted transmitters with electrical wires/cables in flexible conduits up to the terminal blocks with necessary cable and conduit supports, clamps, glands, sleeves, conductor markers/ferrules, lugs etc.
- g) Cabling from transmitter rack up to local junction box through flexible conduits, supporting and fixing of conduits at both ends, glanding of cables, ferruling and terminating are in Contractor's Scope of Work.

2.03.03 Stanchions, Site Structures and Mounting Frames

Contractor's scope of work shall include fabrication and installation of mounting frames, pedestals, canopies, protective enclosures and local gauge boards for mounting local instruments, analyzer and junction boxes. Contractor's scope shall also include mounting of the instruments in these local stanchions/pedestals/gauge/boards with all necessary mounting fixtures; piping, painting cabling up to local junction box and any other associated civil work like chipping, grouting etc.

- a) All steel items shall be de-scaled and degreased by suitable solvent cleaning.
- b) All structures shall be welded throughout.
- c) All faces supporting instruments shall be constructed with MS sheets of thickness not less than 3 mm.
- d) The support structure shall be designed to support all accessories related to the instruments; neatly and rigidly.
- e) While fabricating the structures, attention shall be paid to accessibility and maintainability of all equipment and accessories.
- f) All floor/platform mounted structures shall be self-supporting and free standing type. These should not depend on supports derived from nearby columns/structures/pipelines etc. for their rigidity and mounting.
- g) Adequate stiffness shall be provided on flat faces to avoid waviness of the surfaces. Necessary instrument cutouts are to be formed and all edges shall be rounded to avoid any sharp projection. Gas cutting of sheet metals are not permissible.
- h) All welds should be grounded to smoothness; corners should be rounded and weld splatters should be cleaned.
- i) After welding, the structure surfaces shall be smoothed with emery paper and painted with two coats of red oxide primer.
- j) Before installation, accurate center lines and other auxiliary lines are to be marked for proper leveling and alignment.



- k) Necessary grouting pockets are to be chipped and anchor bolts/studs shall be fixed on floor, column or wall.
- l) Necessary precaution should be taken during locating site mounted structures so as not to interfere with erection activity in the area or block passage for movement of personnel/equipment during normal operation and maintenance.
- m) Contractor shall arrange to provide suitable protective coverings for site fabricated structures to avoid damage due to movement of men and materials with vicinity.
- n) After erection, all site fabricated structures shall be painted with two coats of finishing paints of 2.0 mil/coat DFT. Sags, cracks, blisters, tear drops, fat edges of paint shall render the structures unacceptable.
- o) All instruments shall be mounted as per the recommendation of the manufacturer. Associated impulse and drain pipe work and supporting of accessories; cabling up to local junction box shall be Contractor's responsibility.
- p) Structures supporting indicating instruments shall be so oriented that the dials are visible unassisted from the nearest approach floor/platform. Ideally the height of instruments shall be 1000-1400 mm from the approach floor level.
- q) Contractor shall carry out retouching of painted surface of the structures wherever required, after installation.
- r) Contractor shall fabricate 3 mm MS/Aluminum canopies for shielding of instrument from direct exposure to sun & rain.

2.04.00 Cabling and Interconnection

Cabling and interconnection activity shall include cabling work between local switches, resistance temperature detectors, transmitters, converters, limit switches, smart positioners, torque switches, solenoid valves etc. up to local junction boxes; thermocouples up to local thermostatic junction boxes, temperature transmitters or control room panels from local junction boxes / local panels / transmitter racks / instruments to termination cabinets / panels / electronic cabinets in control room / control equipment room ; command and feedback signals from MCC / Switch Gear room to termination cabinets / panels / electronic cabinets in control room / control equipment room; inter-cabling between various cabinets in control room / control equipment room ;earthing of all panels / racks / cabinets / junction boxes etc, up to ground lug / riser with appropriate cable; special cabling between sensing devices to converter cabinets and cabling work of prefabricated and hiway cables. Cabling work shall normally imply pulling, laying, marking, splicing, glanding, dressing, ferruling, crimping and termination of cables at both ends with associated conduit and sub-tray work; followed by testing of cables.

- a) Single and multi pair/core cable shall be laid on trays or in conduits. Cable shall be neatly laid with proper dressing and adequately fixed.



- b) Cable shall enter in the enclosures through cable glands.
- c) All the cable runs shall be properly identified by easily readable printed permanent tag plate fastened to the cable with steel wires, provided at both field ends and panel ends and at a maximum of 20 meter intervals in straight length. Tags shall be provided in all bends and both sides of the barrier walls as well as at both terminal ends.
- d) In the cable spreader room, cables shall be clamped rigidly below the panel entry. If required, vertical cable tray shall be provided in case where the horizontal cable tray is more than 1 Meter below the respective Panel bottom.
- e) Cables laid near the main Steam Piping and other high temperature steam pipings shall be protected through proper insulation arrangements against damage due to continuous exposure to high temperature.
- f) Bend trays with suitable roller arrangements shall be used for cross over of cables from one section to other in perpendicular direction.
- g) Spare cable runs shall be kept coiled inside the enclosures with the ends suitably protected and cables properly identified.
- h) In case of single piece straight multipair/core cable run, no joint in the cable shall be provided in between.
- i) All Control and Instrumentation Cables shall be laid maximum upto 2 layers for horizontal cable trays and in single layer for vertical trays.
- j) Cable glands and other openings in the junction boxes shall be properly sealed by means of sealing compound to make them thoroughly dust and moisture proof.
- k) The cables laid, shall not be subjected to excessive tension so as to cause damage to the conductors.
- l) At bends where excessive spatial stress may concentrate or where danger exists of damaging the insulation, extreme care shall be taken while laying the cables, to avoid any possible damage.
- m) All cable shall be tested for continuity and insulation before and after installation as per the latest Indian Electricity Rules. Test for continuity shall be done by a circuit tester. Insulation resistance test shall be done with a 500V megger. The measured insulation resistance shall be more than 50 meg. Ohms between conductors and one conductor to ground.
- n) All cable shall run through conduits up to local junction box / nearest sub-tray.
- o) All cable shields shall be individually terminated and jumpered together at the terminal blocks. Earthing of the shields shall, however, be performed at the control panel end.

- p) All cable shall be laid only along the route specified in the cable schedule.
- q) If at any time during progress of work, trays are found inadequate to accommodate the assigned cable, Contractor shall discontinue laying of the cable until the problem is rectified.
- r) Cable conducting AC and DC signals shall be segregated. Compensating cables shall not be mixed with cables carrying milliampere signals. The signal cables and power cables shall not be in the same conduit, tray or junction box. In general, a minimum clearance of 1500 mm shall be maintained between noise generating equipment like large motors, generators, transformers etc. and signal/control cables. The minimum distances to be maintained between the instrumentation signal cables and any AC power cables running in parallel are as follows :

Maximum Circuit Voltage	Separation (mm)
240 V AC	250
415 V AC	300
3.3 KV / 11 KV	600 / 900

- s) All cable shall be carefully laid or pulled in trays so that neither cable nor the trays are damaged. Cable shall be cut sufficiently long to conform to the contour of the trays, especially for vertical inside bends. All excessive slack shall be removed from the cable so that the cables lie parallel to the sides of the trays.
- t) The cable shall be tied to the trays with G.I./ Aluminum or self-locking cable grip strip at not more than 2 meter intervals for horizontal runs and at not more than 1 meter intervals for vertical runs. All cable shall be strapped individually.
- u) Pulling of cable shall be done with manila rope or nylon rope.
- v) Only the type of lubricants recommended by cable manufacturer shall be used.
- w) Before pulling cable from the drum, the drum shall be visually inspected for protruding nails, fastenings or other objects which may damage the cable. Such articles shall be removed before pulling of the cable. Continuity and I.R. test shall also be performed.
- x) Contractor shall perform a thorough visual inspection for flows, breaks, cracks and abrasions in the cable sheath during pulling.
- y) Cable damaged in any way during installation shall be replaced.
- z) The pulling tension of any cable shall not exceed the maximum tension recommended by the cable manufacturer.

- aa) To avoid insulation damage from excessive sidewall pressure at bends in conduit runs, the pulling tension in Kilograms shall not exceed 1.5 times the radius of bend in centimeters.
- bb) For cable without metallic shielding or armor and cable with metallic tape shielding, the cable bend radius shall be in accordance with the requirements of IPCEA standards. For cable with metallic wire shielding or metallic armor the bend radius shall not be less than 8 times the overall diameter of the cable.
- cc) All spare conductors of a multipair/core cable shall be left at their maximum lengths for possible future replacements of any other conductors in the cable. Each spare conductor shall be identified and neatly coiled separately and then taped to the conductors being used.
- dd) All exposed conductor surfaces shall be taped with all-weather vinyl plastic electrical tape.

2.04.01 Instrumentation Twisted Pair Cables

Cabling in this category shall include cabling between local switches, resistance temperature detectors, transmitters, local converter, smart positioner, limit/torque switches, solenoid valves etc. up to local junction box by means of single or multipair armoured cables up to local junction boxes and from local junction boxes to panels/ cabinets in Control Room/ Control Equipment Room etc. and interconnection between various panels/ cabinets.

- a) Contractor's scope of work shall include conduit and sub-tray work from all field instruments to junction boxes, pulling, laying, glanding, dressing, sleeving ferruling, crimping and termination at both ends.
- b) Contractor should take special care regarding wastage of cables while splicing.

2.04.02 Compensating Cables

Compensating cables shall be single or multiple pair cables for connecting thermocouple head to thermostatic or ordinary field junction box or control panel in control room or field mounted converter.

- a) In general, thermocouple will be duplex type and both the elements shall be terminated in local junction box.
- b) Contractor shall also lay multipair compensating cables from local junction boxes to control panel/ cabinets in central control room / control equipment room
- c) All compensating cables shall be drawn through Instrument cable tray.
- d) Compensating cables shall be directly connected from thermocouple head/ junction box to the Input modules of PLC/ instruments.



- e) While connections for thermocouple, due care shall be taken to connect compensating cable with proper polarity to T/C and Input modules of PLC/ instruments.
- f) Sufficient length of multipair cable will be left extra in the form of loop at either end.
- g) Multipair compensating cables shall be laid on the main rack sufficiently away from the power cables as specified in the table of this section so as to eliminate the stray current effect in the temperature measurement.

2.04.03 Prefabricated Cables

Cabling work shall include laying and terminating prefabricated cables between different panels.

- a) All necessary special glands, grommets of nylon or rubber etc. shall be supplied and erected.
- b) Prefab cables shall run through cable spreader room on trays. Vertical riser trays, to support the vertical run of cables from the main trays in cable spreader room to the panel glanding areas shall be supplied and erected.
- c) All the cable runs shall be properly identified by engraved aluminum tag plates fastened to the cable at not more than 10 meter intervals by steel wires.
- d) Cables laid shall not be subjected to excessive tension so as to cause damage to the conductors or plugs.
- e) In cases where the connecting heads/plugs may be supplied loose, Contractor, after laying the cable, shall solder cable cores and screen ends to connector pins/ plug-in crimped ends of the cable to the connector plug socket/crimp-in special connectors for coupling the cable to the plug socket/wire wrap the ends to connector pins, as the case may be. Contractor shall ensure properness of end connection before embarking upon the termination.
- f) All necessary modifications, rework, splitting etc. of the gland plates to accommodate prefab cables, their glands/ grommets shall be performed.
- g) Prefab cables shall be routed through special glands/ grommets as recommended by the manufacturer.

2.04.04 Special Cables

The category of special cables shall include the cabling work related to the data highways, flue gas and water analysis system, vibration monitoring system etc. where proprietary cables are supplied as part of instrument & for the transmission of low level voltage signals or other signals susceptible to noise interference.



- a) Special cables shall not be laid through trays carrying signals having voltage level of more than 60 volts AC/DC. As far as practicable special cables shall be laid through conduits.
- b) Minimum separation to be maintained between special cables and other cables shall be as indicated in the specification, unless specified otherwise by the supplier of the cable/ instrument.
- c) All necessary connectors, lugs, sleeves, conductor markers/ferrules etc. for termination of special cables shall be supplied by Contractor .
- d) Special cables shall not run unsupported for more than 1 meter.
- e) Special cables shall run un-spliced for each individual run. Junctions, loops, bends and long vertical falls shall be avoided to the extent possible.
- f) Tools recommended by the cable/instrument supplier shall only be used for splicing, connecting and terminating special cables.
- g) Where teeing, tapping, looping or branching are required for special or co-axial cables; only the equipment, tools and tackle recommended by the manufacturer shall be used.

2.04.05 Conduits

Flexible and rigid conduits shall be used for connecting instruments to the junction boxes or nearest trays/sub-trays. The activities shall include threading, plumbing, routing, supporting, connecting to cabinets; cleaning, sealing grounding painting and other related activities, as required.

- a) Where threads are required to be formed they shall be cut and cleaned before conduit reaming.
- b) Ends of all conduits shall be reamed to remove all burrs and rough edges.
- c) Cutting oil shall be used for threading operation and the dies shall be kept sharp.
- d) Rigid conduits shall be installed in exposed runs either parallel or perpendicular to dominating surface, with right angle turns made of symmetrical bends only.
- e) Conduit shall not be installed on the outside face of exposed columns but shall be routed on the web or on the inside of the flange of column.
- f) Metal conduits shall be joined by threaded conduit couplings.
- g) A run of conduit shall not contain more than the equivalent of four quarter bends including those immediately at the outlets or fittings of cabinets.
- h) Precautions shall be taken to prevent accumulation of water, dirt, concrete , foreign material etc. in the conduit.



- i) Bending radius of the rigid conduits shall not be less than six times the internal diameter of the conduits.
- j) Rigid conduits shall be regularly clamped at intervals of not more than 600 mm.
- k) Flexible conduits shall be installed in conduit runs across expansion joints.
- l) All screwed joints shall be properly sealed with sealing compound to make them thoroughly water proof.
- m) Loop shall be provided in the flexible conduit while joining with rigid conduit, enclosure or detector. Flexible conduit shall not be kept under tension.
- n) Flexible conduits shall essentially be used for connecting instruments or equipment subjected to vibration, expansion or thermal movement. In all such cases adequate loop lengths shall be provided to allow free movement at the connected points.
- o) Not more than 40% of conduit area shall be taken up by cables.

2.04.06 Sub-trays / Supports

Erection of sub-trays / supports shall include sub-tray sections up to the main trays. In areas where main trays are not available, ray sections shall be laid up to the master junction boxes / local panels / cable spreader areas. Contractor's scope of work shall include laying and supporting of trays, fabrication of trays wherever required, painting of trays and supports and associated minor civil work wherever required.

- a) Normally slotted G.I. trays or aluminum trays shall be used.
- b) Trays shall be used to run pneumatic tubes and electrical cables and shall be mounted on steel structures and along the pipe racks wherever convenient. Special stands/supports have to be fabricated wherever required.
- c) The erection of trays shall include fabrication, welding and installation of racks including supports from structurals and installation of various sizes of tray in position. Trays shall be screwed or bolted to the supports.
- d) The supports shall be welded to the main structures, grouted in the walls/roof or welded to the plate inserts. Welding of supports to main equipment/piping shall never be allowed. Welding or gas cutting of trays shall not be allowed.
- e) The scope of work shall also include the supply, fabrication and fixing of supports, bends, offsets, corners, tees, crossings etc. as per requirement.
- f) Civil / masonry works like grouting, providing inserts, chipping the concrete, bricks etc. for providing supports etc. shall be included.



- g) Contractor shall arrange to provide hangers, jigs, inserts and other fixtures on walls, ceilings, structures and permanent scaffolding etc., for fixing racks. Fabrication and fixing of necessary jigs, hangers, inserts and other fixtures, as required, shall be considered a part of erection of structural steel work.
- h) The trays shall be properly finished and laid to give neat appearance.
- i) Cable trays shall be fixed on angle iron supporting racks fabricated at site.
- j) All supports, clamps and other fixtures shall be painted.
- k) All trays carrying SS tubes shall, in general, be vertical type.
- l) Industry areas, Contractor shall provide covers for trays. In such cases, Contractor shall procure, fabricate and strap the covers with G.I. strips, nuts and bolts.
- m) If any erected tray or its supporting structures are found to be vulnerable to damage or to be fouling/interfering with progress of other activities in the area, the same shall be dismantled and re-erected.
- n) The selection, whether to use rigid conduit or sub-tray shall be judiciously decided.

2.04.07 Earthing

Contractor's scope of work shall include the earthing of all instruments/equipment, enclosures and other metallic parts and objects. Necessary wires, lugs, sleeves, markers/ferrules etc. shall be supplied. In addition to the general guidelines given below, Contractor shall remain responsible to follow the instrument/ equipment manufacturer's grounding recommendation.

- a) Screens of all screened cables between field instruments to local junction box shall be terminated to individual terminal blocks. The other end of the screen shall be left disconnected and taped with adhesive vinyl tape. All screen terminal blocks at JB end shall be shorted with shorting links. The screen of multipair cables to cabinets shall be connected to the screen terminal block in JB and the other end to be grounded at panel end only.
- b) Compensating cable screens shall be terminated at independent terminal blocks in control panel end only. This terminal block shall, however, be wired up to insulated screen bus bar integral to the panel.
- c) All junction boxes, stands, stanchions, local panels, cubicles etc., must be connected to the nearest riser of electrical earth mat by SWG 10 MS galvanized steel wire.
- d) All control panels, desks, consoles, cubicles, cabinets etc. must be physically earthed with the electrical ground mat inside the control room area.

- e) All electrical ground terminals of local instruments shall be individually terminated up to local junction box by one core of the signal cable and these terminal blocks shall be shorted by links. The common earth point then may be led to local earth point by SWG 10 galvanized steel wire.
- f) All local panel and central panel instruments shall be grounded to the common ground bus available inside the panel. Normally the grounding wires will be available as wired-up inside the panels. Wherever grounding wires are not available inside the panel, the same shall be provided by Contractor.
- g) For terminating grounding wires only ring-tongue type lugs shall be used.

Regarding the earthing requirement of power supplies and electronic equipment, manufacturer's recommendation shall be strictly adhered to. The earthing cables shall be carefully sized not to exceed the specified earth impedance. Separate salt pit earth and earth risers shall be created as required.

Design of Earth Pit for Electronic Grounding shall be as per the Control System Supplier's recommendation. However, a general guideline for grounding pit construction may be followed as detailed below.

Copper rod of length 3 (three) meters and diameter approx 15 (fifteen) mm shall be embedded in ground at least 3 (three) meters or more. The recommended earth pit resistance shall be less than 1 (one) Ohm. Copper strip of dimension 25 mm x 3 mm (approx.) is to be placed on electrode with necessary clamps for earth termination. The earth connecting strips may also be put into a Junction Box above ground from where an earth riser may be formed for connection. To enhance the conductivity salt, charcoal etc. may be mixed with soil. Any other earth conductivity enhancement compound may also be used for this purpose. One (1) earth pit cover shall be provided for protection and inspection purpose.

Dedicated redundant earth pit shall be provided which shall be away from the HV equipment and shall also be insulated from other electrical system ground to ensure single point grounding. Grounding resistance shall be better than 1.0 ohm. IEEE guideline shall be followed for the grounding requirement.

2.05.00 Piping and Tubing

Instrument piping and tubing work shall include the impulse piping work between take-off valves on pipe lines or equipment/take-off nozzles (for air and flue gas connections) and the instrument; the drain pipings to the nearby drain point; instrument air sub-header and main header (wherever required) installation and testing and tubings between air header/sub-header to different instruments/consumers.

2.05.01 Impulse Piping / Tubing and Accessories

- a) This section enumerates the basic guidelines for erection of primary impulse pipings, all associated fittings on primary impulse pipings, pipings for all instrument drain and vent lines with all associated valves and fittings, impulse line support and routing with accessories, all impulse line accessories viz condensing pots, temperature equalizing columns, seal



chambers, settling columns, drain headers etc. connections between instruments and valves/manifolds and their testing.

- b) For impulse piping/tubing routing Contractor shall develop a field routing sketch.
- c) The pipes shall be cut with a hacksaw or high speed cutting emery wheel; squarely and all burrs shall be removed. Roller type tube cutters shall not be used.
- d) Cold bending of the pipes shall be performed with the use of a proper pipe bender with radius of bends greater than five times the outside diameter of the pipe / tube. Allowable deformation shall be within 4%.
- e) Impulse piping shall always be installed with a slope greater than 10% in proper direction for draining and shall never be installed in level horizontally.
- f) Piping shall run with the minimum of changes in direction consistent with good practice and neat appearance.
- g) The bends/offsets must be smooth and regular. Bending shall not exceed 90 Deg. in any case. Necessary couplings, unions, fittings etc. shall be provided on impulse lines to facilitate removal and maintenance of instruments conveniently.
- h) No pipe shall be left with strain on it.
- i) Drain lines shall terminate at approved drains only.
- j) The total length of impulse piping/tubing between tapping point and instrument shall, in general, be within 10 meters.
- k) Pipes/tubes and accessories shall be adequately supported and fixed. Distance between the supports shall not exceed 1.5 meters in any case. Process piping shall not be used for supporting instrument piping. If additional structures and scaffoldings etc. are required for proper supporting of instrument pipes or accessories the same shall be arranged.
- l) Contractor shall follow the welding specifications of the main piping for the instrument piping, as well, wherever applicable. While welding, full care shall be taken to provide sufficient grounding so as not to damage any part of the instrument by arc current.
- m) Welding of steam piping and high pressure piping shall be carried out by duly certified welders only.
- n) Pipes installed but not connected, shall have ends closed with caps or plugs to prevent the entry of foreign material. All reasonable precautions shall be taken to prevent the entry of foreign materials in pipelines before and during erection. All drain points, after installation shall be sealed with caps/plugs.
- o) All pipes shall be thoroughly cleaned to remove all foreign materials, scales, oil, grease etc., before installation. This shall invariably be done after



disconnecting the instruments. After testing of steel impulse piping, the same shall be painted.

- p) All instrument impulse pipe fittings and accessories which shall include but not limited to brackets, supports, clamps, angle irons/flats shall also be painted as per the color code above.
- q) SS pipes, tubes and fittings need not be painted. Similarly G.I. pipes and fittings need not be painted.
- r) All clamps shall be first painted properly and then fitted.
- s) All surfaces to be painted and also impulse pipe shall first be cleaned by wire brushing and then with emery cloth to remove all rust/ dust/grease etc. After proper cleaning two coats of red-oxide zinc chromate primer (conforming to IS-2074) / followed by two coats of a D.F.T. of 1 mil shall be applied.
- t) For differential pressure instruments, wherever applicable, both the seal pots/condensate pots shall be brought to the same level.
- u) The preferred path for all instrument piping shall be along concrete walls, ceilings and building steel. Instrument piping may be routed through open areas, if necessary, provided that the lines are adequately supported and protected from damage. Instrument piping and piping supports shall not be supported from electrical raceways or electrical raceway supports, or process piping.

Piping/Tubing shall not be routed :

- i] Across equipment removal areas.
 - ii] Below monorails or cranes.
 - iii] Above or below removable gratings.
 - iv] Above, below, or across cable trays.
- v) All instrument piping shall be installed to permit thermal expansion without placing excessive stress on the piping and without affecting the gradient of slope described above. Long continuous straight runs of piping shall be avoided. Where required, expansion loops shall be provided to take care of thermal expansion/contraction.
 - w) For differential pressure instrument both impulse lines shall run in parallel and shall be as close as possible.
 - x) All impulse pipes shall be subjected to hydraulic test/ leakage test at site after erection.
 - y) When carrying out hydraulic test, hydraulic pressure of 1.5 times the maximum working pressure shall generally be applied but care shall be taken that the pressure more than the pressure rating of the instrument is not applied. In order to prevent the instruments from being subjected to excessive testing pressure for long durations inlet valves of instruments



shall be kept closed. In case of differential pressure instruments equalizing valve shall be kept open.

- z) Before using pipes, fittings, isolation valves and manifolds etc. for impulse line work, the same shall be thoroughly tested. Contractor shall not use any defective or untested material for impulse line work.
- aa) After hydraulic testing of impulse lines, the same shall be completely drained out and service quality air shall be blown through the pipes to dry the pipes completely.
- bb) The instrument take-off piping up to the first isolation valve shall be laid and tested.

Contractor's scope of work shall include the erection of air purging system for the impulse tubes with all necessary valves and fittings, wherever required.

2.05.02 Instrument Air Distribution Piping

Erection of instrument air distribution piping include connection from nearest main air header take-off valves to the vicinity of air consumers viz. control valves, pneumatic controllers, I.P. converters, impulse line purge connections, power cylinders, purge rotameters etc. Sub-headers shall be formed with GI pipes.

- a) Supply and installation of all intermediate pipe fittings, isolation valves etc. including supply and installation of necessary clamps and supports will be considered as in integral part of instrument air piping work.
- b) For instrument air sub-header work, carbon steel hot-dipped, inside and outside galvanized pipes shall be used. Only fittings of carbon steel galvanized threaded type shall be used for GI application.
- c) Outlets of air headers shall be provided with 1/2" isolation valves, for upto 7 consumers. Contractor shall install air sub-headers up to vicinity of the consumer and thereafter 6 mm O.D. tube shall be laid.
- d) Air supply piping shall be installed always with a slope of not less than 1/100 in suitable direction to prevent accumulation of condensed water within the pipe.
- e) All joints in the instrument air header shall be screwed on all screwed joints in air header, of size 1/2" and below, Teflon sealing tape and for other sizes, good quality sealing compound shall be used in proper quantity to ensure leak-proofness.
- f) Gas cutting and gas or arc welding on all GI pipes shall not be allowed.
- g) After completion of air supply piping and prior to connection to the instruments, the piping shall be blown with oil free and dry compressed air at 5 to 7 Kg./Sq. cm to clean out any dust of foreign matter.
- h) After applying the air pressure, all connections shall be checked for possible leaks with soap solution and all leaks shall be rectified.



- i) All instrument air tubes shall be disconnected from instruments, tube ends shall be blocked, air at pressure equal to 1.5 times the working pressure shall be applied and the tubes shall be isolated from the source of pressure. The pressure shall not fall by more than 0.1 Kg./Sq. cm in ten minutes.
- j) Air to be used for testing shall be oil free dry clean air.

2.05.03 Stainless steel Tubings and Fittings

Contractor's scope shall include stainless steel pneumatic tubing for the signal and supply air control valves, servo drives, impulse line purge connections, solenoid valves, local controllers, I/P converters etc. with all necessary fittings and air filter regulators, wherever required.

- a) The tubes shall be thoroughly cleaned and flushed with air before installation and defective tubes detected during checking, if any, shall be removed.
- b) Single tube runs shall be joined together by means of straight connector (double compression fitting) at every joint of the tube or shall be telescopically brazed & sleeved.
- c) The individual single run pneumatic signal tubing shall be run and connected from the field mounted instruments to locally mounted controllers/indicators mostly on tray work or on angles.
- d) Tube runs shall be properly dressed, neatly laid and adequately clamped / supported on angles/trays. Distance between any two supports shall not exceed one meter in any case.
- e) Tubes installed but not connected shall have ends suitably closed to prevent the entry of foreign materials.
- f) Tube runs shall be provided with suitable identification tags indicating the run number for easy correlation and identification of connections. Identification ferrules at both ends shall be provided.
- g) Fittings shall be of brass flareless, of double compression type, and in accordance with ASTM or similar standard specifications. All compression fittings shall be provided by Contractor.
- h) When tightening up the nuts of the compression type fittings, spanner of suitable size shall be used. To avoid any deformation to the compression ring, adjustable wrench shall never be used.
- i) The bending radius for single tubes shall be more than five times the outside diameter of the tubes. The tubes shall be bent with proper benders and care shall be taken not to cause an flattening of the bend.
- j) The tubes shall be properly dressed on the trays to remove bends, dents etc. Tubes shall not be directly hit by steel hammers.



- k) Aluminum clamps or self-locking straps shall be used for clamping the tubes on trays/angles and same shall be supplied by Contractor at his own cost.
- l) When connecting tubings on servo-drives / valves mounted on structures having thermal movement, sufficient expansion loops shall be formed at the ends to allow for equipment movement without developing any stress on the end fittings.
- m) All tubing shall be checked for proper connections and pressure tested by Contractor.

2.06.00 Control Valves and Accessories

Contractor's scope of work shall include erection of control valves along with all related accessories like air filter regulator, smart positioners, limit switches, mechanical indicators, solenoid valves, airlock relays, volume boosters etc. Contractor's scope of work shall also include all related interconnecting tubing work for the above accessories and terminating all electrical connections up to local junction box. Any supporting structures, pedestals etc. required to make the installation complete shall be considered part of erection activity. Contractor's scope of work also include testing and commissioning of all pneumatic control valves.

- a) After completing the installation satisfactorily in all respect, Contractor shall perform the following tests.
 - i] Linearity of stem movement shall be checked at four points (inputs 25%, 50%, 75%, 100% of spring range) while rising and while falling.
 - ii] Hysteresis shall be checked.
 - iii] Response time shall be noted.
 - iv] Operation of airlock relay shall be checked.
 - v] Operation of stay put conditions (under electrical signal failure shall be checked).
- b) After testing, the valve shall be boxed up with blind gaskets at both ends to prevent entry of foreign materials and clogging of plug and seat.

2.07.00 Flow Elements

2.07.01 Orifice Plates

For orifice plates with flange taps Contractor's scope shall include fixing of nipple and first take-off valve, fixing and supporting condensation pot (wherever applicable) and insertion of orifice plate with suitable gaskets, nuts and bolts. For orifice plates with D, D/2 tapping, pipe welded stubs shall be available.

The general guidelines for installation of orifice plates are given below.



- a) The length of the take-off nipples shall be sufficient so that the first take-off valve protrudes beyond the thermal insulation.
- b) The take-off nipples shall be screwed/welded according to the design requirement.
- c) The hand wheel of the take-off valves shall be so oriented that they can be operated conveniently from approach platform, ladder etc.
- d) For steam services, condensation pots shall be connected to the tapping point before or after first take-off valves. Utmost care shall be taken to ensure that both the condensation pots are at the same level. All necessary bracing, saddle etc. shall be fabricated and used to support the condensation pots with the main pipe.
- e) Orifice plates shall be inserted with proper orientation with respect to fluid flow in line.
- f) Orifice plate should only be inserted in position for checking the alignment. Thereafter, it will be withdrawn and preserved till pre-commissioning activities are over.
- g) Contractor shall supply suitable gaskets while fixing the orifice plates in position.
- h) The orifice bar handle, shall be so oriented that the imprints are readable unassisted from the access floor of platform.
- i) Contractor shall ensure proper orientation of drain or vent holes.

2.07.02 Flow Nozzles

Flow Nozzles shall normally be shop assembled in branch pipe and welded in position with main pipe. The flow nozzles shall generally have D - D/2 tappings and shall be shop assembled with take-off nipples and root valves. Contractor's scope of work shall include connecting the condensation pots (for steam services) before installation of the differential pressure instrument.

2.08.00 Control Room Control Panels / Desks, Consoles & Cubicles / Cabinets

This section provides guidelines for the erection of desks, panels, consoles, cabinets etc, in the Control Room, Control equipment room, Local Control Room and other such locations.

Clauses (c), (d), (e), (i), (j), (k), (f), (g), (h), (i), (m) for the installation of Local Panels shall apply.

- a) After Inter-sectional bolting with necessary nuts and bolts, inter-sectional wiring shall be terminated at both ends



- b) Contractor shall arrange anchor bolts or grouting spikes and grout the same in the pocket. Any civil job concerned with the proper installation of the panel shall be considered as part of the panel installation work.
- c) After installation, the main incoming fuse of each panel section shall be removed and preserved till commissioning.
- d) For panels, desks, consoles etc. supplied without instruments and accessories mounted on them, Contractor shall mount and terminate all instruments & desk accessories as per drawing. Contractor shall also dress & bunch the cables properly after termination is over.
- e) If Solid state panels / desks / consoles / cubicles are supplied without the electronic PCB's plug-in modules etc. mounted on them, Contractor's responsibility shall include inserting these in position as per drawings. This activity shall be carried out only after complete installation of the panel/cubicles.
- f) After installation the following tests shall be carried out.
 - i] Visual inspection for proper alignment and inter-sectional crevices.
 - ii] Meggering shall be done between terminal blocks and ground before terminating the panel instruments.
 - iii] Visual inspection of surface finish for scratches & blemishes.
 - iv] Tightness of nuts and bolts to be physically checked.
 - v] Dressing and bunching to internal wires after termination to panel instruments.

2.08.01 Desks and Consoles / Local Control Panels / consoles and Desks

Contractor's scope of work shall include the installation of Operator's Terminals, Engineering Terminals, system cabinets/panels and other terminals, consoles and some other peripheral devices in the Local Control room wherever applicable. Associated activities shall include laying, glanding and terminating prefabricated cables, related structural work and other completing activities viz. modification of internal wirings, mounting and termination of instruments / equipment supplied loose etc.

- a) Erection of panels and desks in Control room area shall involve precise alignment and matching of surfaces. Contractor shall perform all related activities to achieve an aesthetic completion of the job. All necessary realignment, foundation work, packing and filling shall be done to compensate for shifting, waviness, misalignment etc.
- b) When bolting the panel sections, care shall be taken not to leave excessive strain on any of the surfaces. All necessary packing and filling materials shall be provided.
- c) Instruments and accessories supplied loose for mounting on panels shall be installed only after installation of the panels.



- d) If matching prefab connectors are available in pig-tail form the properness of connection shall be checked by Contractor before plugging-in. Contractor shall be fully responsible for improper connection of the connectors.

2.08.02 LVS, LED Monitors, etc.

- a) All items must be unpacked at installation site only.
- b) Contractor shall follow the general guidelines for installation of the blind panels as spelt out in previous sections.
- c) All unarmoured prefab cables shall run through flexible / rigid conduits and all conduiting and tray laying shall be considered to be a part of Contractor's scope of work.
- d) Installation and commissioning of LVS & LED Monitors in the control room is under Contractor's scope of work. This includes supply laying and termination of all interconnecting cables to complete the installation.
- e) Interconnection with existing Plant Master Clock and its Display devices (i.e. slave clocks) at different locations are under Contractor's scope of work. This includes supply of all mounting hardware and accessories, laying and termination of all interconnecting cables and other accessories to make the installation complete.

3.00.00 **CONSUMABLE, TOOLS AND TACKLE, CALIBRATION AND TEST, INSTRUMENTS AND ERECTION MATERIALS**

The purpose of this section is to outline, in general, the minimum necessary equipment / tools & tackle and consumable that may be required for erection work. The list hereunder is only meant to be a guideline and Contractor shall be responsible to arrange for supply any other equipments/ tools & tackle or consumable that may be required for satisfactory completion of the job.

- a) Erection consumables shall include but not be limited to the following :
 - i) Polythene sheets for covering field instruments and panels.
 - ii) Grease of approved quality.
 - iii) Colored adhesive PVC tapes.
 - iv) Gaskets and washers of various size and types as required.
 - v) Paints of approved quality and shade.
 - vi) Brass shims/foils for levelling of panels
 - vii) Welding electrodes, Oxygen, Acetylene and Argon Cylinders.
 - viii) Dry seal type thread sealant.



- ix) Insulated PVC/Vinyl adhesive tapes, sleeves etc.,
- x) Cable markers and clamps (G.I. or Aluminum)
- xi) Hacksaw
- xii) Cleaning solvent, petrol, rustolene, kerosene etc.
- xiii) Gland sealing compound
- xiv) 2 mm thick Aluminum Sheets
- xv) Twisted galvanized steel wire
- xvi) Cutting oil
- xvii) Teflon tape
- xviii) Liquid soap, Jute
- xix) Solder and flux
- xx) Nuts, bolts, screws and gaskets as required
- xxi) Perforated G.I./aluminum tray (if required)

- b) Necessary tools & tackle/equipment that may be required for erection/ installation/testing shall be provided.

The items listed below are indicative in nature and any other tools & tackle/equipment that may be required shall be arranged by Contractor.

- i) Hydraulic Test Jack (0-400 Kg/Sq. mm) [2 sets at least]
- ii) Continuity Tester and 500V Megger
- iii) Engraving machine
- iv) Sheet punching machine
- v) Hand drill with bits of various sizes
- vi) Welding kit (2 sets at least).
- vii) Thread cutter (with different sizes of die)
- viii) Test pressure gauges for hydraulic testing
- ix) Wire wrapping tool and soldering iron
- x) Materials for scaffolding



- xi) Materials for rigging
 - xii) Sets of wrenches, spanners, Allen keys, screw drivers and other tools for wiring and impulse piping work.
 - xiii) Crimping tool, splicing tool
 - xiv) Pipe bending jig
 - xv) High speed cutting emery wheel
 - xvi) Sheet bending machine
 - xvii) Multimeter
 - xviii) Air compressor and spray painting gun
 - xix) Air filter regulators
 - xx) Slide caliper/screw gauge
 - xxi) Tube cutter
 - xxii) Tube bender
 - xxiii) Hacksaw
- c) Necessary tools & tackle, jig, instruments/equipments that may be required for loop checking, calibrating and commissioning of all supervisory and modulating control loops, binary system, and calibration/checking of all field instruments, etc. as detailed in this specification shall be arranged.
- d) This section grossly summarizes the different items to be supplied by Contractor for completion of activities specified. The detailed job-wise requirement shall be guided by final engineering drawings and various clauses of the technical specification :
- i) Conductor markers/Ferrules, lugs, connectors as required for cabling and terminations.
 - ii) Glands and grommets for cable entry.
 - iii) Straps, nylon rope fasteners for cable support and dressing.
 - iv) Bends, tees, unions, crosses, plugs, caps and other fittings for impulse and drain pipe work.
 - v) Compression fittings, adapters ferrules etc. for SS tubing.
 - vi) G.I. tees, unions, elbows, reducer, screwed brass needle valves.
 - vii) Perforated G.I./Aluminum subtrays (50, 100, 150 mm) for cabling and tubing work.
 - viii) 1/2 & 3/4" rigid and flexible conduit fittings

- ix) Terminal blocks (1.5 Sq.mm).

Contractor shall include all structural steel items.

4.00.00 INSTRUMENT CALIBRATION / CHECKING AT SITE PRIOR TO ERECTION

The general guidelines for calibration and functional checking of instruments and accessories are as given below :

- a) For calibration and functional checking of different types of instruments, check lists shall be prepared. The results and observations of checks and tests shall be recorded in appropriate forms.
- b) Qualified and experienced engineers, supervisors and skilled technicians shall be deployed for calibration and functional checking of instruments.
- c) Only precision testing instruments of certified accuracy specially made for testing particular make/type of instruments shall be used for calibration and functional checking of instruments.
- d) Physical checking of the instruments shall be carried out to find out any possible damage to the instruments.
- e) Instruments requiring calibration shall be calibrated, in general, throughout the instrument range at five check points viz. 0%, 25%, 50%, 75% & 100% of span, both upscale run and downscale run. The error between theoretical and calibration figures thus obtained at each check point shall not exceed the instrument manufacturer's stated figures. If the error exceeds the limits specified by the manufacturer, the instruments shall be adjusted to achieve calibration accuracy within the specified limits.
- f) Regarding the calibration and functional checking of special instruments, the instruction of the manufacturer shall be followed.

4.01.00 Pressure / DP Gauges

4.01.01 Calibration for pressure / DP gauges shall be carried out with dead weight testers / hydraulic testers / vacuum pumps against manometers / precision manometers/sub-standard gauges of certified accuracy.

4.01.02 Test results shall be presented to indicate accuracy, hysteresis and linearity.

4.01.03 Gauges shall be subjected to over-range test as per manufacturer's recommendation. Gauges shall be recalibrated after over-range test.

4.01.04 Gauges for compressed air service shall be tested with air compressor and sub-standard gauges.

4.01.05 Low pressure/dp gauges shall be tested with compressed air test jigs and sub-standard gauges.

4.02.00 Pressure / DP Switches



- 4.02.01 Pressure / DP switches shall be tested for adjustability and repeatability of set point by means of dead weight tester / hydraulic testers / vacuum pumps against manometers/precision manometers / sub-standard gauges of certified accuracy.
- 4.02.02 Exact operating point of the switches shall be identified by means of a multimeter or any appropriate instrument.
- 4.02.03 For switches having adjustable differential, the differential shall be maintained fixed during the test.
- 4.02.04 Test results shall be presented to indicate linearity and differential.
- 4.02.05 Switches shall be subjected to over-range and contact rating test. Switches shall be recalibrated after over-range test.
- 4.02.06 Switches for compressed air service shall be tested with air compressor test jigs and sub-standard gauges. Low pressure/dp gauges shall be tested with compressed air and sub-standard gauges.
- 4.02.07 The switches shall be set at the desired set point after calibration. Where set points are not available at the time of erection, the same shall be set in site, after erection, by means of compressed air/hydraulic hand jack and sub-standard gauges through the instrument drain connection after closing the instrument root valve.
- 4.03.00 Temperature Gauges
- 4.03.01 Temperature gauges shall be calibrated in controlled temperature oven with the help of standard laboratory thermometer of certified accuracy in addition to check ambient temperature reading.
- 4.03.02 Zeroing of the gauges shall be done separately by means of ice bath.
- 4.03.03 Test results shall be presented to indicate accuracy, hysteresis and linearity.
- 4.04.00 Temperature Switch (if applicable)
- 4.04.01 Temperature switches shall be calibrated in controlled temperature oven with the help of standard laboratory thermometer of certified accuracy in addition to check ambient temperature reading.
- 4.04.02 Switches shall be set at known set point after testing for repeatability and hysteresis as mentioned above. Differential, if adjustable, shall be kept fixed.
- 4.04.03 Set point and differential shall be adjusted as per Engineering data.
- 4.04.04 Temperature switches shall be set prior to installations. However, in situ setting may be necessary during commissioning by comparison with other gauges on the line.
- 4.05.00 Temperature Elements

- 4.05.01 Temperature elements shall be tested for continuity from their terminals at element head.
- 4.05.02 Temperature elements shall be ungrounded and duplex type. Both the elements shall be checked for continuity.
- 4.05.03 I.R. shall be measured between individual elements and between element and thermowell.
- 4.05.04 In general, thermocouples and RTDs will be factory tested. However, in case of any malfunction while loop testing, an element may have to be tested for linearity and accuracy at Contractor's shop.
- 4.05.05 Thermocouple & RTD will be tested in temperature controlled bath at several temperature (depending on the type of T/C or RTD) points with digital millivoltmeter / Thermocouple or RTD calibrator. The results thus obtained must be compared with standard table as per ASME / DIN.
- 4.06.00 Electronic Pressure and Differential Pressure Transmitter
- 4.06.01 Calibration of electronic transmitters will be carried out with dead weight tester or hydraulic tester with sub-standard gauges or multifunction calibrator. The output (4-20 mA) shall be checked with standard DMM at five different points throughout the specified range including zero and span with rising and falling input. Power supply to the transmitter receiver 2-wire loop should be given from 24V DC source in the Analog Input Card and the series load should be around 500 Ohms.
- 4.06.02 Following performance data should be calculated from observed input-output data and should be presented in agreed proforma.
- a) Accuracy
 - b) Hysteresis
 - c) Dead band
 - d) Repeatability
 - e) Linearity
- 4.06.03 Transmitter shall always be calibrated in vertical position rigidly fixed to a suitable jig.
- 4.06.04 It may be necessary to recalibrate the zero while commissioning by equalizing the ports of dp transmitters or opening input port of pressure transmitters to atmosphere.
- 4.06.05 Electrical tests shall include supply voltage sensitivity, short circuit proofness and maximum loading in sample cases.
- 4.07.00 Level Switch (if applicable)

- 4.07.01 Level switch shall be functionally checked by operating the float mechanically and hydraulically and testing the make and break of the switches with ohmmeter or continuity tester.
- 4.07.02 Contractor shall also be responsible for checking the current rating of the contacts.
- 4.08.00 Current to Pneumatic Converters (if applicable)
- 4.08.01 Contractor shall shop test I/P converters with input of 4-20 mA DC from standard current source. The output (0.2 to 1 Kg/Sq. cm) shall be read against substandard gauges and input- output relation shall be presented.
- 4.08.02 Air supply to the I/P Converter should be given through air filter regulator.
- 4.09.00 Receiver Instruments (wherever applicable)
- 4.09.01 Receiver instruments, in general, shall cover all panel mounted instruments like digital panel meters etc.
- 4.09.02 Contractor's responsibility shall include calibrating all receiver instruments with specified inputs like mA, pulse etc.

Indicators

- a) Input shall be provided from constant current source/ voltage generator depending upon the specified input.
 - b) Input shall be given for 0%, 25%, 50%, 75% and 100% of the span and the readings shall be taken for both rising and falling input.
 - c) Indicators will generally be scaled in Engineering Units.
 - d) Zero and span shall be readjusted, if necessary, after mounting in position during loop checking and commissioning.
 - e) Tag No., service, range and multiplication factor shall be neatly typed / engraved and pasted to the body / casing of the instrument.
- 4.10.00 Control Valves
- 4.10.01 Valves shall be lubricated (if required), stroked and checked for hysteresis. Alignment of valve positioners shall be checked. Connection and operation of solenoid valves and air lock relays (if provided) shall also be checked.
- 4.10.02 Action of actuator shall be checked by applying spring range pressure through air filter regulator / multifunction calibrator and observing the stem travel against a scale.
- 4.10.03 Smart positioner shall be tuned to achieve proper valve response.. Necessary adjustment of zero and span shall be done by the Contractor for accurate valve positioning and feedback .



- 4.10.04 Contractor shall also check the function and adjustability limit switches.
- 4.11.00 Gas Analyzers
 - 4.11.01 Zirconium probe type oxygen analyzers shall be calibrated in situ with the aid of two-point automatic calibration kit and reference gas cylinders.
 - 4.11.02 Test procedure available in the manufacturer's catalogue shall be followed.
 - 4.11.03 Prior to calibration all air and gas lines shall be tested for leakage and air tightness and all electrical connections are to be checked for correctness.
 - 4.11.04 Reference gases shall approximately have 0.4 and 8 percent Oxygen.
 - 4.11.05 Sample and air flow regulators shall be preset to recommended settings prior to the test.
 - 4.11.06 Probes shall be purged for at least 30 seconds with instrument quality air between introduction of successive test gases.
 - 4.11.07 The action of the temperature controller shall be checked prior to the test.

5.00.00 **EXAMINATIONS AFTER INSTALLATION**

- 5.00.01 On completion of erection of the equipment and before start-up, each item of the equipment shall be thoroughly cleaned and inspected by Contractor for correctness and completeness of installation and acceptability for start-up, leading to initial pre-commissioning tests at Site. The list of pre-commissioning tests to be performed shall be as mutually agreed and included in Contractor's quality assurance program.
- 5.00.02 Contractor's commissioning / start-up engineers shall be responsible for carrying out all the pre-commissioning tests. On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the complete equipment shall be placed on Initial Operation during which period the complete equipment shall be operated integral with sub-systems and supporting equipments.
- 5.00.03 All insulated conductors furnished and installed shall be electrically tested after installation.
- 5.00.04 All circuits shall be tested complete except for connections at equipment end.
- 5.01.00 Continuity, Identification and Short Circuit Tests

All insulated conductors shall be tested for continuity and conductor identification. In addition, all insulated conductors of multi-conductor cable shall be tested for short circuit. Short circuit tests shall include all tests necessary to confirm that no conductor of a multi-conductor cable is short circuited to another conductor in that cable.
- 5.02.00 Insulation Tests



All insulated conductors shall be tested with a 500 volt megger or an equivalent testing device. Insulation resistance measurements shall be made between each conductor and ground and between each conductor and all other conductors of the same circuit. Minimum acceptance resistance values shall be 10,000,000 ohms.

5.03.00 Testing

5.03.01 Tests shall be performed as many times as necessary to assure proper quality of materials and workmanship. If any tests reveal unsatisfactory materials or workmanship, such materials or installation shall be repaired or replaced.

5.03.02 All hydrostatic and pneumatic testing shall conform to ANSI B 31.1 - Code for Pressure Piping, Paragraph 137.

5.04.00 Hydrostatic Testing

5.04.01 All instrument piping which connects to process piping shall be hydrostatically tested. The specified test pressure shall be applied to the instrument piping upon completion of erection.

5.04.02 Before the leak tests are performed all instrument piping welds and screwed connections shall be inspected and all air expelled from the piping being hydrostatically tested. Welds shall be visually inspected for defects and screwed connections shall be inspected for tightness.

5.04.03 Leak tests shall be performed using cold water to pressurize the systems. The adverse effects upon test results caused by air pockets shall be avoided by expelling all of the air from the system during filling.

Tests shall be made by one of the two following methods :

- a) Isolate the instrument piping from the instrument and the process piping by disconnecting the flexible connection from the instrument and closing the root valve(s). Fill and pressurize the instrument piping through the flexible connection.
- b) Coordinate testing of instrument piping with the testing of associated process piping. Isolate the instrument by closing the shut off valve and disconnecting the flexible connection from the instrument. Test the instrument piping by opening root valve(s) and visually inspecting the instrument piping for leaks. Special precautions shall be exercised by Contractor to avoid damage to instruments and conflict with others performing the process piping hydrostatic tests.

5.05.00 Air Testing

5.05.01 All control air headers, branches and short tubing drops and all pneumatic signal tubing shall be air tested as specified herein. Additionally, all boiler draft and all vacuum instrument piping shall be air tested as specified herein.



- 5.05.02 All control air headers and instrument supply take-offs shall be blown out with clean dry air using full receiver air pressure. Larger headers shall be blown first, using full size valves. Smaller headers and take-offs shall be blown last. All supply headers shall be blown before any instrument connected to the header system is turned on. Instrument air headers and branch lines shall be tested by the pressure decay method.
- 5.05.03 Flexible hoses and short signal tubing runs between adjacent components shall be tested at normal operating pressure by visually inspecting for leaks using a commercial leak detection fluid. Long signal tubing runs shall be tested by charging each tube with air at 2 Kg/Sq. cm through a bubbler sight glass. Tubing shall be isolated from associated instruments with all open ends plugged.
- 5.05.04 Boiler draft and all vacuum instrument piping shall be tested by the same method as long signal tubing runs above except that the boiler draft tap root valve shall be closed in each case and the instrument piping shall be charged from the flexible connection at the instrument. Close shutoff valves to any permanently installed purge meters. Special considerations shall be given to multiple instruments sharing the same process connection or signal source. The Pressures applied shall not in any case exceed the allowable pressure rating of any connected devices which cannot be isolated.

6.00.00 PROTECTION DURING MANUFACTURE, TRANSPORTATION AND STORAGE BEFORE ERECTION

This section provides special precautions, protection & care to be taken for delicate electronic items and supplements the general guidelines provided in the specification.

6.01.00 Protection

- a) All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or non-metallic protecting device. Ends of valves and conduit shall be sealed with suitable devices to protect them from damage. The parts which are likely to get rusted due to exposure to weather, should be properly treated and protected in a suitable manner.
- b) All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. The surfaces that are to be finish painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer.
- c) Special high temperature primer shall be used on surfaces exposed to temperature higher than 95°C.

6.01.01 Protective Guards

Suitable guards shall be provided for protection of personnel and delicate instrument. All such guards shall be designed for easy installation and removal for maintenance.



- 6.02.00 Storing
- 6.02.01 Stored equipment and materials shall be adequately supported and protected to prevent damage.
- 6.02.02 Stored equipment and materials shall not be allowed to contact the ground in ware houses that do not have dry concrete or suspended floors, material and equipment shall be stored on platforms or shoring.
- 6.02.03 Strip heaters and similar heating devices shall be energized immediately upon placement of the equipment in storage.
- 6.02.04 Mechanical dehydrators provided in control panels shall be maintained in operation from the date of receipt of equipment.
- 6.03.00 Defects
- 6.03.01 All defects in erection shall be corrected. The dismantling and reassembly to remove defective parts, replace parts, or make adjustments shall be included as a part of the work.
- 6.03.02 The removal of control and instrument equipment in order to allow bench calibration, if required, and the reinstallation of said equipment after calibration shall also be included as a part of the work under these specifications.

7.00.00 QUALITY ASSURANCE SERVICES

This section outlines, in general terms, the inspection, testing and QA/QC procedures to be adhered to with suitable check-points for Owner's intervention for Control & Instrumentation items. The general conditions outlined elsewhere in the specification over and above. The special requirements furnished below.

- 7.01.00 Quality Assurance Program
- 7.01.01 To ensure that the equipment and services of Control & Instrumentation items under the scope of this Contract, whether manufactured or assembled within Contractor's works or at his Sub-contractor's premises or at the site or at any other place of work, are in accordance with the specification, Contractor shall adapt suitable quality assurance program to ensure proper quality and workmanship at all points. A quality assurance program of Contractor for Control & Instrumentation items shall generally cover the following :
- a) Organization structure for the management and implementation of proposed quality assurance program.
 - b) Documentation control system.
 - c) Qualification and experience data of his key personnel.
 - d) The procedure for Purchase of materials, parts, components and selection of Sub-contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of materials purchased etc.



- e) System for shop manufacturing and site erection controls including process controls and fabrication and assembly controls.
- f) Control of non-conforming items and system for corrective actions.
- g) Inspection and test procedure both for manufacture and field activities.
- h) Control of calibration and testing of control, measuring and testing instruments/systems.
- i) System for indication and appraisal of inspection status.
- j) System for quality audits.
- k) System for handling, storage and delivery.
- l) Item/System-wise QA/QC and inspection flow charts clearly identifying the check-points of three types
 - Where in-house checks will be performed
 - Where in-house test reports will be submitted for Owner's approval
 - Where Owner's inspection is necessary
- m) System for authorizing release of manufactured product.
- n) System for maintenance of records, and
- o) A quality plan detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component furnished.

7.02.00 Quality Assurance Documentation

7.02.01 Contractor shall be required to submit the following Quality Assurance Documents well ahead of dispatch of the equipment :

- a) All non-destructive calibration, testing , examination procedures and repair procedure actually used during fabrication.
- b) The inspection plan with verification, inspection plan checkpoints, verification sketches (if used) and methods used to verify that the inspection were performed satisfactorily.
- c) Factory test results for testing required as per applicable codes and standards.

7.02.02 Owner shall have access to the works of Contractor and Sub-contractor at all times for the purpose of carrying out system audits, conducting quality surveillance, witnessing of tests and inspections etc.

7.02.03 Owner or his authorized representative may periodically check the work and Contractor's method of operation to assure that quality control practices are being



followed. At the time of Owner's visit, all quality documentation pertaining to test, qualifications, inspections etc., shall, upon request, be made readily available.

- 7.02.04 All reports of tests and inspections as per Quality Control Practices and Quality Plans shall be made available to Owner on demand.
- 7.02.05 Contractor shall prepare quality plan in two sections, one for quality control at shop and the other for quality control at site.
- 7.02.06 Testing/inspection procedures as detailed herein gives a basic program to be followed and is in no way comprehensive or complete. Any other inspection stages not mentioned in these clauses but required as per Contractor's quality assurance program shall included. Any tests necessary from operation, safety and reliability point of view shall also be included.
- 7.02.07 These procedures shall include all checks/tests conducted at site for preservation, pre-assembly, alignment, positioning of equipment, foundation preparation, grouting, welding/bolting, heat treatment, non-destructive examination, hydraulic test, performance tests, etc.
- 7.03.00 Shop Test
- 7.03.01 Shop tests shall include all tests to be carried out at Contractor's works, at works of his sub-contractor and at works where material used for production of the equipment is manufactured.
- 7.03.02 Individual components, instruments and devices furnished in accordance with specification shall be shop tested by manufacturer prior to shipment. The tests and test certificates shall be in accordance with the agreed QA program.
- 7.03.03 Such tests shall include electrical, mechanical, performance and hydraulic tests in accordance with relevant standards called for in the specifications to ensure that the plant being supplied fulfills the requirement of the specifications. Equipment not covered by any approved standards shall be tested in accordance with Contractor's quality control program.
- 7.03.04 All material shall be of tested quality, supported with duly correlated test certificates and wherever called upon by the Indian Boilers Regulations or by the design code, the test pieces shall be prepared and tested as per such regulation/code.
- 7.04.00 Site Test
- 7.04.01 Site tests shall include but not be limited to calibration, pre-commissioning trials, start-up trials, trial operation and performance guarantee test.
- 7.04.02 Contractor shall provide all required test equipment and simulation devices of reputed make, of required accuracy class and recently calibrated by some appropriate authority.

8.00.00 INSPECTION AND TESTING



8.00.01 General Requirements

- a) Equipment furnished under this specification shall be subject to test by quality assurance personnel of Contractor and Owner during manufacture, erection and on completion at specific agreed hold points.
- b) Contractor shall conduct all necessary shop and site tests and maintain proper records to fully meet the following requirements.
- c) Demonstrate to Owner's satisfaction that each equipment/sub-system fully meet all functional, parametric and other requirement of this specification and Owner's approved drawings/documents under all operating regimes.
- d) All applicable requirements of latest revised edition of I.S.A. Recommended practice MC-55.1 - 1982/ANSI MC 8.1-1975 regarding hardware testing of Digital process computers shall be fully met.
- e) All applicable tests shall be performed in accordance with the latest revisions of pertinent codes of ANSI, ISA and other applicable codes and standards. For equipment not covered by these codes, Bidder shall apply his standard shop and site testing procedures subject to Owner's approval.
- f) Contractor shall prepare detailed shop and site "Draft Quality Assurance Program" to fully meet the requirements of this specification. The document shall cover the following :
 - Quality assurance and testing procedures from component inspection stage up to final acceptance test at site.
 - Formats for recording calibration/test results.
 - Formats for test reports.
 - Specifications of test equipment proposed to be used for shop and site tests.
- g) The "**Quality Assurance Program**" as approved by Owner shall be used for conducting all shop and site tests.
- h) Additionally all standard quality assurance procedures of Contractor shall also be followed to ensure proper quality of equipment and compliance with specification requirements.

8.00.02 Shop Tests

- a) Contractor shall maintain proper records duly signed by authorized quality assurance personnel regarding all stage inspections, tests on individual equipment/sub-system/systems which are conducted by Contractor as per his standard procedure as well as those conducted to meet the requirements of his specification and Owner's approved "Quality Assurance Program". These records shall be made available to Owner during Acceptance Test.
- b) Contractor shall provide a complete factory test report of the system hardware and software.



8.01.00 Functional And Pre Acceptance Test

The authorized quality assurance personnel of Contractor shall conduct all tests as per the requirements of approved quality assurance program and fully satisfy compliance with specification requirements by all equipment / sub-systems and the system as a whole before sending notification for Acceptance test to Owner. Contractor shall maintain accurate records for all pre-acceptance test which shall be properly documented and duly certified documents shall be furnished to Owner at least one month prior to Factory Acceptance Test.

8.01.01 Input-output wiring check (for system cabinets, relay cabinets etc.)

- a) Contractor shall conduct a point by point wiring continuity check to every input and output and verify that the wiring connections agree with documentation. The test shall be performed by connecting a controlled signal to each input point in sequence. One point at a time, the wiring of all outputs shall be checked.
- b) Upon completion of point wiring checkout, Contractor shall conduct a system operational test employing static signals over the range of input signal. Appropriate static signals simulating each input shall be applied, scanned, processed, printed etc. as directed by the program. Signal strength shall be varied in order to check alarm functions and output fidelity. Simulation shall include testing of all specified system functions and operation. All calculations and conversions shall be verified against pre-calculated results.
- c) Calibration of outputs shall be individually tested for the quality and range over the period of not less than ten days (i.e. 240 hours) after completion of debugging, in order to confirm system stability and accuracy and to detect faulty programming, operation and components.

8.01.02 Special Tests for Solid State Equipment

All solid state equipment shall be subjected to Burn-in and Elevated temperature test and surge protection test :

- a) Surge protection test shall be conducted on all fully equipped system panels as per IEC information 255-4 Class-II. The equipment shall be designed to successfully withstand, without damage to component and/or wiring.
- b) Burn-in & Elevated Temperature Test

All solid state equipment shall be tested for a minimum of 168 hours continuously under power and simulated load prior to shipment.
- c) Acceptance Criteria for Burn-in and Elevated Temperature Test :
 - i) Functional test to be performed before and after Burn-in + ET Test.
 - ii) At no point of time the average temperature rise inside the cabinet shall be 10°C more than the ambient temperature.



8.01.03 Test for Closed Loop Control System

- a) Closed loop control system furnished as per this specification shall be subject to shop and site tests as per the requirements of this specification, applicable codes and Owner approved Quality Assurance Program so as to demonstrate to Owner, that the equipment furnished by Contractor meets the intent and requirements of this specification. These tests shall include but not be limited to the tests indicated in the subsequent clauses.
- b) All control systems shall be factory tested for circuit continuity and direction of the response. The components to be tested shall include all controllers, stations, other system modules, alarm contacts and multi-conductor inter-connecting cables. The tests shall be performed with all of the system components connected to form a complete system with the exception of field instrument. The tests shall include a means of confirming the mathematical design response of the control system by simulating changes in system inputs. The tests shall be a qualitative functional test of each component of the control system which simulates dynamic inputs and monitors system outputs.

8.01.04 Tests for Field Instruments and Devices

The shop test for all field instruments, control actuators and devices shall include electrical, mechanical, performance and hydraulic tests in accordance with relevant IS, IBR or any other relevant approved standard or any other tests called for by Owner approved Quality Assurance Program.

8.01.05 Notification for Acceptance Test at Shop

- a) Owner, his duly authorized representative and/or an outside inspection agency acting on behalf of Owner shall have access at all reasonable times to inspect and examine the material and workmanship of the works during its manufacture of erection and if part of the works is being manufactured or assembled on other premises or works.
- b) Contractor shall give Owner/Inspector written notice of any material being ready for testing.
- c) Owner or Inspector shall within fifteen (15) days from the date of inspections, as notified by Contractor give notice in writing to Contractor of any objection to any drawings and if any equipment and proposed workmanship which in his opinion is not in accordance with the Contract. Contractor's shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objection or shall inform in writing to Owner/Inspector giving reasons therein, that no modifications are necessary to comply with the Contract.
- d) The completion of these tests or the issue of the certificate shall not bind Owner to accept the equipment should it, on further tests after erection, be found not to comply with the Contract.

- e) The inspection by Owner and issue of inspection certificate thereon shall in no way limit the liabilities and responsibilities of Contractor in respect of the agreed quality assurance program forming a part of the Contract.
- f) Contractor shall furnish copies of the following as implemented documents as prior to Acceptance Tests, failing which, Owner may withhold program for Acceptance Tests :
 - i) System configuration drawings
 - ii) Copies of all as-built drawings
 - iii) Final approved copies of all drawings/documents.
 - iv) All off-line diagnostic program listings
 - v) Off-line diagnostic manuals
 - vi) Dump of individual and complete data base
 - vii) Detailed main and bulk memory maps
 - viii) Final Design Specification Volumes
 - ix) Test data to verify all calculations
 - x) All console operation manuals
 - xi) Procedures of generating graphic displays, data base, logs, structuring/tuning of controllers etc.
 - xii) Test procedures, copies of approved data sheets and relevant pages of approved QAP for field instruments & control actuators.
 - xiii) All test reports for all types of tests carried out by Contractor.

8.01.06 Acceptance Test

8.01.06.1 The Acceptance Test shall include all reasonable exercises which the combination of equipment and software can be expected to perform. The test shall include but not be limited to, the following :

- a) Demonstration of the proper function of all hardware.
- b) Demonstration of required spare system capacity and all other parametric requirements of this specification.
- c) Demonstration of all man/machine functions.
- d) Demonstration of the proper functioning of all software.
- e) Demonstration of all diagnostic features.
- f) Point by point exercising of each input and output.
- g) Thorough exercising of each device, including the processor/ CPUs, Peripherals etc.

8.01.06.2 The Acceptance Tests shall also include the following Tests :



- a) Simulation of Inputs - to verify conversion accuracies, scan rates, operator functions, corrections of calculations.
- b) Operational Tests - to verify that the system performs all required functions and meets the specification requirements with respect to "free" processor time, spare memory requirements, loop response time and other parametric requirements.
- c) Diagnostics Test - to test working and bulk memory locations, instruction complements, functioning of outputs and peripheral devices, functioning of system check modules, etc.
- d) Power-consumption test - to verify KW consumption.
- e) Power failure test - to observe the consequences of a total power failure.
- f) Functions - All system functions shall be tested to demonstrate that they are in accordance with the specification.
- g) Format - All printouts and CRT display formats shall be checked to demonstrate that they are in accordance with the specification.
- h) Calculations - All calculations shall be tested to demonstrate that they are in accordance with the specification and I/O schedule. Contractor shall prepare all test cases for calculations (three for each calculation at low, mid and upper ranges of inputs) and submit them for Owner's review in accordance with contract schedule. Test cases shall include performance calculations, flow and level calculations.
- i) Demonstration of the manual and auto switch over from main to standby Bus/Controllers.

8.01.06.3 The following minimum criteria shall be followed during all tests :

- a) System shall meet all parametric and functional requirements of contract specification.
- b) The PLC shall be able to perform all specified functions without any interruption and/or degradation.
- c) Any allowable operator inputs through keyboards shall not result in system crash or hanging.
- d) Except for bulk memory failure, the disconnection / failure of any peripheral device while system is operating shall not lead to system crash.
- e) Disconnection/Failure of any offsite DPU shall not result in loss of any control function.
- f) Pulling out or insertion of any I/O module from its slot, shall not result in any system/sub-system failure.



8.01.06.4 The results of all Acceptance Tests shall be properly documented by Contractor and submitted to Owner.

8.01.06.5 Upon successful completion of Acceptance Test, Owner will provide Bidder with a written authorization for shipment of the system equipment to the project site.

8.02.00 On Site Tests

- a) On-site test shall include all tests to be carried out by Contractor at site upon receipt of equipment. These shall include but not be limited to inspection of equipment, preliminary on-site checks and tests, pre-commissioning trials, start-up tests, trial operation, performance and guarantee test, availability test etc. as per the requirements of clause 4.00.00 and other applicable clauses of this specification.
- b) Contractor shall perform the site tests in accordance with the requirements of these specifications and Owner's approved **"Quality Assurance Program"**.
- c) Contractor shall maintain all test records in Owner's approved formats. These shall be countersigned by the authorized quality assurance personnel of Contractor supervising these works.

8.02.01 Preliminary On-Site Inspection And Tests

After field installation and before equipment energization and connection of field inputs, Contractor shall inspect all equipment and shall check wiring and cable to assure correctness of connections and power equipment installation. After these checks, Contractor's representative shall power the system and perform standard diagnostic tests on all system modules and equipment to assure that the system is working. The field inputs and outputs will then be connected by Contractor.

8.02.02 Start-up

- a) On completion of erection of the equipment and before start-up, each item of the equipment shall be thoroughly cleaned and inspected for correctness and completeness of the installation and acceptability for start-up, leading to initial pre-commissioning tests at site. The list of pre-commissioning tests to be performed shall be as Owner's approved "Quality Assurance Program".
- b) On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the complete equipment shall be operated integrally with sub-systems and supporting equipment as a complete system.

8.02.03 Programmable Logic Control System (Site Testing)

Site testing of PLC system being largely system-specific, only general guidelines have been provided in this section to ascertain the end-behavior of the system offered. However, detail site test procedure shall be mutually decided between Owner and Contractor during detail engineering stage and shall be followed at site.



- a) The front end or the I/O sub-system calibration and functional check procedure shall be as per the recommendation of the system manufacturer.
- b) Cards shall be inspected visually and subjected to standard pre-commissioning checks in standard test jigs before insertion in sub-racks.
- c) Cards requiring recalibration at site shall be calibrated before insertion.
- d) Contractor's activities may include minor hardware and software modification work at site.
- e) Contractor scope of work regarding the commissioning of modulating control sub-system shall include presetting of values of loop constants in respective cards, setting of alarms, timers, visual checking, mechanical and electrical testing and functional checking of all closed loop modulating controls associated with PLC. All tests shall be carried out after isolating field inputs/outputs from the system.
- f) Tests on the control system shall broadly consist of the following :
 - i) Check of Equipment

Cable termination of the cubicles will be checked.

Locks, door function, lamps etc. shall be visually checked.
 - ii) Functional Test

Functionally test the system according to control diagram, wiring diagram and functional diagram. In case of any non-conformity, do some minor rectifications. All loops prior to functional test shall be ensured to be in manual position.

Function test will be performed for each individual control loop successively, related or cascaded control loops must also be tested together. All normal as well as disturbance functions of the control loop and the cubicle shall have to be tested.
 - iii) Testing of closed loop modulating control functions :

Closed loop modulating control functions shall be tested with simulated input signals. Contractor shall check at least the following function :

 - Inputs and outputs shall be checked for polarity
 - MVS and 1/2 selection circuits shall be checked
 - Controller cards shall be adjusted to initial setting
 - Alarm limit shall be set to process requirement
 - A/M bumpless transfers/tracking
 - Transparent fall backs and retransfer

- Release function
 - Loading of output of signal distributors
 - Memory retention time on power failure.
- g) Contractor's responsibility shall also include testing of the following performance criterion of CLCS together with control peripherals :
- i) Keyboard operation of closed loop controls
 - ii) Mimic diagram and graphic displays
 - iii) Logs
 - iv) Current and Historical trend displays of parameter associated to CLCS
 - v) Alarm displays in VDU
 - vi) Printer activation test
 - vii) Keyboard latency, control latency
 - viii) A/M transfer from keyboard
- h) In addition, to the above functional tests, Contractor shall also check the function of the Engineer's console with respect to loop configurability, graphic & log generation, power failure rebooting, trend generation etc at software level and all hardwire interface requirement with other systems.
- i) The tests on binary and sequential control sub-system shall be similar to modulating control sub-systems. The functional tests shall be performed at drive level as well as in group level.
- j) Complete off-line simulation testing of the binary control sub-system shall be carried.
- k) Prior to simulation test, Contractor should ensure that all the interposing relays are in position.
- l) Contractor shall also check the reporting function system to the Information System over the system bus.
- m) Setting of all timers as per process requirement shall also be done by Contractor during start-up.

8.03.00 Loop Checking and Pre-Commissioning

- a) After successful completion of erection and in situ calibration of field and control room instruments and equipment and on completion of associated cabling and tubing activity, Contractor shall undertake progressive loop checking of supervisory/binary and modulating loop controls to ensure all elements in measurement, protection and control loops to function in desired fashion.



- b) In the category of instrument loop checking Contractor's activities shall include broadly the following :-

- i) Loop checking for supervisory instruments.
- ii) Loop checking for modulating control sub-system
- iii) Loop checking for binary & sequential sub-system

All loop checking shall be properly recorded and shall be submitted to Owner after completion of loop checking section wise/equipment wise.

8.03.01 Supervisory Loops

- a) Supervisory loops shall imply measurement loops having monitoring functions only and shall include the bulk data acquisition system.
- b) All loops shall be checked for electrical continuity and air leakage prior to loop checking.
- c) All associated groundings shall be checked before the electrical power system is energized.
- d) Spare cores of field cables can be used for communication during commissioning.
- e) If discontinuity is noted in any field cabling, Contractor shall identify the run of cable/junction at which the discontinuity has developed.
- f) Cable identification markers shall be checked at all points of the loop.
- g) Termination of all associated cable screens shall be checked for properness.
- h) All instrument fuses and power line fuses which were removed after erection shall be reinserted.
- i) If any failure of any component of the loop occurs during loop checking and commissioning the same shall be replaced by drawing from commissioning spare and reerected.
- j) All outgoing cables from temperature elements shall be disconnected at the junction head during loop checking. Proper simulated signals shall be inputted from field through the field cables to simulate temperature.
- k) Similarly, for field transmitters, field cables shall be disconnected from transmitter terminal box and simulated 4-20 mA current signal shall be injected to the loop from field through a constant current signal generator.
- l) In case of inputs connected to bulk data acquisition system the input interface card shall be progressively adjusted to obtain proper display at the console.
- m) Simulated signals shall be inputted for at least five points at equal intervals (including span and zero) of the span, both upscale and downscale.



- n) All accessories related to the measurement loops shall be adjusted/checked as a part of loop checking and commissioning.

8.03.02 Modulating Control Loops

- a) Loop checking will be carried out with all the devices hooked up as per drawings. The intent of loop checking is to establish that all wiring and tubing are as intended and all components are in functional condition. Final tuning of control loops will however be done only during commissioning/pre-commissioning stage depending upon complexity of the loops and as per manufacturer's recommendation.
- b) Before a particular modulating control loop is selected for loop checking, Contractor shall carry out the following checks :
 - i) Final control element (control valve/damper etc.) shall be checked for proper tagging, stroke and sealing, frictionfree movement of stem and positioner setting.
 - ii) Air supply to smart positioners, actuator shall be ensured at proper values.
 - iii) Contractor shall ensure that all primary sensors are properly installed, calibrated and are functioning properly.
 - iv) All scales and charts for indicators/recorders are installed properly.
 - v) Check proper hook-up between operator interface station (A/M station) and control cabinets
 - vi) All control loops must be selected in MANUAL MODE while checking.
- c) All input process signals shall be given from the field terminals in terms of current/voltage or resistance. The input signals should be variable over the total span.

8.03.03 Binary and Sequential Loops

- a) All loops shall be checked for electrical continuity and air leakage prior to loop checking.
- b) All associated groundings shall be checked before energizing the loop component.
- c) Suitability of power at final control element (air or electrical) shall be checked.
- d) All process switches, limit switches etc. shall be mechanically activated from the field and shall be checked at the receiving end. After testing for proper operation of the switches, these will be hooked up to the receiving system as applicable.



Loops will be tested as follows :

- i) One functional loop will be energized at a time.
- ii) Binary inputs shall be simulated from the field end by actuating the initiating devices mechanically whenever possible after setting the design set values.
- iii) The logical output from the binary system shall be checked at the receiving end like MCC, SWGR, DC starter panel, lamps, annunciation, PLC etc.
- iv) All timers will be set at optimum values.

8.04.00 Commissioning

During plant / equipment / section trial run, start up, running etc. Contractor shall put the associated instruments, loops, controls etc. in service in respective sections/areas for smooth commissioning. The instruments/equipment are to be put in operation/service as per sound engineering practice & manufacturer's recommendations. Any instrument problem/trouble that may arise during commissioning and afterwards is to be attended and solved promptly by Contractor.

8.04.01 Trial Operation

- a) The plant shall then be on Trial Operation during which period all necessary adjustments shall be made by Contractor while operating, over the full load range enabling the system to be made ready for Performance and Guarantee Tests.
- b) The duration of Trial Operation of the complete equipment shall be 14 days out of which at least 72 hours shall be continuous operation on full load, or any other duration as may be agreed to, between Owner and Contractor. The trial operation shall be considered successful, provided that each item of equipment/ sub-system/software supplied and erected by Contractor and the system as a whole can operate continuously at the specified operating characteristics for the period of trial operation.
- c) For the period of trial operation, the time of operation with load shall be counted. Minor interruptions not exceeding 4 hours at a time caused during the continuous operation shall not affect the total duration of trial operation. However, if in the opinion of Owner, the interruption is longer, the Trial Operation shall be prolonged for the period equivalent to the duration of interruption.
- d) Trial Operation Report comprising of observation and recording of various parameters to be measured in respect to the above described Trial Operation shall be prepared by Contractor. This report, besides recording the details of the various observations during trial run, shall also include the dates of start and finish of the Trial Operation and shall be signed by the representatives of both the parties. The report shall record all the details of interruptions, adjustments made and any minor repairs done during Trial Operation. Based on the observations, necessary modifications/repairs to

the system shall be carried out by Contractor to the full satisfaction of Owner to enable the latter to accord permission to carry out Performance and Guarantee Tests on the System.

- e) During the preliminary on site inspection and test, start up and Trial Operation the system shall be completely tested in the presence of Owner's representative to fully satisfy Owner that each equipment/sub-system/ software module individually and the system as a whole fully meets the functional, parametric and other requirements of this specification. All diagnostic and software debug tests performed at the factory shall also be performed in the field. These tests shall include a full demonstration of all operating software program operating in the real time environment. Contractor shall be responsible for documentation of all test results, records of defects observed and adjustments / modifications made during these tests. Contractor shall furnish certified copies of the site tests carried out prior to date of commencement of Performance and Guarantee Test.

8.04.02 Performance and Guarantee Test

- a) Performance and Guarantee Test shall be conducted by Owner after the following requirements are met.
 - i) Preliminary on site inspection, start up test and trial operation tests are successfully completed.
 - ii) Certified copies of the results of all site tests are furnished by Contractor.
 - iii) All deficiencies noticed during shop tests and site-tests including trial operation are satisfactorily resolved.
 - iv) System documentation check is successfully completed.
- b) Performance and Guarantee Test shall cover all test covered under Acceptance Test using actual plant inputs and outputs. Additionally, Owner may perform any other test which in his opinion is required for satisfying himself regarding full compliance of equipment with the intent and requirements of this specification.
- c) The guaranteed performance figures of all equipment as well as functional and parametric requirements of this specification shall be provided / demonstrated during these Performance and Guarantee Tests.
- d) Should the results of these tests show any decrease from guaranteed value or non fulfillment of specification requirements, Contractor shall provide all necessary enhancements / replacements / modifications / additions in hardware, software, system configuration and other technical features as required to enable the system and parts thereof to meet the guarantees and specification requirements. In such cases the Performance and Guarantee Test shall be repeated for retest.

8.04.03 Availability Guarantee and Stability Test Run



- a) Contractor shall guarantee 99.7 percent system availability for a period of 180 days. An Availability Guarantee Test shall be conducted to assure this level of availability. If the accrued down time exceeds 0.3 percent of 180 days, during availability test run, a new 180 days test run shall start at the time when the system becomes available again. Loss of availability shall be defined as the loss of the system's guaranteed accuracy and repeatability or of any system function; except, however, that the loss of a function for not more than five percent of the I/O points shall not be considered loss of availability. Loss of a function for not more than five percent of the points shall be treated as partial unavailability and the corresponding outage time shall be weighted with respect to function and the percentage of the points for which the function is unavailable. Loss of each function shall have one weighing factor and unavailability of each equipment, peripheral device or process I/O card etc. shall have another weighing factor. The guaranteed accuracy and repeatability and system parametric requirements specified elsewhere shall be maintained for the entire 180 days run without any manual recalibration or any other changes made to the system.
- b) Downtime shall start upon loss of a system function and shall end upon full restoration of the affected system function. A minimum of one hour's down time shall be charged for each loss of availability in determining system availability.
- c) If availability is lost due to Owner's error, down time will not be charged to Contractor.

8.04.04 Availability Test Dates

The availability test shall commence at a date which will occur between the commissioning date and 5 months following commissioning.

Contractor will be notified of the test starting date at the time of Performance and Guarantee Test. Any subsequent changes in the starting date shall require the mutual consent of both Contractor and Owner.

8.04.05 Test Duration and Definition

- a) The availability test duration shall be 180 days of accumulated test duration time. Such duration time shall be continuous from the start of test, except as defined hereinafter.
- b) The availability shall be expressed by a percentage which shall be calculated as

$$\frac{100 \times [\text{Test Duration Time} - \text{Accumulated System Outage Time}]}{\text{Test Duration Time}}$$
- c) The accumulated system outage time shall be a total of time in which all systems and system functions are not available. A weighing factor shall be used to determine the amount of outage time assessed due to partial failures. System outage time shall be calculated as :

$$(\text{Outage time}) \times (\text{Weighing factors})$$



- d) System outage time shall be accumulated over the test duration and shall be the accumulated system outage time.

8.04.06 Outage Time and Weighting Factors

- a) Contractor shall submit a list of weightage factors for all system elements / components required for conducting the availability test. A list shall be submitted along with the bid documents. The finalization of the same shall be subject to Owner's approval.
- b) Outage time will be assessed for the length of time in which all or any part of any of the functions are either continuously available or not available when requested by operator action. The outage time shall be weighed by each functions associated weighing factor.
- c) Weighing factors for system elements shall be defined and mutually agreed upon before award of Contract.

8.04.07 Conditions

- a) Downtime shall start at the time of notification exclusive of actual travel time required by Contractor but not in excess of 8 hours.
- b) Contractor shall state in his proposal the unit price and quantity of each spare part which will be required at site during the availability test run to maintain the guaranteed availability figure.
- c) If the spare parts which are necessary for repair are not available with Owner at his site stock, the outage time necessary for obtaining the parts by Contractor shall not be counted if the spare part is on Contractor's recommended list and within the quantities indicated for each type of spares.
- d) If Contractor had not listed the spare parts or in case the requirement exceeds the quantity indicated as per point (b) above the time required to obtain the part by Contractor shall be multiplied by a weighing factor of 0.05 and counted as accumulated outage time.
- e) Spare parts which are used by Contractor and not promptly replaced by Contractor, shall accumulate outage time at the rate of time required to obtain the spare parts multiplied by a weighing factor of 0.05 if the part is on a subsequent outage.
- f) Contractor shall be responsible for replacing any of Owner's spare parts which are used in the availability run.
- g) Failure of peripheral output devices shall be counted as outage time if failure of the device affects any or part of any function as per clause.
- h) Any degradation of function shall accrue to outage time regardless of system configuration.



- i) During a period of system outage, Owner shall use operable functions of the system provided that such use does not interfere with maintenance of the inoperable functions or hardware as determined by Contractor.
- j) Should Contractor determine that partial use of the system by Owner will interfere with Contractor's maintenance procedures, system outage time shall accumulate with a weighing factor of 1.0 since no functions are available to Owner. This shall include off-line servicing.
- k) Outage time for each function shall stop at the time Contractor returns each of the functions as listed in clause on "outage time and weighing factors" to full service and relinquishes full use of the system to Owner.

8.04.08 Criteria for Handing-over of Control & Instrumentation System

- a) Contractor shall apply in writing to Owner for handing over of the complete Control & Instrumentation System after successful demonstration of tests as specified up to "Availability Guarantee Test".
- b) Owner shall take over charge of the C&I system subject to fulfillment of the conditions enumerated hereunder :
 - i) All site check-list prepared by Owner are fruitfully attended by Contractor and certified by Owner.
 - ii) All Operation / Instruction manuals are updated to incorporate changes made up to Availability Test Run.
 - iii) All drawings / sketches are submitted as per Contract, on as-built basis.
 - iv) All Close loop controls, Binary & Sequential controls should be working on auto and all interlocks are demonstrated to be functional.
 - v) All equipments and system supplied by Bidder are in working condition.
 - vi) All short supply items, as per Contract, are refurbished by Contractor.
 - vii) The above conditions are in addition to fulfillment of any / all other contractual obligations of Contractor towards Owner. Partial handing-over of systems / equipment shall not be permissible, except if desired so by Owner in special cases.



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

**VOLUME: II-F
SECTION-I
GENERAL ELECTRICAL SPECIFICATION**





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VOLUME II-F

SECTION-I

GENERAL ELECTRICAL SPECIFICATION

1.00.00 PROJECT SYNOPSIS

The electrical system and equipment shall include items related to Flue Gas Desulphurisation (FGD) Package with their auxiliaries viz. Gypsum Handling System, Limestone Handling System etc. for 2X500 MW Thermal power Plant at Tuticorin, Tamil Nadu.

2.00.00 SCOPE OF WORK

- 2.01.00 The scope of Bidder shall include but not be limited to complete design, engineering, manufacture, inspection, testing at manufacturer's work, packing, assembling, and forwarding to site, transportation, unloading, storage at site, erection, painting, civil and structural works, insurance, supervision, pre-commissioning, testing, commissioning and performance testing of all electrical equipment / systems including successful commercial operation of each of the equipment required for Flue Gas De-Sulphurisation Package (FGD).
- 2.02.00 The scope of work shall cover detailed design and engineering of electrical works related to FGD system power distribution, illumination, cabling, grounding, lightning protection for construction, installation, testing and putting into successful commercial operation of the electrical system under FGD Package.
- 2.03.00 Items not specifically mentioned here but needed to complete the system & equipment and as required to meet the intent of the specification or required for operation of the equipment shall be deemed to be included in the scope of work of the Bidder unless specifically mentioned in other's scope of work.
- 2.04.00 Items specified in schemes, write up, data sheets, etc. are complementary to one another and anything laid down in one but not covered by other, items not explicitly specified but considered necessary for completion of the job shall be deemed to be included in the scope.
- 2.05.00 The systems and equipment shall conform to the technical requirements specified in respective sections of the specification.
- 2.06.00 Under FGD package contract, the Bidder shall execute the whole and every part of the work in the most substantial and workmanship manner and shall hand over the plant to Purchaser in full satisfactory working condition after successful completion of Trial Operation.





- 2.07.00 Purchaser shall interpret the meaning of the specification, drawings, requirement of operation, maintenance, redundancy etc., and shall have a right to reject or accept any work or material which in his assessment is not technically complete to meet the requirements of this specification and/or applicable National and International standards mentioned elsewhere in this specification.
- 2.08.00 The Bidder is required to carefully examine and understand the specifications and seek clarifications, if required, to ensure that he has understood the specifications as intended by the Purchaser. In the absence of any specific clarifications made by the Bidder during bidding stage, the interpretation of Purchaser shall be final. The Bidder's offer should not carry any sections like clarifications, interpretations and/or assumptions. All such points are required to be clarified during bidding stage.
- 2.09.00 In the event of conflict between requirements of any two clauses of this specification/documents or requirements of different codes/standards, specified, the more stringent requirement as per the interpretation of the Purchaser shall be the final.
- 2.10.00 Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific items mentioned shall be understood as establishing type, function and quality desired. Other manufacturers' products may be considered provided sufficient information is furnished so as to enable the Purchaser to determine without the need for any additional clarification/data, that the products proposed are proven and equivalent to any Indian or International standards.
- 2.11.00 **The equipment / systems covered under scope of work shall include but not be limited to the following:**
- 2.11.01 **Station Transformer** – one no. 220/11.5/11.5/11 kV, 63/31.5/31.5 MVA, YNyn0yn0d11, ONAN/ONAF, Station Transformer with OLTC & RTCC (Remote Tap Changer Control) and complete with all fittings and accessories will be provided to feed power to the 11kV FGD loads.
- 2.11.02 **HT Auxiliary Power Transformer** –11000V / 3600V, 3 phase, 2 winding, delta / star (Dyn11) connected with OCTC on the high voltage side to take care of voltage variation to the extent of $\pm 5\%$ in steps of 2.5%, outdoor type and oil filled with natural air cooling Auxiliary Power Transformers will be provided to feed power to the FGD 3.3kV loads complete with all fittings and accessories.
- 2.11.03 **Service Transformer (LV Transformer)** - 11/0.433 kV transformers for feeding supply to LV auxiliary loads for FGD package. Transformers shall be vacuum pressure impregnated dry type (AN) and located indoors.
- 2.11.04 **Neutral Earthing Equipment** – Earthing resistors for 11kV & 3.3kV system neutrals sized to limit the earth fault current to 300A (maximum) for duration of 10 seconds.

- 2.11.05 **HV Switchgear (11kV and 3.3kV)** - Complete with breakers, busbars, instrument transformers, numerical relays, meters, transducers, interposing relays, terminal blocks, dummy panels, bus trunking & accessories for balance of plant loads. All 11 KV / 3.3kV switchgears to be provided with manual / auto closing of bus coupler and manual / auto live changeover with check synchronizing and other synchronizing equipment. The short circuit rating of 11 KV switchgear and its associated equipment shall be designed for 40KA for 3Sec and that of 3.3KV HT switchgear and its associated equipment shall be designed for 40KA for 3Sec. Numerical relays with dual redundant IEC 61850 ports, manageable switches / RTUs for establishing communication with DDCMIS shall also be considered as per requirement. Numerical relay network shall be on IEC 61850 protocol. Accordingly all numerical relays shall be connected to the respective panel redundant Ethernet switches through suitable communication cable (RJ45). The groups of numerical relays shall be connected to the DDCMIS. Multifunction meters (MFM) shall be connected in a loop to form RS485 network with Modbus or any industry standard open protocol. The RS485 network of MFMs shall be connected to industrial grade RS485 to TCP/IP converter via serial port. The RS485 to TCP/IP converter shall be connected to the respective panel redundant ethernet switches and further to the EMS. Redundant ethernet switches for respective HT SWGRs as indicated above shall be provided by the SE3 bidder and shall be housed in separate network panel which shall be either wall mounted or standalone as decided during detail engineering & further to be hooked up to BOP DDCMISs. A marshalling panel shall be provided on each bus of 3.3kV switchgear for interfacing with BOP.
- 2.11.06 **LV Switchgear (415V)** complete with breakers / contactors, busbars, instrument transformers, numerical relays, meters, transducers, interposing relays, intelligent modules, terminal blocks, dummy panels, bus trunking & accessories for catering the loads of FGD package. All 415V PCC/PMCC/MCC to be provided with manual / auto closing of bus coupler and auto/manual live changeover with check synchronizing. A marshalling module shall be provided on each bus of LV Switchgear for interfacing with PLC. Control of incomers and bus-coupler breakers of LV switchgears shall be possible from the PLC. The check synchronizing relay shall be housed in the respective switchboards. Dummy panels shall be integral part of the LV switchgear and of same size. Emergency MCC shall cater to the emergency loads of FGD package.
- 2.11.07 **Segregated Bus Ducts** – 3.3kV side of 11kV / 3.3kV Auxiliary Transformer will be connected with the associated switchgears through segregated-phase bus duct with required bends, supporting structures with related civil work. Phase Cross over, if required in 11kV/3.3kV shall be accommodated at the switchgear end in the rear dummy panel.
- 2.11.08 **Non-Segregated Bus Ducts** – Non-segregated Bus Duct (NSPBD) between 415V Service Transformer to LV service PCC/PMCC for FGD package with required bends, supporting structures with related civil work. Phase Cross over, if required in 415V systems shall be accommodated at the switchgear end in the rear dummy panel.



- 2.11.09 **Local Control Panel/JB/PBs**- Local control panels for auxiliaries like EOT crane and hoist electrics, trolley lines and power supply arrangement, electrics for ventilation, air-conditioning, JBs as required for all systems and local stop PB stations for all unidirectional motors and bidirectional drive motors under FGD package, local push buttons as per technological requirement, etc.
- 2.11.10 **Motors** - Drive motors (AC & DC) for all rotating mechanical equipment of FGD package as required. Motors with VFD wherever required as per system requirement shall be supplied.
- 2.11.11 **Actuators** - All motor driven actuators of FGD package shall be integral type.
- 2.11.12 **Cable & Cable Carrier System** - HV/MV/LV power, control, fire survival and special cables along with cable raceway system with necessary fire barriers, fire proof sealing and coating systems, cable supporting structures, cable trenches, cable racks, cable trays, duct banks, conduits, cable laying and cable termination, termination kits. Cable carrier system shall be provided for the entire FGD package area as specified elsewhere in this specification.
- 2.11.13 **DC System** - The DC power supply system shall provide a reliable source of power for critical control and power function during normal and emergency plant operating conditions. For this purpose, 1 x 100% rated 220V float charger and 1 x 100% rated 220V float cum boost charger for each battery and 2 x 100% rated battery for catering DC loads of FGDs of both units and common auxiliaries for three (3) hour has been considered.
- One set of above battery and battery chargers shall feed one DCDB. The DCDB shall have two incomers with bus coupler.
- All the batteries shall be sized for the required load and three (3) hour load cycle, taking into account the temperature correction, design margin and aging compensation factors. Battery shall be of storage type planté lead acid. Battery shall be sized for continuous operation at design ambient of 50 deg. C.
- 2.11.14 **Emergency Power System** – The emergency power system provides for the essential loads required as listed below for safe shut down of the unit in the event of plant blackout (i.e. loss of UT).
- i) Flue Gas Quenching water pump
 - ii) Clean Gas Emission Monitoring system.
 - iii) Agitators in Absorber tanks
 - iv) Absorber drain pit pumps
 - v) Agitators in Absorber drain pits
 - vi) Agitators in Limestone slurry tanks

- vii) Agitators in Emergency Absorber tanks
- viii) UPS by pass supply
- ix) Battery chargers
- x) Emergency lights
- xi) Elevators
- xii) Fire alarms
- xiii) Any other essential load deemed necessary for the system.

The emergency power shall be obtained from the Diesel Generator (DG) system. Two (2) numbers (1 running + 1 standby) 415V quick starting diesel generator set with automatic mains failure (AMF) would be provided.

Emergency bus shall have normal supply from unit FGD PMCC and the emergency supply from the independent Diesel Generator (DG) system.

On build-up of the rated voltage and frequency, the DG incomer breaker to DG PCC shall be closed automatically and the DG PCC outgoing breakers are normally kept closed. After the automatic closing of DG incomer breaker, the respective feeder of Emergency switchboard to DG PCC shall be closed automatically.

The standby DG set will also start automatically whenever main DG Starts up i.e. starting signal will go to main as well as standby DG set whenever an emergency arises. This will ensure quicker availability of emergency power in the event of failure of main D.G. set to start. However, the incomer from the standby DG set will be closed automatically only when the main DG fails to start.

Auto mains failure (AMF) panel shall have the provision for automatic starting of Diesel engine and generator set.

On restoration of normal power, stopping of DG shall be shut down manually through manual push button in DG AMF control panel.

2.11.15 **UPS System** – Two (2) numbers UPS System shall be provided to cater the PLC loads etc. for FGD package. There shall be no separate Battery & Charger for UPS system. Required DC shall be taken from 220V DC system.

2.11.16 **Cable & Cable Carrier System** - HV/MV/LV power, control, fire survival and special cables along with cable raceway system with necessary fire barriers, fire proof sealing and coating systems, cable supporting structures, cable trenches, cable racks, cable trays, duct banks, conduits, cable laying and cable termination, termination kits. Cable carrier system shall be provided for the entire FGD package area as specified elsewhere in this specification. For the incomer Power and control cables from 11 KV Unit sections and from



FGD Power Transformer (220 / 11.5/11.5/11 KV) the space in the existing cable trays can be utilised to the extent possible. If not Cables trays, supports and all other accessories as required for laying of cables from the above transformers, switchgears shall be in the scope of FGD bidder only.

- For 11kV and 3.3kV system: 11kV and 3.3kV unearthed grade respectively, stranded aluminium conductor cross linked polyethylene (XLPE) insulated, “extruded FRLSH PVC of Type-ST2” inner sheathed, galvanised steel wire armoured for three core or aluminium wire armoured for single core and overall FRLSH extruded PVC of Type-ST2” sheathed cables conforming to IS : 7098.
- For low voltage system: Power cables of 1100V grade, stranded aluminium conductor, XLPE insulated, “extruded FRLSH PVC of Type-ST2” inner sheathed, galvanised steel wire armoured for three cores or aluminium wire armoured for single core and overall “FRLSH extruded PVC of Type-ST2” sheathed cables conforming to IS : 7098.
- For control applications: 1100V grade annealed high conductivity stranded copper conductor, PVC (Type-A) insulated, “Extruded FRLSH PVC compound Type-ST1” inner sheathed, galvanised steel wire armoured and “FRLSH Extruded PVC compound Type-ST1” outer sheathed cables conforming to IS: 5831.

- 2.11.17 **Earthing and Lightning Protection-** For the entire area in FGD package complete with earth grids and electrodes buried in soil in the plant area, embedded in concrete inside the buildings to which all the electrical equipment, metallic structures are connected to have earth continuity for safety reasons. Lightning protection complete with vertical air termination rods, horizontal roof conductors, down-comers, test links and electrodes. Treated earth pits are to be provided for transformer neutral earthing and electronic earthing. All system neutrals (including neutrals of transformers), are connected to two numbers treated test pit, which in turn are connected to the grounding grid. Neutral point of HV transformers shall be earthed through NG resistors. Dry type transformer neutrals shall be connected to earth pit through cable of 1.1kV grade (AI) XLPE insulated armoured cable.
- 2.11.18 **Illumination system** - Shall include Lighting transformers, MLDB, ELDB and DCLDB, AC normal / AC emergency / DC lighting panels, lighting masts, poles, lighting fixtures, LED lamps, power sockets, etc. for the entire area in FGD package.
- 2.11.19 Welding sockets in FGD package area, including welding transformers & welding PMCC and power supply network.
- 2.11.20 Electrics associated with air conditioning & ventilation system of FGD control room and any other building if required.
- 2.11.21 Electrics associated with hoisting & handling system including cranes.
- 2.11.22 Electrics associated with elevators.





- 2.11.23 Waste water & oily waste from FGD Power, Auxiliary transformer yard areas shall be collected in common oil pits. These common oil pits shall be connected to ETP. Two nos. (1W+1S) vertical screw pumps shall be installed in each common oil pit. These pumps shall transfer oily waste to common oily pit located in ETP area for further treatment through suitable piping system.
- 2.11.24 Drives prone to vibration shall have power JB for terminating the power cables. Unarmoured copper flexible cable shall be used between power JB and the motor terminal box. This flexible copper cable shall be routed in GI conduit or suitable mechanical protection shall be provided.
- 2.11.25 In drives, whenever bigger size multi run power cables are envisaged, power JB's for terminating the power cables shall be used. Unarmoured copper flexible cable shall be used between power JB and the motor terminal box. This flexible copper cable shall be routed in GI conduit or suitable mechanical protection shall be provided.
- 2.11.26 All civil and structural works associated with the above.
- 2.11.27 **Construction Power**– Construction power shall be provided free of cost to the Bidder. Two nos. 415V, 630A feeders at one location common for two units shall be provided in the purchaser's board approximately 300meters from FGD battery limit. Further distribution to various loads shall be in the scope of the bidder. Bidder shall arrange necessary DBs, capacitor banks along with APFCR, cables etc. for the distribution to various loads.
- 2.11.28 **Electrical Erection and Testing** – Installation, testing and commissioning of equipment like Neutral Earthing Equipment, SPBD, NSPBD, DC System, Switchgear (HV and LV), Motors (HV, MV and LV), Power Transformer, Service Transformers (LV Transformers), cables etc. with all the equipment are in the scope of bidder.
- Retrofitting of 11KV existing Panels for FGD Incomer & Tie-feeder (6nos) as detailed below are in the scope of bidder.
- Unit Switchgear – 1BA
 - Unit Switchgear – 2BB
 - Station switchgear – 0BA
 - Station switchgear – 0BB
 - Station Switchgear – 0BC
 - Station Switchgear – 0BD

Necessary Hard and Soft connection for this new facility associated, with existing Station DCS apart from new FGD DCS is under the scope of the bidder.



- 2.11.29 Mandatory spares and Tools & Tackles as given in elsewhere.
- 2.11.30 Any other electrical equipment required to complete a functional, reliable operating power plant.
- 2.11.31 Electrical equipment & systems integral with mechanical equipment, systems and subsystems, even if not specifically referred to shall also be provided as per relevant sections of mechanical specifications. In the absence of any stipulation in the mechanical specifications, such equipment and systems shall be supplied as per applicable clauses of the electrical specifications, proven engineering practice and applicable codes and standards.
- 2.11.32 All cable trays (along with supporting arrangement) required for the FGD package.
- 2.11.33 The design of all equipment shall conform to the best and current engineering practice. It shall ensure reliability, simplicity and provide long continuous service with high economy and low maintenance. In addition the Electrical Plants and Electric Lines shall be designed to comply with the requirements stipulated in the following regulations and the amendments:
- Central Electricity Authority (Installation and Operation of Meters) Regulations, 2006;
 - Indian Electricity Grid Code issued by Central Electricity Regulatory Commission (CERC); Applicable State Grid Code issued by appropriate Regulatory Commission;
 - Central Electricity Authority (Measures relating to Safety and Electric Supply), Regulations, 2010;
 - Central Electricity Authority (Safety Requirements for Construction, Operation and Maintenance of Electrical Plants and Electric Lines) Regulations, 2011;
 - Central Electricity Authority (Grid Standards) Regulations, 2010.
- 2.12.00 **Terminal Points**
- For terminal points and exclusions of the FGD package refer Volume – IIA of specification for FGD package.
- 2.13.00 **Scope of Design Work**
- The scope of design work shall include detail design for construction and installation of entire electrical system of FGD package.
- 2.13.01 **Design Work - Electrical**
- The following scope of design is indicative only. The Bidder shall be responsible for the complete electrical system even though the same has not been completely and specifically mentioned herein.



- Design Memorandum for various Equipment & Systems
- Design Calculation, Bill of Material
- Electrical Single Line Diagrams
- Electrical layouts, showing equipment location, cable trays/trenches, overhead cable routes, etc.
- Control, metering, protection and signaling scheme of each equipment and the system.
- Electrical I/O list for PLC
- QAP, MQP and FQP for all equipment
- Foundation Plan and loading data
- Vendor Drawings wherever applicable
- Cable schedule and interconnection charts.
- List of equipment and respective ratings.
- Cabling and cable tray system.
- Grounding and lightning protection system including underground grounding mat, over ground grounding grid, air terminal network, lightning mast.
- Relay setting and Co-ordination
- Lighting system including receptacles and power socket outlets. Illumination layouts showing dispositions of fixtures, conduit routing.
- Pre-commissioning check lists.
- Preparation of installation, commissioning, operation and maintenance manuals.

3.00.00 CODES AND STANDARDS

3.01.00 Equipment

3.01.01 All electrical equipment and materials shall conform to latest applicable standards published by the Bureau of Indian Standards (BIS) and other standards mentioned in the various volumes of sections of this specification. In case of a conflict between IEC and other standards, the requirement of IEC shall govern. The provisions of tender specifications (except the clause of





codes and standards of individual specification) shall however have precedence over all other standards. publications of International Electro technical Commission (IEC) or equivalent

3.01.02 Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted (subject to owner's approval). In such cases, copies of the English version of the standard adopted shall be submitted along with the bid.

3.02.00 **Installation**

3.02.01 All electrical installation work shall comply with the provisions of the Indian Electricity Act, the Indian Electricity Rules as amended up-to-date, relevant IS Codes of Practice and recommendations of CBIP, NFPA, etc. In addition, other rules or regulations applicable to the work shall be followed. In case of any discrepancy, the more restrictive rules shall be binding.

3.02.02 Nothing in this specification or in the equipment specification shall be construed to relieve the Bidder of his responsibility.

3.02.03 Major standards (IS, IEC, IEEE, BS, etc.), which shall be followed, are listed in Annexure-A. Other applicable Standards, even if not covered in the listed standards shall be followed.

4.00.00 **ENVIRONMENTAL CONDITIONS AND ELECTRICAL SYSTEM DESIGN CRITERIA**

4.01.00 The equipment shall be installed in hot humid and tropical atmosphere highly polluted with lignite dust, fly ash.

4.02.00 Unless otherwise noted, electrical equipment/system design shall be based on the service conditions given in Vol-IIA of Specification for FGD package: Site Conditions.

4.03.00 Sensitive relay and other electrical and electronic devices shall be located in controlled environment such as air-conditioned control room and electronic equipment room etc. as applicable.

4.04.00 For equipment installed outdoor and exposed to direct sun rays, the effect of solar heat shall be considered in determining the design ambient temperature.

4.05.00 The electrical system shall be designed and engineered to provide a high degree of reliability, operational flexibility and personnel safety. The electrical equipment shall generally conform to the latest Indian Standards & Indian Electricity Rules/Acts.

The standardized voltage level as shall be adopted as specified elsewhere in this specification.

4.06.00 **Permissible Variations:**





The auxiliary power supply system & equipment shall be designed for a voltage & frequency variations as given below under worst operating conditions:

AC System

(a)	Voltage variation	±10%
(b)	Frequency variation	+5% to -5%
(c)	Combined voltage & frequency variation	10% (absolute sum)

DC System

(a)	Voltage variation	-15% to +10%

- 4.07.00 All equipment covered under this contract shall be so designed as to withstand & work continuously with the above mentioned variation in AC/DC supplies without any deterioration in performance.
- 4.08.00 The system shall consist of required Service transformers and associated 11kV/3.3kV/415V switchgears to cater to FGD loads. The bidder shall mark out his own design as per the system requirement and the actual distribution shall be arranged by him as per load centre to be approved by the Owner. Any additional feeder requirement during detailed engineering shall be arranged by the bidder without any price implication.
- 4.09.00 All 11kV, 3.3kV buses shall have facility for auto/manual changeover facility. All 415V switchgears fed from transformers shall be provided with live manual changeover. Auto changeover to the reserve supply source shall be arranged for all 415V switchgears/MCCs to prevent the loss of unit or to ensure the equipment safety.
- 4.10.00 Design fault level shall be 50kA for 415V system. For higher voltage systems it shall be 40kA for 11kV systems and 3.3kV systems.
- 4.11.00 The nominal voltage of DC system shall be 220V for control, protection, annunciation and DC drives.
- 4.12.00 CT & PT secondary wiring shall be color coded i.e. wires or sleeves or ferules of Red, Yellow, Blue & Black colors shall be provided for respective phases & neutral.
- 4.13.00 The connections of CT secondary circuits shall be through drop out type links.
- 4.14.00 To minimize inventory of spare parts and ease of maintenance all 11kV & 3.3kV and 415V switchgear being supplied by package vendor shall be of same make (voltage wise).
- 4.15.00 For the purpose of design of equipment/systems, an ambient temperature of 50°C shall be considered. The equipment shall operate in a highly polluted (with dust and fly ash) and highly corrosive environment.





**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- 4.16.00 Bidder shall provide fully compatible electrical system, equipment, accessories and services for the entire station/plant in his scope as well as those specifically required by the Owner.
- 4.17.00 Areas where flammable and combustible liquids, gases, and dusts are handled and stored shall be classified for the purpose of determining the minimum criteria for design and installation of electrical equipment to minimize the possibility of ignition. The criteria for determining the appropriate classification are as specified in the relevant codes and standards.
- 4.18.00 Electrical equipment in areas classified as hazardous shall be constructed and installed in accordance with the requirements of the appropriate codes and standards.
- 4.19.00 **System Particulars**

Description	220 kV System	11kV System	3.3kV System	415V System	415V System (Lighting & Welding System)	240V System	220V DC System
Nominal Voltage	220kV	11kV	3.3kV	415V	415V	240V	220V
Highest System Voltage	245kV	12kV	3.6kV	457V	457V	264V	242V
Number of Phases (Conductor)	Three (3)	Three (3)	Three (3)	Three (3)	Four (4)	Two (2)	Two (2)
Frequency	50Hz	50Hz	50Hz	50Hz	50Hz	50Hz	NA
Voltage Variation	±5%	±10%	±10%	±10%	±10%	±10%	+10% to -15%
Frequency Variation	±5%	±5%	±5%	±5%	±5%	±5%	NA
Combined Voltage & Frequency Variation	10%	10%	10%	10%	10%	10%	NA
Neutral Earthing	Solidly Grounded	Resistance Grounded	Resistance Grounded	Solidly Grounded	Solidly Grounded	Solidly Grounded	Un-grounded
Design Fault Level to be adopted	40kA for 3 second	40kA for 3 second	40kA for 3 second	50kA for 1second	20kA for 1second	9kA	25kA for 1second \$\$

Note: \$\$ denotes fault level at DCDB level shall be 25kA while at DLDB level fault level shall be 9kA.





4.20.00 **Insulation Levels**

Nominal System Voltage	Rated 1min Power Freq. Withstand Voltage (kVrms.)	Rated Lightning Impulse Withstand Voltage (kVpeak)
400kV	630	1425
220kV	460	1050
11kV	28	75
3.3kV	10	40

5.00.00 **SYSTEM DESCRIPTION**

5.01.00 Electrical Systems and equipment shall cover all items related to FGD package scope.

5.02.00 The main function of electrical system under FGD package is supply & distribution of power to auxiliary equipment.

5.03.00 The system connection is shown in drawing no 17A14-DWG-E-001: Typical Power Distribution Arrangement for FGD System.

5.04.00 The electrical system shall be developed considering the requirement of efficient and reliable operation of the plant in normal and adverse system conditions.

5.05.00 The system configuration shall be developed on the concept that failure of any auxiliary transformer or supply feeder shall not affect full load operation or start-up/shut down of any unit.

5.06.00 **Source of power supply to FGD plant**

The power supply to the auxiliaries of the FGD plant shall be arranged from Owner's existing 220KV switchyard **spare Line bay (Bay no. 207) which will be modified for Transformer bay** (Fully equipped up to SF6 to Air Bushing) and for the booster fans power supply shall be availed from Unit Switchboards at 11 kV level. 220 / 11.5/ 11.5/ 11KV Power supply transformer shall be installed and connected to SF6 to Air bushing of 220KV Switchyard. All necessary inter connecting hardwares, such as intermediate gantries, connecting tube conductors, clamps etc. Necessary Relay Panels in Switchyard to suite the new Station Transformer for FGD are also covered in the scope of bidder. The tentative location of the Station Transformer is shown in the Tender Drawing (Drawing no. 17A14-DWG-M-0002A, Rev-1).

11000V / 3600V, 3 phase, 2 winding, delta / star (Dyn11) outdoor type and oil filled with natural air cooling Auxiliary Power Transformers will be provided to feed power to the FGD 3.3kV loads. Indoor type, LT service transformers three-phase, two winding, 11/0.433 kV dry type cast resin, natural air cooled (AN), housed in a metal enclosure of protection class IP-33 shall be provided to cater LT loads of the FGD system.



For extending supply to FGD Auxiliaries with the provision of Power Transformer the following shall be considered.

Lightning arrester shall be station class, heavy duty, metal oxide gapless type with ratings as detailed below.

5.07.00 The arrester shall have adequate thermal discharge capacity for severe switching surges, long duration surges and multiple strokes.

5.08.00 Following materials and hardware are to be furnished:

- a) ACSR conductors & aluminium tube conductor (if applicable)
- b) G.S. shield wire
- c) Tension & suspension insulator string assembly sets
- d) Disc insulators & post insulators
- e) Conductor spacers, clamps, connectors & flexible copper bonds
- f) Corona control ring

5.09.00 The aluminium stranded conductor and steel reinforced shall have the technical parameters matching the system requirements. ACSR conductors shall conform to the latest revision of IS 398. The material of tubular aluminium bus shall be of grade 63401 WP (Range-2) of IS 5082 or equivalent having best possible combination of electrical and mechanical properties.

All clamps, connectors and S.S. hardware shall be designed, manufactured and tested as per relevant standards. All clamps & connectors for connection with ACSR conductors shall have high tensile aluminium alloy body. U-bolt/hex head bolt and nut, plane washer, bevel washer for the clamp shall be made of non-magnetic material e.g. stainless steel. Bolt, nut, washer, shackle etc. required for other purpose shall be of forged steel with adequate strength and the surface shall be so protected as to offer maximum resistance to corrosion. Malleable iron wherever used for any part shall be of best quality and shall correspond to latest amendments of relevant IS. Various fittings & accessories of the clamps & connectors shall be so designed as to eliminate sharp edges & maintain bright smooth surface. All bolts, nuts, rivets etc. shall have round profiles.

All disc insulators shall be dimensioned appropriately so as to have the required electro - mechanical strength for EHV outdoor duties. Suspension and tension string assemblies shall be supplied as per details below. All insulators and fittings shall generally be supplied as per relevant IS amended to date. Insulator shall be wet-process porcelain, brown glazed and free from all blemishes. Metal parts and hardware shall be hot-dip galvanized. When operated at maximum system voltage there shall be no electrical discharge. Shielding rings, as necessary, shall be provided. Insulation shall be coordinated with basic impulse level of the system. The creepage distance shall correspond to very heavily polluted atmosphere (31mm/kV).

Nom./Highest System Voltage	220 KV
1.2 x 50 μ s Lightning Impulse withstand voltage (kVp)	1050
Wet 1 min. Power Frequency Withstand voltage (kVrms)	460
Corona Extinction voltage kv rms(min)	156
Total no. of discs per string nos	18
Electro-Mechanical Strength KN	120

Post insulator stack shall be used to support the tubular aluminium bus or ACSR conductor of outdoor EHV switchyard. Height of the stack shall be adequate in order to maintain proper clearance of live conductor from ground surface. Post insulator shall be solid core type. Each post insulator will be mounted on pipe steel structure. Post insulator shall be complete with necessary fixing clamp at top for clamping of tubular aluminium bus/ACSR conductor, as required. The insulators shall be provided with necessary nuts, bolts and washers. Creepage distance shall be 31mm/kV.

Nom./Highest System Voltage	220/ 245 kV
1.2 x 50 μ s Lightning Impulse withstand voltage	1050 kVp
Dry/Wet 1 min. Power Frequency Withstand voltage	430 kVrms
Corona Extinction voltage	156 kVrms (min.)
Cantilever Strength (Per Stack)..KN	8

Galvanized steel shield wire shall conform to the relevant IEC, BS or IS. The steel strands shall be drawn from high carbon steel rods produced by either acid or basic open-hearth process, the electric furnace process or basic oxygen process. The wire shall be hot dip galvanized. Zinc used for galvanizing shall be electrotype high-grade zinc of 99.5% purity and shall conform to IS: 209 - 1966 or equivalent BS specification. The hot dip galvanizing shall be done as per IS: 4826 - 1968 for heavy coating. There shall be no joint of any kind in the finished strand wire entering into the construction of earth wire. The wire shall be 7/9SWG galvanised steel wire. The ultimate strength of individual strand shall not be less than 1000 Kgs and that of complete wire shall not be less than 6972 Kgs.

Bundle spacers shall have enough strength so as to restore normal spacing of conductors after displacement by winds, short circuits etc. without damage or permanent deformation. The spacers shall have long life without fatigue or wear and shall have gentle but firm grip on conductor. They shall be able to withstand all the electromagnetic and electrostatic forces under different operating conditions including dead short circuit. They shall be of one piece construction and shall not have separate small components. The materials used in spacers shall be corrosion resistant and made of aluminium alloy of an approved type. All type of nut/bolt/washers shall be made from stainless steel.



The spacers shall be flexible enough so as to avoid distortion or damage to the conductor or themselves. Rigid spacers are not acceptable.

Civil scope of works shall cover design, supply, fabrication, galvanizing, erection of galvanized structural steel work for 220KV GIS, intermediate gantry at SWYD, LA, Post Insulator etc. The scope of work covered under this specification is as follows:

- Towers
- Beams
- Equipment Supporting Structure (Pipe, Lattice Type Supports) & Lighting Towers etc.
- Miscellaneous items like all types of Bolts, Nuts, Hangers, Shackles, Clamps, Anti-Climbing Devices, Bird Guard, Step-Bolts/Ladder, Number Plates, Insert Plates etc.

The work shall involve complete design, supply, fabrication, galvanizing, erection of galvanized rolled sections and pipes, as well as sections fabricated out of plates in base plates, cleats, erection bolts and nuts etc. involving cutting, fabrication, welding, bolting, shop painting, galvanizing etc. The bidder will be completely responsible for safety of structures from design, fabrication and erection aspects.

Design will be done as per IS: 802 (Part-1/Sec-1) 1995 & IS: 802(Part-1/Sec-2) 1992 for design and fabrication of transformer yard / switchyard Structure.

5.10.00 Medium Voltage Power Distribution

5.10.01 This system distributes power to 11000Volt and 3300Volt plant auxiliaries, for FGD load.

5.11.00 Low Voltage Power Distribution

5.11.01 L.V. distribution system shall supply power to all 415V loads during normal operation and emergency condition of the plant.

5.11.02 Unit loads shall be fed through L.T. transformers connected to the respective 11000V system buses. Incomer of all PMCCs shall be through dry type LT transformers.

5.11.03 Connection of the L.T. transformers to 11000V switchgear shall be through cable and to L.V. Boards through non-segregated phase bus duct.

5.11.04 L.V. system shall be solidly grounded to ensure sufficient ground current for positive operation of series trip units and fuses, which are used for protection of most L.T. circuits.

5.11.05 L.V. switchgear shall have duplicate supply source through two incoming line breakers and one bus section breaker, with provision of auto changeover from one source to the other in case of failure of one source. Manual provision of





planned in-phase transfer, supervised by synchro-check relay, shall also be kept for all L.V. Switchgear.

5.12.00 Emergency Power System

The emergency power shall be obtained from the Skid mounted Diesel Generator (DG) system. Two (2) numbers (1 running + 1 standby) 415V quick starting diesel generator set with automatic mains failure (AMF) would be provided.

Diesel generator for each unit shall provide the necessary AC power upon loss of all normal AC power and maintain emergency load for an extended period of time. The diesel generator shall auto-start upon loss of AC power.

The rating of DG set of 415V, 0.8 p.f, 3 phase, 3 wire shall be decided by the bidder.

DG shall be connected to DG PCC through cable.

5.13.00 D.C. System

5.13.01 D.C. system provides reliable source of D.C. power for control, indication and protection of plant equipment.

5.13.02 In addition, it provides for the following emergency loads/services on failure of A.C. supply.

- a) Emergency Lighting
- b) Any other load [To be indicated by Bidder]
- c) UPS

5.13.03 Two (2) nos. batteries, one float charger & one float-cum-Boost-charger for each battery and one D.C. distribution board per unit is considered under FGD package bidder's scope.

Battery, battery charger and DC distribution boards shall be sized accordingly.

5.13.04 All the batteries shall be sized for the required load and three (3) hour load cycle, taking into account of temperature correction, design margin and aging compensation factors. Battery shall be of storage type planté lead acid. Battery shall be sized for continuous operation at design ambient of 50 deg. C.

5.13.05 The voltage at the end of duty cycle shall be 1.85V/cell (ECV) for lead acid Planté type battery.

5.13.06 A general guideline towards consideration of loads in a duty cycle is stated below. However duty cycle shall be developed separately by the Bidder.

5.13.07 The sizing of 220V DC system is in accordance to the above.



a) For duration 0 minute to 1 minute

- Tripping breakers.
- Solenoid valves.
- Indicating lamps, Protective relays, Auxiliary relays on switchgears and control panels
- Emergency lighting

b) For duration : 1 minute to 179 min minutes duration

- Indicating lamps, Protective relays, Auxiliary relays on switchgears and control panels
- Emergency lighting

c) For duration : 179 minutes to 180 min duration

- Closing and spring charging of breakers
- Indicating lamps, Protective relays, Auxiliary relays on switchgears and control panels
- Emergency lighting

The sizing of the lead acid with plante batteries shall be as per IEEE-485. Following Factors to be considered for Battery Sizing:

- Design Margin: 1.15
- Aging Factor: 1.0

The No. of cells, end cell voltage shall be considered based on the minimum and maximum voltage windows and cable drop etc. as per system requirement.

DC scheme shall ensure that each critical consumer is fed from two different bus sections. DCDBs shall be provided with adequate number of feeders on each section.

5.14.00 **Uninterrupted Power Supply**

5.14.01 The UPS loads of each unit are connected to main UPS DB for each unit.

5.14.02 One (1) number UPS system (comprise of 2x100% UPS and 1x100% bypass system) and UPS distribution board (DB) per unit is envisaged under FGD package bidder's scope.

5.15.00 **Neutral Earthing Equipment**

Earthing resistors for 11kV & 3.3kV system neutrals to limit the earth fault current to 300A (maximum) time duration of 10 sec.

5.16.00 **Segregated Phase Bus Ducts**

Segregated phase bus duct shall be rated for secondary side current of transformer at principal tap plus 20% margin rounded off to the next higher



rating. Rating of segregated phase bus duct used as interconnection between two switchgears shall be rated equal to the current rating of connected circuit breaker.

5.17.00 **11kV Switchgear**

5.17.01 There shall be one no. 11kV Switchgear common for both the units. The switchgear shall be fed from the 220Kv / 11 KV Power Transformer to be installed by the bidder.

5.17.02 The design short circuit level of the 11kV station switchgear shall be as indicated in the table above.

5.17.04 Incomers, motor feeders, and transformer feeders of 11kV switchgears shall have single comprehensive numerical type relays of latest version for protection and they shall communicate with PLC System through open protocol (IEC-61850).
The current ratings of all the outgoing breakers shall be same to facilitate interchangeability of the breakers.

5.17.05 11kV Switchgears shall be provided with Vacuum Circuit Breakers (VCB).

5.17.06 Heat run (temperature rise) test shall be carried out on one 11kV Switchgear of each rating.

5.18.00 **3.3KV Switchgear**

5.18.01 There shall be one no 3.3kV Switchgear (two incomers and a bus coupler) common for both the Units. per Unit. 3.3kV switchgear shall be fed from the secondary winding of 11kV / 3.45kV Unit Auxiliary Transformer.

The incomers and bus-couplers of 3.3kV switchgear will be sized as per the current rating of 3.3kV side of MV auxiliary transformer. The outgoing breaker rating will be as per current ratings required to cater to load connected to the respective feeder including 10% margin rounded off to the next higher rating. The current ratings of all the outgoing breakers shall be same to facilitate interchangeability of the breakers.

5.18.02 3.3kV Switchgears of FGD system shall be provided with manual/auto closing of incomers, bus coupler with live changeover.

5.19.00 **LT Service Transformer**

5.19.01 The LT service transformers shall be Indoor, three-phase, two winding, 11/0.433 kV dry type cast resin, natural air cooled (AN), housed in a metal enclosure of protection class IP-33, with off-circuit taps of +/- 5% in steps of 2.5% on HV side. The transformers shall be suitable for indoor applications having Dyn11 Vector group. The star point shall be solidly earthed. Required number of LT service transformers shall be provided to feed unitized LT auxiliary loads for FGD systems such as Gypsum Handling System, Limestone Handling System or Ammonia Handling System, as applicable, etc.





- 5.19.02 Each switchgear/MCC/distribution board shall be fed by 2x100% transformers/feeders and these shall be rated to carry the maximum load expected to be imposed.
- 5.19.03 An appropriate diversity factor with a minimum of 0.9 for continuously running loads & purchaser feeders and 0.4 for intermittent loads like cranes, plug points, sump pumps, elevator and 0.2 for stand-by feeders etc., shall be considered. Voltage variation factor of 4% shall also be considered. The rating established shall take into account, load variations during the course of engineering.
- 5.19.04 20% spare margin shall be considered over & above the estimated total load on the L.T. board.
- 5.19.05 Additional starting & running of one largest stand by motor with driven equipment shall also be considered while sizing the transformer. The motor terminal voltage during above operations shall be within specified limits.
- 5.19.06 All anticipated future loads in or around the load center shall be taken into consideration while finalizing size of L.T. Transformers.
- 5.19.07 The maximum rating of the transformer shall be limited to 2.5MVA. If the calculated rating crosses the maximum rating bidder has to provide one more separate switchgear with suitable capacity transformers.
- 5.19.08 Through fault current withstand capability of transformer shall be 2 Sec.
- 5.19.09 The transformer shall be capable of withstanding without damage 1.4 times the rated voltage at its termination for 5 seconds.
- 5.19.10 Neutral CTs for REF and Backup earth fault protection shall be included.
- 5.19.11 Heat run (temperature rise) test and impulse test shall be carried out on one 11/0.433 kV Transformer of each rating.
- 5.19.12 The service transformers shall be of dry type with coils resin impregnated under vacuum and pressure (VPI) type and AN cooling.
- 5.20.00 **Non-Segregated Phase Bus Duct**
- 5.20.01 The secondary of the Service transformers shall be connected to the individual 415V PCC/ PMCC through 415V Non-segregated phase bus duct, which shall be rated for secondary side current of LV Service transformer at principle tap plus 20% margin rounded off to the next higher rating.
- 5.21.00 **LV Switchgear**
- 5.21.01 Power from LV service transformers shall be supplied to 415V switchgears. Power from 415V switchgears to the various MCCs, PDBs, ACDBs, etc. shall be supplied from redundant incomers. These switchgears shall distribute power to LV auxiliary motors and also to other auxiliary loads viz. MCCs / ACDBs, etc. LV switchgears shall be of metal enclosed indoor type. Incomers / bus- couplers,

outgoing tie feeders rated 630A & above and motor feeders rated above 90kW shall be equipped with air circuit breakers of fault interrupting capacity of 50KA rms. Incomers / bus- couplers, outgoing tie feeders rated up to 630A and motor feeders rated up to 90kW shall be equipped with motorized MCCB.

- 5.21.02 All the boards shall be sectionalized.
- 5.21.03 Not more than 2 out of 3 ACBs can be closed at a time unless at the time of planned short time paralleling through synchro check.
- 5.21.04 Under normal mode of operation each incoming source shall be connected to the respective bus sections with bus coupler open.
- 5.21.05 During the normal mode of operation if there is a loss of normal source to any bus-section, slow bus auto changeover shall be initiated to first trip the normal incomer connected to this section and further close the bus coupler to extend power from healthy bus section.
- 5.21.06 Restoration of normal operating condition shall be through planned manual changeover through synchro check paralleling or manual dead bus closing. Incase parallel running between two sources prolong over a set time, an alarm shall be generated and the last ACB to close shall be opened.
- 5.21.07 The AC control supply voltage for motors rated 90kW & below shall be 110V AC. For this purpose each motor feeder of PMCC/MCC shall be provided with suitable rated 415/110V Control Transformer. Separate control transformer for test bus supply shall be provided for each bus section.
- 5.21.08 All circuit breakers shall have 220V DC control.

Non Intelligent Draw-out Type PMCC

- 415V FGD PMCC-1
- 415V FGD PMCC-2

Fixed Type Distribution Boards

- DCDB
- Power Distribution Board (PDB)
- Main Lighting Distribution Boards (MLDB)
- Emergency Main Lighting Distribution Board (EMLDB)
- DC Lighting Distribution Board (DCLDB)

- 5.21.09 Any other PCC/PMCC/MCC/DB required as per the distribution of load and for any other system which is part of mechanical system under FGD package.

5.22.00 **Protection Philosophy**

- 5.22.01 Single comprehensive Numerical type protective relays of latest generation shall be provided to isolate the faulty equipment and system as early and as expeditiously possible. All numerical relays shall communicate with PLC through Open protocol (IEC 61850). Protection requirement for individual equipment have been elaborated under respective switchgear sections.

5.23.00 **LV Power Supply**

LV power supply feeders shall have moulded case circuit breaker (MCCB) for over current & short-circuit protection.

5.24.00 **Operation and Control Philosophy**

5.24.01 **Auxiliary Power supply system control**

- a) All controls, indications, measurements, annunciation and sequential event logging for all drives shall be provided in PLC.
- b) Control of all 415V incomer and bus coupler breakers of PCC / PMCC / MCC shall be done from PLC.

5.24.02 **Interface with PLC**

- a) Control, monitoring, measurement, annunciation of complete electrical system supplied under this contract shall be possible from the PLC system.
- b) All relevant data shall be made available to the PLC by the Bidder.

5.24.03 **Control**

- a) All the electrical drives shall be generally controlled (starting, stopping and sequencing) from the FGD control room through the PLC. Remote position, service position, breaker healthiness, permissive for interlocks, status of emergency stop Push button etc., shall be considered as minimum inputs to the PLC.
- b) Control of incomers and bus-coupler breakers of LV Switchgear shall be possible from the PLC. Check synchronizing relay shall be housed in the respective switchboards. Provision shall be made in PLC based system for selection of only one breaker at a time for synchronizing. The synchronizing selection shall also activate the check synchronizing relay provided in the respective switchgear panels.
- c) Control of all breakers/contactors from PLC based control system shall be done through interposing relays. These interposing relays shall be available in the respective switchgear panels. Any auxiliary relay required for linking with PLC shall also be provided. Interposing relays shall be plug-in type.
- d) No hard-wired switch is envisaged near the motor or control desk for selection of motors. Selection of motor is only through software through mouse click.

5.24.04 **Monitoring**

- a) Indication-Status of breakers / vacuum contactors, position of Local/Remote selector switches, spring charged indication etc.

b) Abnormal conditions of LV System: -

- Breaker auto trip, individual protective relay operation, trip circuit failure, DC supply failure, bus under voltage, VT fuse failure. Successful/Unsuccessful changeover of 415V supplies.

c) Single line diagram showing voltage, current, frequency, MW and MVAR flows, breaker positions shall be available on CRT.

d) Trending facility shall be provided for all analogue parameters. Separate Transducers shall be considered for this.

5.24.05

Measurement

Multi-functional Transducers, if any required for giving analogue input to PLC system from LV modules shall be provided in the switchgear modules.

SI No	Feeder Description	CRT
a)	Incoming feeders of LV Switchgears & MCCs rated 630A and above.	Voltage (All phases)
		Current (All phases)
		KW, KWH
b)	Incomer feeder of LV MCC rated below 630A	Current Y phase
c)	Bus coupler of LV switchgears & MCC rated 630A and above.	A (All phases)
d)	Bus coupler of LV MCC rated below 630A	Current Y phase
e)	LV Buses	Voltage (All phases)
f)	Outgoing feeder of LV Switchgear and MCC rated 630A and above.	Voltage (All phases)
		Current (All phases)
		KW, KWH
g)	Outgoing feeder of LV MCC rated below 630A	NIL
h)	Motor feeder rated above 90kW	Current (All phases)
		KW, KWH
i)	Critical drive feeder rated above 18.5kW upto 90kW	Current Y phase
j)	Motor feeder rated up to 18.5kW	NIL
k)	Incomer of ACDB/MLDB/PDB/MCCB	Voltmeter with voltmeter selector switch.
		Electronic energy meter with communication port suitable for IEC-61850 protocol. Electronic energy meter suitable for communication with protocol Modbus RS 485 is also acceptable.

5.24.06

Event Logging

Event logging shall be provided for all manual operations and relay operations as detailed below: -

- a) Status of each ACB of all equipment being controlled
- b) Close and open commands
- c) Each protective relay, trip relay, alarm relay operation. Event logging for each phase shall be provided wherever applicable (e.g. fuse fail alarm, etc.).

Event logger shall be a part of the PLC based control system.

PLC based control system shall be directly interfaced with numerical relays for digital / analogue signals through open protocol IEC 61850. All sequence of event recorder (SER) signals shall be with time stamping in PLC based control system.

5.24.07 **Synchronizing**

LV Switchboards / MCC incomer and bus coupler breakers shall have facility for dead bus and synchronizing closure through PLC based control system.

5.25.00 **Motors**

5. 25.01 Motors rated up to and including 160kW shall be connected to 415V, 50Hz AC supply. Motors rated above 160kW up to and including 750kW shall be connected to 3.3KV, 50Hz supply. Motors rated above 750kW shall be connected to 11kV, 50Hz supply.

5. 25.02 All LT motors of S1 duty cycle shall conform to minimum efficiency performance standards (MEPS) of IE3 mentioned in IS: 12615. All HT motors shall have efficiency and power factor higher than 90% and 0.83 power factor respectively. For crane motors S4 duty with 40% cyclic duration factor shall be considered. Motors operating through variable frequency drives shall be suitable for inverter duty.

5. 25.03 The motor name-plate rating at 50°C shall have at least 15% margin for HT & LT system over the input power requirement of the driven equipment at rated duty point and also covering the 10% margin on maximum load demand of the driven equipment under entire operating range, including voltage and frequency variations, unless stated otherwise in driven equipment specification or in general electrical specification.

5. 25.04 All motors shall have Class F insulation with temperature rise limited to Class-B.

5.26.00 **Selection of Cables**

5.26.01 HV & MV cables and LV power cables shall be selected on the basis of current carrying capacity, short circuit rating and permissible voltage drop.



- a) While sizing power cables, following aspects shall be considered: -
- i) Ground / ambient air temperature.
 - ii) Depth of laying
 - iii) Power cables laid in touching formation for multicore cables and in trefoil formation for single core cables.
 - iv) Fault current & duration
 - v) Full load current of the circuit
 - vi) Steady state voltage drop with maximum load current
 - vii) Transient voltage dip on motor starting
 - viii) Consideration shall also be given to limit the cable to the nearest standard sizes instead of using too many types.
 - ix) The standard cable sizes, ampacities, de-rating factors, etc. shall be as given in IS or relevant standard.
 - x) Route length.
- b) The fault current & interrupting time shall be as under: -
- i) For 11kV - 40kA - 0.2 sec for outgoing motor feeders and transformer feeders and 40kA - 1sec for tie and incomer feeders.
 - ii) For 3.3kV - 40kA - 0.2 sec for outgoing motor feeders and transformer feeders and 40kA - 1 sec for incomers & tie feeders.
 - iii) For 415V - 50kA - 0.25 sec for motor feeders and 50kA -1sec for incomer & tie feeders.

For sizing of 11 kV incoming cable to FGD Switchgear from Station Transformer bidder shall consider the full load current of the 32/16/16MVA Station Transformer as current carrying capacity of the cable.

- 5.26.02 For MCCB/MPCB protected feeders, minimum cross section criteria shall not apply. Also Outgoing feeders where only IDMTL protection is provided, 1sec shall be considered for cable sizing.
- 5.26.03 For ACB / MCCB / MPCB protected circuits the conductor size shall depend upon full load current subject to voltage drop limited to 3% during running of all feeders and 15% during starting of motors having rigid coupling. For motors having fluid coupling the starting voltage drop can be considered as 20%. In addition, transformer regulation shall also be considered for loads fed from 415V PMCC.
- 5.26.04 For all HV & LV power and 220V DC cable 10% design margin in load current shall be considered.
- 5.26.05 The voltage drop from main lighting distribution board to any fixture shall not exceed 3%. For welding receptacles 3% running drop shall only be considered.
- 5.26.06 The minimum cable sizes in control cables shall be 2.5 sqmm. copper conductors unless otherwise specifically warranted. However higher size may be selected based on the burden calculations.

5.26.07 The minimum sizes of L.T power cable to be chosen are as below: - AL - 16 mm² (3 core) & Cu - 2.5 mm² (3 core).

Note: - Wherever the termination of Aluminium cable is not possible due to size of motor terminal box, local JB to be suitably located near the motor terminal box and then copper cable of appropriate cross section shall be provided from the local JB to the motor terminal box.

5.26.08 Multicore Control Cables shall generally have at least 20% spare cores.

5.26.09 Above 19 core two or more of above cables the core size of control cable shall not exceed 19 core. In case there is a requirement of more cores then two or more cables should be used.

5.26.10 In power cables maximum conductor size to be used shall be 400 sq. mm and 630 sqmm for multi core and single core cables respectively. In case of multi core cables not more than 3 runs to be used or otherwise single core cable to be used.

5.26.11 Cables between Battery/Battery charger and Main DC distribution board shall be single core and cables other than these systems may be single core/Multi core.

5.26.12 HV & MV cables & LV power cables shall be laid in ladder type cable trays. Control & Instrumentation cables shall be laid in perforated trays. However, in vertical risers control & instrumentation cables shall be laid in ladder type trays.

5.27.00 **Fire Proof Sealing**

5.27.01 Fire proof sealing of all the package cables within FGD battery limit shall be provided by the bidder.

5.27.02 Cables / cable tray openings in walls and floors or through pipe sleeves from one area to another or one elevation to another, between the units and within the same unit, shall be sealed by a fire-proof sealing system. The fireproof sealing system (FPSS) shall effectively prevent the spread of fire from the flaming to the non-flaming side, in the event of a fire. The FPSS shall conform to the following requirements: -

- i) FPSS shall have a fire rating of two hours.
- ii) The FPSS shall be subjected to fire endurance test, hose stream test, temperature measurement of non-flaming side as per ASTM-E119. 'Standard method of fire tests of building construction and materials'.
- iii) The FPSS shall also conform to the in-combustibility test carried out in accordance with IS: 3144-1992.
- iv) Under fire condition, the FPSS material shall not emit excessive smoke or any corrosive or toxic fumes.

v) FPSS shall have life of 25 years.

5.28.00 **Fire Break**

5.28.01 Fire break of all the package cables within FGD battery limit shall be provided by the bidder.

5.28.02 Fire break shall be provided by applying a suitable fire-resistant coating on cables for the required length to meet the fire rating of 2 hours.

5.28.03 Fire break shall be provided at an interval of 15meters in the straight portion of each of the cable tray above ground, at intervals of 30meters in cable trenches and at 5M for all vertical trays. All cable inter section and tee offs shall be provided with firebreaks.

5.28.04 When pipe sleeves are provided for cables from outdoor areas to indoor areas, the pipe opening at the outdoor side shall be sealed by fire proof sealing material, which is also continuously waterproof. The indoor side of the pipe opening shall also be sealed by continuous fire proof sealing materials. The duct banks in outdoor areas also need to be sealed by water proof seals. It is necessary to explore possibility of applying waterproof coating on fireproof sealing.

5.29.00 **Cable Accessories**

5.29.01 Termination and Straight through Joint Kits

a) Cable trays shall be well away from hot steam pipelines and shall not be immediately above or below the steam pipes.

b) Materials of construction for a joint/termination shall perfectly match with the dielectric chemical and physical characteristics of the associated cables. The material and design concepts shall incorporate a high degree of operating compatibility between the cable and joints. The protective outer covering (jacket) used on the joints/terminations shall have the same qualities as that of the cable outer sheath in terms of ambient/operating temperature withstand capability and resistance to hazardous environments and corrosive elements.

c) The materials required for termination and straight through joints shall be supplied in kit form. The kit shall include all insulating and sealing materials apart from consumable items and installation instruction.

d) The termination kits shall be suitable for termination of the cables to indoor switchgear or to a weatherproof cable box of an indoor/outdoor mounted transformer/motor. The termination kits shall preferably be as of the following types: -

i) PUSH ON type for LV power cables.

- ii) Heat Shrinkable sleeve type for HV & MV cables and LV power cables. However terminating kits for HV & MV cables shall be of heat shrinkable type of make with specific approval of Purchaser.
- e) For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.
- f) The straight through jointing kits shall be suitable for underground installation with uncontrolled backfill and possibility of flooding by water. Straight through joints shall be used for LV power cable sizes of 70sqmm and above. The jointing kit shall be one of the following types: -
 - i) 'TAPEX' of M-seal make or equivalent for LV power cables
 - ii) Heat Shrinkable sleeve type for HV & MV cables and LV power cables. However straight through joints for HV & MV cables and LV power cables shall be of heat shrinkable type of make with specific approval of Purchaser.

5.29.02 **Raceway & Conduit**

The design and specifications for the raceway and conduit systems used in supporting and protecting electrical cable shall be in accordance with the provisions of the appropriate codes and standards.

5.30.00 **Conduit**

5.30.01 Conduit shall be used to protect unarmoured conductors routed to individual devices and where the quantity of cable does not economically justify the use of cable tray.

5.30.02 Rigid conduit shall be used for hazardous and outdoor areas.

5.30.03 Galvanized rigid steel conduit shall be used for all conduit encased in concrete and all exposed conduit.

5.30.04 All conduits cast in concrete shall be routed in exposed runs parallel or perpendicular to dominant surfaces with right-angle turns made of symmetrical bends or fittings. Conduit shall be routed at least 150mm from the insulated surfaces of hot water, steam pipes, and other hot surfaces. Where conduit must be routed parallel to hot surfaces, special high temperature cables shall be used.

5.31.00 **Duct Banks & Manholes**

5.31.01 All underground duct banks shall consist of plastic conduit encased in reinforced concrete. The minimum nominal diameter/hume pipes of the plastic ducts shall be 125mm. A 75mm galvanized steel conduit shall also be installed where required for digital and analog low-level circuits requiring noise immunity from adjacent power circuits.

- 5.31.02 Conduits from manholes to the equipment at remote locations shall be changed to rigid steel prior to emerging from below grade. The steel conduit shall be encased in concrete.
- 5.31.03 All underground duct banks shall be installed in accordance with the following methods:-
- Ducts shall be sloped not less than 75mm per 30meters to manholes to provide adequate drainage.
 - Reinforcing steel shall not form closed magnetic paths between ducts.
 - Non-metallic spacers shall be used to maintain duct spacing.
 - Reinforced concrete manholes shall be provided, where required, so that cable may be installed without exceeding allowable pulling tensions and cable sidewall pressures. Each manhole shall have the following provisions:-
 - ❖ Provisions for attachment of cable pulling devices.
 - ❖ Provisions for racking of cables
 - ❖ Manhole covers of sufficient size to loop feed the largest diameter cable through the manhole without splicing.
 - ❖ Sealed bottoms and sumps.
- 5.32.00 **Cable Trays**
- 5.32.01 Cable trays shall be of ladder / perforated type complete with all necessary coupler plates, elbows, tees, bends, reducers, stiffeners and other accessories. Cable trays of ladder and perforated types and the associated accessories such as coupler plates, tees, elbows, etc. shall be fabricated from 14 gauge mild steel sheets. Cable trays covers shall be provided for all top row cable trays and raceways. The cable tray accessories like trays, elbows, bends, etc., shall be fabricated and galvanized before bringing to site. Cable tray covers shall be fabricated from 16 gauge MS sheets. All the sheet steel shall be hot dip galvanized. There shall be a maximum spacing of 1500 mm between cable tray supports, except fittings (elbows, tees, etc.) which shall be supported at each splice.
- 5.32.02 HV, MV and LV power single core cable shall be laid in trefoil formation with 2D gap where 'D' is the diameter of cable.
- 5.32.03 HV & MV cables and LV power cables (95 sq. mm & above) multicore cables shall be laid in touching formation in single layer. 1100V multicore cables below 95 sq. mm shall be laid in two layers. Control and instrumentation cables shall be laid in 3 layers.
- i) Individual tray systems shall be established for the following services:
- a) Control cable shall be laid along with LV power cables and Instrumentation cables if required for short lengths near the equipment with GI separators.
 - b) 3.3 kV and higher voltage power cables.
 - c) 415 Volt power cables.
 - d) Special noise-sensitive circuits or instrumentation cables.
 - e) Control cables.

- f) Further subdivision of tray systems shall be provided if required to meet special segregation/separation requirements.
- ii) In areas having lignite dust, cable trays shall be run in vertical formation while horizontal trays shall be provided in other areas. Cable depth not to exceed two cables for vertical trays.
- iii) The minimum design vertical spacing for trays shall be 300 mm measured from the bottom of the upper tray to the top of the lower tray. At least a 300mm clearance shall be maintained between the top of a tray and beams, piping, or other obstacles to facilitate installation of cables in the tray. A working space of not less than 600 mm shall be maintained on at least one side of each tray. Tray covers shall be provided on the top most tray of each tier of cable trays.

5.32.04 In areas, where acid/ alkali ingress is likely (such as Battery Room, etc) to occur, Fibre Reinforced Plastic trays with fire retardant corrosion resistance properties shall be used.

5.32.05 **Specification of FRP trays (if applicable):**

The FRP cable tray shall be ultra violet resistance. FRP cable trays shall be manufactured in accordance with NEMA FG-1-1984-1993 and ASTM E 84. Manufacturing process shall be pultrusion using automated pultrusion machines. Resin to be used shall be ultraviolet resistance polyester resin.

All cable tray and accessories shall be corrosion / chemical resistant, weather resistant, easy to drill and cut. Lightweight, high strength and flame retardant in accordance with ASTM E-84-Class 1 Rating and as per IS-6746-very low Flammability. An additive material shall be mixed with the FRP to make them resistant to ultraviolet light. The oxygen index shall be minimum 30 as per ASTM-D-2863.

The minimum glass content in the FR material shall be 55%.

The Ladder type trays shall have side rails and horizontal rungs. Both of these shall be of same material i.e. the FRP with additive material. The rungs shall be placed 300mm apart from each other. The side runner of the Ladder type FRP cable trays shall be pultruded FRP channel of 100x35mm height. The minimum thickness of the tray will remain 4mm. The rungs to side member are connected to the Larger portion of the side rail by using pin made of fiberglass reinforced thermoplastic, and should have both mechanical and adhesive lock.

Minimum thickness of perforated type FRP cable tray shall be 4mm. Minimum thickness of coupler plates shall be 4mm.

5.33.00 **Grounding and Lightning Protection**

5.33.01 The grounding requirement of the area is divided into the following three main categories:-

- System grounding



- Equipment grounding
- Electronic Equipment grounding

- 5.33.02 The system grounding is adopted to facilitate ground fault relaying and to reduce the magnitude of transient over voltage. The system grounding involves grounding of the transformer neutrals treated earth pits. High resistance grounding is envisaged for generator neutral, which would be achieved through a distribution transformer shunted by a resistor in the secondary.
- 5.33.03 All electrical equipment shall be earthed by two separate and distinct earth connections with earth.
- 5.33.04 For 11KV & 3.3KV System, low resistance grounding is envisaged so as to facilitate selective clearance of ground fault through earth leakage relay connected in the residual circuit of phase current transformers. The 415Volt System shall be solidly grounded with protections. The 220V DC systems shall be ungrounded.
- 5.33.05 Grounding of equipment body is to be adopted to provide protection to personnel from potential caused by ground fault currents and lightning discharges.
- 5.33.06 A stable ground grid shall be provided for grounding of equipment and structures and for maintaining the step and touch potentials within safe limits. An earth mat shall be laid in and around the FGD plant area. The length of the ground conductors below earth shall be sufficient to ensure a ground resistance of less than one (1) ohm measured at the driest season.
- 5.33.07 All metallic parts of equipment, supposed to be kept at earth potential, shall be connected to the grounding mat. Buildings, structures, towers, plant rail, road tracks, the perimeter fencing shall also be connected to the grounding mat. Grounding systems shall be interconnected. Suitable number of risers shall be provided from his grounding mat for building/equipment within FGD plant grounding zone. Number of such risers shall be as per system requirement. For every upper/lower floor the distance between two adjacent risers from below the grounding grid shall not be greater than 10m.
- 5.33.08 For grounding of electronic equipment, a separate earthing system consisting of a number of deep driven treated earthing rods interconnected with insulated cables and insulated risers are to be installed. This system shall be totally isolated from the power equipment earthing mesh risers described above and shall be located underground vertically below the electronic equipment room.
- 5.33.09 Lightning protection system shall be provided as per IS: 2309. Lightning protection system shall comprise vertical air terminations, horizontal air terminations, down conductors, test links and earth electrodes.
- 5.33.10 Air terminations, down conductors and test links shall be of galvanized steel conductors and earth connection below ground level shall be of mild steel rod.



Hazardous area shall be protected by a system of aerial earth as per IEEE 142.

5.33.11 All system neutrals (including neutrals of power transformers), connected to two Nos. treated test pits, which in turn are connected to the ground grid.

5.34.00 **Illumination System**

5.34.01 Suitable illumination necessary to facilitate normal operation and maintenance activities and to ensure safety of working personnel shall be provided. This shall be achieved by following artificial lighting: -

- i) Normal AC lighting
- ii) Emergency AC Lighting
- iii) Emergency DC Lighting

5.34.02 About 80% of the total light fittings would be connected to the normal 240V AC lighting supply and the balance 20% to the station emergency bus fed from the DG set in the FGD package areas.

5.34.03 DC emergency lights are envisaged at strategic points in the plant viz., near entrances, staircases, control rooms, etc. These would be fed from 220V DC systems, which would be normally off when AC power is available. These would be automatically switched on when the normal / emergency AC supply fails. Battery backup time shall be at least one (1) hour.

5.34.04 Apart from maintenance factor as given below, Temperature correction factor shall be considered in the lighting design: -

Air-conditioned indoor area	: 0.8
Non-air-conditioned indoor area	: 0.7
Dust prone and outdoor area	: 0.6

5.31.05 Necessary Lighting distribution boards and further distribution FGD area shall be carried out by the Bidder. Power distribution from the Lighting Transformers would be through 415V, 3 phase, 4 wire MLDB. Each MLDB shall have two Incomer and one bus coupler. Each bus section shall be fed from suitably rated, 415 V/433 V Lighting Transformer, which shall be fed from respective 415 V Switchgear.

5.34.06 The lighting system would be designed to ensure uniform illumination. The lighting fixtures shall be designed for minimum glare. The design shall prevent glare/luminous patch seen on VDU/ Large video screens, when viewed from an angle.

5.34.07 All outdoor fixtures shall be weather proof. Lighting pole shall be considered for Road Lighting and Lighting Mast shall be used for General Area Lighting. Minimum 4 Nos. lighting mast shall be considered. All Outdoor lighting shall be automatically controlled by synchronous timer and / or photocell. Provision to bypass the timer and / or photocell shall be provided in the panel.

5.34.08 At least one 5/15A, 230V AC universal socket outlet with switch shall be provided in each office, cabins, etc. 20A, 230V AC industrial receptacle with switch shall be provided strategically in all industrial area.

5.35.00 Welding Sockets

Suitable number of 63A, 3ph., 4 wire, 5 pin, 415V AC industrial receptacles shall be provided for entire plant for welding purposes, particularly near all major equipment and at an average distance of 50m

63A welding sockets shall be fed from 415V FGD PMCC.

5.36.00 Degree of Protection for Enclosures of Electrical Equipment

5.36.01 Degree of protection for various enclosures as per IS: 13947 shall be as follows:-

Description of Equipment	Degree of Protection
LV Switchgear/MCC/DBs/Fuse Boards	
Compartments and bus bar chambers up to 1600A	IP52
Compartments and bus bar chambers above 1600A	IP42
Switchgear located outdoor	IP55
Motors	
Indoor motors	IP55
Outdoor motors	IP55 with external FRP canopy
Actuator	IPW-67
Push button stations and any other kiosk/box/panel/ enclosure	
Indoor	IP42 for Control & Relay panels located in air-conditioned areas
Outdoor	IP55
In dusty areas, e.g. conveyor galleries, transfer points, bunker floor, lignite feeder, ESP area, Mill area etc	IP65
Junction boxes for cables/wires	IP55

6.00.00 LAYOUT CRITERIA

6.01.00 Criteria of Oil Pit for Transformer

6.01.01 Oil Pit under Transformer and its Cooler Bank:

Gravel filled open oil pit shall be provided under each transformer and its cooler bank or reactor. The pit shall be such that it can take oil/water surge of 1/3 of the volume of the transformer oil when filled with gravel of size 38mm. Level of pit shall be such that there shall not be accumulation of oil/water in the pit. Each

pit shall be connected to the drain line of at least 2 nos. 150mm diameter stoneware pipe with a minimum slope of 1: 96 leading to common oil pit.

6.01.02 **Unitized Common Oil Pit**

Unitized common oil pit for the auxiliary transformers if required as per CBIP guideline shall be provided.

6.02.00 **Equipment Layout**

6.02.01 For finalizing room size, following points shall be considered: -

1. Minimum clearance between HV/MV switchgear and LV switchgear shall be maintained as 2500mm.
2. Minimum clearance between any obstruction like column, wall, and vertical raceway, etc. and rear of LV switchboard shall be maintained as 1000mm respectively.
3. Minimum clearance between two LV switchgear facing each other shall be maintained as 2000mm.
4. Minimum rear to rear clearance of LV switchgear shall be maintained as 1000mm respectively.
5. Minimum rear to front clearance for PCC to PCC shall be maintained as 2000mm.
6. Clearance between the bottom of ventilation duct and top of electrical panel shall be as per statutory requirement
7. Minimum clearance between two non drawout panels facing each other shall be maintained as 1500mm.
8. Minimum clearance between wall and end of switchgear shall be maintained as 1000mm.
9. Minimum clearance between the sides of two switchgears shall be 1000 mm.
10. Minimum clearance between LV switchgear to dry type transformer shall be kept as 2000mm.
11. Access to rooms, doors, etc. to be provided in various floors shall consider movement of the panels during erection and later during maintenance.
12. Switchgear room/MCC room and cable vault shall be pressurized above the atmospheric pressure to prevent ingress of dust.
13. Control room, switchgear room shall be provided with separate entry and exit door. Rating of fire proof door to be provided in cable vault shall be 2 hours.

14. Walkways shall be provided for accessing the cable laid on cable trays in all pipe racks & cable racks.
15. Cable vault floors shall have all openings properly ridged to prevent water drainage into the room below. In addition proper facilities shall be provided at cable vault floor to drain the water in case of operation of sprinkler system.
16. Air-conditioned rooms shall be provided with double door.
17. During design stage adequate space shall be provided for expansion of board on either side to accommodate addition of panel to take care of unforeseen factors.
18. All busducts shall enter the 415V PMCC from top.
19. Minimum clearance between two HV / MV switchgear facing each other shall be maintained as 3500mm.
20. Bottom to roof beam in HT/ LT switchgear room from finished floor level shall be 4.5 metres when the room has busducts and shall be 4.0 metres without busduct.

6.03.00 Cable Termination of L.T. Motors

For L.T. Motors one weatherproof Junction Box (JB) with copper cable connection from JB to L.T. Motors shall be provided when motor terminal box is not adequate for terminating the aluminium power cable. For motors less than 50KW, flexible bimetallic connectors shall be used.

7.00.00 SYSTEM STUDY

On the basis of the transformer capacity and impedance chosen voltage regulation and short circuit levels are to be calculated to determine the followings.

- Voltage dip on starting auxiliary system
- Breaking current capability.
- Maximum momentary current.

Bidder to determine voltage regulation and short circuit levels to ensure that these are within permissible value shall do system study. Various conditions to be considered in Study are as follows.

- 7.01.00** For fault on 11KV & 3.3KV switchgear bus at 110% voltage, the total of system contribution and motor contribution shall be limited to ensure that the worst-case fault current can be handled by the designed interrupting rating of the switchgear breaking current of 40KA rms and momentary current of 100KA peak.



7.02.00 ETAP study details along with the ETAP OTI files are to be furnished to verify the system study by the customer.

8.00.00 TESTING AND ERECTION EQUIPMENT

8.01.01 The major testing equipment that are required to be arranged by the bidder are listed below:

- a) Insulation Tester
 - i) Power operated Megger - 1 KV and 5 KV Grade.
 - ii) Hand operated Megger -1 KV and 500 Volt Grade
- b) Hand driven Earth Resistance Megger, range 0 - 1/3/30 Ohms
- c) High Potential Testing Set - roller mounted type for EHV equipment
- d) Tong testers of suitable ranges
- e) Contact resistance measuring set for Micro-ohms
- f) Torque wrench of various sizes
- g) Multi-meters, test lamp, field telephone with buzzer set, different gauges, etc.
- h) Insulating oil-testing set of range 0 - 60 KV
- i) Stream line oil filter for transformer
- j) Vacuum pump of sufficient capacity for transformer

8.01.02 Other test and erection equipment, as required, shall be arranged by the Bidder.

9.00.00 GENERAL REQUIREMENTS

9.01.00 Drawing Approval

9.01.01 Before starting manufacture of any equipment, the Bidder shall have to take approval of relevant drawings and data from the Purchaser in writing.

9.01.02 Any manufacture done prior to the approval of drawings/data shall be rectified in accordance with the approved drawings/data by the Bidder at his own cost and the equipment shall be supplied within the stipulated period.

10.00.00 TYPE AND RATING OF EQUIPMENT

10.01.00 The number of types and sizes of motor, controls, and other electrical equipment shall be kept to a minimum so that the requirement of spares is minimized.



11.00.00 TROPICAL PROTECTION

11.01.00 All electrical equipment, accessories and wiring shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion.

11.02.00 Fine mesh screen of corrosion resistant material shall be furnished on all ventilating openings to prevent entry of insects.

12.00.00 TESTS

12.01.00 Type Test

All equipment / cables shall be of proven design and type tested as per relevant standards. Type test certificates / specific type tests shall be furnished / conducted, if asked for with reference to any specific equipment in the respective sub-section of the specification. In case of submission of type test if the bidder is not able to submit report of the type test(s) conducted or in the case of type test report(s) are not found to be meeting the specification requirements, the bidder shall conduct all such tests without cost implication in the presence of the purchaser and submit the reports for approval.

12.02.00 Routine Tests

All routine and acceptance tests shall be conducted as per relevant standards in the presence of the purchaser or his representative.

13.00.00 SPECIFIC REQUIREMENT - SERVICES & INSTALLATION

13.01.00 Methods and Workmanship

13.01.01 All equipment shall be installed in a first class, neat workmanlike manner by mechanics/electricians skilled in the trade involved.

13.01.02 The erection work shall be supervised by competent supervisors holding relevant supervisory license from the Government.

13.01.03 All details on installation shall be electrically and mechanically correct.

13.01.04 The installation shall be carried out in such a manner as to preserve access to other equipment installed.

13.02.00 Protection of Work

13.02.01 For protection of this work, the Bidder shall provide fencing and lighting arrangement, connect space heaters and provide heating arrangement as necessary or as directed by the Owner/Consultant.

14.00.00 DRAWINGS, DATA, INFORMATION AND MANUALS





14.01.00 Drawings, Data and Manuals shall be submitted with the bid and for approval/ reference and subsequent distribution after the issue of Letter of Intent in quantities and procedures as specified in General condition of contract and/or elsewhere in this specification.

14.02.00 **To be submitted with the Bid**

- Single line diagrams.
- Filled-up proposal particulars.
- Equipment layouts & layout of transformer yard.
- Dimensional general arrangement drawing along with cross- sections for major equipment.
- Tentative Bill of materials
- Control & operation write up/Block logic diagrams.
- Any other drawings & data as required.
- Vendor List for owner's approval

14.03.00 **To be submitted for Owner / Purchaser's Approval and Distribution after award of the Contract**

(A): 'Approval Category'
(I): 'Information Category'

- Single line diagram giving rating of each equipment (A)
- Design calculations in support of selection of equipment rating and system design. (A)
- Technical Data sheets, characteristic curves. (A)
- Quality Assurance Plan (QAP) of each Equipment & System (A)
- Equipment layouts: Plan & Section. (A)
- Grounding & lightning protection drawings and details. (A)
- Cabling, cable trench and tray layouts with section and details. (A)
- Dimensional general arrangement drawing along with cross- sections for equipment. (A)
- Foundation plan and loading data : design calculation and detail drawing of foundation. (I)
- Design calculation and detail drawing for civil work related to this specification. (A)
- Design calculation, GA drawing for GI structure and equipment supporting structure and subsequently detailed drawings. (A)
- Mounting details of equipment and structure. I
- Control & operation write up/Block logic diagrams. (A)
- I/O List. (A)
- Control schematic and wiring diagram. (I)
- Cable schedule and interconnection. (I)
- Relay co-ordination. (A)
- Routine, Type & Special Test Certificates (A)
- Civil & structural analysis (A), design calculations (A) and working drawings including bar bending schedule I and fabrication. (I)
- Erection and maintenance manual. (I)
- Dossier of plant complete electrical system. (I)
- Any other drawings & data as required for satisfactory installation, operation & maintenance.





- 14.04.00 Equipment & system wise drawings & documents to be submitted by the Bidder after award of contract is indicated in the respective sections of the specification. Division of categories ("For Approval" (A) and "For Reference" (I)).of those drawings shall be in line with the above.
- 14.05.00 The Bidder may note that the drawings, data and manuals listed herein are minimum requirements only. The Bidder shall ensure that all other necessary write-ups, curves and information required to fully describe the equipments & systems are submitted with his bid.
- 14.06.00 Drawings and document marked with (A) above are of 'Approval' category and are subject to review by Owner / Purchaser. Those marked (I) are for 'reference' category.
- The Owner / Purchaser may also review the documents marked (I) if found necessary. The Bidder shall note that the approval of drawings & documents by the Owner / Purchaser does not relieve him of his contractual obligation.
- 14.07.00 The Bidder shall furnish the list of deliverables with "For Approval" (A) / "For Reference" (I) marking under Category column at the beginning of the project for reference.
- 14.08.00 All drawings shall be prepared by using Auto CAD, approved version and documents shall be generated using MS Office. The paper copy of the drawings & document shall be submitted for approval & reference. All final drawings and documents shall be submitted in CD in Auto CAD (approved version) and MS Office format as applicable for Owner / Purchaser's future reference.
- 14.09.00 All the electrical drawings shall be prepared on Auto-cad latest version or any equivalent software package, and editable soft copies of all Drawings / documents shall be submitted.
- 15.00.00 CO-ORDINATION WITH STATUTORY BODIES & OUTSIDE AGENCIES**
- 15.01.00 The Bidder shall be fully responsible for carrying out all co- ordination and liaison work with Electrical Inspectors, Factory Inspector, and other statutory bodies for implementation of the work.
- 15.02.00 Applications on behalf of the Purchaser, for submission to the Electrical Inspector and other statutory bodies along with necessary drawings complete in all respects shall be prepared by the Bidder. Approved drawings and certificates shall be submitted to the Purchaser/Consultant well ahead of schedule so that the actual commissioning of equipment does not get delayed for want of inspection and approval by the Inspector and other statutory bodies. The actual inspection work by the Electrical Inspector shall be arranged by the Bidder and necessary coordination and liaison work in this regard shall be the responsibility of the Bidder.



16.00.00

SAFETY

15.01.00

All equipment shall be complete with approved safety devices and with provision for safe access of personnel to and around the equipment for operation and maintenance. The design of plant & machinery shall include not only those usually furnished components but also the additional covers, stairways, ladders, steel structural platforms for operators control panels, handrails, partitions etc. which are necessary for safe operation of the plant.

16.02.00

The Bidder must take sufficient care in moving his construction plants and equipment from one place to another so that those may not cause any damage to the Property of the Purchaser/other Bidders particularly to the overhead and underground cables and other service lines.

16.03.00

When the work is carried out at night or in the obscure day light, adequate flood lighting in the working area shall be made by Bidder at his own cost and got approved by the Purchaser.

16.04.00

The safety posters/regulation for prevention of accidents shall be displayed by the Bidder at appropriate places. Notices and warning signs shall be displayed for all sources of dangers.

16.05.00

All electrical drives and equipment must be equipped with safety devices. The safety provisions shall conform to the recognized standards, safety codes and statutory regulations.

16.06.00

All safety measures as required to be adopted as per the statutory regulations and the safety rules of the plant shall be strictly followed by the Bidder during the execution of the Contract.

16.07.00

Danger boards shall be provided in line with the statutory requirements.

16.08.00

Rubber mats shall be provided to meet the safety and other statutory requirements.

16.09.00

Adequate number of first aid boxes as defined in the State Factory Rules shall be provided and maintained at all work sites.

17.00.00

SPARES PHILOSOPHY

17.01.00

LV switch board, PMCCs, MCCs, PDBs and MLDBs shall be provided with 20% spare feeders or one no. of each type and rating whichever is higher shall be provided at the time of handing over the plant (irrespective of the spares finalized during detailed engineering).

17.02.00

DCDBs shall be provided with 20% of spare feeders shall be provided at the time of handing over the plant (irrespective of the spares finalized during detailed engineering).

17.03.00

20% spare terminals shall be provided in each module of PCC, PMCC, MCC and each ACB panel.



- 17.04.00 2 Nos. of interposing (24V) plug in type relays fully wired up to the terminal blocks shall be provided in all the incomer/bus coupler feeders of PCC/PMCC/MCC.
- 17.05.00 For HV and MV switchgears. In each switchgear sections
- a) 1 no highest rated motor feeder
 - b) 1 no lowest rated motor feeder
 - c) 1 no highest rated transformer feeder
- 18.00.00 CONSTRUCTION POWER**
- 18.01.00 Two No. 630A feeders at one location common for 2 units shall be provided in the purchaser's board. Further distribution to various loads of the bidder shall be in the scope of the Bidder. Bidder shall arrange necessary DBs, capacitor banks along with APFCR, armoured cables etc. for the distribution to various loads.
- 18.02.00 Bidder shall supply and install electrical equipment as per regulations of the local electrical inspectorate / statutory body for electrical installation. Bidder shall be responsible for getting all the necessary clearances from electrical inspector.
- 18.03.00 On award of contract, the BIDDER shall furnish the electrical scheme for construction power supply for PURCHASER's review/ approval. The Bidder shall indicate 6 monthly maximum demand requirements with in the allotted maximum demand.
- 18.04.00 Operation and maintenance of all construction power supply equipment is in the scope of Bidder.
- 18.05.00 Capacitor banks shall be installed at each LT distribution board and at the load points for P.F. improvement to 0.95.
- 18.06.00 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.
- 18.07.00 Detailing of LT (3 phase, 4 wire) switchgear, protection of transformers etc. are included in the scope of Bidder. Power distribution to loads shall be carried out by suitably rated cables buried under ground by the bidder. All CTs, PTs, necessary meters etc. for protection and metering are included in the scope.
- 18.08.00 Earthing and Lightning protection system shall be provided as per IS and CBIP requirement.
- 18.09.00 Sufficient temporary lighting in all areas shall be provided to facilitate construction activities round the clock.



18.10.00 Operation and maintenance of the construction power supply during the entire period of construction is included in the scope of Bidder



ANNEXURE – A

LIST OF STANDARDS

A. IS Standards

IS-5	Colors for ready mixed paints and enamels
IS-191	Specification for Copper
IS-325	Three Phase Induction Motor
IS-398	Aluminium conductor for overhead transmission line
IS-617	Aluminium and Aluminium Alloy ingots and castings for general; engineering purposes
IS-694	PVC insulated cables for working voltage upto & including 1100 V
IS-800	Code of practice for general construction
IS-996	Single phase AC and universal motor
IS-1248	Direct acting indicating analogue electrical measuring instruments and their accessories
IS-1554	PVC insulated (heavy duty) electric cables
IS-1818	AC Isolators
IS-1913	General & safety requirements for luminaries
IS-2026	Power Transformers
IS-2062	Structural steel
IS-2099	Bushing for alternating voltages above 1000 V
IS-2148	Flame proof enclosure for electrical apparatus
IS-2309	Practice for protection of building and allied structures against Lightning
IS-2486	Metal fitting of insulators for overhead power lines with a normal voltage greater than 1000 V
IS-2544	Porcelain post insulators for system with a normal voltage greater than 1000 V
IS-2629	Recommended practice for hot-dip galvanizing on iron and steel
IS-2705	Current Transformer
IS-2713	Tubular steel pole for overhead power lines
IS-3043	Code of practice for earthing
IS-3156	Voltage Transformer
IS-3188	Characteristics of string insulator units
IS-3231	Electrical relay for power system protection
IS-3347	Dimension for porcelain transformer bushings for use in lightly polluted atmosphere
IS-3427	AC metal enclosed switchgear and control gear for rated voltage above 1000 V and upto and including 52 KV (same as IEC 60298)
IS-3480	Flexible steel conductors for electrical wiring
IS-3975	Low carbon galvanized steel wires formed wires and taps for armoring of cables
IS-4160	Interlocking switch socket outlet
IS-4759	Hot-dip zinc coatings on structural steel and other allied products
IS-4794	Push button switches
IS-5082	Wrought Aluminium and Aluminium Alloy bar rods, tubes & sections for electrical purpose
IS-5561	Electric power connectors
IS-5578	Guide for marking and insulated conductors
IS-5831	PVC insulation and sheath of electric cables
IS-7098	Cross linked polyethylene insulated PVC sheathed cables

IS-8084	Interconnecting busbar for AC voltage above 1000 V and upto and including 52 KV
IS-8130	Conductors for insulated electric cables and flexible cords
IS-8263	Methods for radio interference test on high voltage insulators
IS-8603	Dimensions for porcelain transformer bushing for use in heavily polluted atmosphere
IS-8623	LV switchgear and control gear assemblies (same as IEC Pub 60439)
IS-8828	Circuit breaker for over current protection for household and similar installation (same as IEC Pub 60898)
IS-9046	AC contactors for voltage above 1000 V and upto and including 11KV
IS-9334	Electric motor operated actuator
IS-9385	High Voltage fuses
IS-9537	Conduit for electrical installation
IS-9921	Specification for Alternating Current Disconnectors (Isolators) and Earthing switch for voltage above 1000 V
IS-9968	Elastomer Insulated Cables
IS-10118	Code of practice for selection, installation and maintenance of switchgear and control gear
IS-10322	Luminaries
IS-11171	Dry type power transformer
IS-11353	Guide for uniform system of marking and identification of conductors and apparatus terminals
IS-11955	Preferred current ratings
IS-12021	Control Transformers for switchgear and control gear for voltage not exceeding 1000 V
IS-12063	Classification of degree of protection provided by enclosures of electrical equipment
IS-12615	Energy efficient 3 phase squirrel cage induction motor
IS-12729	Common specification for HV switchgear and control gear standards
IS-13010	AC Watt-hour meters Class 0.5, 1 and 2 - specification
IS-13118	HV alternating current Circuit breaker (same as IEC Pub 60056)
IS-13516	Method of synthetic testing of HV AC Circuit breaker (same as IEC Pub 60427)
IS-13703	Low voltage fuse for voltage not exceeding 1000 V AC or 1500 V DC (same as IEC Pub 60269)
IS-13925	Shunt capacitor for AC Power systems having a rated voltage above 1000 V
IS-13947	Low voltage switchgear and control gear (same as IEC Pub 60947)
IS-15086	Surge Arrester

B. IEC Standards

IEC-60034	Rotating electrical machine
IEC-60056	Contact assignment for Circuit breaker rated voltage lower than 52 KV
IEC-60060	HV test technique
IEC-60068	Environmental testing
IEC-6001-2	Insulation coordination
IEC-60076	Power Transformer
IEC-60099	Surge Arrester
IEC-60168	Test on indoor and outdoor post insulator or ceramic material or glass for systems
IEC-60185	Protective CT for transient performance

IEC-60189	Low frequency cables wires with PVC insulation and PVC sheath
IEC-60214	Tap changer
IEC-60233	Test on indoor and outdoor post insulator or ceramic material or glass for systems with nominal voltage greater than 1000 V
IEC-60255	Electric Relay
IEC-60269	Low voltage fuses
IEC-60273	Test on indoor and outdoor post insulator or ceramic material or glass for systems with nominal voltage greater than 1000 V
IEC-60298	AC metal enclosed switchgear and control gear
IEC-60332	Test on electric and optical fiber cables under fire condition
IEC-60376	Specification and acceptance of new SF ₆
IEC-60383	Insulator for overhead for nominal voltage greater than 1000 V
IEC-60437	Radio interference test on HV insulator
IEC-60598	Luminaries
IEC-60754	Test on gases evolved during combustion of electric cable
IEC-60870	Telecontrol equipment & system
IEC-60947	LV switchgear and control gear
IEC-61000	Electromagnetic compatibility
IEC-62271	High Voltage AC Circuit breaker

C. IEEE Standards

IEEE 32	Neutral grounding devices, standard requirements, terminology and test procedure
IEEE C37.23-1987	Metal enclosed bus and calculating loss in Isolated phase busduct (ANSI C.57-12.01)
IEEE-80	AC substation Grounding
IEEE-383	Type test of class 1E Electric cables, Field plices and connections for Nuclear Power Generating Station
IEEE-1115	Sizing Nickel-Cadmium Batteries for stationary Batteries

D. ANSI Standards

ANSI C.37 20 to 20C	Switchgear
ANSI C.57- 12.01	Distribution, Power and Regulating Transformer, General requirement for liquid immersed

E. CBIP Publications

CBIP - 295	Transformer

F. NFPA Code

NFPA-211	Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances
NFPA-850	Electric Generating Plants



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-F/SECTION-II

A.C. & D.C. MOTORS



Development Consultants Pvt. Ltd.

**Vol. II-F/Section-II
A.C. & D.C. Motors**



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VOLUME: II-F

A.C. & D.C. MOTORS

1.00.00SCOPE

- 1.01.0 This specification covers the general requirements of the electric motors for Limestone based flue gas de-sulphurisation system.
- 1.02.00Motors shall be furnished in accordance with both this general specification and the accompanying driven equipment specification.
- 1.03.00 In case of any discrepancy, the driven equipment specification shall govern.
- 1.04.00 Recommended spare parts for three (3) years operation in addition to mandatory spares

2.00.00CODES & STANDARDS

- 2.01.00All motors shall conform to the latest applicable IS, IEC and CBIP Standards/Publications except when otherwise stated herein or in the driven equipment specification.
- 2.02.00 Equipment and materials conforming to any other standard, which ensures equal or better quality may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

3.00.00SERVICE CONDITIONS

- 3.01.00The motors shall be installed in hot, humid and tropical atmosphere, highly polluted area.
- 3.02.00 Unless otherwise noted, electrical equipment/system design shall be based on the service conditions and auxiliary power supply given in the annexure to this specification.
- 3.03.00 For motor installed outdoor and exposed to direct sunrays, the effect of solar heat shall be considered in the determination of the design ambient temperature.

4.00.00 TYPE AND RATING

4.01.00A.C. Motors

- 4.01.01 Motors shall be general purpose, constant speed, squirrel cage, three/single phase, induction type.
- 4.01.02All motors shall be either totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or closed air circuit air cooled (CACA) or closed air water





cooled (CACW) type. Temperature rise shall be limited to 70 deg C by resistance method for class F insulation.

4.01.03 All motors shall be rated for continuous duty (S1). They shall also be suitable for long period of inactivity.

4.01.04 All LT motor shall conform to minimum efficiency performance standards (MEPS) of IE3 mentioned in IS: 12615. All HT motors shall have efficiency and power factor higher than 90% and 0.83 power factor respectively.

4.01.05 The motor name plate rating at 50°C shall have at least 15% margin for LT system and 10% margin for HT system, over the input power requirement of the driven equipment at rated duty point and also covering the maximum load demand of the driven equipment under entire operating range, including voltage and frequency variations, unless stated otherwise in driven equipment specification or in general electrical specification.

4.01.06 The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating, pull up, break down and full load torques are available for the intended service. The direction of rotation of motor and its cooling fan should be properly matched with the driven equipment.

4.02.00 AC motor for VFD application

4.02.01 Inverter duty motors are designed according to the requirements of IEC/TS- 60034 part 17 & part 25 or NEMA MG-1, Part-30, Part 31 and have performance characteristics match with the driven equipment and variable speed requirement.

4.02.02 Induction motors to be operated in adjustable-speed drive applications should be de-rated as per NEMA/IEC standard due to the reduction in cooling resulting from any reduction in operating speed and the effect of additional losses introduced by harmonics generated by the control.

4.02.03 Inverter duty motors shall have VPI/improved insulation systems that do not degrade readily due to transient voltage spikes and have an adequate thermal margin.

4.02.04 Inverter duty motors shall be self-ventilated without any auxiliary blower. Force ventilation shall be subject to purchaser approval.

4.02.05 Inverter motor shall be suitable for scalar (open loop) control, without any speed feedback signal, where fast response is not required. Vector (closed loop) control will be used with encoder if specified.

4.02.06 The breakdown torque at any frequency within the defined frequency range shall be not less than 150% of the rated torque at that frequency when rated voltage for that frequency is applied.

4.02.07 The motor should be capable of producing a breakaway torque of at least 140% of rated torque requiring not more than 150% rated current when the voltage





boost is adjusted to develop rated flux in the motor and when the inverter is able to produce the required minimum fundamental frequencies.

4.02.08 The motor shall be provided with insulated bearing on one side.

4.02.09 Normally the maximum safe speed shall be as per IEC/NEMA, however it should be co-ordinated with VSD requirement.

4.02.10 In case of a conflict, the requirement mentioned under clause no. 4.02.00 for motors for VFD application shall supersede the corresponding requirement for standard motors.

4.03.00 D.C. Motors (If applicable)

4.03.01 D.C. motor provided for emergency service shall be shunt wound type. It can also be of compound-wound type with the series field shorted.

4.03.02 Motor shall be sized for operation with fixed resistance starter for maximum reliability. Starter panel complete with all accessories shall be included in the scope of supply.

5.00.00 PERFORMANCE

5.01.00 Running Requirements

5.01.01 Motor shall run continuously at rated output over the entire range of voltage and frequency variations as given in the annexure.

5.01.02 The motor shall be capable of operating satisfactorily at full load for 5 minutes without injurious heating with 75% rated voltage at motor terminals. The mill motors shall be suitable for operating at 75% of rated voltage for one (1) minute

5.02.00 Starting Requirements

5.02.01 Motor shall be designed for direct on line starting at full voltage. Starting current shall not exceed 600% of full load current (subject to IS tolerance of 20%) for HT motors rated upto 1000kW. For HT motors above 1000kW upto 3000kW starting current shall not exceed 600% of full load current without any positive tolerance. For HT motors above 3000kW starting current shall not exceed 450% of full load current without any positive tolerance.

For LT motors the starting current shall be as per the limit mentioned in the relevant standard with IE-3 efficiency class. For D.C. Motors the starting current shall be limited to 2 times full load current.

5.02.02 The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.

5.02.03 All motors (except mill motors) shall start with rated load and accelerate to full speed with 80% rated voltage at motor terminals. Mill motors shall start with rated load and accelerate to full speed with 85% of rated voltage.





5.02.04 Motor shall be capable of three equally spread starts per hour, two starts in quick succession from cold condition and one restart from hot condition.

Cold Motor Starting

Under specified voltage variations two (2) starts in quick succession and third start five (5) minutes thereafter, all with full load (including loaded equipment) of driven equipment. No additional start shall be made till lapse of further thirty (30) minutes.

(b) Hot Motor Starting

Under specified voltage variations, one (1) immediate and two (2) fifteen (15) minutes interval starts all with full load (including loaded equipment) of driven equipment. No additional start shall be made till lapse of further thirty (30) minutes.

(c) Motor shall also be suitable for three (3) equally spread starts per hour when the motor is under normal service condition.

5.02.05 Pump motor subject to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% rated speed in reverse direction.

5.03.00 Stress During Bus Transfer

5.03.01 Motors subjected to bus transfer shall be suitable for sudden application of 150% rated voltage during bus transfer, due to the phase difference between the incoming voltage and motor residual voltage.

5.03.02 The motor shall be designed to withstand any torsional and/or high current stresses, which may result, without experiencing any deterioration in the normal life and performance characteristics.

5.04.00 Locked Rotor Withstand Time

5.04.01 For motors with starting time up to 20 secs, starting time at minimum permissible voltage should be less than the locked rotor withstand time under hot condition at highest voltage limit by at least 2.5 secs.

For motors with starting time more than 20 secs. and upto 45 secs, starting time at minimum permissible voltage should be less than the locked rotor withstand time under hot condition at highest voltage limit by at least 5 secs.

For motors with starting time more than 45 secs, starting time at minimum permissible voltage should be less than the locked rotor withstand time under hot condition at highest voltage limit by at least 10% of the starting time.

5.04.02 To prevent unwanted tripping of a high inertia load at start-up, there may be need to shunt out the motor's overload trip device. Speed switches mounted



on the motor shaft may be provided in such case. Heating experienced during start-up must still be considered when sizing the motor.

5.04.03 Hot thermal withstand curve shall have a margin of at least 10% over the full load current of the motor to permit relay setting utilising motor rated capacity.

5.05.00 Torque Requirements

5.05.01 Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.

5.05.02 Pull out torque at rated voltage shall not be less than 205% of full load torque.

6.00.00 SPECIFIC REQUIREMENTS

6.01.00 Enclosure

6.01.01 All motor enclosures and terminal boxes 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.

Motors, located inside a building and not directly exposed to coal dust or fly ash, could have screen protected drip proof enclosure conforming to IP-23.

6.01.02 Motor located in hazardous area shall have flameproof enclosure conforming to IS: 2148 /Equiv.

6.03.00 Cooling

6.03.01 The motor shall be self ventilated type, either totally enclosed fan cooled (TEFC) or closed air circuit air- cooled (CACA).

6.03.02 For large capacity motors, totally enclosed tube ventilated (TETV) may be considered for acceptance. In case of motors rated 3000kW and above, closed air circuit water cooled (CACW) motors may be offered for consideration before proceeding with design and manufacturing.

6.04.00 Winding and Insulation

6.04.01 All insulated winding shall be of copper.

6.04.02 HT and LT motors shall have Class F insulation with winding temperature limited to 120°C. Windings shall be impregnated to make them non-hygroscopic and oil resistant. The lightning impulse and coil inter-turn insulation surge withstand level shall be as per IEC-60034 – Part 15.

6.05.00 Tropical Protection

6.05.01 All motors shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion.





6.05.02 All fittings and hardwares shall be corrosion resistant.

6.06.00 Bearings

6.06.01 Motor rated above 1000kW shall have insulated bearings to prevent flow of shaft currents.

6.06.02 Vertical shaft motors shall be provided with thrust and guide bearings.

6.07.00 Noise & Vibration

6.07.01 The noise level shall not exceed 85 db (A) at 1.0 meters from the motor.

6.07.02 Peak amplitude of vibration shall be limited within the values prescribed in IS: 12075 / IEC 60034-14.

6.08.00 Motor Terminal Box

6.08.01 Motor terminal box shall be detachable type, made of cast iron or pressed steel and located in accordance with Indian Standards clearing the motor base-plate / foundation.

6.08.02 Terminal box shall be capable of being turned 360 Deg. in steps of 90 Deg., unless otherwise approved.

6.08.03 The terminal box shall be split type with removable cover with access to connections and shall have the same degree of protection as motor. Terminal box for all LT motors shall be diagonally split type.

6.08.04 The terminal box shall have sufficient space inside for termination / connection of XLPE (11000V/3300V) or XLPE (415V) insulated armoured aluminium cables. Where the specified main cable size demands, adopter / extension box of suitable size shall be provided as a part integral to the motor, for easy termination of the cable.

6.08.05 Terminals shall be stud or lead wire type, substantially constructed and thoroughly insulated from the frame.

6.08.06 The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.

6.08.07 The terminal box shall be capable of withstanding maximum system fault current for a duration of 0.25 sec.

6.08.08 For 11000V and 3300V motor, the terminal box shall be phase-segregated type. The neutral leads shall be brought out in a separate terminal box (not necessarily phase segregated type) with shorting links for star connection.

6.08.09 Motor terminal box shall be furnished with suitable cable lugs and double compression brass glands to match with cable used.





6.08.10 The gland plate for single core cable shall be non-magnetic type.

6.08.11 Motors rated 1000kW and above shall be provided with neutral current transformers of PS class on each phase in a separate neutral terminal box for differential protection.

6.09.00 Grounding

6.09.01 The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer.

6.09.02 The grounding connection shall be suitable for accommodation of ground conductors as follows:

Motor above 90KW	:	50 x 6 mm GS Flat
Motor above 30KW up to 90KW	:	25 x 6 mm GS Flat
Motor above 5KW up to 30KW	:	25 x 3 mm GS Flat
Motor up to 5KW	:	8 SWG GI Wire

6.09.03 The cable terminal box shall have a separate grounding pad.

6.10.00 Rating Plate

In addition to the minimum information required by IS, the following information shall be shown on motor rating plate:

- Temperature rise in Deg.C under rated condition and method of measurement.
- Degree of protection (IP No.).
- Bearing identification no. and recommended lubricant.
- Location of insulated bearings.

7.00.00 ACCESSORIES

7.01.00 General

Accessories shall be furnished, as listed below, or if otherwise required by driven equipment specification or application.

7.02.00 Space Heater

7.02.01 Motor of rating 30KW and above shall be provided with space heaters, suitably located for easy removal or replacement.





7.02.02 The space heater shall be rated 240V, 1 phase 50Hz and sized to maintain the motor internal temperature above dew point when the motor is idle.

7.03.00 Temperature Detectors

7.03.01 All 11000V and 3300V motors shall be provided with minimum four (4) numbers simplex or two (2) numbers duplex platinum resistance type winding temperature detectors per phase.

7.03.02 11000V and 3300V motor bearing shall be provided with one (1) duplex or two (2) simplex type temperature detectors.

7.03.03 The temperature detector mentioned above shall be resistance type, 3 wire, platinum wound, 100 Ohms at 0 deg.C.

Leads of all duplex or 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 shall be connected to numerical protection relay and another set shall be kept free for DDCMIS connectivity.

7.04.00 Indicator/Switch

7.04.01 Dial type local indicator with alarm contacts shall be provided for the following:

- a) 11000V and 3300V motor bearing temperature.
- b) Hot and cold air temperature of the closed air circuit for CACA and CACW motor.

7.04.02 Flow switches shall be provided for monitoring cooling water flow of CACW motor and oil flow of forced lubrication bearing, if used.

7.04.03 Alarm switch contact rating shall be minimum 0.5A at 220V D.C. and 5A at 240V A.C.

7.05.00 Current Transformer for Differential Protection

7.05.01 Motor above and including 1000KW shall be provided with three differential current transformers (PS class) mounted over the neutral leads within the enclosure. Loose three (3) numbers matching PS class CT shall be supplied for mounting on switchgear.

7.05.02 The arrangement shall be such as to permit easy access for C.T. testing and replacement. Current transformer characteristics shall match with the requirements of differential protection relay.

7.06.00 Accessory Terminal Box

7.06.01 All accessory equipment such as space heater, temperature detector, current transformers etc., shall be wired to and terminated in terminal boxes, separate from and independent of motor (power) terminal box.





7.06.02 Accessory terminal box shall be complete with double compression brass glands and pressure type terminals to suit required cable connections.

7.07.00 **Drain Plug**

Motor shall have drain plugs so located that they shall drain the water, resulting from the condensation or other causes from all pockets of the motor casing.

7.08.00 **Lifting Provisions**

Motor weighing 25 Kg. or more shall be provided with eyebolt or other adequate provision of lifting.

7.09.00 **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.

7.10.00 **Painting**

Motor including fan shall be painted with corrosion proof paints.

8.00.00 TESTS

8.01.00 Upon completion, each motor shall be subject to standard routine tests as per IS. In addition, any special test called for in the driven equipment specification shall be performed.

8.02.00 Unless and otherwise stated, Six (6) copies of routine test certificates shall be submitted for approval prior to the dispatch of the motors from works.

8.03.00 The following type test reports shall be submitted for each type and rating of 11 kV & 3.3 kV motor:

- a) Degree of protection test for the enclosure followed by IR, HV and no load run test.
- b) Fault level withstand test for each type of terminal box.
- c) Lightning impulse withstand test on the sample coil as per IEC 60034, part-15.
- d) Surge withstand test on inter-turn insulation as per clause no. 5.1.2 of IEC 60034, part-15.

SPARES

Recommended spares for three (3) years operation shall be quoted along with the bid clearly identifying the part numbers with recommended quantities.





09.00.00 DRAWINGS, DATA & MANUALS

Drawings, data & manuals for the motors shall be submitted as indicated below:

09.01.00 Along with the bid

- a) List of the motors
- b) Individual motor data sheet as per format of the proposal data sheets.
- c) Scheme & write up on forced lubrication system, if any
- d) Type test report

09.02.00 After Award of the Contract

- a) Dimensional General Arrangement drawing
- b) Foundation Plan & Loading
- c) Cable end box details
- d) Space requirement for rotor removal
- e) Thermal withstand curves hot & cold
- f) Starting and speed torque characteristics at 80% & 100% voltage
- g) Complete motor data
- h) Erection & Maintenance Manual
- i) Efficiency curves.
- j) List of motors.
- k) Test reports

ANNEXURE – A

DESIGN DATA

1.0 SERVICE CONDITIONS

Refer Vol-IIA of Specification for FGD package.

2.0 AUXILIARY POWER SUPPLY

Supply	Description	Consumer
H.T. Supply	11000V, 3Ø, 3W, 50 Hz, non-effectively earthed. Fault level 40kA symm. for 3sec	Motors above 750kW
	3.3kV, 3Ø, 3W, 50 Hz, non-effectively earthed. Fault level 40kA symm for 3sec	Motors above 160kW up to & including 750kW
L.T. Supply	415V, 3Ø, 3W, 50 Hz, effectively earthed. Fault level 50kA symm for 1sec	Motors above 200W upto 160 kW
	240V, 1Ø, 2W, 50 Hz, effectively earthed.	Motors less than 200W, Lighting, space heating, A.C. control & protective devices
D.C. Supply	220V, 2W, unearthed. Fault level 25*kA for 1sec	D.C. alarm, control & protective devices

* Indicative only; actual value shall be decided by the Bidder, after substantiating the same by calculation.

3.0 RANGE OF VARIATION

A.C. Supply

Voltage: $\pm 10\%$ Frequency: $\pm 5\%$

Combined Volt & frequency: 10%(absolute sum)

D.C. Supply

Voltage: (+10% to -15%)



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-F

SECTION-III

ELECTRIC MOTOR ACTUATORS



Development Consultants Pvt. Ltd.

**Vol. II-F/Section-III
Electric Motor Actuators**



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

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VOLUME: II-F

SECTION-III

ELECTRIC MOTOR ACTUATORS

1.00.00 SCOPE

- 1.01.00 This Section covers the general requirements of Electric Motor Actuators for valves, dampers and gates.
- 1.02.00 All electric motor actuators shall be furnished in accordance with this general specification and the accompanying driven equipment specification.

2.00.00 CODES & STANDARDS

- 2.01.00 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS), IEC, ANSI & NEMA Standards except when otherwise stated herein or in the driven equipment specification.
- 2.02.00 Equipment and material conforming to any other standards, which ensure equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.
- 2.03.00 The electrical installation shall meet the requirements of Indian Electricity Rules as amended up-to-date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

3.00.00 SERVICE CONDITIONS

- 3.01.00 The actuator shall be suitable for operation in hot, humid and tropical atmosphere, highly polluted at places with dust and/or fly ash.
- 3.02.00 Unless otherwise noted, electrical equipment / system design shall be based on the service conditions and auxiliary power supply given in the annexure to this specification.

4.00.00 RATING

- 4.01.00 For isolating service, the actuator shall be rated for three successive open-close operation of the valve / damper or minimum S2-15 minutes.
- 4.02.00 For regulating service, the actuator shall be suitably time-rated for the duty cycle involved with necessary number of starts per hour, but in no case less than 150 starts per hour.



- 4.03.00 A safety factor of 300% shall be used for sizing of operators for valves and dampers and all drive system components. Operators shall be capable of transmitting design torque (including safety factor) within the torque range specified by the actuator manufacturer. The strength of the operator mounting, based on the required operator torque, shall not exceed 30% of the yield strength in any mode of stress.

5.00.00 PERFORMANCE

The actuator shall meet the following performance requirements:

- 5.01.00 Open and close the valve completely and make leak-tight valve closure without jamming.
- 5.02.00 Attain full speed operation before valve load is encountered and impart an unseating blow to start the valve in motion (hammer blow effect).
- 5.03.00 Operate the valve stem at standard stem speed and shall function against design differential pressure across the valve seat.
- 5.04.00 The motor reduction gearing shall be sufficient to lock the shaft when the motor is de-energised and prevent drift from torque switch spring pressure.
- 5.05.00 The entire mechanism shall withstand shock resulting from closing with improper setting of limit switches or from lodging of foreign matter under the valve seat.

6.00.00 SPECIFIC REQUIREMENT

6.01.00 Construction

- 6.01.01 The actuator shall essentially comprise the drive motor, torque / limit switches, gear train, clutch, hand wheel, position indicator / transmitter, in-built thermostat for over load protection, single phase preventer protection, space heater and internal wiring. Actuator shall be integral type. Two sets of torque and limit switches shall be provided to use in PLC logic and electrical logic/ interlock independently.
- 6.01.02 The actuator enclosure shall be totally enclosed IPW-67, dust tight, weather-proof suitable for outdoor use without necessity of any canopy.
- 6.01.03 All electrical equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.
- 6.01.04 The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.

6.02.00 Motor





- 6.02.01 The drive motor shall be three phase, 415V, 50Hz squirrel cage, induction machine with minimum Class F insulated with three thermoswitches embedded, one in each winding of the motor for protection against burnout and IPW-67 enclosure, designed for high torque and reversing service.
- 6.02.02 The motor shall be designed for full voltage direct on-line start, with starting current limited to 6 times full-load current.
- 6.02.03 The motor shall be capable of starting at 85 percent of rated voltage and running at 80 percent of rated voltage at rated torque and 85 percent rated voltage at 33 percent excess rated torque for a period of 5 minutes each.
- 6.02.04 Earthing terminals shall be provided on either side of the motor.
- 6.03.00 **Limit Switches**
- Each actuator shall be provided with following limit switches: -
- 6.03.01 2 torque limit switches, one for each direction of travel, self-locking, adjustable torque type.
- 6.03.02 4 end-of-travel limit switches, two for each direction of travel.
- 6.03.03 2 position limit switches, one for each direction of travel, each adjustable at any position from fully open to fully closed positions of the valve/damper.
- 6.03.04 Each limit switch shall have 2 NO + 2 NC potential free contacts. Contact rating shall be 5A at 240V A.C. or 0.5A at 220V D.C.
- 6.03.05 Limit switches shall be drum type and adjustable to open, close and intermediate position.
- 6.03.06 The motor actuators shall have 2 nos. potentiometric type transmitters.
- 6.04.00 **Hand Wheel**
- Each actuator shall be provided with a hand wheel for emergency manual operation. The hand wheel shall declutch automatically when the motor is energized.
- 6.05.00 **Position Indicator/Transmitter**
- The actuator shall have:
- 6.05.01 One (1) built-in local position indicator for 0-100% travel
- 6.05.02 One (1) position transmitter, potentiometer type, for remote indicator
- 6.06.00 **Space Heater**



A space heater shall be included in the limit switch compartment suitable for 240V, 1 phase, 50 Hz supply.

6.07.00 Wiring

All electrical devices shall be wired up to and terminated in a terminal box. The internal wiring shall be of sufficient size for the power rating involved but in no case less than 1.5 Sq.mm copper. All wiring shall be identified at both ends with ferrules.

6.08.00 Terminal Box

The terminal box shall be weather proof, with removable front cover and cable glands for cable connection. The terminal shall be suitable for connection of 2x2.5 Sq.mm copper conductor.

6.09.00 Interfaces:

- i) Open/Close command termination logic with position & torque Limit Switches, positioner circuit shall be suitably built in the PCB inside the actuator.
- ii) For Binary Drive (both ON-OFF and Inching type) :- Open/Close command & status thereof and disturbance monitoring signal (common contact for Overload, Thermostat, control supply failure, L/R selector switch at local & other protections operated) shall be provided.
- iii) Interface with the control system shall be through hardwired signal only. Inter posing relays provided in the actuator shall be energized to initiate opening and closing, by 24V DC signal from the external control system.
- iv) For Modulating drive: - the command to actuator shall be in form of 4-20mA signal. The necessary positioning circuit and motor protection shall be provided.
- v) Open/close command termination logic shall be suitably built inside actuator.

7.00.00 ACCESSORIES

As required for the driven equipment, the actuator shall be furnished with starting equipment mounted on the actuator. This shall include:

7.01.00 One (1) triple pole breaker

7.02.00 One (1) reversing starter, with mechanically interlocked contactors, 3 thermal overload relays, 2 N.O. + 2 N.C. auxiliary contacts for each contactor.

7.03.00 One (1) remote-local selector switch

7.04.00 CLOSE-STOP-OPEN oil tight push buttons with indication lights





7.05.00 415/110V control transformer with primary & secondary fuses.

8.00.00 TEST

8.01.00 The actuator and all components thereof shall be subject to tests as per relevant standards. In addition, if any special test is called for in equipment specification, the same shall be performed.

8.02.00 Following routine test for integral starters shall be conducted as per IEC/IC standard. (a) Meggar Test, (b) Continuity test, (c) Operational test. Test certificates duly signed by inspecting agency shall be furnished.

8.03.00 The actuator shall be type tested as per IEC/National Standard, by international/national recognized test house. The test certificates issued by this house shall be furnished. Otherwise, the equipment shall have to be type tested, free of charge, to prove the design.

9.00.00 DRAWINGS, DATA & MANUALS

9.01.00 To be Submitted with Bid

Data sheet for each type of actuator shall be furnished along with internal wiring diagram, suggested control schematic and torque limit switch contact development and manufacturer's catalogues.

9.02.00 To be Submitted after Award of Contract

- a) Actuator Data Sheet
- b) Internal wiring diagram and suggested control schematic
- c) Torque switch and limit switch contact development
- d) Manufacturer's Catalogue
- e) Instruction manual indicating clearly the installation methods, check ups and tests to be carried out before commissioning of the equipment.

9.03.00 The Bidder may note that the drawings, data and manuals listed herein are minimum requirements only. The Bidder shall ensure that all other necessary write-ups, curves and information required to fully describe the equipment are submitted with his bid.



ANNEXURE-A

DESIGN DATA

1.0. SERVICE CONDITIONS

Refer Vol-IIA of Specification for FGD package.

2.0 AUXILIARY POWER SUPPLY

Supply	Description	Consumer
L.T. Supply	415V, 3Ø, 3W, 50 Hz, effectively earthed Fault level 50 KA symm.	Motors above & including 200W up to 200kW
	240V, 1Ø, 2W, 50 Hz effectively earthed	Motors less than 200W Lighting, space heating A.C. control & protective devices
D.C. Supply	220V, 2W, unearthed Fault level 25* kA	D.C. alarm, control & protective devices

* Indicative only; actual value shall be decided by the Bidder, after substantiating the same by calculation.

3.0 RANGE OF VARIATION

A.C. Supply

Voltage : $\pm 10\%$

Frequency : $\pm 5\%$

Combined Volt + frequency : 10% (absolute sum)

D.C. Supply

Voltage: (+10% to -15%)



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-F
SECTION-IV
11KV & 3.3KV SWITCHGEARS



Development Consultants Pvt. Ltd.

**Vol. II-F/Section-IV
11 KV & 3.3 KV Switchgears**



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VOLUME: II-F

SECTION-IV

11KV & 3.3KV SWITCHGEAR

1.00.00 SCOPE OF SUPPLY

- 1.01.01 Two (2) nos. of 11000V Switchgears as detailed below:
- a) 11000V FGD Auxiliary Switchgear-1 : # UNIT -1
 - b) 11000V FGD Auxiliary Switchgear-2 : # UNIT -2
- 1.01.02 Two (2) nos. of 3300V Switchgears as detailed below:
- a) 3300V FGD Auxiliary Switchgear-1 : # UNIT -1
 - b) 3300V FGD Auxiliary Switchgear-2 : # UNIT -2
- 1.01.03 Incomers from Transformers shall be provided with Lightning Arrestor at 11kV side.
- 1.01.04 Incomers from the Transformers shall be provided with drawout type line PTs in separate drawout cubicle.
- 1.01.05 Each bus-section of the 11kV / 3.3kV switchgear shall be provided with separately mounted drawout type bus PTs in separate drawout cubicle.
- 1.01.06 Rubber mat suitable for 11kV and 3.3 kV grade as per IS 15652-2006 shall be provided in front and rear of the switchgear.
- 1.01.07 Base channel frame of the switchgear with hardware
- 1.01.08 Set of accessories as detailed below:
- Earthing equipment suitable for earthing the bus/cables:
- a) Earthing truck for bus : Two (2) sets for each 3.3KV & 11KV bus
 - b) Earthing truck for cables : Two (2) sets for each 3.3KV & 11KV Cable
- 1.01.10 All relevant drawings, data and instruction manuals

2.00.00 CODES AND STANDARDS

- 2.01.00 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.





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Tuticorin, Tamil Nadu**

2.02.00 Equipment and material conforming to any other standards, which ensure equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

2.03.00 The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

3.00.00 DESIGN CRITERIA

3.01.00 The switchgear shall be used to supply power to HV motors, transformers and other loads for various plants.

3.02.00 Duty involves direct on line starting of large induction motors and also under certain emergency conditions transfer of loads from normal to stand-by source of supply.

3.03.00 The switchgear shall be located in a clean but hot, humid and tropical atmosphere.

3.04.00 11 kV and 3.3 kV FGD switchgears shall feed FGD loads. The distribution of the various loads shall be such that the switchgears shall be evenly loaded. Breaker rating of all outgoing feeders shall be same and possible to interchange irrespective of the feeder rating.

3.05.00 Continuous Current Ratings

3.05.01 For continuous operation at specified ratings, temperature rise of the 11 kV & 3.3 kV switchgear components shall be limited to the permissible values stipulated in the relevant standards and/or this specification.

3.05.02 The switchgear busbar rating shall be equal to the rating of incomer. Ratings of bus-coupler and tie breaker shall be equal to the rating of the incomer breaker of the respective board. For indicative power distribution scheme "Typical power distribution arrangement for FGD system" Dwg. No. 17A14-DWG-E-0001 shall be referred.

3.05.03 The Switchgear and components thereof shall be capable of withstanding the mechanical forces and thermal stresses of the short circuit current listed in the annexure without any damage or deterioration of material.

3.05.04 The circuit breakers shall not produce over voltage, which may be harmful for the motors / transformers or any other equipment while switching off this equipment at any load from no load to stalled condition. If required, surge protective device shall be provided in the scope of supply to limit over-voltage. to 2.2 times the peak value of rated phase to neutral voltage.

3.05.05 Short Circuit Ratings





The short circuit current and short time ratings of HV switchgear including, circuit breakers, earth switch, busbars etc. shall not be less than 40kA for 3secs for 11kV and 3.3kV SWGR.

3.05.06 Each 11kV & 3.3kV SWGR Section shall be provided with the followings:

- (i) 1 no highest motor rating spare feeder.
- (ii) 1 no lowest motor rating spare feeder
- (iii) 1 no spare transformer feeder of 2.5MVA rating

4.00.00 SPECIFIC REQUIREMENT

4.01.00 Construction

4.01.01 The switchgear shall be indoor, metal-clad, floor mounted, self standing, dust proof construction, draw out type. Design and construction shall be such as to allow extension at either end. Both ends of busbars must be suitably drilled for this purpose.

The Switchgear, shall be internal arc tested and shall conform to partition guideline as per latest edition of relevant IEC.

4.01.02 The switchgear enclosure shall conform to the degree of protection IP-4X. The minimum thickness of CRCA sheet steel used shall be 2mm.

4.01.03 The switchgear assembly shall comprise a continuous, dead-front, line-up of free standing, vertical cubicles. Each cubicle shall have a front-hinged door with latches and a removable back cover. All covers and doors shall be provided with neoprene gaskets. No opening should be left. Steel screws, bolts and washers shall be plated. Each cubicle shall have suitable lifting device. The switchgear shall be of arc flash protection compliance tested for full fault level for 1sec. The bidder shall submit the required test certificates.

4.01.04 Switchgear cubicle shall be so sized as to permit closing of the front access door even when the breaker is pulled out to TEST position. The working zone shall be restricted within 750mm to 1950mm from floor level.

4.01.05 Circuit breakers, instrument transformers, bus bars, cable compartment etc., shall be housed in separate compartments within the cubicle. The design shall be such that failure of one equipment shall not affect the adjacent units and the design should conform to the stipulation of Loss of Service Continuity and Partition guideline as per the latest edition of relevant IEC.

The sides of the Switchgear, which are accessible according to the testing arrangement, shall be specially designed to withstand internal explosions to prevent personnel injury.

4.01.06 Pressure relief device (at the option of Owner) shall be provided in each panel and shall prevent the possibility of spreading the fault to other compartments and panels. The pressure relief device shall not be deterrent to achieving the degree of protection of Switchgear Panel.



- 4.01.07 All panels shall come fitted with infrared inspection windows along with the removable plate for measuring the temperature of joints/hotspots during charged condition. The plate shall be removable from outside the panel, exposing the termination joint for scanning by Infra red Camera.
- 4.01.08 All relays, meters, breaker control switches, selector switches and indicating lamps shall be flush mounted on the respective cubicle door or on control cabinet built on the front of the cubicle. AC/DC auxiliary supply switches / isolation switches for cubicle space heater, cubicle lamp, and spring charging motor circuit shall be located inside metering compartment.
- 4.01.09 Suitable base frames made out of sheet steel channels shall be supplied along with anchor bolts and other hardware, for mounting the switchgear panels.
- 4.01.10 Incomers shall be located at the extreme ends of the switchgear with Bus-sections at the middle. Location of Incomers shall also be decided based on the incoming bus duct layout.
- 4.01.11 Dummy panel shall be provided in the switchgear line up, if required, for easy termination access of power and control cables. Dummy panel / bus trunking panel shall be of full cubicle with closed roof and rear door similar to enclosures for active cubicles.
- 4.02.00 **Bus and Bus Taps**
- 4.02.01 The main buses and connections shall be of high conductivity copper or / aluminum alloy, and may be bare or coated and sized for specified current ratings with maximum temperature limited to:
- a) For bolted joints (Bare) : 90°C (i.e. 40°C rise over 50°C ambient)
 - b) For bolted joints (Tin coated) : 105°C (i.e. 55°C rise over 50°C ambient)
 - c) For bolted joints (Silver coated) : 115°C (65°C rise over ambient 50°C)
- 4.02.02 Busbars shall be of same size for the entire length of the switchgear. Continuous current rating of bus connections / dropper shall be same as that of continuous in panel current rating of associated breaker.
- 4.02.03 Adequate contact pressure shall be ensured by means of two bolts connection with plain and spring washers and locknuts. Bimetallic connectors shall be furnished for connections between dissimilar metals.
- 4.02.04 Busbars and connection shall be fully insulated for working voltage with adequate phase/ground clearances. Insulating sleeves for busbars and cast-resin shrouds for joints shall be provided, suitable for maximum temperature rise of busbars corresponding to maximum system voltage
- 4.02.05 Bus insulator shall be flame-retardant, track resistant type with creepage distance suitable for heavily polluted atmosphere (@31mm/kV).



- 4.02.06 All buses and connections shall be supported and braced to withstand stresses due to maximum short circuit current and also to take care of any thermal expansion.
- 4.02.07 Busbars shall be color coded for easy identification and so located that the sequence R-Y-B shall be from left to right, top to bottom or front to rear, when viewed from front of the switchgear assembly.
- 4.03.00 **Circuit Breaker**
- 4.03.01 Circuit breaker shall be triple pole, single throw. Vacuum circuit breaker shall be utilized for incomers and tie breakers, all motor feeder units and all transformer feeder units. The continuous ratings specified shall be achieved under installation conditions i.e. specified ambient temperature when installed within the breaker cubicle and without use of cooling fans.
- 4.03.02 Circuit breakers shall be horizontal isolation and horizontal draw out type, having SERVICE, TEST and DISCONNECTED positions with positive indication for each position.
- 4.03.03 Circuit breakers of identical rating shall be physically and electrically interchangeable.
- 4.03.04 Circuit breaker shall have motor wound spring charged trip free mechanism with anti pumping-feature and shunt trip. In addition facility for manual charging of spring shall be provided.
- 4.03.05 Circuit breaker shall have motor wound spring charged trip free mechanism with anti pumping-feature and shunt trip. In addition facility for manual charging of spring shall be provided. "An anti-pumping relay shall be provided for each breaker, even if it has built-in mechanical anti-pumping features."
- 4.03.06 Mechanical safety interlock shall be provided to prevent:
- a) The circuit breaker from being racked in or out of the service position when the breaker is closed.
 - b) Racking in the circuit breaker unless the control plug is fully engaged and breaker is in open position.
 - c) Rack In/Out of the CB from Test to Service and vice versa with cubicle door open.
 - d) The enclosure cannot be open and the low voltage circuits cannot be disconnected when the withdrawable part is in the service or intermediate position.
- 4.03.07 Automatic safety shutters shall be provided to fully cover the female primary disconnects when the breaker is withdrawn.



- 4.03.08 Each breaker shall be provided with an emergency manual trip, mechanical ON-OFF, indication, an operation counter and mechanism charge/discharge indicator.
- 4.03.09 Each breaker shall be provided with two (2) numbers trip coil along with following:
- a) Auxiliary switch, with 6 NO + 6 NC contacts, mounted on the drawout portion of the switchgear.
 - b) Position/cell switch with 3 NO + 1 NC contacts, one each for TEST and SERVICE position.
 - c) Auxiliary switch, with 4 NO + 4 NC contacts, mounted on the stationary portion of the switchgear and operated mechanically by a sliding lever from the breaker in SERVICE position.
- 4.03.10 The above no. of contacts are indicative minimum number only. Actual number shall be decided by the bidder taking into account the scheme requirements and spares. Limit/auxiliary switches shall be convertible type that is facility for changing N.O. contact to N.C. and vice-versa. Switch contact shall be rated 10A A.C. and 2A D.C. at operating voltage. All spare contacts shall be wired up to the terminal.
- 4.03.11 The surge arrestors shall be provided for all motor/ transformer feeders and shall be metal oxide, gapped or gap less type generally in accordance with IEC 60099-1 and suitable for indoor duty. These shall be mounted within the switchgear cubicle between line and earth, preferably in the cable compartment. Surge arrestor selected shall be suitable for non-effectively earthed system and rating shall be in such a way that the value of steep fronted switching over voltage generated at the switchgear terminals shall be limited to the requirements of switchgear.
- 4.04.00 **Control & Indication**
- The circuit breaker shall be wired up for local & remote operation. Each breaker cubicle shall be equipped with following:-
- 4.04.01 One (1) TEST-NORMAL-TRIAL selector switch stay put type with pistol grip handle and key interlock.
- 4.04.02 One (1) Spring Return TRIP-NEUTRAL-CLOSE breaker control switch
- 4.04.03 indicating lights on front of compartments:-
- | | | |
|--------|---|---|
| GREEN | : | Breaker Open |
| RED | : | Breaker Closed |
| AMBER | : | Trip/Trip circuit trouble |
| BLUE | : | Spring Charged |
| WHITE | : | Trip circuit healthy |
| YELLOW | : | SF6 gas pressure low (Applicable for SF6 breaker) |

- 4.04.04 Lamps shall be clustered type LED module pilot lights in thermoplastic enclosure with polycarbonate lens and diffuser. LED shall be protected by in-built fuse with surge suppressor and leakage voltage glow protection. Lamp and lens shall be replaceable from front.
- 4.04.05 The general scheme of connection for control, interlock and protection is shown in the enclosed drawings. Detailed requirements shall be intimated later to the Bidder, who shall develop and furnish the schemes accordingly.
- 4.05.00 **Current Transformer**
- 4.05.01 Current transformers shall be cast resin type. All secondary connections shall be brought out to terminal blocks where wye or delta connection shall be made.
- The Current Transformers shall be capable of withstanding the stresses arising out of making, breaking and symmetrical short circuit currents for the specified durations.
- 4.05.02 Accuracy class of the Current Transformers shall be:
- a) Class PS for differential relaying (or as required depending on the type of relay selected).
 - b) Class 5P20 (or 5P10, if specified in the drawing) for other relaying.
 - c) Class 1.0 and ISF ≤ 10 for metering.
 - d) Class 0.5S and ISF ≤ 2 for performance / precision metering.
- 4.05.03 Other particulars of the CTs, like ratio, burden, knee point voltage, excitation current and secondary resistance shall be decided by the bidder. Current transformer secondary shall be rated for 1A or 5A, depending on requirement.
- 4.06.00 **Voltage Transformer**
- 4.06.01 Voltage Transformer (VT) shall be cast-resin, draw out type and shall have an accuracy class 1.0. Voltage transformer shall be mounted in a separate vertical panel.
- 4.06.02 High voltage windings of voltage transformer shall be protected by current limiting fuses. The voltage transformer and fuses shall be completely disconnected and visibly grounded in fully draw-out position.
- 4.06.03 Low voltage winding of voltage transformer shall have MCB, installed in all ungrounded secondary leads. MCBs shall be suitably located to permit easy replacement while the switchgear is energized.
- 4.07.00 **Relays**

- 4.07.01 All the Numerical relays shall be of latest generation comprehensive with all protection functions in one relay. Small auxiliary relays may be in non-drawout execution and mounted within the cubicle.
- 4.07.02 Relays shall be rated for operation on 110V secondary voltage and 1A secondary current as shown on drawings. Number and rating of relay contacts shall suit the job requirements.
- 4.07.03 Unless mentioned otherwise in the specification, protective relays shall be multifunction type numerical relays.
- 4.07.04 Multifunction numerical relays shall be selected to provide an integrated protection, and monitoring functions. Features such as self-diagnosis and external testing, disturbance recording, sequence of event recording, time stampings shall be available with the relay. Relevant data shall be possible to be stored in non-volatile memory backed up by battery. The relay shall have multiple setting groups, optically isolated input / output, front LCD display and menus, fixed function and programmable LEDs, keypad and password protection. All functions including protection, automation, communication, LEDs, input / output shall be programmable and can be modified, if required, using the front panel user interface. Communication port for local and remote (with suitable protocol) communication shall be located in the front and rear part of the relay. A laptop loaded with support software (complete version) shall be supplied for local off line programming, measurements, extracting and viewing of events, disturbance etc. Protection relay communication protocol shall be compliant with IEC 61850. The relay shall be housed in dust tight enclosure, suitable for IP 52 degree of protection. All the printed circuit boards of the numerical relays shall be provided with "conformal coating". 2DI and 2DO shall be provided as spare for each numerical relay.
- In addition to achieving the functions as described above, continuous measurement of various electrical parameters shall also be possible with an accuracy class of either 0.5 or 1.0 subject to Owner's requirement. Separate multifunction meter shall be provided in the event of said accuracy class cannot be met by the numerical protection relay. Multifunction meter shall be communicable type and be compliant with IEC 61850.
- 4.07.05 The Bidder shall furnish, install & co-ordinate all relays to suit the requirements of protection, interlock schemes and bus transfer schemes.
- 4.07.06 **Interface with PLC**
- Modules are to be interlinked by serial communications to data concentrator unit which in turn will provide serial communication facilities to PLC.
- 4.08.00 **Meter**
- 4.08.01 Indicating instruments (96 x 96 mm) shall be switchboard type, with 240 degree scale, anti-glare glass and accuracy class of $\pm 2\%$ full scale. Each meter shall have zero adjuster on the front.



4.08.02 Motor ammeter shall have extended suppressed end-scale range to indicate starting current (6-8 times full load).

6.08.03 **Multi Function Meter**

The multifunction power meter shall be digital type with communication port and suitable for display the following parameters on selection basis. The meter shall have accuracy class of 0.5S. Bidder shall get approved the make of MFM from Owner/Purchaser before providing the MFM.

- Voltage L-L
- Voltage L-N per phase
- Current per phase
- Neutral Current
- Frequency
- Power Factor
- Active Power
- Reactive Power

4.09.00 **Transducer**

Transducers shall be provided for conversion of AC electrical quantities such as voltage, current and power. Transducers shall be of low burden type having 4 – 20 mA DC linear galvanically isolated output compatible with secondary indicating instrument. Transducer shall be dual channel type.

4.10.00 **Switch**

4.10.01 Switches shall be dust protected, heavy duty, switchboard type complete with escutcheon plate. Contacts shall be silver surfaced, rated 10A at operating voltage.

4.10.02 Lockable stay-put type switchgear / field / remote selector switch shall be provided as per requirement and mounted on switchgear cubicle.

4.10.03 Meter selector switches shall be maintained contact, stay put type with knob handle. Ammeter & voltmeter selector switches shall be four position type. Ammeter selector switches shall have make before break feature to prevent open circuiting of CT secondary.

4.10.04 Breaker control switch shall be multistage, spring return to normal, with lost motion device and pistol grip handle.

4.11.00 **Fuse & MCB**

4.11.01 Fuses shall be HRC, link type, with minimum interrupting capacity equal to the listed short circuit current. Fuses shall be furnished complete with fuse bases and fittings. Visible indication shall be provided on blowing of the fuse.

4.11.02 MCBs, if used, shall be three/four pole, trip free, with manual close / open mechanism. Automatic tripping provision for over load and short circuit shall also be provided. MCBs shall be rated for full fault level of the system. MCB



shall be provided with required number of auxiliary contacts as per circuit requirement.

4.12.00 MCCB (Optional)

4.12.01 MCCB shall be triple pole, air break, single throw type having trip free mechanism with quick make, quick break contacts. The MCCB shall have current limiting feature.

Motors duty MCCB shall be capable of safely making and breaking the locked rotor current of the associated motor circuit including number of starts.

4.12.02 Molded case circuit breakers of identical rating shall be physically and electrically interchangeable.

4.12.03 The compartment door shall be interlocked mechanically with the MCCB such that the door cannot be opened unless the MCCB is in OFF position. Further, the compartment door can only be closed when the MCCB is in service position.

4.12.04 Short circuit protection shall be provided with the MCCB.

4.12.05 All incoming and outgoing feeders shall be provided with bolted disconnect link for isolation of neutral, if necessary.

4.12.06 Molded case circuit breaker shall be provided with 1 NO and 1 NC electrically separate auxiliary contact.

4.13.00 Push Button

Push button shall be heavy duty, shrouded, push to actuate type with colored button and inscription plate. Each push button shall have 2 NO + 2 NC contacts, rated 10A and 0.5A at their respective AC and DC operating voltage.

4.14.00 Secondary Wiring

4.14.01 The switchgear shall be fully wired at the factory to ensure proper functioning of control, protection, transfer and interlocking schemes.

4.14.02 Fuse, links and MCB shall be provided to permit individual circuit isolation from bus wires without disturbing other circuits. All spare contacts of relays, switches and other devices shall be wired upto terminal blocks.

4.14.03 Wiring shall be done with flexible, 1100V grade, PVC insulated, FRLS type switchboard wires with stranded copper conductors of 2.5 mm² for current circuits and 1.5 mm² for control and voltage circuits.

4.14.04 Each wire shall be identified, at both ends, with interlocking type permanent markers bearing wire numbers as per Contractor's Wiring Diagrams. AC / DC wiring shall have separate color-coding.



- 4.14.05 Wire termination shall be made with crimping type connectors with insulating sleeves. Wires shall not be spliced between terminals.
- 4.14.06 All spare contacts of relays, timers, auxiliary switches shall be wired up to the terminal block.
- 4.15.00 **Terminal Block**
- 4.15.01 1100V grade, multi way terminal block complete with mounting channel, binding screws and washers for wire connections and marking strip for circuit identification shall be provided for terminating the panel wiring. Terminals shall be stud type, suitable for terminating 2 nos. 2.5mm² stranded copper conductor and provided with acrylic insulating cover. Terminals for C.T. secondary leads shall have provision for shorting and grounding.
- 4.15.02 Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished. Separate terminal blocks shall be used for AC/ DC wiring termination.
- 4.15.03 Terminal blocks shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.
- 4.15.04 Terminal blocks used for interface with PLC via termination cabinet shall be suitably sized to facilitate proper termination of interconnecting cables.
- 4.16.00 **Cable Termination**
- 4.16.01 Switchgear shall be designed for cable entry from side / top / bottom, as specified. Sufficient space shall be provided for ease of termination and connection.
- 4.16.02 All provisions and accessories shall be furnished for termination and connection of cables, including removable gland plates, cables supports, crimp type tinned copper/ aluminum lugs, brass compression glands with tapered washer (Power cables only) and terminal blocks.
- 4.16.03 Gland plates shall be minimum 3 mm thick. The gland plate and supporting arrangement for 1/C power cables shall be of aluminum.
- 4.16.04 Sufficient space shall be provided between the power cable termination and gland plate. Core balance CTs wherever specified, shall be accommodated within this space, inside the cubicle.
- 4.17.00 **Bus Duct Connection**
- 4.17.01 Bus duct connections, when specified on annexure / drawings, shall be furnished along with transition panel, if required. Unless mentioned otherwise bus duct connections shall generally be from the top.
- 4.17.02 All connecting bus work shall have the same continuous rating as associated switchgear bus and shall be fully braced for the listed short circuit current.



4.17.03 All provisions such as matching flange and other accessories shall be furnished for connection to bus duct supplied by others. Necessary details for this purpose shall be furnished later.

4.18.00 Ground Bus

4.18.01 A ground bus, rated to carry maximum fault current, shall extend for the full length of the switchgear.

4.18.02 The ground bus shall be provided with two-bolt drilling with G.I. bolts and nuts at each end to receive 75 x 10mm G.I. flat.

4.18.03 Each stationary unit shall be connected directly to the ground bus. The frame of each circuit breaker and draw out VT unit shall be grounded through heavy multiple contacts at all times except when the primary disconnecting devices are separated by a safe distance.

4.18.04 Wherever, the schematic diagrams indicate a definite ground at the switchgear, a single wire for each circuit thus grounded shall be run independently to the ground bus and connected thereto.

4.18.05 CT and VT secondary neutrals shall be earthed through removable links so that earth of one circuit may be removed without disturbing other.

4.19.00 Earthing Truck

4.19.01 Earthing trucks shall be provided for earthing the switchgear bus bars or outgoing cables. The trucks shall have a voltage transformer and an interlock to prevent earthing of any live connection. The trucks shall have audio-visual annunciation to warn the operator against earthing of live connections. It shall not be possible to use bus-earthing truck for cable earthing & vice versa. Earthing truck shall be non-fault making type. Circuit breakers provided with integral earth switch, as an alternative, is to be provided wherever specified.

4.20.00 Nameplate

4.20.01 Nameplates of approved design shall be furnished at each cubicle (one no. each at front as well as at backside of cubicle) and at each instruments & device mounted on or inside the cubicle.

4.20.02 The material shall be lamicaid or approved equal, 3 mm thick with white letter on black back ground.

4.19.03 The nameplate shall be held by self-tapping screws. Nameplate size shall be minimum 20 x 75mm for instrument/device and 40 x 150mm for panels.

6.20.04 Caution notice on suitable metal plate shall be affixed at the back of each vertical panel.

4.21.00 Space heaters and Plug socket





- 4.21.01 Each cubicle shall be provided with thermostat controlled space heaters and 5A, 3 pin plug socket.
- 4.21.02 In addition, motor feeder cubicle shall be wired-up for feeding the motor space heater through suitable rated breaker auxiliary NC contact and/or contactor.
- 4.21.03 Cubicle heater, Motor heater, Plug/socket circuits shall have individual switch fuse units.
- 4.22.00 **A.C/D.C Power Supply**
- 4.22.01 The following power supplies shall be made available to each switchgear:
- A.C. supply : Single Feeder
- D.C. supply : Double Feeder
- 4.22.02 Isolating switch fuse units shall be provided at each switchgear for the incoming supplies, 4-pole, single throw for A.C. and 2-pole, double throw for D.C. Molded case circuit breaker (MCCB) shall also be accepted as an alternative.
- 4.22.03 Bus-wires of adequate capacity shall be provided to distribute the incoming supplies to different cubicles. Isolating switch fuse units / MCCB shall be provided at each cubicle for A.C/D.C. supplies.
- 4.22.04 A.C. load shall be so distributed as to present a balance loading on three-phase supply system.
- 4.22.05 Redundant DC control supply shall be designed for auto/manual changeover to alternate back up DC supply.
- 4.23.00 **Tropical Protection**
- 4.23.01 All equipment, accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects & corrosion.
- 4.23.02 Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent the entrance of insects.
- 4.24.00 **Painting**
- 4.24.01 All surfaces shall be sand blasted, pickled and grounded as required to produce a smooth, clean surface free of scale, grease and rust.
- 4.24.02 After cleaning, the surfaces shall be given a phosphate coating followed by 2 coats of high quality primer and stoved after each coat.
- 4.24.03 The switchgear shall be finished in light gray color with two coats of powder paint. The coating shall be done electro statically followed by stoving.
- 4.24.04 Sufficient quantity of touch-up paint shall be furnished for application at site.



4.25.00 **Accessories**

Following accessories shall be furnished along with the switchgear:

- a) Earthing equipment suitable for earthing the bus.
- b) Earthing equipment suitable for earthing the outgoing cable.

5.00.00 **TESTS**

5.01.00 The switchgear shall be completely assembled, wired, adjusted and tested at the factory as per the relevant IS/IEC/IEEE standards.

5.02.00 **Routine Test**

The tests shall include but not necessarily limited to the following:

- a) Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme & proper functioning of the equipment.
- b) All wiring and current carrying part shall be given appropriate High Voltage test.
- c) Primary current and voltage shall be applied to all instrument transformers.
- d) Routine test shall be carried out on all equipment such as circuit breakers, instrument transformers, relays, meters etc. as per relevant standard.

5.03.00 **Type Test**

Following minimum tests shall be performed on a typical section of the bus assembly, unless otherwise mentioned in the Annexure:

- a) P.F. & Impulse Test
- b) Temperature rise Test
- c) Short circuit Test
- c) Internal Arc Test

5.04.00 **Test Witness**

All tests shall be performed in presence of Owner's representatives, if so desired by the Owner. The Contractor shall give at least seven (7) days advance notice of the date when tests are to be carried out.



5.05.00 Test Certificate

- 5.05.01 Certified reports of all the tests carried out at the works shall be furnished in six (6) copies for approval of the Owner.
- 5.05.02 The equipment shall be dispatched from works only after receipt of Owner 's written approval of the test reports.
- 5.05.03 Type test certificate of not older that five (5) years from date of contract on any equipment, if so desired by the Owner, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

6.00.00 DRAWINGS, DATA & MANUALS

- 6.01.00 Drawings, Data and Manuals shall be submitted with the bid and in quantities and procedures as specified in General Conditions on Contract and / or elsewhere in this specification for approval and subsequent distribution after the issue of Letter of Intent.

6.02.00 To be submitted with the Bid

- 6.02.01 Typical general arrangement drawing of the equipment and foundation plan.
- 6.02.02 Bill of material
- 6.02.03 Proposal sheets duly filled in
- 6.02.04 Type test certificate of the offered model of the circuit breaker and switchboard for the specified type tests. The type test certificates shall not be more than 5 years old.
- 6.02.05 Leaflets on equipment and other accessories explaining their constructional details, principle of operation, special features etc.

6.03.00 To be submitted for Owner / Purchaser's Approval and Distribution

- 6.03.01 Guaranteed Technical Particulars and Quality assurance plan
- 6.03.02 Dimensional general arrangement drawing showing disposition of various fittings
- 6.03.03 Bill of material
- 6.03.04 Foundation plan and loading
- 6.03.05 Single Line Diagram , Control schematic and wiring diagrams.
- 6.03.06 Instruction manuals on circuit breakers and its accessories

The manual shall clearly indicate method of installation, check ups and tests to be carried out before commissioning of the equipment.





- 6.03.07 Details of all protective devices along with all associated time-current curves
- Magnetisation curves for class PS current transformer
- 6.03.08 Any other relevant drawing or data necessary for satisfactory installation, operation and maintenance.
- 6.03.09 The drawings and document marked with (A) above are of 'Approval' category and are subject to review by Owner. Those marked (R) are for 'reference' category.
- The Owner / Purchaser may also review the documents marked (R) if found necessary. The contractor shall note that the approval of drawings & documents by the Owner does not relieve him of his contractual obligation.
- 6.03.10 All drawings shall be prepared by using Auto CAD, approved version and documents shall be generated using MS Office. The paper copy of the drawings & document shall be submitted for approval & reference. All final drawings and documents shall be submitted in CD in Auto CAD (approved version) and MS office format as applicable for Owner future reference.
- 6.03.11 The Bidder may note that the drawings, data and manuals listed herein are minimum requirements only. The Bidder shall ensure that all other necessary write-ups, curves and information required to fully describe the equipment are submitted with his bid.



ANNEXURE – A

RATINGS AND REQUIREMENTS

1.0	SWITCHGEAR		11KV	3.3KV
1.1	General			
	Type	:	-----Metal-clad, draw out-----	
	Service	:	-----Indoor-----	
	Enclosure	:	-----IP – 4X-----	
	Reference Standard	:	IEC-62271-200	
	Internal Arc Classification	:	IAC AFLR	
	IAC Test Current & Duration	:	As per IS/IEC	
	Loss Of Service Continuity & Partition Class	:	LSC 2B PM	
1.2	System			
	Rated Voltage	KV rms	:	11000±10% 3300±10%
	Phase		:	-----Three-----
	Rated Frequency		:	-----50Hz ±5%-----
	System grounding		:	Non effectively earthed though resistance. Earth fault current limited to 300A for 10 sec.
1.3	Design ambient temperature		:	-----50°C-----
1.4	Rated Current inside the cubicle and at design ambient temperature of 50°C		:	
	Bus bar		:	To be decided by the bidder
	Circuit breaker		:	To be decided by the bidder
1.5	Short Circuit Rating			
	Rated short time withstand current	:	40KA	40KA
	Duration	:	----- 3Sec-----	



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

	Rated peak withstand current	:	100KA	100KA
1.6	Insulation level	:		
	Rated lightning impulse withstand voltage	:	75KV (peak)	40KV (peak)
	Rated one minute power frequency withstand voltage	:	28KV (r.m.s)	10KV (r.m.s)
1.7	AC/DC Power Supply			
	Control voltage	:	----220 V DC +10% to-15% ----	
	Service voltage	:	240V ±10%, 1Ph, 50Hz ±5%	
2.0	CIRCUIT BREAKER			
2.1	Duty Cycle	:	-----0 - 3' - CO - 3' – CO-----	
2.2	Breaking Current			
	A.C. Symmetrical	:	40KA	40KA
	A.C. Asymmetrical		-----As per IEC-----	
2.3	Making Current	:	100KA	100KA
2.4	Operation Time			
	Opening time (ms)		-----Not more than 60 -----	
	Closing time (ms)	:	-----Not more than 100-----	
2.5	Auxiliary Voltage			
	Closing	:	----220 V D.C. (85% - 110%) ----	
	Tripping	:	-----220 V D.C. (70% - 110%) ---	
	Spring Charging	:	----220 V D.C. (85% - 110%) ----	
	Heater/ Lamp/Socket	:	----240 V A.C. (90% - 110%) ----	
3.0	BUS TRANSFER SCHEME			
3.1	Application		Between 11kV Bus sections	Between 3.3kV Bus sections
3.2	a) Manual bus transfer			





**Tender Specification
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Tuticorin, Tamil Nadu**

i)	Without voltage interruption	:	Yes	Yes
ii)	With voltage interruption	:	Yes	Yes
b)	Automatic transfer with voltage interruption	:	Yes	Yes



ANNEXURE – B

PROTECTIONS

1.0 Minimum protection functions to be provided for different type of circuits through latest generation numerical relay are listed below -

- A. Incomer :
 - a. IDMTL over current (51) for phase fault
 - b. Instantaneous over current protection 50
 - c. IDMTL over current (51N) for earth fault
 - d. Instantaneous earth protection 50N
 - e. IDMTL over current (51SN) for stand by earth fault (for incomer from transformer only).
 - f. Restricted E/F (64) (for incomer from transformer only)
 - g. Under voltage with time delay (27)
 - h. VT fuse failure
 - i. Circuit breaker failure
- B. Tie feeder :
 - a. IDMTL over current (51) for phase fault
 - b. Instantaneous over current protection 50
 - c. IDMTL over current (51N) for earth fault
 - d. Instantaneous earth protection 50N
 - e. Under voltage with time delay (27)
 - f. VT fuse failure
 - g. Circuit breaker failure
 - h. Synchronizing check relay, if applicable, complete with guard relay and hard wires.
- C. Motor :
 - a. Thermal overload (49)
 - b. Phase fault (50)
 - c. Unbalance (Negative seq.) (46)
 - d. Locked rotor (50 LR)
 - e. Definite time O/C (50G) for earth fault (through CBCT)
 - f. Differential (87) protection for motor 1000 KW & above rating.





- g. Under voltage (27) protection with time delay.
 - h. Vibration Monitor (39) (optional)
 - i. Number of Starts per Hour (66).
 - j. Startup Supervision
 - k. Circuit breaker failure
 - l. Winding temperature
 - m. Bearing temperature
- D. Auxiliary Transformer :
- a. IDMTL over current (50/51) with high set instantaneous units for phase faults.
 - b. Definite time O/C (50G) for earth fault (through CBCT)
 - c. Winding temperature alarm and trip.
 - d. Differential protection (for transformers rated 5MVA and above)
 - e. Auxiliary relays for Transformer Protection like Buchholz Relay Alarm & Trip, Oil Temperature Alarm & Trip, Winding Temperature Alarm & Trip, OLTC Buchholz Alarm & Trip, Oil Pressure level, MOG and Pressure relief device operated Alarm.
 - f. Circuit breaker failure.
- E. Line feeder :
- a. IDMTL over current (51) for phase fault.
 - b. Instantaneous over current protection (50)
 - c. IDMTL over current (51N) for earth fault.
 - d. Instantaneous earth protection 50N
 - e. Circuit breaker failure.
- F. Bus-coupler :
- a. IDMTL over current (51) for phase fault.
 - b. Instantaneous over current protection (50)
 - c. IDMTL over current (51N) for earth fault.
 - d. Instantaneous earth protection (50N)
 - e. Circuit breaker failure.
 - f. Partial differential scheme shall be provided, wherever applicable.

- 2.0 In case any trip function is not available in a single relay, separate numerical relays shall be provided to achieve the requirement.
- 3.0 All protective relays shall be provided with self reset type of contacts.
- 4.0 Apart from protection relays, each breaker shall be provided with separate discrete auxiliary relays for anti-pumping (94), trip annunciation (30), trip supervision (74), electrically reset type breaker contact multiplication (52X) and lockout (86) functions. Lockout relay shall be hand reset type. For multifunction relays however, trip circuit supervision function as an integral feature of the relay is acceptable. Individual trip circuit supervision function shall be provided with respect to each trip coil of circuit breaker.
- 5.0 Numerical under voltage relays (27) with time delay relay including VT fuse failure relay shall be provided for Bus VTs.
- 6.0 One no. DC supply supervision relay (80) shall be provided for each panel of the switchboard.
- 7.0 One no. DC supply failure annunciation relay shall be provided for each incoming DC supply to the switchboard.
- 8.0 Auxiliary relays (hand reset type) with flag indications shall be provided for each type of transformer fault.
- 9.0 IDMTL relay version shall be decided as per system requirement and the same shall be finalized during detail engineering.
- 10.0 Zero-sequence CT and associated relay combination shall be such as to ensure a pick-up sensitivity of 10A primary ground fault current (for transformer and motor feeder only).
- 11.0 Bus differential protection relay (87B) shall be provided and all live parts of the Switchgear shall be covered within the differential protection zone. (optional)
- 12.0 Separate locked rotor protection relay (50 LR) with auxiliary relay (50 LRX) shall be furnished, if required.



ANNEXURE – C

WRITE UP ON BUS TRANSFER SCHEME

- 1.0 Bus transfer scheme (BTS) shall be provided, when specified, between two switchgears connected through tie-breakers (or bus coupler breaker between two bus sections) and fed independently from two upstream power sources.
- 1.1 Bus transfer could be manual (planned transfer) in the event of transfer of load from one source to the other or automatic when fault is characterized by operation of protective relay.
- 1.2 The manual and automatic bus transfer shall be arranged in such a way that any of the following mode of operation is possible.
- 2.0 **Manual Bus Transfer**
 - 2.1 Without voltage interruption

This means by allowing momentary parallel operation of two sources.
 - 2.2 With voltage interruption
 - a) Slow Transfer
 - b) Fast Transfer
- 3.0 **Automatic Bus Transfer**
 - 3.1 With Voltage Interruption
 - a) Slow Transfer
 - b) Fast Transfer
- 4.0 The requirement under various modes of bus transfer are further detailed as under :
- 4.1 **Manual bus transfer without voltage interruption**

In this mode, two sources are allowed to operate in parallel for short duration. Facility shall be provided to bypass the normal interlock against parallel operation. The changeover involves 'check synchronizing' the two sources whenever the breaker for new source of supply is closed. Closure of 'new source breaker' gives tripping command to the 'existing source breaker' automatically.

However, this mode of operation is generally not used in normal course, as it involves paralleling of two sources, however briefly, which may give rise to the fault level beyond the specified withstand and rupturing capacity of circuit breakers. This scheme shall therefore be used, with due precautions, only in case of emergency when other modes of bus transfers are not available.



ANNEXURE – C**4.2 Manual bus transfer with voltage interruption**

Under this condition bus transfer is either Slow transfer or Fast transfer.

Slow Transfer

This changeover consists in switching off the existing source of supply and allowing the residual voltage of motors connected to the bus to decay sufficiently, (about 20% of the rated voltage) where after only the impulse goes to the breaker of new source of supply for closure.

Necessary VTs and voltage sensing relays are used for sensing the appropriate voltage condition for bus transfer. This ensures that at the moment of bus transfer, even if residual voltage of motor is in phase opposition to the voltage of new source of supply, the motors shall not be subjected to magnetic shock.

To avoid the excessive voltage drop due to simultaneous restarting of all motors connected to the existing bus, some of the pre selected non-essential motors and other loads are switched off in this scheme along with the existing source breaker. This allows the bus voltage drop during restarting the motors to remain within acceptable limit. The details of selection scheme for automatic tripping of such motors is decided during detail engineering.

Fast Transfer

In this mode of bus transfer the existing source breaker is switched off and the new source breaker is closed. The switchover is so rapid that the vector difference between motor residual voltage and the new source voltage is very little so that closure of breaker against phase opposition is not encountered. On the other hand, at the time of closure, speed of connected motors drops down only marginally, with the result that at the moment of transfer of motors loads to the new source of supply, there is only a small rise in current as compared to the normal running current of motors. The voltage drop during this transfer is therefore marginal and bus transfer is satisfactory.

Since the closing time of breaker is considerably longer than the tripping time, this scheme gives the closing command to the new source breaker first and only after a preset time interval it gives the tripping command to the existing source breaker. The interval between these two commands is so selected that the actual interruption time is limited to few cycles.

4.3 Automatic bus transfer with voltage interruption

As compared to the bus transfer described under 4.2 above, the changeover in this mode of transfer is initiated automatically upon sensing under voltage in the existing bus. Thus with the help of appropriate sensing relays, the bus transfer takes place automatically when the existing bus voltage drops below a certain voltage level (about 85 % of the rated voltage) for a preset time. This scheme initiates bus transfer only in case of external faults responsible for voltage drop. In case of voltage drop due to internal fault, the transfer scheme is locked out.

ANNEXURE -C

The automatic bus transfer scheme is generally a fast bus transfer scheme and the sequence of operation are similar to that explained in fast bus transfer scheme in manual mode. However, if the fast bus transfer is found not responding to the command-, it shall automatically go for slow bus transfer scheme in a manner explained against slow bus transfer scheme under manual mode.

5.0 General requirement

The equipment for bus transfer scheme described above shall be wired in separate panels. The equipment shall include selector switches, indicating lamps, transfer circuit, supervising relays, microprocessor based fast acting voltage sensing relay and phase comparison relays etc. Necessary voltage transformers of required accuracy class shall be provided in appropriate high voltage switchgear panels. Auxiliary relays shall be incorporated with a view to enable inter panel wiring and easy fault location.

Testing facility shall be provided for on line testing of the operating circuits of each bus transfer scheme. However, in case need arises for automatic changeover, when testing of schemes are in progress the automatic changeover operation shall override the testing activities by resetting the test circuits.

Necessary selector switches shall be provided to select the mode of transfer i.e., manual or automatic. In case of manual transfer, there shall be additional selector switch for selecting manual without voltage interruption, manual fast and 'manual slow' changeover with voltage interruption. Mode selection and bus transfer initiation switches shall be located in the control panel.

The supervision of operating circuit of each mode of bus transfer shall be duly signalled in the control room. All relevant indication and annunciation with audible alarm, accept and reset facility shall be provided. Facility shall also exist in the form of potential free auxiliary contacts for remote annunciation. Similarly actuation of any mode of bus transfer either manual or automatic shall also be signalled together with an audible alarm in the control room. Certain important information of bus transfer event is to be recorded in the data acquisition system. Necessary potential free contacts shall be kept wired for event logging.

Exact type of bus transfer scheme to be used for an electrical system in a particular plant is furnished under Ratings and Requirement, cl. no.3.0 (Annexure – A) of this specification. The write up on bus transfer shall be used accordingly.



ANNEXURE – D

INTERFACE WITH PLC

A.	HT SWITCHGEAR - ELECTRICAL	
1.	Incomer – 1/2	
a.	Breaker Close	DO
b.	Breaker Trip	DO
c.	Breaker ON	DI
d.	Breaker OFF	DI
e.	Switchgear Disturbance (Control Supply Fail)	DI
f.	Numerical Relay Unhealthy	DI
g.	Trip Coil Healthy	DI
h.	Switchgear Available (Breaker in service / Spring Charged / Switchgear in Remote)	DI
i.	Electrical Trip (Lockout relay operated)	DI
j.	Numerical Relay	Interface through IEC 61850 protocol
2.	Line PT – 1/2	
a.	Line PT under voltage	DI
b.	Line PT Fuse Fail	DI
c.	PT in service position	DI
3.	Bus-coupler	
a.	Breaker Close	DO
b.	Breaker Trip	DO
c.	Incomer-1 Check Syn	DO
d.	Incomer-2 Check Syn	DO
e.	Bus Coupler Check Syn	DO
f.	Breaker ON	DI
g.	Breaker OFF	DI
h.	Switchgear Disturbance (Control Supply Fail)	DI
i.	Numerical Relay Unhealthy	DI
j.	Trip Coil Healthy	DI
k.	DC Supply-1 Fail	DI
l.	DC Supply-2 Fail	DI
m.	Switchgear Available (Breaker in Service / Spring Charged / Switchgear in Remote)	DI
n.	Electrical Trip (Lockout Relay Operated)	DI
o.	Numerical Relay	Interface through IEC 61850 protocol
4.	Bus PT – 1/2	
a.	BUS PT under voltage	DI
b.	BUS PT Fuse Fail	DI
c.	PT in service position	DI
5.	Outgoing Feeder	
a.	Breaker Close	DO
b.	Breaker Trip	DO
c.	Breaker ON	DI
d.	Breaker OFF	DI
e.	Switchgear Disturbance (Control Supply Fail)	DI



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f.	Numerical Relay Unhealthy	DI
g.	Trip Coil Healthy	DI
h.	Switchgear Available (Breaker in Service / Spring Charged / Switchgear in Remote)	DI
i.	Electrical Trip (Lockout Relay Operated)	DI
j.	Numerical Relay	Interface through IEC 61850 protocol
6.	Transformer Feeder (Dry Type)	
a.	Breaker Close	DO
b.	Breaker Trip	DO
c.	Breaker ON	DI
d.	Breaker OFF	DI
e.	Switchgear Disturbance (Control Supply Fail)	DI
f.	Numerical Relay Unhealthy	DI
g.	Trip Coil Healthy	DI
h.	Winding Temperature High (A)	DI
i.	Winding Temperature High (T)	DI
j.	WTI Surveillance Unit unhealthy	DI
k.	Switchgear Available (Breaker in Service / Spring Charged / Switchgear in Remote)	DI
l.	Electrical Trip (Lockout Relay Operated)	DI
m.	Numerical relay	Interface through IEC 61850 protocol
7.	Transformer Feeder (Oil Type) Applicable only in case of Transformers having 11kV or 3.3kV secondary voltage.	
a.	Breaker Close	DO
b.	Breaker Trip	DO
c.	Breaker ON	DI
d.	Breaker OFF	DI
e.	Switchgear Disturbance (Control Supply Fail)	DI
f.	Numerical Relay Unhealthy	DI
g.	Trip Coil Healthy	DI
h.	Oil Temp High (A)	DI
i.	Oil Temp High (T)	DI
j.	Winding Temp High (A)	DI
k.	Winding Temp High (T)	DI
l.	Buchh Relay (A)	DI
m.	Buchh Relay (T)	DI
n.	MOLG Alarm	DI
o.	PRD Trip	DI
p.	Switchgear Available (Breaker in Service / Spring Charged / Switchgear in Remote)	DI
q.	Electrical Trip (Lockout Relay Operated)	DI
r.	Numerical Relay	Interface through IEC 61850 protocol



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A) Incomers			
		Metering (for remote)	Local Indication
		Current in all the three phases	Current in all the three phases
		Voltage – Phase to phase, phase to neutral	Voltmeter with voltage selector switch
		kW	
		kWH	
B) Bus-couplers & Tie Feeders			
		Metering (for remote)	Local Indication
		Current in all the three phases	Current in all the three phases
		Voltage – Phase to phase, phase to neutral	Voltmeter with voltage selector switch for Bus A
		kW	Voltmeter with voltage selector switch for Bus B
		kWH	
C) Motor Feeders			
		Metering (for remote)	Local Indication
		Current in Y Phase	Current (Y phase)
D) Outgoing Feeders			
		Metering (for remote)	Local Indication
		Current in all the three phases	Current (Y phase)
		Voltage – Phase to phase, phase to neutral	
		kW	
		kWH	



B. TYPICAL LIST OF ANALOG SIGNALS (All are the Part of MFM)

INCOMER

- Line current R phase, Y phase, B phase.
- Power Factor
- KW
- KVAR
- KVA
- KVAH
- KWH

LV TRANSFORMER FEEDER

- Line current R phase, Y phase, B phase.
- KWH.

BUS PT

- Voltage R – Y phase, Y-B phase, B-R phase.

LINE PT

- Voltage R – Y phase, Y-B phase, B-R phase.

MOTOR

- Line Current R Phase, Y Phase, B Phase.
- KWH.
- HR.

NOTE:-

Signal List as indicated above are indicative only. Vendor shall finalize the input/output list as required during detail engineering.



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VOLUME: II-F

SECTION – V

SEGREGATED PHASE BUS DUCT



Development Consultants Pvt. Ltd.

**Vol. II-F/Section-V
Segregated Phase Bus Duct**



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SECTION-V

3.3KV SEGREGATED PHASE BUS DUCT

1.00.00 SCOPE OF SUPPLY

1.01.01 3.3kV Bus duct and associated equipment with all necessary accessories for connection between equipment:

Each set of Bus duct shall consist of the followings:

1.01.02 Each set of 3300V segregated phase bus duct (SPBD) shall originate from 3300V switchgear incomer and shall terminate to corresponding transformer three phase terminals. The bus duct run shall be complete with all bends, flexibles, bellows, phase segregated terminal adaptor box, flanges with seal off bushings, wall frame assembly, interconnection hardware, etc. as required.

1.01.03 All supporting steel structures, fasteners and necessary hardware for complete bus-duct installation

1.01.04 One Portable hot air blower including electrical heater and other electrics in a single carriage with portable hot air duct for hot air blowing.

1.01.05 One set of special tools and tackles.

1.01.06 All relevant drawings, data and installation manuals

2.00.00 CODES AND STANDARDS

2.01.00 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.

2.02.00 Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

2.03.00 The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

3.00.00 DESIGN CRITERIA

3.01.00 The segregated phase bus duct will serve as interconnection between the 3.3 kV Indoor Switchgear and outdoor transformer terminals.





- 3.02.00 The bus ducts shall be installed partially indoor and partially outdoor in a hot, humid and tropical atmosphere. All panels associated with bus ducts shall be located indoor.
- 3.03.00 Bus duct, associated equipment and wiring shall be provided with tropical finish to prevent fungus growth. All ventilation openings shall be screened and drains shall be filtered to prevent entrance of dust and insects.
- 3.04.00 The portion of bus duct at the transformer end shall be subject to vibration normally prevalent for this type of installation in a power generating station. Suitable means shall be provided to isolate the transformer vibration from rest of the bus structure/bus duct.
- 3.05.00 For continuous operation at specified ratings, temperature rise of the bus duct and auxiliary equipment shall be limited to the site permissible values stipulated in annexure to this specification.
- 3.06.00 The current carrying capacity shall take into account the service conditions, including skin effect, ambient temperature, bus insulation and exposure to sunlight.
- 3.07.00 Busduct and auxiliary equipment shall be capable of withstanding the mechanical forces and thermal stresses of the short-circuit currents listed in the annexure without any damage or deterioration of material. Bus conductor support insulator span shall be chosen considering minimum safety of 2.5 for cantilever strength under short circuit condition.
- 3.08.00 The busducts and supporting structures shall be designed & constructed so as to withstand without damage the horizontal/ vertical ground accelerations due to earthquake.
- 3.09.00 The busducts shall be self-cooled and shall not be equipped with blower or any other type of forced ventilation.
- 3.10.00 The equipment rating shall be based on an ambient temperature of 50°C. For the portion of the bus-duct installed outdoor and exposed to direct sun-rays, the effect of solar heat shall be considered in the determination of the design ambient temperature.

4.00.00 SPECIFIC REQUIREMENTS

4.01.00 General

- 4.01.01 The bus duct shall be segregated phase, enclosure natural air cooled type.
- 4.01.02 All parts and accessories shall have appropriate match mark and part numbers for easy identification and installation at site.

4.02.00 Enclosures





4.02.01 Phases shall be enclosed in a weather-proof, dust-tight, segregated phase type with metal barrier between phases, metal enclosure as indicated in the Annexure preferably rectangular in shape adequately rigid with stiffeners as required complying to enclosure protection specified in the datasheet. The enclosure shall be made of aluminum alloy of thickness not less than 3 mm and protection class shall be IP 55.

All horizontal runs of the bus ducts shall have a suitably sloped enclosure top to prevent retention of water.

4.02.02 Circumferential neoprene rubber gaskets (joint less type) shall be provided for dust tight joints with adjacent enclosure sections.

4.02.03 The bus enclosure shall have extended bellows or equivalent means to allow for temperature changes and vibrations. Flexible joints shall be provided in enclosures at all points where the bus duct terminates at equipment to withstand vibration, expansion/contraction and at suitable intervals in any straight run of the bus duct where expansion and contraction would otherwise result in stresses in the supporting structures.

4.02.04 Horizontal runs of bus duct shall have suitably sloped enclosure top to prevent retention of water for both indoor and outdoor portions of the bus duct. For outdoor runs, the shipping sections shall be provided with flange protection hood to facilitate additional protection against rain water ingress through joints.

4.02.05 Suitable inspection openings shall be provided for access to support insulators, bus joints, transformer terminals, switch gear terminals etc. All inspection openings shall have reliable sealing arrangement with neoprene gaskets.

4.02.06 Seal-off bushings complete with wall-frame and support plates shall be provided where the bus duct penetrates the building wall. The seal is to prevent free exchange of air between indoor and outdoor portions of the bus duct.

4.02.07 Silica-gel breather (regenerative or maintenance free) shall be provided on both indoor and outdoor portions of the bus duct.

4.02.08 Filtered drains for drainage of condensate shall be provided at the lowest points and at such locations where accumulation of condensate can be expected.

4.02.09 Suitable blanket flanges with cover shall be provided on the enclosure of HV bus-duct (indoor and outdoor) for connection of hot air duct in case of hot air blowing necessary to improve insulation level after long shut-down etc.

4.02.10 Phase segregation barrier shall be of aluminum alloy of grade same as of bus enclosure shall be provided. The thickness of the barrier shall be same as that of enclosure and shall be welded to the enclosure.



- 4.02.11 Shipping length of the bus duct shall be not more than three (3) meters in length.
- 4.03.00 **Bus Conductor**
- 4.03.01 The bus conductor shall be of high conductivity, electrolytic grade copper or aluminum alloy as indicated in the annexure, supported on porcelain insulators fixed on enclosure.
- 4.03.02 The bus conductor shall be in form of flat or 'C' type channel in box formation. The bus conductor shall be designed for bolted connections throughout the run.
- 4.03.03 Flexible connections shall be provided between bus sections to allow for expansion and contraction of the conductor. Flexible connection shall also be provided at all equipment terminations.
- 4.03.04 All contact surfaces shall be silver plated to ensure an efficient and trouble-free connection. All connection hardware shall be non-magnetic and shall have high corrosion resistance.
- 4.03.05 All bolted joints shall be provided with high grade stainless steel nuts bolts plain and belleville washers.
- 4.04.00 **Insulators**
- 4.04.01 Bus support insulators shall be interchangeable, high creep; high strength, wet processed, and fine glazed porcelain.
- 4.04.02 Insulator shall be mounted in such a way so as to permit easy removal or replacement without disassembly of the bus. The insulator mounting plate shall be designed for cantilever loading to withstand the short circuit. Support span shall be taken into consideration.
- 4.04.03 The conductor shall be fastened on the insulator through fixed and slip joints so as to allow conductor expansion or contraction without straining the insulator.
- 4.05.00 **Connections & Terminations**
- 4.05.01 All matching flanges, seal-off bushings, gaskets, fittings, hardware and supports required for termination of the bus duct at the switchgears, transformers and other equipment shall be furnished.
- 4.05.02 Flexible connection both for conductor and enclosure shall be furnished:
- a) At all equipment termination to provide for misalignment up to 25 mm. (1") in all directions.
 - b) Between the bus duct portions supported from building steel to prevent transmission of vibration.



- 4.05.03 The equipment terminal connections shall be readily accessible and shall provide sufficient air gap for safe isolation of equipment during testing.
- 4.05.04 If the material of bus conductor and that of the equipment terminal connectors are different then suitable bi-metallic connectors shall be furnished.
- 4.06.00 **Grounding**
- 4.06.01A separately run Galvanized steel flat suitably clamped along the enclosure shall be used as the ground bus. All parts of the bus enclosure, supporting structures and equipment frames shall be bonded to above ground bus.
- 4.06.02 Ground pad shall be bolted type to accommodate 75 x 10mm. Galvanized steel flats at two points at each end of termination, complete with suitable tapped holes, bolts and washers.
- 4.07.00 **Supporting Structures**
- 4.07.01 All supporting structures required for hanging and/or supporting the complete bus duct shall be furnished. These include all members, indoor/outdoor posts, bolts, shims, base plates, beams, hangers, brackets, bracings and hardware.
- 4.07.02 All buses shall be adequately supported and braced to successfully withstand normal operation, vibration, thermal expansion, short circuit forces and all specified design loads.
- 4.07.03 Support shall be designed to provide tolerance of ± 12 mm. (1/2") in the horizontal and vertical directions.
- 4.07.04 All steel members shall be hot-dip galvanized after fabrication. All hardware shall be of high strength steel with weather resistant finish.
- 4.07.05 Concrete foundation, building steel, concrete, inserts/plates and all other materials necessary shall be provided by Bidder.
- 4.08.00 **Portable hot air blowing equipment.**
- 6.08.01 Portable hot air blowing equipment mounted on a steel carriage (trolley) shall be provided for easy movement. Hot air blowing system shall be complete with blower, fan, electric heater, starter, switch fuse unit, main incoming switch fuse unit with flexible cables, plug etc. for connection to the Owner's power receptacle.
- 6.08.02 The capacity of Hot Air Blowing system shall be such that drying out of complete bus duct is possible within four (4) hours. During hot air blowing the bus duct enclosure temperature shall not exceed 85°C.
- 4.09.00 **Name Plate**
- 4.09.01 Suitable nameplate shall be furnished with each piece of equipment.



4.09.02 Materials for nameplate shall be Anodized Aluminium, 3mm thick, using white letters on black background.

4.10.00 **Finish**

4.10.01 Except for supporting steel structures, which shall be galvanized, all equipment shall be finished with an undercoat of high quality primer followed by two coats of synthetic enamel paints unless otherwise stated.

4.10.02 The interior surface of the bus duct enclosure shall be treated with matt black paint to enable efficient heat dissipation. The shade of exterior surface finish for indoor and outdoor portion shall be as per Manufacturer standard.

4.10.03 Pretreatment consisting of degreasing, derusting etc. shall be done on all fabricated parts before painting or galvanizing.

4.10.04 Paints shall be carefully selected to withstand heat and weather conditions. The paint shall not scale-off or crinkle or get removed by abrasion due to normal handling.

4.10.05 Sufficient quantities of all paints and preservatives required for touching up at sites shall be furnished.

5.00.00 **TESTS**

5.01.00 **Routine Test**

Bus Duct shall be subjected to the following tests:

- a) Visual inspection and verification of dimensions.
- b) Dry power frequency voltage withstand for 1-minute.
- c) Milli-volt drop test.
- d) Water tightness test.

5.02.00 **Type Test**

Certified copies of type test certificates (not less than five years old) for similar equipment supplied by the bidder shall be submitted otherwise type test shall be carried out by the bidder within the contracted price and delivery schedule. Type test certificate for the following test shall be furnished:

- a. Impulse voltage withstand on a typical section of 3300V bus duct including one bend.
- b. Heat run test on representative sections of 3-phase bus duct, including one bend and flexible joints.



- c. Short circuit test on representative sections of 3-phase bus duct, including one bend. The sections having longest span between support insulators shall be chosen.
- d. Degree of protection test (air and water) on a representative section of bus duct.

5.03.00 Auxiliary Equipment

- a) All component parts and auxiliary equipment such as insulator etc. shall be routine tested as per relevant Indian Standards.
- b) All cubicles shall be completely wired up at the factory and subject to wiring check and power frequencies withstand tests on control/secondary wiring.

5.04.00 Test Certificates

- 5.04.01 Certified reports of all the tests carried out at the works shall be furnished in six (6) copies for approval of the Owner.
- 5.04.02 The equipment shall be dispatched from works only after receipt of Owner/Purchaser's written approval of the test reports.
- 5.04.03 Type test certificate not older than ten (10) years from date of contract on any equipment, if so desired by the Owner/Purchaser, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

6.00.00 SPECIAL TOOLS & TACKLES

- 6.01.00 A set of special tools & tackles which are necessary or convenient for erection, commissioning, maintenance and overhauling of the equipment shall be supplied.
- 6.02.00 The tools shall be shipped in separate containers, clearly marked with the name of the equipment for which they are intended.

7.00.00 DRAWINGS, DATA & MANUALS

Drawings, Data and Manuals shall be submitted with the bid and for approval/reference and subsequent distribution after the issue of Letter of Intent in quantities and procedures as specified in General condition of contract and/or elsewhere in this specification.

7.01.00 To be Submitted with the Bid

- 7.01.01 General Arrangement Drawing - Plan and Sections
- 7.01.02 Typical details of bus-insulator assembly, conductor/ enclosure connections rigid & flexible, seal-off bushings, connections with switchgear and transformer terminals etc.





- 7.01.03 Bill of Materials
- 7.01.04 Technical leaflets/Write-ups on various pieces of equipment offered.
- 7.01.05 General Arrangement Drawing of Hot Air Blowing System.
- 7.01.06 Type test reports on similar equipment. The type test certificates shall not be more than 5 years old.
- 7.01.07 Bus duct layout - plan and sections
- 7.02.00 **To be Submitted after Award of Contract**
- 7.02.01 Calculation for temperature rise for bus and enclosure
- 7.02.02 Calculation for short circuit forces justifying the proposed arrangement
- 7.02.03 Calculation for sizing of system components of hot air blowing equipment
- 7.02.04 Dimensional general arrangement drawings with cross-sections of Busduct layout and Hot Air Blowing Equipment
- 7.02.05 Detailed material list with parts number.
- 7.02.06 Details of bus insulator assembly, rigid and flexible connections of both bus conductor and enclosure, grounding provision, seal-off bushings, equipment termination arrangement, etc.
- 7.02.07 Foundation Plan and loading
- 7.02.08 Supporting steel structure and calculations
- 7.02.09 Set up layout of the busduct for carrying out type test
- 7.02.10 Instruction manual for Busduct and associated equipment
- The manual shall clearly indicate method of installation, check ups and tests to be carried out before commissioning of the equipment. The manual shall also indicate detail procedure of field welding of conductor and enclosure.
- 7.02.11 Any other relevant drawing or data necessary for satisfactory installation, operation and maintenance.
- 7.03.00 The bidder may note that the drawings, data and manuals listed herein are minimum requirement only. The bidder shall ensure that all other necessary write-up, curves, etc require to fully describe the equipment are to be submitted with the bid.



ANNEXURE – A

RATINGS & REQUIREMENTS

1.0 EQUIPMENT: 3.3kV SEGREGATED PHASE BUSDUCT

1.1	System nominal voltage	:	3.3 KV	
1.2	System maximum voltage	:	3.6 KV	
1.3	Number of phases	:	3	
1.4	Frequency	:	50 Hz	
1.5	Neutral Grounding	:	Non effectively grounded through resistance. Ground fault current limited to 300A for 10secs.	
1.6	Insulation Level			
	a) 1-min. dry power frequency withstand	:	10 KV	
	b) 10-sec. wet power frequency withstand	:	10 KV	
	c) Impulse withstand	:	40 KV peak.	
1.7	Short Circuit Level		Symmetrical KA r.m.s	Momentary KA peak
		:	40	100
1.8	Service Voltage			
	Hot Air Blowing 3wire.	:	415V±10%,	3ph, 50Hz±5%,

2.0 GENERAL FOR ALL SEGREGATED PHASE BUS DUCT

2.1	Type	:	Segregated phase self cooled.	
2.2	Service:		Indoor/Outdoor	
2.3	Rated Continuous Current in Amp	:	Shall be rated for secondary side current of transformer at minimum tap plus 10% margin rounded off to the next higher rating.	

ANNEXURE – A

- 2.4 Rated hottest-spot temperature rise (Over 50°C ambient)
- i) Bus conductor
- Silver joint : 55 °C
- Plain or tinned joint : 40 °C
- ii) Bus enclosure & support structure : 40 °C
- iii) Conductor temp. after short-circuit : 250 °C
- 2.5 Material
- a) Bus conductor : Aluminum alloy grade 63401 (56.5% IACS)
- b) Bus enclosure : Al-alloy grade 31000 (56% IACS)
IACS: International Annealed Copper Standard
- c) Thickness of enclosure & barrier : 3 mm (Minimum)
- 2.6 Rated Short time Current for duration of 1 Sec. : 40kA for 3.3kV
(Symmetrical kA for 3 sec.)
- 2.7 Degree of Protection : IP55
- 2.8 Insulator
- Voltage Class : 3.6KV
- Material : Porcelain
- Power frequency withstand Voltage : 10KVrms
- Creepage Distance (Minimum) : 31mm/kV



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-F

SECTION-VI

**415V PCC/PMCC/MCC, 415V AC AND
220V DC DB**



Development Consultants Pvt. Ltd.

**Vol. II-F/Section-VII
415V PCC/PMCC/MCC, 415V AC &
220V DC DB**



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VOLUME: IIF

SECTION-VI

**415V PCC/PMCC/MCC, 415V AC AND
220V DC DB**

1.00.00 SCOPE

1.01.01 This specification is intended to cover design, engineering, manufacture, assembly, shop testing, inspection, packing, delivery to site, erection, testing and commissioning of following with all fittings and accessories for efficient & trouble free operation:-

- i) 415V Power Control Centre (PCC)
- ii) 415V Motor Control Centers (MCC)
- iii) 415V Motor cum Power Control Centre (PMCC)
- iv) 415V Distribution Boards (DB)
- v) DC Distribution Board
- vi) AC Fuse Board

1.01.02 The base channel frame with hardware and lifting angles.

1.01.03 One set of special tools and tackles.

1.01.04 Recommended spare parts for three (3) years of operation in addition to mandatory spares parts.

1.01.05 Mandatory spares as given in elsewhere.

1.01.06 All relevant drawings, data and instruction manuals.

2.00.00 GENERAL REQUIREMENTS

2.01.00 Codes and Standards

2.01.01 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.

2.01.02 Equipment and material conforming to any other standard which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

2.01.03 The electrical installation shall meet the requirements of Indian Electricity Rules as amended upto date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.



3.00.00 DESIGN CRITERIA

3.01.00 PMCC/ MCC/ DB

3.01.01 The PMCC will be used to supply auxiliary power for normal and start-up operation of FGD system.

The MCCs/DBs will be used to provide power, control and protection for 415/240V A.C. and 220V D.C. auxiliary services (Motors & Feeders) of FGD System.

3.01.02 For PMCC Duty involves direct-on-line starting of large induction motors and also under certain emergency conditions automatic transfer of loads from one source of supply to other.

Motor starting current varies from 6 to 8 times full load current at very low power factor (0.2 to 0.3) with maximum of 3 starts per hour.

For MCC/ DB Duty involves direct-on-line starting of large squirrel cage motors upto 110 KW. The starting current varies from 6 to 8 times rated current at very low power factor.

3.01.03 The equipment will be located in a hot, humid and tropical atmosphere, highly polluted at places with coal dust and/or fly ash.

3.01.04 Equipment ratings and quantities are detailed in the enclosed drawings and annexure. Equipment shall be furnished in strict compliance with the same.

3.01.05 For continuous operation at specified ratings, the temperature rise of various equipment/components shall be limited to the permissible values stipulated in relevant standards and/or this specification.

3.01.06 All equipment and components thereof shall be capable of withstanding the mechanical forces and thermal stresses of the short-circuit currents listed in the annexure without any damage or deterioration of the materials.

3.01.07 Circuit breaker shall not produce any harmful over voltage during switching off induction motors. If required, surge protective devices shall be included in the scope of supply to limit over-voltage.

4.00.00 SPECIFIC REQUIREMENTS

4.01.00 Construction

4.01.01 The PMCCs/ MCCs/ DBs shall be indoor, metal-clad, air insulated, floor mounting type. All PMCCs/ MCCs shall be fully draw out type and DBs shall be fixed type. The design and construction shall be such as to allow extension at either end.

4.01.02 Unless otherwise noted, DB shall be of single front construction, front wired and front connected, suitable for mounting against the building wall. PMCCs/



MCCs shall be double front construction and suitable for floor mounting. Breaker panels of PMCCs/ MCCs shall be single front construction.

4.01.03 PMCC/MCC/DB enclosure shall be dust and splash proof, conforming to a degree of protection IP-52. Minimum thickness of sheet metal used shall be 2 mm.

4.01.04 The PMCC shall comprise a continuous line up of single/multi-tier cubicles. The installations of circuit breakers however shall be limited to the bottom two tiers only.

MCC/DB assembly shall comprise a continuous line up of dead front, free-standing vertical sections, housing the control modules in multitier formation.

All MCCs/ DBs shall be front wired and front connected.

4.01.05 The design shall be fully compartmentalized with metal/insulating partitions between compartments. The working height shall be limited within 450 mm to 1800 mm from floor level.

4.01.06 Each breaker/ control module shall be housed in a separate compartment, complete with an individual front access door. Each vertical section shall have a removable back cover.

All doors and covers shall be gasketed.

4.01.07 All switches, lamps and indicating instruments shall be flush mounted on the respective cubicle door whereas relays and other auxiliary devices may be mounted on a separate cubicle.

4.01.08 For single front assemblies a full height vertical cable chamber with cable supports shall be provided in each section to facilitate unit wiring. The chamber shall be liberally sized to accommodate all cables and shall have removable cover at the front for access.

4.01.09 A horizontal wireway, extending the entire length, shall be provided at the top for inter panel wiring.

4.01.10 Breaker cubicle shall be so sized as to permit closing of the front access door when the breaker is pulled out to ISOLATED position. The breaker can be operated both in service & test position with door closed.

4.02.00 **Bus and Bus Taps**

4.02.01 The main buses and connections shall be of high conductivity Aluminium/Aluminium alloy, sized for specified current ratings with maximum temperature limited to 85°C (Temperature rise based on maximum ambient temperature).

4.02.02 Vertical busbars shall be designed for minimum current rating of 200 A.



- 4.02.03 All bus connections shall be silver plated. Adequate contact pressure shall be ensured by means of two bolt connection with plain and spring washers and locknuts.
- Bimetallic connector shall be furnished for connection between dissimilar metals.
- 4.02.04 Busbars and connections shall be fully insulated for working voltage with adequate phase/ground clearances. Insulating sleeves for busbars and shrouds for joints shall be provided.
- Bus insulators shall be flame retardant, track-resistant type with high creepage surface.
- 4.02.05 Busbars shall be supported and braced to withstand the stresses due to maximum short circuit current and also to take care of any thermal expansion.
- 4.02.06 Busbars shall be colour coded for easy identification and so located that the sequence R-Y-B shall be from left to right, top to bottom or front to rear when viewed from the front of the assembly.
- 4.02.07 Bolted disconnect links shall be provided for all incoming and outgoing feeders for isolation of neutral, if necessary.
- 4.03.00 **Circuit Breaker**
- 4.03.01 Circuit Breaker shall be three poles, single throw, air break type with stored energy, trip free mechanism and shunt trip.
- 4.03.02 Circuit breakers shall be drawout type, having SERVICE, TEST & ISOLATED positions with positive indication for each position.
- 4.03.03 Circuit breakers of identical rating shall be physically and electrically interchangeable.
- 4.03.04 Circuit breakers marked E shall have motor wound spring charged mechanism and those marked M shall have hand operated spring charged mechanism.
- 4.03.05 For motor wound mechanism, spring charging shall take place automatically after each breaker closing operation. One open-close-open operation of the circuit breaker shall be possible after failure of power supply to the motor.
- 4.03.06 Mechanical safety interlock shall be provided to prevent the circuit breaker from being racked in or out of the service position when the breaker is closed.
- 4.03.07 Automatic safety shutters shall be provided to fully cover the female primary disconnects when the breaker is withdrawn.
- 4.03.08 Each breaker shall be provided with an emergency manual trip, mechanical ON-OFF indicator, an operation counter and mechanism charge/discharge indicator.



- 4.03.09 In addition to the auxiliary contacts required for normal breaker operation and indication, each breaker shall be provided with following for interlocking purpose :-
- Position/cell switch with 4NO + 4NC contacts.
 - Auxiliary switch, with 6NO + 6NC contacts, mounted on the stationary portion of the switchgear and operated mechanically by a sliding level from the breaker in SERVICE position.
- 4.03.10 Limit/auxiliary switches shall be convertible type, that is, suitable for changing N.O. contact to N.C. and vice-versa.
- 4.04.00 **MCC/ DB Control Modules**
- 4.04.01 Draw-out type control module shall have self-aligning power/control disconnects. All disconnects shall be silver plated to ensure good contacts.
- 4.04.02 The design shall be such as to permit easy withdrawal/reinsertion of the unit with guide rails to ensure correct alignment.
- 4.04.03 Control Module shall house the control components for a circuit such as switch, fuse, contactors, relays, push buttons, lamps etc.
- 4.04.04 The equipment layout shall provide sufficient working space in between the components and subject to Owner's approval.
- 4.04.05 Various module/compartiment sizes shall be multiple of one basic unit to facilitate modifications at site. Suitable provision for this purpose should also be incorporated in the vertical bus bars.
- 4.04.06 Drawout type control modules of same size and type shall be electrically and physically interchangeable.
- 4.05.00 **Switches**
- 4.05.01 Switches shall be triple pole, air break, AC23 motor duty for motor feeders and AC22 heavy duty for other feeders.
- Motors duty switches shall be capable of safely making and breaking the locked rotor current of the associated motor circuit.
- 4.05.02 The switch shall have a quick-make, quick-break mechanism operated by a suitable external handle, complete with position indicator. This handle shall have provision for padlocking in ON and OFF position.
- 4.05.03 The compartment door shall be interlocked mechanically with the switch such that the door cannot be opened unless the switch is in OFF position. Means shall be provided for releasing this interlock at any time.



- 4.05.04 Switches shall be capable of withstanding the let-through fault current of back-up fuses or circuit breakers.
- 4.05.05 If two incoming switches are specified for any MCC/DB incomer, these switches shall be mechanically/key interlocked so as to ensure that only one switch can be closed at a time.
- 4.05.06 All incoming and outgoing feeders shall be provided with bolted disconnect link for isolation of neutral if necessary.
- 4.06.00 **Fuses**
- 4.06.01 Fuses shall be HRC, preferably link type, with a minimum interrupting capacity equal to the listed Short Circuit Current.
- 4.06.02 Fuses shall be furnished complete with fuse bases and fittings of such design as to permit easy and safe replacement of fuse element.
- Visible indication shall be provided on blowing of the fuse.
- 4.06.03 Motor fuse characteristics and ratings shall be chosen to ride over starting period without blowing. The fuse on incoming feeder, if specified, shall be chosen to provide discrimination with motor/feeder fuses.
- 4.07.00 **Moulded Case Circuit Breaker**
- 4.07.01 Moulded Case Circuit Breaker shall be three pole, single throw, air break type having trip free mechanism with quick make quick break contacts. Moulded Case Circuit Breakers shall be used for feeders of MCC/MCCB Boards and for outgoing feeder from PMCCs.
- 4.07.02 Moulded case circuit breakers shall have current limiting design.
- 4.07.03 Moulded Case Circuit breakers of identical rating shall be physically and electrically interchangeable.
- 4.07.04 Moulded case circuit breakers shall be provided with 1 NO and 1 NC electrically separate auxiliary contacts.
- 4.07.05 MCCB used for 50 kW and above motor rating shall have additional E/F protection
- 4.08.00 **A.C. Starter**
- 4.08.01 **Contactors**



- a. The contactors shall be three pole, air break type designed for duty class III - Category AC3 with non-bouncing silver/ silver alloy contacts.
- b. Each contactor shall be provided with two (2) normally open and two (2) normally closed auxiliary contacts rated 10 A at 240V A.C.
- c. Reversing contactors shall be electrically and mechanically interlocked.
- d. Contactors with delayed dropout feature shall be provided for some essential auxiliaries if so detailed in the annexure. These contactors shall not dropout on power failure if the voltage is restored within 3 seconds.

4.08.02 **Protection**

- a. Thermal overload relays shall be three element, positive acting, ambient temperature compensated with adjustable settings.
- b. Single phase preventer relay shall be provided, preferably as an inbuilt feature of thermal overload.
- c. Relays shall be manual reset type with one changeover contact. Resetting of relays shall be possible with compartment door closed.
- d. Relays may be direct acting or C.T. operated, depending on current rating. C.T.s shall be included in the scope of supply.
- e. Earth fault relays with adjustable settings and time delays fed from core balance CT shall be provided.
- f. Numerical / Digital Motor protection relay with short circuit, over load, earth fault, locked rotor and unbalance (NPS) load protection functions shall be provided for motor rated above 90 kW.

4.09.00 **Control & Indication**

4.09.01 The circuit breaker shall be wired up for local & remote operation. Each breaker cubicle shall be equipped with following :-

4.09.02 One (1) TEST-NORMAL-TRIAL selector switch stay put type with pistol grip handle and key interlock for breaker marked 'E'.

4.09.03 Two (2) heavy duty, oil-tight, push buttons for TRIP & CLOSE.

4.09.04 Five (5) indicating lights on front of compartment :-

Breaker open	-	GREEN
Breaker closed	-	RED



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

Breaker charged	-	BLUE
Breaker Trip Circuit Healthy	-	WHITE
Breaker Trip	-	AMBER
-
- 4.09.05 Lamps shall be low watt, filament type with series resistor. Lamp and lens shall be replaceable from the front.
- 4.09.06 The general scheme of connections for control, interlock and protection is shown in the enclosed drawings. Detailed requirements of individual circuits will be intimated later to the successful Bidders, who shall develop and furnish the schemes accordingly.
- 4.09.07 Push button shall be heavy duty, oil tight, push to actuate type with integral escutcheon plate marked with its function.
- 4.09.08 Each push button shall have one (1) normally open and one (1) normally closed contacts rated 10 A at 240 V A.C.
- 4.09.09 One (1) NORMAL-TRIAL selector switch shall be provided for all motor feeders.
- 4.09.10 Lamps shall be LED type. LED lamps shall be made in accordance with InP technology (Aluminium Indium Gallium Phosphide Technology). The body shall be made of Poly Carbonate with unbreakable Lens. LED shall be protected by inbuilt fuse with surge suppressor or leakage voltage glow protection.
- LED circuit shall be PCB mounted. Intensity shall be greater than 200 mcd. All Push Button lamp shall be as per LED indicating lamp.
- 4.09.11 For control supply the Contractor shall provide 415/110V, +/- 5% in steps of 2.5% control transformers with 100% standby arrangement. But for Service voltage it shall be 415V/240V AC.
- 4.10.00 **Meters**
- 4.10.01 All indicating instruments (96 x 96 mm) shall be switchboard type, with 250 degree scale, anti-glare glass and accuracy class of $\pm 2\%$ full scale. Each meter shall have zero adjuster on the front.
- 4.10.02 Motor ammeter shall have an extended suppressed end-scale range to indicate starting current (6 to 8 times full load current).
- 4.10.03 Watt-hour meter shall be provided in drawout cases with built-in test facilities. Alternatively, they may have test block to facilitate testing of meter without disturbing C.T. or V.T. secondary connections.





- 4.11.00 **Current Transformer**
- 4.11.01 Current Transformers shall be cast-resin type. All secondary connections shall be brought out to terminal blocks where wye or delta connection will be made.
- 4.11.02 Accuracy class of the current transformers shall be :-
- a. Class PS for differential
 - b. Class 5P20 for other relaying.
 - c. Class 1.0, ISF < 5 for metering.
- 4.12.00 **Voltage Transformer**
- 4.12.01 Voltage transformers shall be cast-resin, drawout type and shall have an accuracy class of 1.0. Voltage transformer mounted on breaker carriage is not acceptable.
- 4.12.02 High voltage windings of voltage transformer shall be protected by current limiting fuses. The voltage transformer and fuses shall be completely disconnected and visibly grounded in fully drawout position.
- 4.12.03 Low voltage fuses, sized to prevent overload, shall be installed in all ungrounded secondary leads. Fuses shall be suitably located to permit easy replacement while the switchgear is energized.
- 4.13.00 **Relays**
- 4.13.01 Relays shall be numerical type of drawout design with built-in testing facilities. Small auxiliary relays may be in non-drawout execution.
- 4.13.02 Relays shall be rated for operation on 1A secondary current and 110V secondary voltage; number and rating of relay contacts shall suit the job requirements.
- 4.13.03 The Bidder shall furnish, install & co-ordinate all relays to suit the requirements of protection, interlock and bus transfer scheme as broadly indicated in the annexures and drawings.
- 4.14.00 **Secondary Wiring**
- 4.14.01 The MCC/PMCC/DB shall be fully wired at the factory to ensure proper functioning of control, protection and interlocking schemes.
- 4.14.02 Fuse and links shall be provided to permit individual circuit isolation from bus wires without disturbing other circuits. All spare contacts of relays, push buttons and other devices shall be wired upto terminal blocks.



- 4.14.03 Wiring shall be done with flexible, 1100V grade, PVC insulated FRLS type switchboard wires with stranded Copper conductors of 2.5 mm² for control & current circuits and 1.5 mm² for voltage circuits.
- 4.14.04 Each wire shall be identified, at both ends, with permanent markers bearing wire numbers as per Contractor's wiring diagrams.
- 4.14.05 Wire terminations shall be made with crimping type connector with insulating sleeves. Wires shall not be spliced between terminals.
- 4.15.00 **Terminal Blocks**
- 4.15.01 Terminal blocks shall be 1100V grade, box-clamp type with marking strips similar to ELMEX 10 mm² or equal. Terminals for C.T. secondary leads shall have provision for shorting.
- 4.15.02 Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished.
- 4.15.03 Terminal blocks shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.
- 4.16.00 **Cable Terminations**
- 4.16.01 MCC/ DB shall be designed for cable entry both from top and bottom. PMCC shall be designed for cable entry from the bottom. Sufficient space shall be provided for ease of termination and connection.
- 4.16.02 Cables shall be PVC insulated, armoured, PVC overall sheathed with 2.5 mm² stranded Copper conductor for controls and motors upto 5.5 KW and stranded Aluminium conductor for rest-of power circuits as detailed in annexure.
- 4.16.03 All provisions and accessories shall be furnished for termination and connection of cables, including removable gland plates, cable supports, crimp type tinned Copper/Aluminium lugs, brass compression glands with tapered washer (Power Cables only) and Terminal blocks.
- 4.16.04 Gland plates shall be minimum - 4 mm thick. The gland plate and supporting arrangement for single core power cables shall be such as to prevent flow of eddy current.
- 4.17.00 **Bus Duct Connection**
- 4.17.01 Bus duct connections when specified on drawings/annexures shall be furnished along with transition panel if required. Bus duct connection shall be generally from the top.
- 4.17.02 All connecting bus work shall have the same continuous current rating as associated PMCC/ MCC/DB bus and shall be fully braced for the listed short circuit current.



- 4.17.03 All provisions such as matching flange and other accessories shall be furnished for connection to bus duct being supplied by others. Necessary details for this purpose will be furnished later.
- 4.18.00 **Ground Bus**
- 4.18.01 A Cu / Al ground bus rated to carry the maximum fault current, shall extend full length of the assembly.
- 4.18.02 The ground bus shall be provided with two-bolt drilling with G.I. bolts & nuts at each end to receive 50 x 6 mm G.I. flats.
- 4.18.03 All stationary units shall be directly connected to the ground bus for effective grounding.
- The frame of each circuit breaker and drawout V.T. unit shall be grounded through heavy multiple contacts at all times except when the primary disconnecting devices are separated by a safe distance.
- The frames of drawout module shall be ground at all times except when the power disconnects are separated by a safe distance.
- 4.18.04 Wherever the schematic diagrams indicate a definite ground at the switchgear, a single wire for each circuit thus grounded shall be run independently to the ground bus and connected thereto.
- 4.18.05 C.T. & V.T. secondary neutrals shall be earthed through removable links so that earth of one circuit may be removed without disturbing others.
- 4.19.00 **Nameplate**
- 4.19.01 Nameplate of approved design shall be provided for each cubicle, at the top of the assembly at each instrument & device mounted on or inside the cubicle.
- 4.19.02 The material shall be lamicaid or approved equal, 3 mm thick with white letter on black background.
- 4.19.03 The name plate shall be held self-tapping screws. Name plate size shall be minimum 20 x 75 mm for instrument/devices & 40 x 150 mm for panels.
- 4.19.04 Caution notice on suitable metal plate shall be affixed at the back of each vertical panel.
- 4.20.00 **Control supply for MCC modules**
- 4.20.01 Each motor feeder of MCC shall be provided with suitably rated 415/110V control transformer, for arranging control supply for the module. All the necessary auxiliary and main contactors shall be provided suitable for this control supply.

All the intelligent controllers shall be provided with UPS supply for their failsafe, reliable operation, by running separate UPS bus.

4.20.02 In test position module control supply shall be disconnected and provision shall be available to test the control circuit through test bus, obtained from separate control transformer provided for this purpose.

4.20.03 Control supply for ACBs of PCC and PMCC modules

- a) Two 220V DC feeders shall be provided in each board for power supply of control, shunt tripping and annunciation purpose.
- b) Control supply shall have supervision facility, alarm shall be provided for non-availability of any one of the control supply.
- c) MCCBs/MCBs shall be provided on incoming sides of supplies. Control buses of two sections shall be connected through auto changeover scheme.
- d) LEDs shall be provided for the indication purpose.
- e) Isolation arrangement shall be provided on each panel to facilitate fault location and testing. Separate fuses shall be provided for spring charging motors, for indication lamps and for closing / Tripping circuits of each cubicle

4.20.04 TEST Control Transformers

For TEST control supply control transformers of adequate rating (min. 2 KVA rating) shall be provided.

For motor space heating supply, the transformers of adequate rating (min. 2 KVA rating) with 100% standby shall be provided.

All the control transformers shall be placed in spacious compartments to have proper air circulation and keep lower temperature of transformer and its module.

All the control transformers shall be provided with selector switch, fuses, indicating lamps. Each control transformer shall feed to its control buses of respective bus section during normal operation. In case of failure of one of the control transformer, provision shall be made to tap the control supplies from other bus section control transformer by auto changeover using aux. relays contacts/switch. Bidder has to develop scheme accordingly. This logic shall be made applicable for space heating and winding heating control transformer also.

All control transformer shall conform to IS: 12021.

Control transformer shall have OCTC tap range of $\pm 5\%$ in steps of 2.5% per tap.

4.21.00 Space Heaters and Plug Sockets



- 4.20.01 Each vertical section shall be provided with thermostat controlled space heater and 5A, 3 pin plug socket.
- 4.20.02 In addition, motor feeder 30 KW and above cubicle shall be wired-up for feeding the motor space heater through suitably rated breaker (or contactor) auxiliary "OFF" contact .
- 4.20.03 Cubicle heater, Motor heater, Plug-socket circuit shall have individual switch fuse units.
- 4.21.00 **A.C./D.C. Power Supply**
- 4.21.01 The following power supplies will be made available to each PMCC :
A.C. supply : Single feeder
D.C. supply : Double feeder
- 4.21.02 Isolating switch fuse units shall be provided at each switchgear for the incoming supplies, 4-pole, single throw for A.C. and 2-pole, double throw for D.C.
- 4.21.03 Bus-wires of adequate capacity shall be provided to distribute the incoming supplies to different cubicles. Isolating switch-fuse units shall be provided at each cubicle for A.C./D.C. supplies.
- 4.21.04 A.C. load shall be so distributed as to present a balance loading on three-phase supply system.
- 4.22.00 **Tropical Protection**

All equipment, accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects & corrosion.

Screens of corrosion resistant material shall be furnished on all ventilating louvres to prevent the entrance of insects.
- 4.23.00 **Painting**
- 4.23.01 All steel surfaces shall be sand blasted, grounded and pickled as required to produce a smooth, clean surface free of scale, grease & rust.
- 4.23.02 After cleaning, the surfaces shall be given a phosphate coating followed by two coats of high quality primer and stoved after each coat.
- 4.23.03 PMCC/ MCCs/DBs shall be finished in light grey (IS:631) with two coats of synthetic enamel paint.

Sufficient quantity of touch-up paint shall be furnished for application at site.
- 4.23.04 Caution notice plate shall be affixed at the back of each vertical panel.



4.24.00 **Accessories**

- 4.24.01 The following accessories shall be furnished along with the switchgear :
- Breaker lifting and handling truck.
 - Device for slow opening and closing of breaker.
 - Test cabinet with coupling cables for testing the breaker in drawout position.
 - Breaker racking in/out handle (if required).

5.00.00 **TESTS**

- 5.01.00 All equipment shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards.

5.02.00 **Routine Test**

The tests shall include but not necessarily limited to the following :-

- Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme and proper functioning of the equipment.
- All wiring and current carrying part shall be given appropriate High Voltage Test.
- Primary current & voltages shall be applied to all instrument transformers.
- Routine test shall be carried out on all equipment such as circuit breakers, switch-fuse, contactors, relays meters etc.

5.03.00 **Test Witness**

All tests shall be performed in presence of Owner's representatives, if so desired by the Owner. The Contractor shall give at least seven (7) days advance notice of the date when tests are to be carried out shall be given.

5.04.00 **Test Certificate**

- 5.04.01 Certified reports of all the tests carried out at the works shall be furnished in six (6) copies for approval of the Owner.
- 5.04.02 The equipment shall be despatched from works only after receipt of Owner's written approval of the test reports.



5.04.03 Type test certificate on any equipment, if so desired by the Owner, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

6.00.00 SPECIAL TOOLS & TACKLES

6.01.00 A set of special tools & tackle which are necessary or convenient for erection, commissioning, maintenance and overhauling of the equipment shall be supplied.

6.02.00 The tools shall be shipped in separate containers, clearly marked with the name of the equipment for which they are intended.

7.00.00 SPARES

7.01.00 The Bidder shall quote and supply **mandatory spare parts** as per the tentative list. The final quantity shall be decided during placement of order.

7.02.00 Each list shall be complete with specification, make, identification number, unit rate, quantity etc.

8.00.00 DRAWINGS, DATA & MANUALS

8.01.00 Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

8.02.00 **To be submitted with the bid :-**

- a. General arrangement drawing showing constructional features, space required in front for withdrawals, power & control cable entry points etc.
- b. Typical foundation plan
- c. Typical control schematic
- d. Bill of materials
- e. Type test reports on circuit breaker
- f. Technical leaflets on :-
 - i) Circuit breaker
 - ii) Switch-fuse units
 - iii) Contactors
 - iv) Relays, meters, push buttons, selector switches etc.
 - v) Glands/terminals blocks



8.03.00 To be submitted for Approval & Distribution:

- a. Outline dimensional drawing showing general arrangement, space requirements and bus duct/cable entry points.
- b. Cross-section with parts list.
- c. Foundation plan & loading.
- d. Consolidated bill of materials
- e. Control schematics.
- f. Diagrams.
- g. Instruction manuals of MCC/DB and individual equipment.

The manual shall clearly indicate the installation method, check-up and tests to be carried out before commissioning of the equipment.

8.04.00 The Bidder may note that the drawings, data and manuals listed herein are minimum requirements only. The Bidder shall ensure that all other necessary write-ups, curves and information required to fully describe the equipment are submitted with his bid.



ANNEXURE-A

RATINGS & REQUIREMENTS

1.0 GENERAL

Type : Metal-clad, drawout (PMCC/MCC) Metal-clad, fixed (DB)

Service : Indoor

1.1 System AC DC

Voltage : 415V $\pm$ 10% 220V(+ 10% to -15%)

Phase : 3-phase and neutral -

Frequency : 50 Hz +3 to -5% -

Combined voltage and frequency variation : 10% (absolute sum) -

System grounding : Solidly grounded Ungrounded

1.2 Rated Current at 50°C ambient

Busbar : To be decided by the Bidder

Circuit breaker : - Do -

Switches : 16A to 630A

1.3 Short Circuit Rating AC DC

Interrupting : (*) 50 KA 25** KA

Short Time for 1 second : (*) 50 KA 25** KA

1.4 Hivoltage test for 1 minute (min.) : 2.5 KV 1.5 KV

** Indicative only ; actual value to be decided by the Bidder and to be substantiated by calculation .

1.5 A.C./D.C. Power Supply

Control Voltage for : 220V DC (+ 10% to -15%)
Circuit breaker

ANNEXURE-A





Control voltage for MCC modules : 110V AC $\pm$ 5%, 1 Ph, 50 Hz +3 to -5%

Service voltage : 240V AC $\pm$ 10%, 1 Ph, 50 Hz +3 to -5%

2.0 CIRCUIT BREAKER

2.1 Duty Cycle : 0-3'-CO-3'-CO

2.2 Breaking Current

A.C. Symmetrical : (*) **50 KA**

2.3 Making Current : (*) **105 KA Peak**

2.4 Auxiliary Voltage

Closing : 220V D.C. (85 - 110%)

Tripping : 220V D.C. (70 - 110%)

Spring Charging : 220V D.C. (85 - 110%)

ANNEXURE-B

MODULE SELECTION

A. MOTOR FEEDER (WITH MCCB)

Type	Motor Rating (kW)	MCCB Rating (A)	Contactor Rating (A)	Cable size
AU / AR	0 – 2.2	Note-2	16	3/C – 2.5 mm sq - Cu
BU / BR	2.3 – 3.7	-do-	16	3/C – 2.5 mm sq - Cu
CU / CR	3.8 – 5.5	-do-	32	3/C – 2.5 mm sq - Cu
DU / DR	5.6 – 7.5	-do-	32	3/C – 16 mm sq - Al
EU / ER	7.6 – 11	-do-	32	3/C – 16 mm sq - Al
FU / FR	11.1 – 22.5	-do-	80	3/C – 35 mm sq - Al
GU	22.6 – 37	-do-	80	3/C – 95 mm sq - Al
HU	37.1 – 45	-do-	95	3/C – 95 mm sq - Al
JU	45.1 – 75	-do-	140	3/C – 185 mm sq - Al
KU	75.1 – 90	-do-	225	2-3/C – 185 mm sq - Al
LU	90.1 – 110	-do-	265	2-3/C – 185 mm sq - Al

1. “U” stands for Unidirectional and “R” for Reversible drives
2. MCCB are to suitably selected maintaining Type-2 coordination as per IS: 13947
3. MCCB with E/F protection to be considered for motors above 50 kW.

B. OUTGOING FEEDER (WITH MCCB)

Type	MCCB Rating (A)	Cable size
AF	32	4/C – 16 mm sq - Cu
BF	63	4/C – 35 mm sq - Al
CF	100	3.5/C – 95 mm sq - Al
DF	200	3.5/C – 300 mm sq - Al
EF	400	4x1/C – 630 mm sq - Al
FF	630	7x1/C – 630 mm sq - Al
ACB	800	7x1/C – 630 mm sq - Al
ACB	1000/1250/1600	14x1/C – 630 mm sq - Al
ACB	2500	18x1/C – 630 mm sq - Al
ACB	3150	21x1/C – 630 mm sq - Al

ANNEXURE-C

Metering and Protection

The feeders shall have the following protections / metering required for the switchgear panels. The minimum protections / metering required for various typical feeders including ACB operated feeders are given below. For non ACB controlled feeders having intelligent controller, the metering indicated shall be in-built.

1) ACB controlled feeders with numerical relays

A) Incomers			
	Protections	Metering (for remote)	Local Indication
	Instantaneous over current protection 50	Current in all the three phases	Current in all the 3 phases
	IDMT over current protection 51	Voltage – Phase to phase, phase to neutral	Voltmeter with voltage selector switch
	Instantaneous earth protection 50N	kW	
	IDMT Earth fault protection 51N	kWH	
	Circuit breaker failure protection 50BF		
	Under voltage protection 27		
	Restricted earth fault protection 64R		
	Backup (Standby) earth fault protection 64S		
	Apart from above protection relays, each electrically operated breaker shall be provided with anti-pumping (94), lockout (86) and trip circuit supervision (95) relays. Lockout relay shall be a hand reset type and shall not be clubbed with numerical relay.		
	Check synchronizing 25 through relay mounted in bus coupler.		
B) Bus Couplers			
	Protections	Metering (for remote)	Local Indication
	Instantaneous over current protection 50	Current in all the three phases	Current in all the three phases
	IDMT over current protection 51	Voltage – Phase to phase, phase to neutral	Voltmeter with voltage selector switch for Bus A

	Instantaneous earth protection 50N	kW	Voltmeter with voltage selector switch for Bus B
	IDMT Earth fault protection 51N	kWH	
	Circuit breaker failure protection 50BF		
	Under voltage protection 27		
	Check synchronizing 25		
	Apart from above protection relays, each electrically operated breaker shall be provided with anti-pumping (94), lockout (86) and trip circuit supervision (95) relays. Lockout relay shall be a hand reset type and shall not be clubbed with numerical relay.		
C)	Motor Feeders (above 90KW)		
	Protections	Metering (for remote)	Local Indication
	Numerical Composite motor protection to cover a min. protections such as negative phase current (46), thermal over load (49), phase over current (50/51), earth fault (50N/51N), locked rotor (51LR), No. of starts per hour (66), breaker failure (50BF), under voltage (27 from PT)	Current in all the three phases	Current (Y phase) for feeders rated above 30 kW.
	Apart from above protection relays, each electrically operated breaker shall be provided with anti-pumping (94), lockout (86) and trip circuit supervision (95) relays. Lockout relay shall be a hand reset type and shall not be clubbed with numerical relay.	A, kW, kWH	
D)	Outgoing Feeder (630A and above) (Breaker Operated)		
	Protections	Metering (for remote)	Local Indication
	Instantaneous over current protection 50	Current in all the three phases	Current (Y phase)
	IDMT over current protection 51	Voltage – Phase to phase, phase to neutral	
	Instantaneous earth protection 50N	kW	
	IDMT Earth fault protection 51N	kWH	
	Circuit breaker failure protection 50BF		
	Apart from above protection relays, each electrically operated breaker		

	shall be provided with anti-pumping (94), lockout (86) and trip circuit supervision (95) relays. Lockout relay shall be a hand reset type and shall not be clubbed with numerical relay.		

2) MCCB Controlled feeders rated below 630A.

A)	Incomers (with motorized MCCB)		
	Protections	Metering (for remote)	Local Indication
	Over current protection	Current transducer (Y phase)	Current (Y phase)
	Short circuit protection		Voltmeter with voltage selector switch
B)	Bus Couplers (with motorized MCCB)		
	Protections	Metering (for remote)	Local Indication
	Over current protection	Current transducer (Y phase)	Current (Y phase)
	Short circuit protection		
C)	Outgoing Feeder (Below 630A) with MCCB (non-motorized)		
	Protections	Metering (for remote)	Local Indication
	Over current protection		Current (Y phase)
	Short circuit protection		
D)	Incomers for ACDB/MLDB/PDB MCCB (non-motorized)		
	Protections	Metering (for remote)	Local Indication
	Over current protection	Electronic energy meter with suitable communication protocol	Voltmeter with voltage selector switch
	Short circuit protection	Electronic energy meter suitable for communication with Modbus RS485.	

3) Other feeders

A)	Bus PT / Line PT Modules		
	Protections	Metering (for remote)	Local Indication
	Under voltage protection 27	Voltage – phase to phase, phase to neutral	

	Fuse failure protection		
B)	Motor feeders up to 18.5kW (MPCB with Contactors)		
	Protections	Metering (for remote)	Local Indication
	Intelligent controllers with current measuring module and overload & short circuit protection.		
C)	Motor feeders above 18.5kW but upto 90KW (MCCB with Contactors)		
	Protections	Metering (for remote)	Local Indication
	Intelligent controllers with current measuring module and Overload, single phase preventor & short circuit protection.	Phase current (for motors of rating 30KW and above)	

4) DC System

A)	Incomer Breaker/MCCB		
	Protections	Metering (for remote)	Local Indication
	With indication only no protection with O/L alarm to BOP DDCMIS	Bus voltage	Load Voltage
			Bus Voltage
			Shunt with ammeter
B)	Outgoing Feeder		
	With indication only no protection with O/L alarm to BOP DDCMIS		Shunt with ammeter

Note: Fuse failure relay shall be provided on the secondary side of voltage transformer to monitor HV and LV fuses.



ANNEXURE-D

FITTINGS & ACCESSORIES

Each PMCC/ MCC shall be furnished complete with fittings and accessories as listed below :-

1. Operating mechanism complete with all accessories, fittings and tripping coil and closing coil, pole discrepancy feature, etc. as required.
2. Base frame and anchor bolts and nuts.
3. Auxiliary contacts and relays.
4. LOCAL/REMOTE Selector switch, TRIP/CLOSE Push Buttons.
5. Manual tripping devices with protective flap.
6. Mechanical ON-OFF indicator.
7. Operation counters.
8. Set of switch fuse units/MCCB for A.C. and D.C. supply.
9. Space heater with thermostat and ON-OFF switch.
10. Cubicle illumination lamp with ON-OFF switch.
11. 3 Pin 5A Socket with ON-OFF Switch.
12. Terminal blocks and internal wiring - lot as required.
13. Other standard accessories which are not specifically mentioned but supplied with breakers of similar type and rating for efficient and trouble-free operation.
14. Bimetallic terminal connectors.



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-F
SECTION-VII
415V NON-SEGREGATED PHASE BUSDUCT



Development Consultants Pvt. Ltd.

**Vol. II-F/Section-VII
415 Non Segregated Phase Bus duct**



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

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VOLUME: IIF

SECTION-VII

415V NON-SEGREGATED PHASE BUSDUCT

1.00.00 Scope of Supply

- 1.01.01 415V non-segregated phase bus duct with all necessary accessories : As required
- 1.01.02 The bus duct run shall be complete with all bends, flexible, bellows and terminal adaptor boxes, interconnection hardware etc. as required.
- 1.01.03 All supporting steel structures, fasteners and necessary hardware for complete bus-duct installation.
- 1.01.04 Recommended spare parts for three (3) years operation
- 1.01.05 All relevant drawings, data and instruction manuals.

2.00.00 GENERAL REQUIREMENTS

2.01.00 Codes and Standards

- 2.01.01 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.
- 2.01.02 Equipment and material conforming to any other standard which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.
- 2.01.03 The electrical installation shall meet the requirements of Indian Electricity Rules as amended upto date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

3.00.00 Design Criteria

- 3.01.00 The busduct will serve as interconnection between L.V. terminals of Auxiliary L.T. Transformers to their respective PCC/PMCC and also for trunking connection between each set of PCC/PMCC, if required.
- 3.02.00 The busduct shall be non-segregated type, self cooled. The cooling medium inside the duct shall be air.
- 3.03.00 The busduct will be installed in a hot, humid and tropical atmosphere.



- 3.04.00 The portion of bus duct at the transformer end will be subjected to vibration normally prevalent for this type of installation in a power generating station/industrial plants. Suitable means shall be provided to isolate the transformer vibration from rest of the bus structure/ bus duct.
- 3.05.00 It shall be capable of withstanding the mechanical forces and thermal stresses of the specified short-circuit currents without any damage or deterioration of material.
- 3.06.00 Bus duct and supporting structures shall be designed & constructed so as to withstand without damage the horizontal/ vertical ground accelerations due to earthquake.
- 3.07.00 All parts and accessories shall have appropriate match mark and part numbers for easy identification and installation at site.
- 3.08.00 The bus ducts shall be self cooled and shall not be equipped with blower or any other type of forced ventilation.

4.00.00 SPECIFIC REQUIREMENTS

4.01.00 Enclosure

- 4.01.01 All the three phases shall be enclosed in a weather proof, dust tight enclosure without any barrier between phases. It shall preferably rectangular in shape adequately rigid with stiffeners as required. Enclosure for indoor run shall be IP52 protected. Outdoor enclosure shall have IP 55 degree of protection
- 4.01.02 The enclosure shall be made of sheet steel for rated continuous current up to and including 2000A at site condition. Above 2000A bus duct enclosure shall be made of Aluminum alloy. The thickness of enclosure material shall not be less than 3mm.
- 4.01.03 Weather resistant type circumferential gaskets shall be provided for making the joints with adjacent enclosures dust-proof and impervious to moisture.
- 4.01.04 The connection flanges shall be sufficiently stiffened so as not to bend while tightening the bolts.
- 4.01.05 The bus enclosure shall have extended bellows or equivalent means to allow for temperature changes and vibrations. Flexible joints shall be provided in enclosures at all points where the bus duct terminates at equipment to withstand vibration, expansion/contraction and at suitable intervals in any straight run of the bus duct where expansion and contraction would otherwise result in stresses in the supporting structures.
- 4.01.06 Seal-off bushings complete with wall-frame and support plates shall be provided where the bus duct penetrates the building wall. The seal is to prevent free exchange of air between indoor and outdoor portions of the bus duct.
- 4.01.07 Horizontal runs of bus duct shall have suitably sloped enclosure top to prevent retention of water for both indoor and outdoor portions of the bus



duct. For outdoor runs, the shipping sections shall be provided with flange protection hood to facilitate additional protection against rain water ingress through joints.

- 4.01.08 Suitable inspection openings shall be provided for access to support insulators, bus joints, transformer terminals, switchgear terminals etc. All inspection openings shall have reliable sealing arrangement with neoprene gaskets.
- 4.01.09 Filtered drains for drainage of condensate shall be provided at the lowest points and at such locations where accumulation of condensate can be expected.
- 4.01.10 Shipping length of the bus duct shall be not more than three (3) meters in length.

4.02.00 Bus Conductor

- 4.02.01 The conductor shall be of high conductivity aluminium / aluminium alloy supported on fine glazed porcelain / cast resin insulators fixed to enclosure sized for the same rating as associated PCC/PMCC bus.
- 4.02.02 The bus conductor shall be designed for bolted connections throughout the run.
- 4.02.03 For bolted rigid/expansion joints, necessary bolts, nuts, (cadmium plated) washers and other hardware shall be supplied. All bolted joints shall be provided with high grade stainless steel nuts bolts, plain and belle-ville washers.
- 4.02.04 Busbars shall be colour coded at regular intervals for easy identification. The markings on the bars shall be Red for R-phase, Yellow for Y-phase, and Blue for B-phase.
- 4.02.05 All contact surfaces shall be silver plated to ensure an efficient and trouble-free connection. All connection hardware shall be non-magnetic and shall have high corrosion resistance.

4.03.00 Insulators

- 4.03.01 Bus support insulators shall be bus post type, interchangeable, high creep, high strength, flame retardant, non hygroscopic, wet processed, fine glazed porcelain. Alternatively good quality cast resin / FRP insulators may be offered.
- 4.03.02 Insulator shall be mounted in such a way so as to permit easy removal or replacement without disassembly of the bus. The insulator mounting plate shall be designed for cantilever loading to withstand the short circuit. Support span shall be taken into consideration.
- 4.03.03 The conductor shall be fastened on the insulator through fixed and slip joints so as to allow conductor expansion or contraction without straining the insulator



4.04.00 Connections & Terminations

- 4.04.01 All matching flanges, gaskets, fittings, hardware and supports required for termination of the bus duct at the switchgears, transformers and other equipment shall be furnished.
- 4.04.02 In this connection the contractor is required to co-ordinate through the Engineer with the suppliers of the 415V Switchgears, transformers with regard to connection details, mechanical and thermal stresses.
- 4.04.03 Flexible connections both for conductor and enclosure shall be furnished :
- a. At all equipment termination to provide for misalignment upto 25 mm. in all directions.
 - b. Between bus duct supported from building steel to prevent transmission of vibration.
- 4.04.04 The equipment terminal connections shall be readily accessible and shall provide sufficient air gap for safe isolation of equipment during testing.
- 4.04.05 If the material of bus conductor and that of the equipment terminal connectors are different then suitable bi-metallic connectors shall be furnished.

4.05.00 Supporting Structures

- 4.05.01 All supporting structures required for hanging and/or supporting the complete bus duct shall be furnished. These include all members, indoor/outdoor posts, bolts, shims, base plates, beams, hangers, brackets, bracings and hardware.
- 4.05.02 All buses shall be adequately supported and braced to successfully withstand normal operation, vibration, thermal expansion, short circuit forces, and all specified design loads.
- 4.05.03 All steel members shall be hot-dip galvanised after fabrication. All hardware shall be of high strength steel with weather resistant finish.
- 4.05.04 For each shipping section, the enclosure shall be supported at minimum two positions.
- 4.05.05 Support shall be designed to provide tolerance of ± 12 mm. (1/2") in the horizontal and vertical directions.
- 4.05.06 The enclosure supporting arrangement shall be such that the bus duct load is not transmitted onto the terminations.

4.06.00 Grounding



4.06.01 A separately run Galvanized steel flat suitably clamped along the enclosure shall be used as the ground bus. All parts of the bus enclosure, supporting structures and equipment frames shall be bonded to above ground bus.

4.06.02 Ground pad shall be bolted type to accommodate 75x10 mm. Galvanized steel flats at two points at each end of termination, complete with suitable tapped holes, bolts and washers.

4.07.00 **Name Plate**

4.07.01 Suitable nameplate shall be furnished with each piece of equipment.

4.07.0.2 Materials for nameplate shall be anodized aluminium, 3 mm thick, using white letters on black background.

4.08.00 **Finish**

4.08.01 Except for supporting steel structures, which shall be galvanised, all other material shall be finished with a undercoat of high quality primer followed by two coats of synthetic enamel paint.

4.08.02 The interior surface of the bus duct enclosure shall be treated with matt black paint to enable efficient heat dissipation. The shade of exterior surface finish for indoor and outdoor portion shall be as indicated in the Annexure.

4.08.03 Pretreatment consisting of degreasing, derusting etc. shall be done on all fabricated parts before painting or galvanising.

4.08.04 Paints shall be carefully selected to withstand heat and weather conditions. The paint shall not scale off or crinkle or get removed by abrasion due to normal handling.

4.08.05 Sufficient quantities of all paints and preservatives required for touching up at site shall be furnished.

5.00.00 **TESTS**

The busduct shall be completely assembled and checked at the factory for correctness of alignment.

5.01.00 **Routine Tests:**

Busduct shall be subjected to the following tests:

- a) Visual inspection and verification of dimensions.
- b) Dry power frequency voltage withstand test for 1-min.
- c) Insulation resistance measurement.
- d) Milli-volt drop test.



- e) Water tightness test.

5.02.00 Type Test

5.02.01 Certified copies of type test certificates (not less than five years old) for similar equipment supplied by the bidder shall be submitted otherwise type test shall be carried out by the bidder within the contracted price and delivery schedule. Type test certificate for the following test shall be furnished:

- a. Impulse voltage withstand on a typical section of bus duct including one bend.
- b. Heat run test on representative sections of 3-phase bus duct, including one bend and flexible joints.
- c. Short circuit test on representative sections of 3-phase bus duct, including one bend. The sections having longest span between support insulators shall be chosen.
- d. Degree of protection test (air and water) on a representative section of bus duct

5.02.02 All cubicles shall be completely wired up at the factory and subject to wiring check and power frequency withstand tests on control/secondary wiring.

5.03.00 Test Witness

Tests shall be performed in presence of Owner's representative if so desired. The Contractor shall give at least seven (7) days' advance notice of the date when the tests are to be carried out.

5.04.00 Test Certificates

5.04.01 Certified reports of all the tests carried out at the works shall be furnished for approval of the Owner/Purchaser.

5.04.02 The equipment shall be dispatched from works only after receipt of Owner's written approval of the test reports.

5.04.03 Type test certificate (not more than 5 years old from date of contract) on any equipment, if so desired by the Owner, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

6.00.00 DRAWINGS, DATA & MANUALS

6.01.00 Drawings, Data and Manuals shall be submitted with the bid and for approval/information and subsequent distribution after the issue of Letter of



Intent in quantities and procedures as specified in General condition of contract and/or elsewhere in this specification.

6.02.00 To be Submitted with the Bid

6.02.01 General Arrangement Drawing - Plan and Sections

6.02.02 Typical details of bus insulator assembly, conductor/enclosure connections rigid & flexible, etc.

6.02.03 Bill of Materials.

6.02.04 Technical leaflets/Write-ups on various pieces of equipment offered.

6.02.05 Type test reports on similar equipment. The type test certificates shall not be more than 5 years old.

6.03.00 To be Submitted for Approval and Distribution

6.03.01 Calculation for temperature rise for bus and enclosure & Calculation for short circuit forces justifying the proposed arrangement.

6.03.02 Dimensional general arrangement drawings with cross-sections of Busduct layout

6.03.03 Detailed material list with parts number.

6.03.04 Details of bus insulator assembly, rigid & flexible connections of both bus conductor and enclosure, grounding provision, equipment termination arrangement etc.

6.03.05 Foundation Plan and loading.

6.03.06 Supporting steel structure and calculations.

6.03.07 Set up layout of the busduct for carrying out type test

6.03.08 Instruction manual for Busduct

The manual shall clearly indicate method of installation, check up and tests to be carried out before commissioning of the equipment. The manual shall also indicate detail procedure of field welding of conductor and enclosure

6.03.09 Any other relevant drawing or data necessary for satisfactory installation, operation and maintenance.

6.03.10 The bidder may note that the drawings, data and manuals listed herein are minimum requirement only. The bidder shall ensure that all other necessary write-up, curves, etc require to fully describe the equipment are to be submitted with the bid.



ANNEXURE – A

**RATINGS AND REQUIREMENTS
FOR 415V NON-SEGREGATED PHASE BUSDUCT**

1.0 General

Type	:	Non-segregated
Service	:	Indoor/Outdoor
Material:		
Enclosure	:	Aluminium Alloy/ Sheet steel (Aluminium Alloy for bus rating including and above 2000A and sheet steel fabricated type for normal bus current rating (<2000A))
Conductor	:	Aluminium/Aluminium alloy Aluminum alloy Grade 63401 (56.5% IACS)
Thickness of Enclosure	:	3 mm (min.)

IACS: International Annealed Copper Standard

2.0 System

Voltage	:	415V AC $\pm 10\%$
Phase	:	3-Phase and neutral
Frequency	:	50 HZ $\pm 5\%$
Combined voltage and Frequency variation	:	10% (absolute sum)

3.0 Rated current at 50°C ambient : To be decided by the Tenderers.

4.0 Short time current rating for one (1) second : 50 KA

5.0 One(1) minute power frequency withstand voltage (minimum) : 2.5 KV (rms)

6.0 Temperature rise (maximum) (over 50°C ambient)

a) Bus conductor



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- i) With Silver Plated bolted joints : 55°C
- ii) With Plain or Tin joints : 40°C
- b) Bus enclosure and structure : Accessible Portion 20°C
Non-accessible Portion 30°C
- c) Conductor temp. after short-circuit : 250 °C
- 7.0 Shipping Section (Maximum) : 3M
- 8.0 Insulator
 - voltage Class : 1.1 KV
 - material : Flame retardant, non-hygroscopic, high strength track resistant Epoxy, SMC Moulded / FRP / Porcelain
 - Creepage : 31 mm/kV
 - Conductor mounting : Fastened through fixed and slip joints
 - Phase to Phase clearance : 25 mm
 - Earth clearance : 25 mm
- 9.0 Rated continuous current : To be decided by the bidder





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2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: IIF

SECTION-VIII

**LOCAL CONTROL BOARDS / PANELS, LOCAL ISOLATING
SWITCH UNITS AND LOCAL PUSH BUTTON STATIONS**



Development Consultants Pvt. Ltd.

**Vol. II-F/Section-VIII
Local Control Boards, Panels, etc.**



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
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VOLUME: IIF

SECTION-VIII

**LOCAL CONTROL BOARDS / PANELS, LOCAL ISOLATING
SWITCH UNITS AND LOCAL PUSH BUTTON STATIONS**

1.00.00SCOPE OF SUPPLY

- 1.01.00 The following equipment shall be furnished with all accessories:
- a) Complete set of Local Control Boards / Panels: As required
 - b) Local Push Button Stations: As required
 - c) Local Isolating Switch Units: As required
- 1.02.00 Furnishing, Mounting, and wiring of all equipments, devices and accessories.
- 1.03.00 Floor Channel sill, vibration damping pad, and kick plates for all floor-mounted control boards / panels, complete with holding down bolts and nuts.
- 1.04.00 Mounting hardware for all control boards/panels, Local Push Button Stations (L.P.B Station), and Local Isolating Switch Units (L.I.S units).

2.00.00CODES AND STANDARDS

- 2.01.00 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.
- 2.02.00 Equipment and material conforming to any other standards, which ensure equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.
- 2.03.00 The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

3.00.00DESIGN CRITERIA

- 3.01.00The Local Control Boards / Panels shall be used for controlling incomers / bus-section / electrically operated radial breaker feeders of the associated PCC / PMCC / MCC. Necessary indications, meters, annunciations and mimic representation shall also be provided on these control boards / panels.

Local control of all drives shall be done from Process Control Boards / Panels, as described in respective sections of mechanical specification.





The Local Control Boards / Panels shall have to be duly matched with the Process Control Boards / Panels.

- 3.02.00 Local Push Button (L.P.B.) stations shall be used for controlling drives from local.
- 3.03.00 All equipment except L.I.S. Units and L.P.B stations, shall be located in a clean but hot, humid, and tropical atmosphere. The L.I.S. Units and L.P.B. stations shall be generally installed in a hot, humid, and tropical atmosphere, heavily polluted at places with fly ash and / or coal dust, and shall be suitable for outdoor service with degree of protection specified elsewhere in this specification.
- 3.04.00 All Control Boards / Panels, L.I.S. Units, and L.P.B. stations shall be liberally sized so as to provide spacious layout of equipment and devices with sufficient working space in between.
- 3.05.00 Adequate space / terminals shall be kept in the boards / panels for installing additional equipment in future.
- 3.06.00 For continuous operation at specified ratings, temperature rise of the various components / equipment shall be limited to the permissible values stipulated in the relevant standards and / or this specification.
- 3.07.00 All equipment / components thereof shall be capable of withstanding the mechanical forces and thermal stresses of the system short circuit current without any damage or deterioration of material.
- 3.08.00 Design, material selection, and workmanship shall be such as to present a neat appearance outside and inside with no welds, rivets, screws, or bolt heads apparent from the exterior surface of the boards / panels. All instrument cut-outs, mounting studs, and support brackets shall be accurately located.

4.00.00 SPECIFIC REQUIREMENTS

4.01.00 Construction

4.01.01 Local Control Boards / Panels

- a) Local Control Boards may consist of a number of vertical panels mounted side-by-side, in which case, they shall be bolted together to form a compact unit. Where two panels meet, the joints shall be smooth, close-fitting, and unobtrusive.
- b) The control boards / panels shall be totally enclosed type, conforming to degree of protection IP-55 or better.





- c) Generally, the local control boards / panels shall be free-standing, floor-mounted, dead-front assemblies. In some cases, however, wall-mounted type control boards / panels may also be accepted.
- d) Floor-mounted control boards / panels shall be assembled on channel / angle base plates with anti-vibration mountings and stainless-steel kick-plates.
- e) Control boards / panels shall be of folded sheet steel construction, minimum 2 mm. thick, and free from all surface defects.

The boards / panels shall have sufficient structural reinforcement to ensure a plane surface, to limit vibration, and to provide rigidity during shipment and installation.

- f) All floor-mounted panels shall have rear door.
- g) Doors shall have concealed type hinges and padlocking arrangement. Doors shall be grounded by flexible copper braid.
- h) All doors and removable covers shall be provided with neoprene rubber gaskets all round and latches sufficiently strong to hold them in alignment when closed.
- i) Working height of the panels shall be limited between 450 mm and 1800 mm above floor level.

4.01.02

Local Push Button Stations

- a) L.P.B. Stations shall be furnished in sheet steel enclosure of dust and vermin-proof, weather-proof, gasketed construction, suitable for outdoor use without canopy, and conforming to degree of protection IPW-55 or better.
- b) L.P.B. Stations shall be suitable for column / structure / wall mounting and shall be complete with push-buttons, terminal blocks, anodised aluminum inscription plate, two (2) nos. earthing terminals, removable gland plate along with crimp type tinned copper lugs and compression type glands for cable / conduit entry from top and bottom. The earthing terminals shall be suitable for connection to one (1) no. 8 SWG G.I. wire.
- c) L.P.B. Stations shall be of the following basic type and equipped with:
 - Type-A : One (1) START push-button and One (1) STOP push-button.
 - Type-B : One (1) OPEN (FORWARD) push-button, one (1) CLOSE (REVERSE) push-button, and one (1) STOP push-button.





Type-C : Flame proof type as per IS-2148. One (1) START push-button and One (1) STOP push-button

Type-D : One (1) STOP Lock-out switch.

Any other type of L.P.B. Station, if required, shall be subject to approval of the Purchaser.

- d) OPEN, CLOSE push-buttons shall be spring return to normal type. STOP push-buttons shall have mushroom head actuator with press-to-latch and turn-to-release feature.
- e) STOP push buttons shall be RED, OPEN buttons may be GREEN and CLOSE buttons may be YELLOW.
- f) All push-buttons shall have a minimum of two (2) Normally-Open and two (2) Normally-Closed electrically separate contacts, rated minimum 10 A at operating voltage.
- g) Wiring shall be done by 1/C – 2.5 sq.mm. 1100V grade, PVC / XLPE insulated, stranded copper conductor, cable. Each wire shall be identified at both ends by ferrules with wire designation.
- h) Terminals shall have provision for connecting at least two (2) nos. 2.5 sq.mm. copper cable and shall be rated for carrying continuously minimum 10 A at 240V A.C. and 2 A at 220V D.C.

4.01.03 WELDING SOCKETS

Industrial type 415V, 63A, 5 pin welding sockets shall be provided in sufficient number to facilitate extension of power supply to various machine tools, welding sets etc.

Welding socket outlets shall be provided at every 60m distance. The number of welding socket outlets for main technological plant units shall be decided based on requirement, approach etc. Generally the socket outlets shall be provided in such a manner so that using 30m flexible cable with welding set, total plant area can be covered. Up to three switch socket outlets shall be looped per feeder circuit. Sheet metal clad MCCB units shall be provided for feeding power to sockets.

The welding socket outlets shall be fed from separate distribution board.

- 4.01.04 Miscellaneous starter-cum-control panels shall house AC starters consisting of switches, fuses and contactors, bimetallic overload relays, auxiliary relays, time delay relays, push buttons, indicating lamps, variable speed modules comprising of thyristors and their controls, etc. The panels shall be complete with all the hardware necessary to perform required electrical starting and control functions.





4.02.00 Equipment Mounting

- 4.02.01 All equipment shall be so mounted that removal and replacement may be accomplished individually without interruption of services to others. No equipment shall be mounted on panel door.
- 4.02.02 All equipment mounted inside the panels shall be so located that their terminals and adjustments are readily accessible for inspection or maintenance.
- 4.02.03 For Local Control Boards / Panels control components such as push buttons, indicating lamps, selector switches, indicating meters etc. shall be flush mounted on the front face of the board / panel while switch fuses, supervision relays (AC / DC) etc. shall be mounted inside.

4.03.00 Name Plate

- 4.03.01 Nameplates shall be furnished for each panel and for each instrument or device mounted on the panel. Each LPB Station shall also be provided with a nameplate.
- 4.03.02 The material of the nameplate shall be lamicoid or approved equal, 3 mm thick, with white letters on black background.
- 4.03.03 The nameplates shall be held by self tapping screws. The size of nameplate shall be approx.. 20mmx75mm for equipment and 40mmx150mm for the panels. The size of the nameplate shall suit the overall dimensions of LPB station / L.I.S Unit. The size and location of nameplates shall be subject to acceptance of the Owner.
- 4.03.04 Nameplates for panels shall be provided both on the front and on the rear and shall be according to final device / designation list.
- 4.03.05 Control and meter selection switches shall have integral nameplates. Nameplates for all other devices shall be located below the respective devices.
- 4.03.06 Instruments and devices mounted on the face of the panels shall also be identified on the rear with the instrument or device number. The number may be painted on or adjacent to the instrument or device case.

4.04.00 Mimic Diagram

- 4.04.01 Mimic diagram of electrical connections shall be furnished on the front face of all electrical control panels.
- 4.04.02 Mimic buses shall be at least 3mm thick and 10mm in width, made of suitably treated metal strips or approved equivalent and colour coded to denote different voltages.
- 4.04.03 The mimic representation, colour and size of diagram are subject to the approval of the Owner.





4.05.00 **Illumination, Space Heating and Receptacles**

4.05.01 Each panel shall be provided with interior fluorescent tube with door switch, space heater with thermostat and 5A, 3-pin receptacle with plug. Third pin of the socket shall be effectively grounded through the metallic structure.

4.05.02 Tube, heater and receptacle circuits shall be suitable for available A.C. supply and furnished with individual ON-OFF switch.

4.05.03 The lamp shall be located at the ceiling and guarded with protective cage. Space heater shall be located near the floor so as not to pose any hazard to service personnel.

4.06.00 **AC / DC Power Supply**

4.06.01 Necessary A.C. and D.C. supplies as required for control and service shall be arranged by the Bidder. Duplicate feeder shall be arranged for A.C supply and D.C supply and the arrangement may be located in Bus P.T or Bus coupler panel with selector switch.

4.06.02 Isolating MCB's shall be provided for the incoming AC / DC power supplies and bus wires shall be run for power distribution to different panels.

4.06.03 MCB shall be provided for individual circuits for protection and also for isolation from bus wire without disturbing other circuits.

4.06.04 The fuse requirements in each panel shall be grouped in easily accessible fuse blocks or distribution panel. The grouping shall be done in a neat and orderly fashion.

4.06.05 Alarm relays with reverse flag & LED indication lamps shall be provided to annunciate failure of main incoming A.C. and D.C. power supplies and annunciation D.C. supply in each panel. Lamp indications shall be provided individually for main D.C. supply-1 fail, main D.C. supply-2 fail, and panel annunciation D.C. supply fail. A common A.C. electric bell shall be provided to give an audible alarm in case of failure of D.C. supply-1 / D.C. supply-2 / annunciation D.C. supply in any panel. A common push-button shall also be provided for cancellation of lamp indications and audible alarm.

4.06.06 Separate circuits shall be provided for (a) indication and alarm (b) tripping, and (c) control.

4.06.07 For lighting, auxiliary supply and space heating A.C. supply shall be used. D.C. supply shall be used for providing control supply to annunciator.

4.06.08 Bus wires of adequate capacity shall be provided to distribute the incoming supplies to different cubicles of a DB. Isolating switch fuse units shall be provided at each cubicle for A.C/D.C supplies.

4.07.00 **Wiring**





- 4.07.01 The panels shall be fully wired up at the factory to ensure proper functioning of control, protection and metering schemes.
- 4.07.02 All spare contacts of relays and switches shall be wired up to terminal blocks.
- 4.07.03 Wiring shall be done with flexible, heat resistant, 1100V grade, PVC insulated, switchboard wires with stranded copper conductor, 2.5sq.mm for current, control circuits and voltage circuits.
- 4.07.04 Each wire shall be ferruled by plastic tube with indellible ink print at both end having terminal Block No., terminal numbers, destination number as per approved wiring drawing.
- 4.07.05 All wire termination shall be made with insulated sleeve solderless crimping type tinned copper lugs. Wires shall not be tapped or spliced between terminals.
- 4.07.06 Wiring shall be neatly bunched in groups by non-metallic cleats or bands. Each group shall be adequately supported along its run to prevent sagging or strain on the termination.
- 4.07.07 Colour codes shall be used for wiring as per latest revision of IS: 375.
- 4.08.00 **Terminal Block**
- 4.08.01 Multi-way terminal blocks complete with necessary binding screws and washers for wire connections and marking strip for circuit identification shall be furnished for terminating the panel wiring and outgoing cables. Terminals shall be stud type, suitable for terminating 2nos. 2.5mm² stranded copper conductor and provided with acrylic insulating cover. Terminals for C.T. secondary leads shall have provision of shorting and grounding.
- 4.08.02 Not more than two wires shall be connected to one terminal. If necessary, a number of terminals shall be jumpered together to provide wiring points.
- 4.08.03 Each terminal shall be identified with designation as per approved schematic. At least 20% of the total number of active terminals shall be furnished as spare in each panel.
- 4.08.04 The wiring and terminals shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.
- 4.08.05 The terminal blocks shall be located to allow easy access and also to suit floor openings for cable entry.
- 4.08.06 The terminal blocks within the panels shall be mounted on vertical support brackets. The support brackets shall be tack welded to the interior sheet steel mounting plates of the cabinet. Support brackets shall not be welded directly to the walls of the enclosure. The terminal blocks shall be attached to the support brackets with round head machine screws.



- 4.08.07 Terminal blocks shall generally be mounted vertically with adequate spacing (not less than 100mm) between adjacent rows.
- 4.08.08 The bottom of the terminal block shall be at least 200mm above the incoming cable gland plate.
- 4.09.00 **Cable Entry**
- 4.09.01 The Control Boards / Panels L.P.B shall have provisions of cable entry from the bottom. Bottom plate shall be provided to make entry dust-tight. Suitable cable gland-plates shall be provided.
- 4.10.00 **Grounding**
- 4.10.01 50x6mm TINNED COPPER ground bus shall be provided in each control panel extending along the entire length of the assembly.
- 4.10.02 The ground bus shall have two-bolt drilling with GI bolts and nuts at each end and shall be suitable for connection to 50x6mm G.S. flat.
- 4.10.03 The ground bus shall be bolted to the panel structures and shall effectively ground the entire assembly. The cases of meters, relays and switching devices shall be grounded through the steel structure.
- 4.10.04 Whenever a circuit is grounded, a single wire from the circuit shall be run independently to the ground bus and connected to it.
- 4.11.00 **Painting**
- 4.11.01 Panels and Push-button Stations shall be finished with two coats of synthetic enamel paint as indicated in Section-I. Panels and push-button stations shall be stoved after each spraying of finish paint. Painting process shall be of powder coating.
- 4.11.02 Caution Notice plate shall be affixed at the back of each vertical panel.
- 4.12.00 **Switches**
- 4.12.01 Switches shall be dust protected, heavy duty, switchboard type, complete with escutcheon plate. Contacts shall be silver surfaced and rated minimum 10A at operating voltage.
- 4.12.02 415V Breaker control switches shall be 3-position (TRIP / NORMAL / CLOSE), 120°, spring return to neutral with lost motion device, non-lockable, sequence device, pistol grip handle, RED / AMBER / GREEN (circuit breaker CLOSED / TRIPPED-OR-TRIP CIRCUIT UNHEALTHY / OPEN) indicating lamps shall be provided with each breaker control switch.
- 4.12.03 Contact details and type of handle required for other types of switches are given below:





Sl. No.	Application	Switch description
a)	Synchronizing Selector switch	180°, 4-position (INCOMER-1/ BUS-SECTION/INCOMER-2/OFF), stayput type, pistol grip handle. OR 120°, 3-position (INCOMER/TIE/OFF) stayput type, pistol grip handle.
b)	Trip Selector Switch	120°, 3-position (INCOMER-1/ BUS-SECTION OR TIE/INCOMER-2), stayput type, pistol grip handle.
c)	Meter Selector Switch	4-position (OFF/R/Y/B for ammeter selector switch and OFF/R/Y/YB/RB for voltmeter selector switch), maintained contact, stay-put type, knob handle. Ammeter selector switches shall have make-before-break contacts.
d)	Auto-Manual Selector switch	120°, 2-position (AUTO/MANUAL), stayput type, non-lockable, spade handle.
e)	On-off Switch/Local- Remote Selector Switch	90°, 2-position (ON/OFF OR LOCAL/REMOTE), stayput type, non-lockable, spade handle
4.12.04	Any other type of switch, if required, shall be subjected to approval of Owner.	
4.12.05	Tenderer shall decide the number of switch contacts taking into account the scheme requirements and spares.	
4.13.00	Fuses	
4.13.01	Fuses shall be HRC, preferably link type, with a minimum interrupting capacity equal to the system short circuit current.	
4.13.02	Fuses shall be furnished complete with fuse boxes and fittings of such design as to permit easy and safe replacement of fuse element. Visible indication shall be provided on blowing of the fuse.	
4.13.03	Motor fuse characteristics and ratings shall be chosen to ride over motor starting period without blowing. The fuse on incoming feeder, wherever provided, shall be chosen to provide discrimination with motor / feeder fuses.	
4.14.00	Contactors	





- 4.14.01 Contactors shall be three pole, air break type, with non-bouncing silver / silver alloy contacts. Contactor duty shall be class III – category AC3 for unidirectional drives and AC4 for bi-directional and inching drives / class I – category DC2.
- 4.14.02 Each contactor shall be provided with minimum two (2) N/O and two (2) N/C auxiliary contacts rated 10A at operating voltage. The exact requirement of contacts shall be decided by the Tenderers taking into account the scheme requirements and spares.
- 4.14.03 Contactor starters shall comply with the requirements of IS-8544 (Part – 1) in respect of co-ordination of the characteristics of contactor, overload relay, and fuse. The type of co-ordination shall be Type-C as per IS-8544.
- 4.15.00 **Thermal Overload**
- 4.15.01 Thermal overload relays shall be three elements, positive acting, ambient temperature compensated with adjustable settings.
- 4.15.02 Single phasing preventer shall be provided as an inbuilt feature of the thermal overload relay.
- 4.15.03 Overload relays shall be manual reset type with 1 NO and 1 NC contacts. Resetting of relays shall be possible with compartment door closed. Colour of resetting button shall be BLACK.
- 4.15.04 Relays for fan motors having long starting time shall be saturable core C.T. operated.
- 4.16.00 **Current Transformers**
- 4.16.01 Current Transformers shall be cast resin type. All secondary connections shall be brought out to terminal blocks where wye (Y) or delta (Δ) connection shall be made.
- 4.16.02 Accuracy class of the current transformers shall be:
- a) Class PS for differential
 - b) Class 5P20 for other relaying
 - c) Class 0.5, ISF<5 for metering.
- 4.16.03 Drives requiring current monitoring shall be provided with current transducers with calibration for full-scale reading. The output shall be 4-20 Ma D.C; 4-18Ma of which shall correspond to the normal range and 18-20 Ma shall correspond to the suppressed range.
- 4.17.00 **Voltage Transformers**



- 4.17.01 Voltage Transformers shall be cast-resin type and shall have an accuracy class of 0.5.
- 4.17.02 High voltage windings of voltage transformer shall be protected by current limiting fuses.
- 4.17.03 Low voltage fuses, sized to prevent overload, shall be provided in all ungrounded secondary leads. Fuses shall be suitably located to permit easy replacement while the board / panel is energised.
- 4.18.00 **Push Button**
- 4.18.01 All push buttons shall be oil tight, heavy duty, push to actuate type, with coloured button and inscription plate marked with its function. The colour of "ON" and "OFF" push buttons shall be RED and GREEN respectively. RESET push buttons shall be coloured black.
- 4.18.02 Each push button shall have minimum 2 NO + 2 NC contacts, rated 10A at 240V AC and 2A at 220V DC.
- 4.18.03 Push buttons shall be shrouded type except for emergency trip button, which shall be mushroom type for easy identification.
- 4.19.00 **Lamps**
- 4.19.01 Lamps shall be LED type.
- 4.19.02 Lamps shall be clustered LED type. The body shall be made of Poly Carbonate Unbreakable Lens. LED shall be protected by inbuilt fuse with surge suppressor or leakage voltage glow protection. LED circuit shall be PCB mounted. Intensity shall be greater than 200 mcd. All Push Button lamp shall be as per LED indicating lamp.
- 4.20.00 **Operating Range**
- All instruments shall be generally suitable for operation on 1A/ 5A C.T. secondary circuit and/or 110V V.T. secondary circuit.
- 4.21.00 **Meters**
- 4.21.01 All indicating instruments shall be switchboard type, back connected, suitable for flush mounting, 96x96mm with 240 Deg. Scale, antiglare glass and accuracy class of $\pm 2\%$ of the full scale. The dials shall be made of such material as to ensure freedom from warping, fading, and discolouring during the lifetime of the instruments.
- 4.21.02 All indicating instruments shall be enclosed in dust-tight cases suitable for tropical use.
- 4.21.03 Meters shall have provision for zero-adjustment from front of the panel.



- 4.21.04 Meters shall be compensated for temperature errors and factory calibrated to read the primary quantities directly without using a multiplying factor.
- 4.21.05 D.C. ammeters, wherever required, shall be provided with external shunt if the current exceeds 5A. The rated voltage drop for the shunts shall be 75mv/150mV as required.
- 4.22.00 **Annunciator System**
- 4.22.01 Each control panel shall be provided with an annunciator window board. The annunciator boards shall be back-connected and suitable for semi-flush mounting.
- 4.22.02 The annunciator system shall be solid state type with optical isolation for input signals. The functional requirements shall be as per Annexure-C.
- 4.22.03 Each annunciator group shall be independent, complete with its own power supply, acknowledge-reset-test buttons and other necessary accessories. Hooter for audible alarm shall be common for each control panel assembly.
- 4.22.04 Each annunciator group shall be provided with a common alarm relay for group alarm annunciation in remote control room. The common alarm relay shall operate on actuation of any alarm point of the group.
- 4.22.05 The annunciator shall be non-integral type with hardware box mounted separately for easy access and maintenance.
- 4.22.06 Audible alarms with different tones shall be used for trip, non-trip and ring back functions.
- 4.22.07 The window size shall be such as to accommodate minimum three (3) lines of twelve (12) characters each. Each character shall be minimum 4.75 mm high.
- 4.22.08 The annunciator system shall be suitable for operation from both NO and NC type initiating contacts.
- 4.22.09 At least 10% spare channels and window facia shall be provided in each annunciator group.
- 4.23.00 **Relays**
- 4.23.01 Auxiliary relays shall be furnished in fixed, dust-tight, casings and mounted inside the panel.
- 4.23.02 The relays shall have adequate numbers of contacts to suit scheme requirements. Besides, each relay shall have spare contacts for future use.
- 4.23.03 Contacts shall be silver-surfaced, bounce-free, and capable of repeated operation without deterioration.
- 4.24.00 **Auxiliary Devices**





4.24.01 The Bidder shall furnish, install, and wire-up all auxiliary devices such as timing / switching / lockout / auxiliary relays / auxiliary contactors, etc. as required for the proper functioning of the approved schemes.

4.24.02 The Bidder shall number the various types of relays and contactors as per the numbers appearing in the approved Schematic/Wiring appearing in the approved Schematic/Wiring diagrams.

5.00.00 TESTS

5.01.00 All Control Boards / Panels, L.I.S. Units and L.P.B. Stations shall be completely assembled, wired, adjusted and tested at the factory prior to shipment to ensure accuracy of wiring, correctness of control scheme and proper functioning of all components.

5.02.00 Routine Tests

5.02.01 The tests shall include wiring continuity tests, high voltage tests, insulation measurement test both before and after high voltage test, and functional tests to ensure accuracy of wiring operation of the control / protection / metering schemes and individual equipment. Detailed test report including procedure and drawing shall be furnished.

5.02.02 All switches, meters, relays and other devices shall be tested and calibrated in accordance with relevant IS standards.

5.03.00 Type test certificate on any equipment, if so desired by the Owner shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design. Type test certificate shall not be later than 10 years from the award of contract.

6.00.00 DRAWINGS, DATA & MANUALS

6.01.00 To be submitted with the Bid

6.01.01 General Arrangement drawings and cross-section of each equipment showing constructional features, cable entry points etc.

6.01.02 Typical foundation plan.

6.01.03 Bill of Materials.

6.01.04 Technical leaflet and Catalogues of:

- a) Local Control Boards and Local Starter-cum-Control panels
- b) Local Push Button Stations





- c) Switches and Lamps
- d) Meters, relays, push buttons
- e) Switch fuse units
- f) Annunciator System
- g) Auxiliary Devices
- h) Terminal Blocks/glands.
- i) Temperature Scanner

6.02.00 To be submitted after award of Contract

- 6.02.01 Dimensional general arrangement of all Local Control Boards, Local Starter-cum-control panels and Local Push Button Stations showing equipment disposition and identification along with space requirements and cable entry points.
- 6.02.02 Foundation plan and loading diagram, clearly showing panel fixing arrangement, floor opening for cable entry etc.
- 6.02.03 Cross section with parts list.
- 6.02.04 Schedule of materials and label inscriptions.
- 6.02.05 Detailed Control Schematics clearly showing terminal and wire numbering.
- 6.02.06 Wiring diagram showing all equipment and devices in their relative physical positions and all wiring upto the terminal blocks.
- Equipment/Device and terminals shall be identified with designations/numbers as per approved schematic and connection diagrams.
- 6.02.07 Data Sheets and Instruction Manual for each piece of equipment.
- 6.03.00 Tenderers may note that the drawings, data and manuals listed are minimum requirements only. The Bidder shall ensure that all other necessary write-ups, curves and information required to fully describe the equipment offered are submitted with his bid.



ANNEXURE – A

RATINGS & REQUIREMENTS

1.0 Local Control Board

1.1 General

Type	:	Fixed type
Service	:	Indoor
Enclosure	:	IP-55 or better

1.2 System

Voltage	:	415 Volt $\pm 10\%$
Phase	:	3
Frequency	:	50 Hz $\pm 5\%$
System	:	Solidly grounded

1.3 Rated Current at 50°C

Bus bar	:	To be decided by the Tenderers
Switches	:	To be decided by the Tenderers

1.4 Short Circuit Rating

Interrupting	:	50 KA
Short time for 1 Second	:	50 KA

1.5 Insulation Level : 2.5 KV for 1 min.



ANNEXURE – B

A.C. / D.C. POWER SUPPLY

1.0 System Voltages

All systems shall be designed for satisfactory operation from the following power supply: -

A.C. Supply : 240Volt, 1Phase, 50Hz, 2wire, effectively grounded system.

Fault level 50kA rms Symmetrical.

D.C. Supply : 220V, 2Wire, ungrounded.

Fault level 25*kA

* Indicative only; actual value to be decided by the bidder and to be substantiated by calculation.

2.0 Permissible Variation

Equipment and accessories shall be suitable for operation over the entire range of voltage / frequency variation as listed below:

A.C. Supply : Voltage $\pm 10\%$

: Frequency $\pm 5\%$

: Combined Volt + Freq. 10% (absolute sum)

D.C. Supply : Voltage +10% to -15%

Service Voltage for
Control Panels /

Distribution Boards : 240V $\pm 10\%$, 1ph, 50Hz $\pm 5\%$



ANNEXURE – C

FUNCTIONAL REQUIREMENTS OF ANNUNCIATOR

TYPE

The annunciation system shall be manually reset type with ring back facility, suitable for operation from 220V DC ungrounded supply.

FUNCTION

The sequence of operation shall be similar to ISA-2A with fast/slow blinking as detailed below:

Field Condition	Visual Display	Audible Alarm	Ringback Alarm
Normal	Off	Silent	Silent
Abnormal	Fast blinking	On	Silent
Acknowledge	Steady On	Silent	Silent
Return to normal	Slow blinking	Silent	On
Reset	Off	Silent	Silent
Normal Before Acknowledge	Slow blinking	On	On
Acknowledge	Steady On	Silent	On
Reset	Off	Silent	Silent
Test	Fast blinking	On	On



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-F

SECTION-IX

11/3.45KV AUXILIARY POWER TRANSFORMER



Development Consultants Pvt. Ltd.

**Vol. II-F/Section-IX
11/3.45KV Auxiliary Power
Transformers**



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VOLUME: II-F

SECTION-IX

11/3.45KV AUXILIARY POWER TRANSFORMER

1.00.00 SCOPE OF SUPPLY

1.01.00 11KV / 3.45KV 3-Phase, Auxiliary Power Transformer

1.02.00 Each transformer shall be furnished complete with:

- Fittings and accessories
- Auxiliary equipment
- First filling of oil including 10% extra

1.03.00 All relevant drawings, data and instruction manuals

2.00.00 CODES AND STANDARDS

2.01.00 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS), IEC and CBIP Specifications except where modified and/or supplemented by this specification.

2.02.00 Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

2.03.00 The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

2.04.00 HVWS protection shall be provided as per CEA guidelines if the oil capacity more than 2000 liters or capacity of transformer 10MVA or more

3.00.00 DESIGN CRITERIA

3.01.00 The transformer shall be installed in hot, humid and tropical atmosphere. All equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.

3.02.00 The transformer shall be capable of continuous operation at rated output under the following condition:

Voltage variation : $\pm 10\%$

Frequency variation : +5 to -5%





Combined voltage and frequency : 10%
variation absolute sum

- 3.03.00 The transformer including CTs, shall be capable of withstanding the short circuit stresses due to a terminal fault on one winding with full voltage maintained on the other winding for minimum period of two (2) seconds.
- 3.04.00 The transformer shall be free from annoying hum or vibration. The design shall be such as not to cause any undesirable interference with radio or communication circuits.
- 3.05.00 The noise level shall be limited to the value specified by NEMA Standard Publication No. TR-1-1993 when measured in accordance with conditions outlines in ANSI/IEEE C57.12.90-1999/IS13964/CBIP publication.
- 3.06.00 The impedance of the transformers shall be selected keeping in view the short circuit level of the HT switchgear and the voltage dip at motor terminals shall not exceed the limits specified under other specifications e.g. cabling system, motors etc.

4.00.00 SPECIFIC REQUIREMENTS

4.01.00 Tanks

- 4.01.01 The tank shall be fabricated from good commercial grade low carbon steel of adequate thickness.
- 4.01.02 The tank wall shall be reinforced by stiffener to ensure rigidity so that it can withstand without any deformation (a) mechanical shock during transportation, (b) oil filling by vacuum, (c) short circuit forces and (d) continuous internal pressure of 35kN/m² over normal hydrostatic pressure of oil.
- 4.01.03 All removable covers shall be provided with weatherproof, hot oil resistant, resilient gaskets. The design shall be such as to prevent any ingress of water into or oil from the tank.
- 4.01.04 The tank shall be provided with one set of bi directional rollers for rolling the transformer parallel to either centre line.
- 4.01.05 Jacking pads, lifting eyes and pulling lugs shall be provided to facilitate movement of the transformer. All heavy removal parts shall be provided with eyebolt for ease of handling.
- 4.01.06 Manholes/hand-holes of sufficient size shall be provided for access to leads, windings, bottom terminals of bushings and taps.
- 4.01.07 Suitable guide shall be provided in the tank for positioning the core and coil assembly.





4.02.00 Core & Coils

- 4.02.01 The core shall be built up with high grade, non-aging, low loss, high permeability, grain oriented, cold-rolled silicon steel laminations especially suitable for core material.
- 4.02.02 The coils shall be manufactured from electrolytic copper conductor and fully insulated for rated voltage. Insulation shall be of Class A.
- 4.02.03 Insulating material shall be of proven design. Coils shall be so insulated that impulse and power frequency voltage stresses are minimum.
- 4.02.04 Coil assembly shall be suitably supported between adjacent sections by insulating spacers and barriers. Bracing and other insulation used in assembly of the winding shall be arranged to ensure a free circulation of the oil and to reduce the hot spot of the winding.
- 4.02.05 All leads from the windings to the terminal board and bushings shall be rigidly supported to prevent injury from vibration or short circuit stresses. Guide tube shall be used where practicable.
- 4.02.06 The core and coil assembly shall be securely fixed in position so that no shifting or deformation occurs during movement of transformer or under short circuit stresses.
- 4.02.07 The maximum flux density in any part of core and yoke at rated MVA, voltage and frequency shall be such that under 10% continuous over voltage condition it does not exceed 1.9 tesla at any tap position.

4.03.00 Tapping

- 4.03.01 Off circuit tap changer (OCTC) for auxiliary power transformer as specified in the annexure shall be provided on the high voltage winding.
- 4.03.02 The transformer shall be capable of operation at its rated KVA on any tap provided the voltage does not vary by more than $\pm 10\%$ of the rated voltage corresponding to the tap.
- 4.03.03 The winding including the tapping arrangement shall be designed to maintain electromagnetic balance between HV and LV windings at all voltage ratios.
- 4.03.04 The off-circuit tap changing will be affected by a gang operated switch for three-phase unit. Mechanical/electrical protection to prevent operation of tap changer when transformer is in energized condition. Arrangement shall such that switch can be operated at standing height from ground level.
- 4.03.05 The operating handle can be padlocked at any tap position. The design shall be such that the lock cannot be inserted unless the contacts are correctly engaged.



- 4.03.06 The mechanism shall be provided with a mechanical tap position indicator and an operation counter.
- 4.03.07 All contacts shall be silver plated and held in position under strong contact pressure to ensure low contact drop and avoid pitting.
- 4.04.00 **Insulating oil**
- 4.04.01 The transformer shall be filled with mineral insulating oil suitably inhibited to prevent sludging. The insulating oil shall conform to IS 12463.
- 4.04.02 First filling of oil along with 10% excess shall be furnished for each transformer. Excess Oil shall be supplied in non-returnable containers suitable for outdoor storage.
- 4.04.03 Oil preservation shall be by conservator tank with silica gel breather. It shall be complete with level gauges, pipes, drain valve, buchholz relay with shut off valves at both sides etc. The level gauges shall be so placed that same can be readable standing from ground.
- 4.05.00 **Bushing**
- 4.05.01 Bushing rated below 52KV voltage class shall be solid porcelain or oil communicating type.
- 4.05.02 Bushings shall be provided with terminal connectors of approved type and size.
- 4.05.03 Bushing location shall provide adequate phase and ground clearances.
- 4.05.04 Bushing (both phase side as well as neutral) shall be provided with bushing type current transformer (CT).
- 4.06.00 **Terminal Arrangements**
- 4.06.01 The physical position of the terminals and the markings shall be as per relevant IS/IEC.
- 4.06.02 For auxiliary power transformers, high voltage terminals shall be brought out thru' top cover / side wall mounted bushings enclosed inside phase segregated detachable type cable end-box with matching flanges for connection to XLPE cables. The contractor shall furnish all necessary details of cables in this connection for proper co-ordination. The detachable type cable end-box shall be furnished by transformer manufacturer.
- 4.06.03 Cable-end box shall be self-supporting, weatherproof, air filled type with sufficient space inside for termination and connection of cables.
- 4.06.04 Cable-end box shall be furnished complete with removable gland plate, armor clamps and hardware.



- 4.06.05 Low voltage terminals, for busduct connection, shall be brought out thru' top cover mounted bushings. Bushings shall have matching flange around.
- 4.06.06 Low voltage winding neutral shall be brought out thru' top cover mounted bushing.
- 4.06.07 In general, the arrangement shall be such as to permit removal of transformer without dismantling the busduct/ cable installation.
- 4.06.08 Two ground conductors of 75 x 10mm G.I. flats shall run from neutral bushing to the bottom of the tank over pin insulators for connection to Station ground grid.
- 4.07.00 **Cooling System**
- The transformer cooling system shall be oil natural air natural.
- 4.08.00 **Marshalling Box**
- 4.08.01 A sheet steel, weatherproof, IPW55, marshalling box shall be provided for the transformer. The box shall contain all auxiliary devices except those, which must be located directly on the transformer.
- 4.08.02 All terminal blocks for necessary cable connection shall be located in this box.
- 4.08.03 The marshalling box shall be provided with cubicle lamp with door switch, space heater with thermostat and removable cable gland plate.
- 4.09.00 **Wiring**
- 4.09.01 All control, alarm and indication devices provided with the transformer shall be wired upto the terminal blocks.
- 4.09.02 Wiring shall be done with flexible, 1100V grade PVC wires in conduit or PVC armored cable. Minimum wire size for control cable shall be 2.5mm². For other CTs & PT circuit minimum cable size shall be 2.5mm². Not more than two wires shall be connected to a terminal. 20% spare terminals shall be provided and these spare terminals shall be uniformly distributed and mounted on each terminal blocks. Minimum 100mm distance shall be maintained between two sets of terminal blocks.
- 4.09.03 Multi-way terminal block complete with mounting channel, binding screws and washers for wire connections and marking strip for circuit identification shall be provided for terminating the panel wiring. Terminals shall be stud type, suitable for terminating 2 nos. 2.5mm² stranded copper conductor and provided with acrylic insulating cover.
- 4.09.04 All devices and terminal blocks shall be identified by symbols corresponding to those used in applicable schematic or wiring diagram. Each wire shall be





identified, at both ends, with interlocking type permanent markers bearing wire numbers as per Contractor's Wiring Diagrams. AC / DC wiring shall have separate color-coding.

4.09.05 Wire termination shall be made with crimping type connectors with insulating sleeves. Wires shall not be spliced between terminals.

4.10.00 **Grounding**

4.10.01 The grounding pads, located on the opposite sides of the tank, shall be provided for connection to the station ground grid.

4.10.02 Grounding pad shall have clean buffed surface with two tapped holes, M10 G.I. bolts and spring washers for connection to 75x10mm G.I. flat.

4.10.03 Ground terminals shall be also provided on marshalling box to ensure its effective earthing.

4.10.04 For continuity of earth connection, all gasketed joints shall be provided with minimum two (2) numbers copper strip jumpers of adequate size.

4.11.00 **Auxiliary Supply**

4.11.01 A.C. supply shall be made available to each transformer by two separate feeders one normal and the other standby.

4.11.02 Isolating switch fuse unit shall be provided for each of the incoming supply along with automatic changeover scheme to switch on to the standby source in case of failure of the normal supply.

4.12.00 **Auxiliary Equipment**

4.12.01 Neutral bushing CTs shall be furnished when specified in the annexure.

4.12.02 The arrangement shall be such that the C.T. can be removed from the transformer without removing the tank cover.

4.12.03 CT secondary leads shall be wired upto the terminal blocks. The terminals for CT secondary leads shall have provision for shorting and earthing.

4.13.00 **Painting**

4.13.01 All steel surfaces shall be thoroughly cleaned by sand blasting or chemical agents as required, to produce a smooth surface free of scales, grease & rust.

4.13.02 The internal surfaces in contact with insulating oil shall be painted with heat resistant insulating varnish which shall not react with and be soluble in the insulating liquid used.

4.13.03 The external surfaces, after cleaning, shall be given a coat of high quality red oxide or yellow chromate primer followed by filler coats.





- 4.13.04 The transformer shall be finished with two coats of battle ship grey (IS Shade # 632) synthetic enamel paint.
- 4.13.05 The paints shall be carefully selected to withstand tropical heat, rain etc. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.
- 4.13.06 Sufficient quantity of touch up paint shall be furnished for application after installation at site.
- 4.13.07 If it is considered necessary, the transformer may be given a further coating at site by the Owner. The Bidder shall therefore indicate the type and quality of the paint with full specification for this purpose.
- 4.13.08 All supporting structures and hardware shall be hot dip galvanized.

4.14.00 Transportation

Transformer will be dry air filled during transportation, to avoid release of N₂ in the atmosphere when transformer would be purged with dry air at site.

5.00.00 TESTS

5.01.00 Routine Tests

During manufacture and on completion, all transformers shall be subjected to the routine tests in accordance with latest IEC 60076 and its different parts.

In addition, the following tests shall be performed on each transformer:

- 5.01.01 Transformer tank with coolers shall be tested for leaks with normal head of oil plus 35 KN/m² for a period of 8 hours. If any leak occurs, the test shall be conducted again after all leaks have been repaired.
- 5.01.02 During fabrication stage, the tank shall be pressure tested with air at a pressure corresponding to twice the normal head of oil or normal pressure plus 35KN/m² whichever is lower for a period of one hour. Also the tank designed for full vacuum shall be tested for maximum internal pressure of 3.33KN/m² for one hour. The permanent deflection of flat plates shall not exceed CBIP specified figures on release of excess pressure of pressure test and on release of vacuum.
- 5.01.03 After assembly, each core shall be pressure tested for one minute at 2KV (r.m.s.) A.C. between all bolts, side plates, structural steel works & the core.
- 5.01.04 The wiring for auxiliary power and control circuitry shall be subjected to withstand one minute power frequency test with 2.0KV (r.m.s.) to earth.
- 5.01.05 Dielectric special tests as per IEC60076-3
- 5.01.06 Measurement of acoustic sound level





5.01.07 Measurement of zero sequence impedance(s) on three-phase unit

5.02.00 **Type Tests**

Following type tests shall be performed on one transformer in accordance with relevant standard:

- a) Dielectric type test (IEC60076-3)
 - i) Switching impulse withstand voltage test
 - ii) Lightning impulse withstand voltage test.
 - iii) Separate-source withstand voltage test.
 - iv) Induced AC over voltage withstand test.
- b) Temperature rise test.

5.03.00 **Miscellaneous**

All component parts and auxiliary equipment such as oil, bushings, C.Ts etc. shall be routine tested as per relevant Indian Standards. Testing of oil to be done as per IS 335

5.04.00 **Test Witness**

Tests shall be performed in presence of Owner's representative if so desired by the Owner/Purchaser. The Contractor shall give at least seven (7) days' advance notice of the date when the tests are to be carried out.

5.05.00 **Test Certificates**

5.05.01 Certified reports of all the tests carried out at the works shall be furnished in six (6) copies for approval of the Owner.

5.05.02 The equipment shall be dispatched from works only after receipt of Owner's written approval of the test reports.

5.05.03 Type test certificates of not older than five (5) years from date of contract on any equipment, if so desired by the Owner, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

6.00.00 **DRAWINGS, DATA & MANUALS**

6.01.00 Drawings, Data and Manuals shall be submitted with the bid and for approval and subsequent distribution after the issue of Letter of Intent in quantities and



procedures as specified in General condition of contract and/or elsewhere in this specification.

- 6.02.00 **To be submitted with the Bid**
- 6.02.01 Typical general arrangement drawings showing disposition of cooler banks, fittings, terminal arrangement etc.
- 6.02.02 Transport/shipping dimensions and weights, space required for handling parts for maintenance.
- 6.02.03 Technical leaflets on major components and fittings
- 6.02.04 Write-ups on OLTC if specified, oil preservation and cooling system.
- 6.02.05 Type test certificates including short circuit test report of a similar transformer (as per the guidance for identification of a similar transformer as defined in Annexure-A of IEC 60076-5). The type test certificates shall not be more than 5 years old.
- 6.03.00 **To be submitted for Approval and Distribution**
- 6.03.01 Dimensional general arrangement drawing showing disposition of cooler banks and various fittings
- 6.03.02 Transport/shipping dimensions with weights, wheel base detail, un-tanking height etc.
- 6.03.03 Foundation plan & loading
- 6.03.04 Terminal arrangements and Bus Duct flange details.
- 6.03.05 Control schematics and wiring diagrams
- 6.03.06 GA of Marshalling Box, Cooler control panel, OLTC cabinet, RTCC panel as applicable.
- 6.03.07 Rating and Diagram Plate
- 6.03.08 Drawings of major components like bushing, CTs etc
- 6.03.09 Quality Assurance Plan.
- 6.03.10 Test certificates of transformer and auxiliary equipment.
- 6.03.11 Any other relevant drawing or data necessary for satisfactory installation, operation and maintenance.
- 6.03.12 Instruction manuals on transformer and its various fittings



The manual shall clearly indicate method of installation, check-ups and tests to be carried out before commissioning of the equipment.

6.04.00

The Bidder may note that the drawings, data and manuals listed are minimum requirement only. The Bidder shall ensure that all other necessary write-ups, curves and information required to fully describe the equipment offered are submitted with his bid.



ANNEXURE – A

RATINGS AND REQUIREMENTS

1.0	Application	:	Auxiliary Power Transformer
2.0	Service	:	Outdoor, step down
3.0	Type	:	Oil immersed
4.0	Reference standard	:	IS 2026 & IEC60076
5.0	Rated power	:	Shall be decided by bidder during detailed engineering
6.0	Rated voltage ratio (line to line)	:	11 / 3.45KV
7.0	Number of phases of each unit (1-Ph or 3-PH unit)	:	3
8.0	No. of phases	:	3
9.0	Rated frequency	:	50Hz
10.0	Cooling system		
10.1	Type of Cooling	:	ONAN
11.0	Temperature rise		
11.1	Design ambient temperature	:	50°C
11.2	Temperature rise above design ambient temperature.		
	i) in oil by thermometer	:	50°C
	ii) in winding by resistance	:	55°C
12.0	Insulation level (LI: Lightning Impulse Voltage, AC: Short duration induced & separate source AC withstand Voltage)		
	HV- (LI/AC)	:	75 KVp / 28KVrms
	LV- (LI/AC)	:	40 KVp / 10KVrms
	LV Neutral – (LI/AC)	:	40 KVp / 10 KVrms



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13.0	Vector group	:	Dyn11
14.0	Short-circuit impedance at 75°C at principal tap	:	bidder to decide
15.0	Parallel operation of transformer	:	Yes, Momentary
16.0	Type of taps provided	:	Off Circuit, full capacity
16.1	Taps provided on	:	H.V. winding
16.2	Range of taps	:	$\pm 2 \times 2.5\%$
16.3	Method of Tap charge control-		
	i) Manual local	:	Yes
	ii) Electrical local	:	No
	iii) Electrical Remote	:	No
	iv) Automatic	:	No
17.0	Type of tank construction (bell type or conventional tank with cover)	:	Conventional
18.0	Type of oil preservation system	:	As per specification
19.0	System earthing -		
	H.V.	:	Unearthed
	L.V.	:	Non-effectively earthed through resistance
20.0	Terminal arrangement -		
	H.V.	:	11KV XLPE Cable
	L.V.	:	Segregated Phase Busduct
	L.V. Neutral	:	1/C Al, XLPE Cable
21.0	Transformer bushing	:	HV LV HV-N
21.1	Voltage class KV(r.m.s.)	:	12 3.6 3.6
21.2	Material	:	solid porcelain or oil communicating type.
21.3	Creepage distance mm	:	31 mm/KV





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21.4	Minimum clearances for	:	Phase to Phase	Phase to earth
	HV mm	:	160	160
	LV mm	:	120	120
22.0	System fault Level			
	HV Side	:	40 KA (r.m.s.)	
	LV Side	:	40 KA (r.m.s.)	
23.0	Max. Flux density in any part of core & Yoke at 110% rated voltage	:	1.9 Tesla	
24.0	Max. Noise level in accordance with Conditions specified in NEMA Std. TR-1	:	As per NEMA std. TR-1	
25.0	Auxiliary supply	:	415V±10%, 3-ph., 50Hz ±5%	
		:	220V +10%, -15% 2 wire DC	





ANNEXURE – B

Transformer shall be equipped with fittings and accessories as listed below :-

1. Oil conservator with filler cap, drain plug, plain oil level gauge
2. Oil preservation system complete with accessories.
3. Air release plugs.
4. Explosion vent should be double diaphragm type.
5. 150 mm dial magnetic oil level gauge with low level alarm contacts
6. 150 mm dial oil temperature indicator with maximum reading pointer and electrically separate contacts for trip and alarm.
7. 150 mm dial winding temperature indicator with maximum reading pointer and electrically separate sets of contacts for trip, alarm. Thermometer pockets.
6. Double float Buchholz relay with gas release cock, shut-off valve on either sides with separate sets of contacts for trip and alarm.
7. Filter valve with threaded adopter (top and bottom).
8. Drain valve with threaded adopter.
9. Sampling valve.
10. Necessary valves for detachable cooler units.
11. Jacking pads, handling and lifting lugs.
12. Cover lifting eyes.
13. Bi-directional flanged wheels and skids.
14. Clamping device with bolts & nuts.
15. Hand-hole of sufficient size for access to interior of the tank.
16. Two-grounding pads.
17. Weather proof marshalling box for housing control equipment and terminal connections.
18. H.V, L.V and LV bushing terminal connectors.
19. Rating and terminal marking plates.
20. Bushing CT(s) for phase and/or neutral side(s), where required

Note : All indication, alarm, trip contacts provided shall be rated for 0.5A at 220 V D.C. and 5A at 230 V A.C.





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Tuticorin, Tamil Nadu**

**VOLUME: II-F
SECTION-X**

NEUTRAL GROUNDING RESISTOR



Development Consultants Pvt. Ltd.

**Vol. II-F/Section-X
Neutral Grounding Resistor**



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VOLUME : II-F

SECTION-I

NEUTRAL GROUNDING RESISTOR

1.00.00 SCOPE OF SUPPLY

- 1.01.00 Type, rating and connection of the equipment listed below are detailed in the Annexures. The equipment shall be offered in strict compliance with the same.
- 1.02.00 3300 Volts, 300 Amps for 10 seconds Neutral Grounding Resistor: Four (4) Numbers.
- 1.03.00 Each Resistor shall be furnished complete with:
- a) Fittings and accessories.
 - b) Auxiliary Equipment
 - c) All supporting steel work and hardware.
- 1.04.00 All relevant drawings, data and instruction manuals
- 1.05.00 Recommended spare parts for three (3) years continuous operation

2.00.00 CODES AND STANDARDS

- 2.01.01 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.
- 2.01.02 Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.
- 2.01.03 The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

3.00.00 DESIGN CRITERIA

- 3.01.00 The Neutral Grounding Resistor (NGR) shall be used for non-effective grounding of 3300 volt System of the plant. 3.3 kV NGRs shall be connected between the 3300 volt winding neutral point and earth of FGD Auxiliary Transformers.





- 3.02.00 Neutral Grounding Resistor shall be used to limit the magnitude of earth fault current so that damage of electrical equipment is reduced, safety of personnel is increased and sensitive, selective earth fault protection can be provided.
- 3.03.00 The NGR shall be installed in hot, humid and tropical atmosphere. All equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.
- 3.04.00 The rated time for the earth fault current or specified thermal current shall be 10 seconds.
- 3.05.00 The Resistor unit shall be air-cooled type suitable for installation at outdoor locations. shall meet arduous, heavy duty industrial application, unbreakable, rigid, resilient & rustless. The thermal loading of the resistance box should be uniform.
- 3.06.00 The resistor enclosure shall be made of sheet steel and shall have minimum thickness of 2 mm.

4.00.00 SPECIFIC REQUIREMENTS

4.01.00 Resistor

- 4.01.01 The resistor element shall be made of non aging stainless steel having high electrical resistivity and low temperature coefficient of resistance. Group of resistor elements shall be mounted together between end plates to form a bank. Banks are then to be connected in series-parallel combination to provide the current and ohmic value required. Adjacent banks shall be insulated from each other and the metal frame.
- 4.01.02 The resistor unit shall consist of a no. of elements. All the elements shall be mounted inside the cubicle so as to ensure ease of inspection and replacement of individual element.
- 4.01.03 Each Resistor element shall possess a balanced combination of both Mechanical and Electrical properties over the entire intended operating temperature range without any harmful effect on the elements and their accessories.
- 4.01.04 All the resistor elements constituting the NGR shall be assembled and supported inside the cubicle in such a way that no distortion or breakage will occur during the passage of through fault current to earth.
- 4.01.05 All element connections shall be bolted type to ensure stable resistance value throughout the working life of the unit.
- 4.01.06 Wet process type brown glaze porcelain insulators shall be used for supporting resistor elements. Porcelain insulators shall have high creep age value suitable for heavily polluted atmosphere charged with dust particles.
- 4.01.07 The tie rod shall be insulated from the supporting structure by suitable





insulators.

4.01.08 All Resistance Bank to Bank interconnections shall be done by solid stainless steel / copper.

4.02.00 **Enclosure**

4.02.01 Each neutral grounding resistor shall have structural work enclosed on all sides and also on top by sheet steel. Suitable ventilating louvers shall be provided on sides to ensure proper ventilation. The louvers shall be provided with fine wire mesh to make it vermin proof. Protection class shall be IP33 or better.

4.02.02 Each enclosure shall be self supporting, weather proof type suitable for outdoor mounting having a protection class IP33. A sloped bottom sheet is welded to the angle iron structure and drain plug shall be provided at suitable place. A separate CT compartment, wherever applicable, shall be of protection class IP55.

4.02.03 Each cubicle shall be complete with a front access door with handles, lock and also a removable bolted cover. All doors and removable covers shall be properly gasketed with neoprene rubber gaskets. All cubicle door hinges shall be concealed type.

4.02.04 Each cubicle shall be complete with a suitably mounted cable end box fitted with removable gland plate for fixing cable gland. The cable size shall be as indicated in the annexure. Double compression cable glands and tinned copper lugs shall be provided.

4.02.05 Each cubicle shall be provided with suitable base channels for direct bolting to the foundation at site. All necessary galvanised bolts, nuts, washers etc. shall be supplied by the Tenderer for installation of Cubicle at site.

4.03.00 **Cubicle lamp and sockets**

4.03.01 Each cubicle shall be provided with 5A, 3 pin plug socket and door-switch controlled cubicle illumination lamp.

4.03.02 MCB shall be provided for receiving 240 V single phase AC supply for cubicle lamp and illumination circuit.

4.04.00 **Wiring**

4.04.01 All internal wiring between equipment and terminal block shall be carried out by PVC insulated 1100 V grade 2.5 Sq.mm Stranded copper conductor wires.

4.04.02 All wiring shall be suitably ferruled with corresponding wiring identification marks used in the Schematic/wiring diagrams.

4.04.03 All devices and terminal blocks within the terminal box shall be clearly identified by symbol corresponding to those used on applicable schematic/wiring diagram. 20% spare terminals shall be provided in terminal block.





4.05.00 Grounding

4.05.01 All parts of enclosure, supporting structures, equipment frames etc. shall be properly grounded at two points separately.

4.05.02 Each cubicle shall be completed with two (2) nos. ground pads, tapped holes and bolts suitable for connection of 75 x 10 mm galvanized steel flats.

4.06.00 Painting

4.06.01 All surfaces shall be sand blasted, pickled and grounded as required to produce a smooth, clean surface free of scale, grease & rust.

4.06.02 After cleaning, the surfaces shall be given a phosphate coating followed by 2 coats of high quality primer and stoved after each coat.

4.06.03 The cubicle shall be finished with two coats of approved shade.

4.06.04 Sufficient quantity of touch-up paint shall be furnished for application at site.

4.07.00 Auxiliary equipment-Current Transformer (CT)

4.07.01 Neutral bushing current transformers shall be furnished when specified in the annexure.

4.07.02 Current transformer shall be mounted inside the cable box with removable arrangement.

4.07.03 CT secondary leads shall be wired up to the terminal blocks.

5.00.00 TESTS

5.01.00 Routine Tests

Each equipment shall be completely assembled, wired, adjusted and routine tested as per relevant standards at manufacturer's works. The tests shall include :

5.01.01 Resistance measurement

5.01.02 Voltage measurement

5.01.03 Insulation resistance measurement

5.01.04 Dielectric test

5.02.00 Type Test

5.02.01 Temperature rise test (on one unit of each rating)



5.03.00 Test Witness

5.03.01 All tests shall be performed in presence of Owner's representative, if so desired by the Owner.

5.03.02 The Contractor shall give at least seven (7) days advance notice of shop tests.

5.04.00 Test Certificates

5.04.01 Certified copies of all tests carried out at works and at site shall be furnished in six (6) copies for approval of the Owner.

5.04.02 Equipment shall be dispatched from works only after receipt of Owner's written approval of shop test reports.

5.04.03 Type test certificate (not more than 5 years old from date of contract) on any equipment, if so desired by the Owner, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

6.00.00 DRAWINGS, DATA & MANUALS

6.01.00 Drawings, data and manuals shall be submitted with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in this specification for approval and subsequent distribution after the issue of Letter of Intent.

6.02.00 To be submitted with the Bid

6.02.01 Typical general arrangement drawings of the cubicle showing constructional features.

6.02.02 Bill of Materials

6.02.03 Scheme showing series/parallel combination of resistor elements.

6.02.04 Technical leaflets on each piece of Electrical equipment

6.02.05 Type test (Temperature test) certificate of similar equipment not more than five years old)

6.03.00 To be submitted for Owner / Purchaser's Approval and Distribution

6.03.01 Guaranteed Technical Particulars and Quality assurance plan.

6.03.02 Dimensional general arrangement drawing showing disposition of various fittings.

6.03.03 Bill of material.

6.03.04 Foundation plan and loading.

6.03.05 Control schematic and wiring diagrams.





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- 6.03.06 Instruction manual of the equipment and its accessories.
The manual shall clearly indicate method of installation, check ups and tests to be carried out before commissioning of the equipment.
- 6.03.07 Any other relevant drawing or data necessary for satisfactory installation, operation and maintenance.
- 6.04.00 The Bidder may note that the drawings, data and manuals listed are minimum requirement only. The Bidder shall ensure that all other necessary write-ups, curves and information required to fully describe the equipment offered are submitted with the bid.





ANNEXURE-A

RATINGS AND REQUIREMENTS

- 1.0 General
- 1.1 Applicable standard : IEEE-32
- 1.2 Service : Outdoor, free standing
- 1.3 Rated system Voltage & allowable variation : 3.3KV $\pm$ 10%
- 1.4 Rated frequency and allowable variation : 50Hz +5 to -5%
- 2.0 Rating
- 2.1 Rated Voltage KV : 3.3KV
- 2.2 Rated current at rated time duration Amp : 300A
- 2.3 Rated time duration Sec. : 10
- 2.4 Allowable Tolerance in resistance value% : $\pm$ 10
- 2.5 Design ambient Temperature $^{\circ}$ C : 50
- 2.6 Temperature rise of resistor $^{\circ}$ C : 350
above design ambient.
- 2.7 Temp rise of Enclosure $^{\circ}$ C : 30 $^{\circ}$ C for non-accessible
20 $^{\circ}$ C for accessible portion
above design ambient
- 2.8 Insulation class of insulating material : Over 220 $^{\circ}$ C (Class C)
- 2.9 Basic Insulation level and system
insulation class :
3.3KV
System insulation class for
line end & ground end KVRms : 40/10KV
(peak/r.m.s)
Insulation level (applied
1min. power frequency potential) KVRms : 40/10KV
(peak/r.m.s)
- 3.0 NGR & NGR Cubicle
- 3.1 Materials of resistor : Non-aging, punched stainless steel
- 3.2 Resistor element combination : Series-parallel (6 X6)
- 3.3 Enclosure material : Sheet steel



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3.4	Min. Thickness of aluminium sheet	mm	:	2
3.5	Enclosure protection class		:	IP33
3.6	Terminal arrangement		:	Through cable
3.7	Type & size of cable to be terminated		:	to be decided later
4.0	Insulators			
4.1	Type		:	Support insulator
4.2	Materials		:	Porcelain
4.3	Bushing rating	KVrms	:	3.6 KV
4.4	Creepage distance	mm	:	31 mm/KV
5.0	Current Transformer			
5.1	Purpose		:	Restricted earth fault & standby earth fault
5.2	Type		:	Epoxy resin cast
5.3	Reference standard		:	As per IS
5.4	Quantity	Nos.	:	As per requirement
5.5	Accuracy class & ALF		:	5P20 for Standby earth fault PS for Restricted earth fault
5.6	Burden VA		:	Bidder to decide
5.7	Mounting		:	Inside cable box





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Tuticorin, Tamil Nadu**

**VOLUME: II-F
SECTION - XI
L.T. SERVICE TRANSFORMERS**



Development Consultants Pvt. Ltd.

**Vol. II-F/Section-XI
L.T. Transformers**



**Tender Specification
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**NLC Tamil Nadu Power Ltd.
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VOLUME: II-F/2

SECTION-II

L.T. TRANSFORMERS

1.00.00 SCOPE OF SUPPLY

1.01.00 The scope of supply shall include LT Transformers of ratings to be decided by the Bidder based on selection criteria given in this specification and generally in line with Annexures.

1.01.01 Each transformer shall be furnished complete with:

- a) Fittings and accessories
- b) Auxiliary equipment

1.01.02 Recommended spare parts for three (3) years operation in addition to mandatory spares

1.01.03 All relevant drawings, data and instruction manuals.

2.00.00 GENERAL REQUIREMENTS

2.01.00 Codes and Standards

2.01.01 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.

2.01.02 Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

2.01.03 The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

3.00.00 DESIGN CRITERIA

3.01.00 Sizing Criteria

3.01.01 The transformers shall be used to supply power to the loads for unitized FGD System including Gypsum Handling System, Limestone Handling System or Absorber System, as applicable.

3.01.02 Power at 11000V level shall be transformed to 415V level through L.T. transformers to cater to the L.T. loads of plant FGD systems as required.





- 3.01.03 Each of the main L.T. boards which are directly connected to the L.T. transformers shall be fed from 2x100% capacity transformers. During normal operation each transformer shall cater for about half of the total load including spare margin of the L.T. board with the bus section breaker in open condition. In emergency condition of one transformer being out of service the other transformer shall cater for the total load plus spare margin of the corresponding L.T. board.
- 3.01.04 20% spare margin shall be considered while calculating the total load on the L.T. board.
- 3.01.05 Maximum kVA rating of the transformer shall be limited to 2500 KVA.
- 3.01.06 Voltage at load terminal
- a) Under full load condition of the L.T. board, the voltage shall not drop below 90% on the load voltage base.
 - b) At light load condition, the voltage shall not exceed 110% on the load voltage base.
 - c) During largest standby motor starting the voltage shall not drop below 85% on the load voltage base with an initial load on transformer equal to full load on L.T. board minus the running load of the motor which has been started.
- 3.01.07 All anticipated future loads shall be taken into consideration while finalizing size of L.T. Transformers.
- 3.02.00 The transformer shall be installed in indoor, hot, humid and tropical atmosphere. All equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.
- 3.03.00 The transformer shall be capable of continuous operation at specified rating under the following condition:
- a) Voltage variation : $\pm 10\%$
 - b) Frequency variation : $\pm 5\%$
 - c) Combined voltage and frequency variation (Absolute sum) : 10%
- 3.04.00 The transformer shall be capable of withstanding the short circuit stresses due to a terminal fault on one winding with full voltage maintained on the other winding for minimum period of two (2) seconds.
- 3.05.00 The transformer shall be free from annoying hum or vibration. The design shall be such as not to cause any undesirable interference with radio or communication circuits.



- 3.06.00 The noise level shall be limited to the value specified by NEMA Standard Publication No. TR-1-1993 when measured in accordance with conditions outlines in ANSI/IEEE C57.12.90-1999/IS13964/CBIP publication.
- 3.07.00 Transformer shall be installed so designed that it is capable of operation at 110% rated voltage continuously, at 120% rated voltage for a period of one minute. The transformer shall be suitable for continuous operation at rated KVA at an overfluxing factor upto 1.1.
- 3.08.00 The transformer shall be capable of being loaded in accordance with relevant IS/ANSI upto load of 150%. There shall be no limitation imposed by bushings, tap changers, etc. or any other associated equipment.
- 3.09.00 The flux density at normal voltage and frequency shall be such that flux density in any part of the core and yoke at any tap position, with 10% voltage variation from the voltage corresponding to the tap, shall not exceed 1.9 Tesla.
- 3.10.00 Transformer shall operate below the knee of the saturation curve at 110% voltage to preclude ferro-resonance and non-linear oscillations.
- 3.11.00 Transformers and accessories shall be designed for fault levels indicated in 11kV and 415V switchgear specifications. Dynamic ability and thermal ability to withstand the short circuit force shall be demonstrated by tests / calculations.

4.00.00 SPECIFIC REQUIREMENTS

4.01.00 Enclosure

- 4.01.01 The transformers shall be housed in enclosure fabricated from sheet steel of minimum 2mm thick. Degree of protection of the enclosure shall be at least IP33 for indoor installation. Screens shall be perforated sheet steel/wire mesh type. Mesh size shall be such that lizard, rats etc. cannot enter inside the enclosure.
- 4.01.02 The enclosure shall be adequately reinforced to ensure rigidity so as to permit transportation of transformer with enclosure. Base frame for mounting the transformer shall be minimum 4mm thick and shall be provided with bi-directional rollers/mounting skid.
- 4.01.03 Double leaf access, both at front and at rear end, shall be provided with concealed hinge and neoprene gaskets for easy access and also for withdrawal of core and coil assembly if required. Enclosure door shall have provision of padlocking in door-closed position.
- 4.01.04 Enclosure shall be provided with lifting eyes and pulling lugs. Heavy removal parts shall be provided with eyebolt for ease of handling.
- 4.01.05 Enclosure temperature during full load operating condition shall be limited to below 70°C.





4.02.00 Core & Coils

4.02.01 The core shall be built up with high grade, non-aging, low loss, high permeability, grain oriented, cold-rolled silicon steel laminations especially suitable for core material.

4.02.02 The coils shall be manufactured from electrolytic copper conductor and fully insulated for rated voltage. Coils shall be resin impregnated under vacuum and pressure (VPI) type or cast resin (encapsulated) type.

4.02.03 Each coil shall be continuous smooth, high grade, electrolytic copper conductor, without sharp corners or bends and shall be adequately transposed to minimize eddy current losses and equalize current and temperature distribution. Abrasive damage and high dielectric stresses in insulation shall not occur. Similar coils shall be interchangeable. Liberal ducts shall be provided for prevention of 'hot spots' that may affect insulation life. Insulation of windings and other live parts should be adequate to sustain 110% of rated operating voltage continuously.

4.02.04 Insulating material shall be of proven design. The insulating material shall be glass fibre reinforced conforming to class 'H' naturally cooled (AN) with temperature rise limited to Class F. Coils shall be so insulated that impulse and power frequency voltage stresses are minimum and are suitable to withstand even the severest to temperature variation. Separate encapsulation for HV and LV winding shall be provided.

4.02.05 All leads from the windings to the terminal board and bushings shall be rigidly supported to prevent injury from vibration or short circuit stresses. Guide tube shall be used where practicable.

4.02.06 The core and coil assembly shall be securely fixed in position so that no shifting or deformation occurs during movement of transformer or under short circuit stresses.

4.03.00 Tappings

4.03.01 Off-circuit tap changer (OCTC) as specified in the annexure shall be provided on the high voltage winding. The off-circuit tap changing shall be effected by change of links. Arrangement shall such that switch can be operated at standing height from ground level.

4.03.02 The transformer shall be capable of operation at its rated KVA on any tap provided the voltage does not vary by more than $\pm 10\%$ of the rated voltage corresponding to the tap.

4.03.03 The winding including the tapping arrangement shall be designed to maintain electromagnetic balance between HV and LV windings at all voltage ratios.

4.03.04 The tap changing shall be effected manually by change of copper link at the terminal board inside the enclosure. The design of tap changing link shall be such to ensure that same tap is set on all the three phases at a time.



4.03.05 The HV winding of the transformer shall be brought out through suitably rated bushing mounted on non magnetic material in separate air insulated cable box. The cable box shall also be provided with facility for supporting from ground.

4.04.00 **Safety Interlock**

Following safety interlocks shall be provided:

- a) A safety interlock shall be provided to ensure that the enclosure door can be opened only when transformer is de-energized. A suitable danger plate shall be provided on the door.
- b) Safety limit switches operated by door-handle shall be provided for tripping HV & LV side breaker.

4.05.00 **Bushing**

4.05.01 Bushings shall be resin molded type and shall be suitable for heavily polluted atmosphere.

4.05.02 Each Bushing shall be provided with terminal connector of approved type and size.

4.05.03 Bushing location shall provide adequate phase and ground clearances.

4.06.00 **Terminal Arrangements**

4.06.01 The physical position of terminals and markings shall be as per the relevant standards.

4.06.02 Terminals for bus duct connection shall be brought through top cover mounted bushings with matching flange.

4.06.03 Bushing terminals and flange shall be coordinated with bus duct.

4.06.04 Terminals for cable connection shall be brought out through top cover/side wall mounted bushings to a detachable cable-end box with disconnect link.

4.06.05 In general, the arrangement shall be such as to permit removal of the transformer and core/coil assembly without dismantling the bus duct/cable installation.

4.06.06 Low voltage winding neutral shall be brought out thru' top cover mounted bushing. Two ground conductors' 75x10 G.I. flats shall run from neutral bushing to the bottom of the tank over pin insulators for connection to station ground.

4.06.07 **Cable Boxes and Disconnecting Chamber**

- i) When connection is by cable, suitable means shall be provided for disconnecting and moving away the transformer without unsealing the



cables. Cable-end box shall be self-supporting, weatherproof, air filled type with sufficient space inside for termination and connection of cables.

- ii) Cable boxes shall be complete with other accessories including removable gland plate, double compression brass glands, tinned copper lugs, armour clamps, earthing clamps and necessary hardware. The box shall be suitable for heat shrinkable type/push on type/ tapex type termination kits of proven design against short circuit levels of 40 KA for three (3) second with a peak value of 100KA.
- iii) The cable box shall have all standard facilities envisaged for dry type transformer.
- iv) Cable boxes shall be designed to accommodate all cable joint fittings or sealing ends as required. The bottom plate shall be of non magnetic stainless steel, brass or aluminium for all transformers on HV side requiring cable connections.
- v) The disconnecting chamber shall be air insulated; removable links and removable covers shall be provided for the disconnecting chamber. Plates through which high current carrying conductors pass, shall be of non magnetic materials.
- vi) Phase to phase and phase to ground clearances within the chamber shall be such as to enable either the transformer or each cable to be subjected to HV tests. Clearances shall be subject to Purchaser's approval.

4.07.00 **Cooling System**

4.07.01 The transformer cooling system natural air ventilation (AN) only.

4.08.00 **Marshalling Box**

4.08.01 A sheet steel, weatherproof, IP55, marshalling box shall be provided for the transformer. The box shall be located directly on the outside face of the enclosure at suitable height. The box shall contain all auxiliary devices.

4.08.02 All terminal blocks shall be located in this box.

4.08.03 The marshalling box shall be provided with cubicle lamp with door switch, space heater with thermostat and removable cable gland plate.

Reliable supply (220V DC or UPS230V AC) shall be extended to the scanner from the nearby source

4.09.00 **Wiring**



- 4.09.01 All control, alarm and indication devices provided with the transformer shall be wired upto the terminal blocks.
- 4.09.02 Wiring shall be done with 1100V PVC wires in conduit or PVC armoured cable. Minimum wire size shall be 2.5sq.mm stranded copper. Not more than two wires shall be connected to a terminal. 20% spare terminals shall be provided.
- 4.09.03 Multi-way terminal block complete with mounting channel, binding screws and washers for wire connections and marking strip for circuit identification shall be provided for terminating the panel wiring. Terminals shall be stud type, suitable for terminating 2 nos. 2.5mm² stranded copper conductor and provided with acrylic insulating cover.
- 4.09.04 All devices and terminal blocks shall be identified by symbols corresponding to those used in applicable schematic or wiring diagram. Each wire shall be identified, at both ends, with interlocking type permanent markers bearing wire numbers as per Bidder's Wiring Diagrams. AC/DC wiring shall have separate color-coding.
- 4.09.05 Wire termination shall be made with crimping type connectors with insulating sleeves. Wires shall not be spliced between terminals.
- 4.10.00 **Grounding**
- 4.10.01 A ground bus rated to carry the maximum fault current shall extend full length of the enclosure.
- 4.10.02 The ground bus shall be provided with two bolt drilling with GI bolts and nuts at each end to receive 75 x 10 mm GS flats.
- 4.10.03 The core coil assembly shall be directly connected to this ground bus by removable bolted link for effective grounding.
- 4.10.04 Ground terminals shall be also provided on marshalling box to ensure its effective earthing.
- 4.10.05 For continuity of earth connection, all gasketed joints shall be provided with braided copper wire jumpers.
- 4.11.00 **Auxiliary Supply**
- 4.11.01 A.C. supply shall be made available to each transformer.
- 4.11.02 Isolating switch fuse unit shall be provided for receiving the incoming supply.
- 4.12.00 **Painting**
- 4.12.01 All steel surfaces shall be thoroughly cleaned by sand blasting and/or chemical agents, as required, to produce a smooth surface free of scales, grease and rust.



- 4.12.02 The external surfaces, after cleaning, shall be given a coat of high quality red-oxide or yellow chromate primer followed by filler coats.
- 4.12.03 The interior and exterior surfaces shall be finished with specified color shades as per IS5.
- 4.12.04 Sufficient quantity of touch up paint shall be furnished for application after installation at site.
- 4.12.05 The paints shall be carefully selected to withstand tropical heat, rain etc. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.
- 4.12.06 All supporting structures and hardware shall be hot dip galvanized.

4.13.00 ACCESSORIES

- 4.13.01 Necessary lifting lugs, jacking pads, haulage holes and pulling eyes shall be provided capable of lifting and skidding of transformers.
- 4.13.02 The wheels shall be bi-directional flat roller type with locking and bolting devices.
- 4.13.03 The rating and nameplate shall contain all details as per IS 2026. In addition, following details shall also be included.
- a. Connection diagram showing internal connections.
 - b. Temperature rise
 - c. Insulation level of windings
 - d. Transportation weight.
 - e. Untanking weight.
 - f. Core and winding weight.
 - g. Table showing tapping voltage, tapping current, Taping power for each winding.
 - h. Values of short circuit impedance on extreme tapping and on principle tapping and an indication of the winding to which impedance is related.

5.00.00 TESTS

5.01.00 Routine Tests

During manufacture and on completion, all transformers shall be subjected to the routine tests in accordance with latest IS/IEC and its different parts.

In addition, the following tests shall be performed on each transformer:

- 5.01.01 After assembly, each core shall be pressure tested for one minute at 2KV (r.m.s.) A.C. between all bolts, side plates, structural steel works and the core.



5.01.02 The wiring for auxiliary power and control circuitry shall be subjected to withstand one minute power frequency test with 2.0KV (r.m.s.) to earth.

5.01.03 Partial discharge measurement acceptable maximum level of partial discharge shall be as specified in IEC 60076-11: 2004.

5.02.00 **Type Tests**

Following type tests shall be performed on one transformer in accordance with relevant standard:

- a) Impulse withstand test
- b) Temperature rise test
- c) Measurement of acoustic sound level
- d) Partial discharge measurement
- e) Short Circuit test
- f) Ingress Protection Test

5.03.00 **Test Witness**

Tests shall be performed in presence of Owner's representative if so desired by the Owner. The Contractor shall give at least seven (7) days' advance notice of the date when the tests are to be carried out.

5.04.00 **Test Certificates**

5.04.01 Certified reports of all the tests carried out at the works shall be furnished in six (6) copies for approval of the Owner.

5.04.02 The equipment shall be dispatched from works only after receipt of Owners written approval of the test reports.

5.04.03 Type test certificate (not more than 5 years old from date of contract) on any equipment, if so desired by the Owner, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

5.05.00 **Miscellaneous**

All component parts and auxiliary equipment such as bushings, etc. shall be routine tested as per relevant Indian Standards.

6.00.00 **DRAWINGS, DATA & MANUALS**

6.01.00 Drawings, Data and Manuals shall be submitted for approval and subsequent distribution after the issue of Letter of Intent in quantities and procedures as specified in General condition of contract and/or elsewhere in this specification.



- 6.01.01 Typical general arrangement drawings showing enclosure, core & coil assembly and terminal arrangement etc.
- 6.01.02 Transport/shipping dimensions and weights, space required for handling parts for maintenance.
- 6.01.03 Technical leaflets on major components and fittings
- 6.01.04 Type test certificates of a similar transformer (as per the guidance for identification of a similar transformer as defined in Annexure A of IEC 60076-5). The type test certificates shall not be more than 5 years old.
- 6.01.05 Write-up on insulating material used and process of application/method of construction followed.
- 6.01.06 proposal data sheets duly filled in.
- 6.02.00 **To be submitted for Approval and Distribution**
- 6.02.01 Dimensional general arrangement drawing showing enclosure, core & coil assembly and terminal arrangement etc
- 6.02.02 Transport/shipping dimensions with weights, wheel base detail, un-tanking height etc.
- 6.02.03 Foundation plan & loading
- 6.02.04 Terminal arrangements, Bus Duct flange details and cable end-box details.
- 6.02.05 GA of Marshalling Box.
- 6.02.06 Rating and Diagram Plate
- 6.02.07 Cable Interconnection Diagram and Cable schedule
- 6.02.08 Quality Assurance Plan.
- 6.02.09 Test certificates of transformer.
- 6.02.10 Any other relevant drawing or data necessary for satisfactory installation, operation and maintenance.
- 6.02.11 Instruction manuals on transformer and its various fittings
- The manual shall clearly indicate method of installation, check-ups and tests to be carried out before commissioning of the equipment.
- 6.03.00 The Bidder may note that the drawings, data and manuals listed are minimum requirement only. The Bidder shall ensure that all other necessary write-ups, curves and information required to fully describe the equipment offered are submitted with his bid.

ANNEXURE – A

RATINGS AND REQUIREMENTS

1.0	Application	Service Transformer
2.0	Service	Indoor, Step-down
3.0	Rated output	2500KVA, 2000KVA, 1600KVA, 1000KVA, 630kVA
4.0	Reference standard	IS 11171, IS 2026 & IEC60076
5.0	Cooling	AN
6.0	Rated voltage (line to line)	11000/433V
7.0	Number of phases	3
8.0	Rated frequency	50 Hz
9.0	Insulation class	H (with temperature rise limited to class F)
10.0	Temperature rise above 50°C ambient temperature	
	a. in winding by resistance	90°C
	b. on enclosure by thermometer	20°C
11.0	Insulation level (LI/AC)	
	HV winding (12kV)	75 / 28 kV (peak/rms)
	LV winding (1.1kV)	NA / 3 kV (peak/rms)
	LV neutral (1.1kV)	NA / 3 kV (peak/rms)
	Partial discharge level	<10pc
12.0	Vector group	Dyn11
13.0	Parallel operation of transformer	Yes, only momentary.
14.0	Type of taps provided	OCTC, full capacity
15.0	Taps provided on	HV winding
16.0	Range of taps	± 2 x 2½ %
17.0	Method of Tap changer control	
	a) Manual local	Yes
	b) Electrical local	No
	c) Electrical Remote	No
	d) Automatic	No
18.0	Percentage impedance at at 75°C on respective KVA base.	
	a) 2500KVA	As per IS
	b) 2000 KVA	As per IS
	c) 1600 KVA	As per IS
	d) 1000 KVA	As per IS

	e)	630kVA	As per IS
19.0	Enclosure protection class		IP33
20.0	System earthing		
	H.V.		Non-effectively earthed
	L.V.		Effectively earthed
21.0	Terminal arrangement		
	H.V.		Cable
	L.V.		Non-segregated phase busduct
	L.V. Neutral		75 x 10 GS flat
22.0	Transformer bushing voltage class		
	H.V.		12 kV
	L.V.		1.1 kV
	H.V. Neutral		Not applicable
	L.V. Neutral		1.1 kV
23.0	Minimum clearances for transformer bushings		
	H.V.		
	a)	Phase to Phase	280
	b)	Phase to earth	140
	L.V.		
	a)	Phase to Phase	25
	b)	Phase to earth	25
24.0	Creepage Distance		31 mm/kV
	Material of bushings		
	a)	H.V.	Resin molded type
	b)	L.V.	Resin molded type
25.0	System fault level		40 KA (r.m.s.) at HV side 50 KA (r.m.s.) at LV side
26.0	Maximum flux density in any part of core & Yoke at 110% rated voltage		1.9 Tesla
27.0	Max. Noise level in accordance with Condition specified in NEMA Std. TR-1		As per NEMA std.
28.0	Auxiliary Supply		240V $\pm 10\%$, 1ph, 2 wire, 50Hz $\pm 5\%$ 220 V +10% to -15%, 2 wire DC



ANNEXURE – B

FITTINGS AND ACCESSORIES

Each transformer shall be equipped with fittings and accessories, as listed below:

1. Winding temperature monitoring device with electrically separate sets of contacts for alarm and trip, along with temperature sensing element embedded in 433 V windings of all three phases. (Trip and alarm settings shall be separate).
2. Handling & lifting lugs for both enclosure and core-coil assembly.
3. Jacking pad for core-coil assembly.
4. Flat type bi-directional rollers with locking arrangement for core-coil assembly.
5. Inspection covers for cable end box.
6. Door handle operated safety limit switch with 2 NO + 2 NC contact.
7. Ground bus.
8. IP-55 marshalling box.
9. Rating and terminal marking plate.
10. Bushing CT(s) for phase and/or neutral side(s).

Note :

All indication, alarm, trip contacts provided shall be rated for 0.5A at 220 V DC and 5A at 240 V AC.

The accessories, which are necessary for successful operation but not listed above, shall also to be included in the Scope of Supply.



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

**VOLUME: II-F
SECTION-XII
BATTERY AND BATTERY CHARGER**

I



Development Consultants Pvt. Ltd.

**Vol. II-F/Section-XII
Battery & Battery Charger**



**Tender Specification
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FGD Package**

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VOLUME: II-F

SECTION-XII

BATTERY AND BATTERY CHARGER

1.00.00 SCOPE OF SUPPLY

- 1.01.01 220 V DC Lead Acid Plante type Battery (2x100% Battery common for both for unit) for FGD system.
- 1.01.02 220 V battery charger (1 x 100% FC & FCBC with each aforesaid Battery), each comprising of one (1) float charger and one (1) float-cum-boost charger
- 1.01.03 Each set of battery and battery charger shall be supplied complete with fittings and accessories as per list furnished elsewhere in this specification.
- 1.01.04 One set of portable type battery discharge resistor bank and one set of portable type single cell charger shall also be provided common for the above batteries.
- 1.01.05 Base channel frame, floor channel sill and kick plates for all floor-mounted charger panels, complete with holding down bolts and nuts.
- 1.01.06 One (1) sets of special tools and tackles.
- 1.01.07 All relevant drawings, data and instruction manuals.

2.00.00 GENERAL REQUIREMENTS

- 2.01.00 Codes and Standards
- 2.01.01 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) except where modified and/or supplemented by this specification.
- 2.01.02 Equipment and materials conforming to any other standard which ensures equal or better quality may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.
- 2.01.03 The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Codes of Practice. In addition, other rules or regulations applicable to the work shall be followed.

3.00.00 DESIGN CRITERIA

- 3.01.00 Design Basis and Sizing Criteria





- 3.01.01 220 V D.C. systems provides reliable sources of D.C. power for control, indication, protection and annunciation of power plant equipments. In addition, it also provides power supply for the following emergency loads/services on failure of A.C. supply.
- 3.01.02 The 220 V D.C. system comprises of two (2) sets of storage battery having their own one Float Charger (FC) and one Float-cum-Boost Charger (FCBC) for each set of battery and a DCDB for FGD system to be located in Electrical room.
- All sets of batteries mentioned above shall be lead acid PLANTE type and complete with associated float charger and float-cum-boost charger.
- 3.01.03 The battery shall be sized to meet emergency load duty cycle requirements as indicated in attached Duty-cycle (Current vs. Time) curve.
- 3.01.04 The procedure for estimating battery capacities shall be as per guide-lines stipulated in latest revision of IEEE Std. 485 for Lead acid Battery. Derating factor for prolonged float charging shall be duly taken into account, as applicable, in estimating battery capacity.
- While estimating battery capacities, aging margin as per relevant standard, temperature correction factor as per manufacturer's standard and a design margin of 20% shall be considered.
- 3.01.05 The battery and charger combination shall be such as to ensure continuity of DC supply at load terminals at all times without even momentary interruption.
- 3.01.06 Further the voltage at Battery terminals shall not exceed the limits of + 10% and - 15% of the nominal system voltage at any time during the duty cycle.
- 3.01.07 For continuous operation at specified ratings, temperature rise of the various components of battery & battery charger shall be limited to the permissible values stipulated in the relevant standards and/or this specification.
- 3.01.08 The equipment will be installed indoor in a clean but hot, humid and tropical atmosphere.
- 3.01.09 Capacity of each unit batteries shall be so chosen that with one battery out of service, the other battery shall be capable of carrying the total DC load of that unit, without any restriction in plant operation.
- 3.01.10 The bidders shall check the capacity and ratings based on the duty cycle requirement and other design stipulations and submit the offer accordingly. Sizing calculations along with relevant supporting document regarding selection of different factors shall be furnished with the bids.
- 3.01.11 The float charger shall be sized to carry the total DC continuous load and the trickle charging current of the battery plus a 25% margin. The charger shall

also be capable of delivering the rated load under the specified voltage and frequency variations of incoming AC supply.

- 3.01.12 The float-cum-boost charger shall be sized to restore the fully discharged battery to full charge condition in eight (8) for lead-acid battery with 25% margin over maximum charging rate or to operate as a float charger with duty requirement, whichever is greater.
- 3.02.00 **System Concept**
- 3.02.01 The battery charger shall be capable of providing the initial charging current as required for the battery.
- 3.02.02 The Float Charger (FC) will be normally ON, supplying the DC load current and at the same time trickle charging the battery. The characteristics shall be such that if load is high and exceeds the charger capacity, the excess load shall be supplied by the battery.
- 3.02.03 The Float-cum-Boost charger will be normally in stand-by (Auto Float/ Charge) mode and will cut into the circuit automatically-
- a) To provide occasional equalizing charge as required.
 - b) To take over the functions of float charger in case of its failure.
 - c) To operate in boost mode when battery voltage drops below a set value.
- 3.02.04 The float-cum-boost charger shall also have provision for float, equalising, and boost charging the battery through manual selection.
- 3.02.05 On failure of station A.C. supply, both float charger and float-cum-boost chargers shall go out of service and battery shall take over to supply emergency loads.
- 3.02.06 If float charger fails, it will be annunciated in the control room and stand-by float charger of the float cum boost charger will have to cut into the circuit manually by double pole double throw switch to take over the function of float charger.
- 3.02.07 Output of the chargers shall be controlled automatically as well as manually. AUTO/MANUAL selector switch along with voltage/current setter shall be provided for this purpose.
- 3.02.08 Interlock shall be provided to ensure that the battery can be taken to boost mode only if the float charger is healthy and running. Suitable defeating arrangement shall also be provided for initial charging of the battery.
- 3.02.09 For ungrounded DC system, suitable ground fault detection system shall be provided in the battery charger panel to detect ground fault on either polarity for annunciation in charger panel.



4.00.00 SPECIFIC REQUIREMENTS

4.01.00 Layout

4.01.01 The battery and battery charger shall be located indoor only.

4.01.02 Battery room ventilation shall be under the scope of the Bidder. Eye rinsing arrangement, stands for thermometer and hydrometer for specific gravity measurement shall be provided by the bidder.

4.01.03 Sufficient clear space shall be provided for attending individual cells.

4.02.00 **Battery**

4.02.01 General

- a) The battery shall be flooded cell with Plante' type.
- b) The plates shall be designed for maximum durability during all service conditions including high rate of discharge and rapid fluctuation of load.
- c) Each set of battery shall consist of number of cells assembled together on mounting racks.

4.02.02 Construction

- a) Cell container shall be made of heat & electrolyte resistant, shock absorbing, tough translucent, polypropylene or equivalent plastic material having chemical and electrochemical compatibility. The cell shall be mechanically sturdy.
- b) The cell shall be provided with visual electrolyte level checks for ease in of maintenance. Electrolyte level markings shall be for upper and lower limits.
- c) For lead acid battery the pole sealing arrangement should be such that no acid particle gets entrapped due to acid creep as a result of capillary action and it should be possible to remove and refix the sealing to carry out the maintenance.
- d) Sufficient sediment space shall be provided so that the cells shall not have to be cleaned out during normal life.
- e) Open type cells shall be provided with suitable spray arrestors and separate perforated transparent plastic covers; anti-splash type vent plug shall be provided for sealed-in type cell. For flooded cell, suitable mechanism and / or Ceramic Vent plug shall be provided to eliminate emission of acid mist during the float operation. The bidder shall also indicate the Gas emission rate of the battery in their offer for necessary design of the ventilation of the Battery Room.



- f) Separator between plates shall permit free flow of electrolyte. Separator shall be wood or other acid resisting material (in case of lead acid battery). Proper arrangement to keep end plates in position shall be furnished.
- g) The cells shall be supported on porcelain insulator fixed on to the rack with adequate clearance between adjacent cells.
- h) The cell terminals posts shall be provided with connector bolts and nuts, made of copper/ brass effectively coated with lead (for lead acid battery) to prevent corrosion.
- i) Lead coated copper connectors shall be furnished to connect up cells of Battery set.
- j) Positive and Negative terminal posts shall be clearly and indelibly marked for easy identification.
- k) Bent copper plates, tubular copper lugs, teakwood clamp, bolts, nuts, washers, etc. shall be furnished for connection of outgoing Aluminum conductor cables.
- l). The battery shall be shipped uncharged for flooded cell with the electrolyte furnished in a separate non-returnable container. 10% extra electrolyte shall be furnished to cover spillage in transit or during erection.

4.02.03 **Racks**

Battery racks for supporting battery cells shall be constructed of best quality teakwood (for lead acid battery), forming a rigid structure. Racks shall be painted with at least three (3) coats of electrolyte-resistant paint of approved shade. Racks shall be free standing type, mounted on porcelain/ electrolyte – resistant high impact plastic insulators. Numbering tags for each cell shall be attached on to the racks.

4.03.00 **Battery Charger**

4.03.01 General

- a) The charger shall be natural air-cooled, solid-state type, with full wave, fully controlled, bridge configurations.
- b) The charger shall be provided with microprocessor based automatic voltage control, current limiting circuitry, smoothing filter circuit and soft-start feature, under/ over voltage protection and earth fault detection.
- c) Voltage/Current control shall be stepless, smooth and continuous. Voltage control shall be possible either in "Auto" mode or in "Manual" mode. An Auto-Manual selector switch shall be provided for this purpose.



- d) The charger shall be self-protecting against all A.C and D.C transients and steady state abnormal currents and voltages.
- e) Charger A.C input and D.C output shall be electrically isolated from each other and also from panel ground.

Isolation shall also be provided between power and control circuits.

- f) Each battery charger shall be provided with one (1) no. voltage transducer and one (1) no. current transducer for monitoring the D.C. output. These transducers shall have twin-channel output of 4-20 mA and shall be used for analog inputs to PLC system.
- g) Radio frequency suppressor/screening shall be provided with the charger to limit the noise level/interference to radio and other communication equipment to be installed in the same building.

4.03.02 Construction

- a) The charger shall comprise a continuous line up of free-standing, floor mounted sheet steel panels, with access from both front and rear.
- b) In between the float and float-cum-boost charger panels, a central panel shall be provided. This panel shall house the battery terminals, load terminals, battery blocking diodes, and a few meters, annunciators and indicating lamps.
- c) The panels shall conform to the degree of protection IP-52. Minimum thickness of sheet metal used shall be 2 mm.
- d) Access doors shall be with concealed hinges and neoprene gaskets. Ventilating louvres shall be covered with fine wire mesh. Door over 600 mm width shall be of double-leaf design.
- e) All equipment within the panels shall be arranged in modular units and laid out with sufficient space for easy maintenance.
- f) All indicating instruments, control switches etc. shall be flush mounted on the front face of the panels. However potentiometer shall be provided inside the panel. Nameplates of approved size and type shall be provided for all circuits and devices both at front & inside of the panel.
- g) All bus bar and bus connections shall be of high conductivity copper and adequately sized to limit the maximum temperature within the permitted value. All bus connection shall be silver plated.
- h) Heat-shrinkable insulating sleeves shall be provided for busbars. All bus connections shall be shrouded.





Busbars shall be colour coded for easy identification.

- i) Busbars shall be supported and braced to withstand the stresses due to maximum short circuit current and also to take care of any thermal expansion.

4.03.03 Charger Equipment

- a) All power diode and control rectifiers shall be silicon type. Rectifier transformer shall be resin impregnated in vacuum, dry type, double wound with copper conductor and class-F insulated with temperature rise limited to class-B having off-circuit tap $\pm 2.5\%$ on primary side. LC filter suppressor shall be provided in the output to minimize ripple content and to keep the value within the specified limit.
- b) The diode & bridge elements shall be liberally sized for forward current, minimum momentary overloads & voltage spikes. The current & peak inverse voltage (PIV) should be chosen accordingly. Wherever necessary power semiconductor device shall be provided with over current and over temperature protection by using special fuses.

Blocking diodes shall be fully rated and shall have redundancy so that failure of a single diode shall not incapacitate the system in any way.

- c) Isolating switches shall be heavy duty, load break type, operated by an external handle with provision for padlocking in ON and OFF position.
- d) Changeover switch shall be 3 position, 4 pole, load break type with minimum 2 NO + 2 NC auxiliary contacts. The switch shall be installed in such a manner that the operating handle shall be accessible only after opening the front door.

Control switches shall be dust protected, heavy duty, switchboard type complete with escutcheon plates. Contacts shall be silver plated, rated 10A at operating voltage.

Selector switch shall be maintained contact, lockable stay-put type with knob handle. Meter selector switch shall be four-position type.

Ground fault detection switch shall be three-position type spring return to neutral. Ground fault relay shall be provided to detect DC system ground leakage current.

Push button shall be heavy duty, shrouded, push to actuate type with colored button and inscription plate. Each push button shall have 2 NO + 2 NC contacts, rated 10A at 240V AC and 0.5A at 220V DC.

- e) Contactor shall be air-break type with hand reset type thermal overload relays having in built temperature compensator and single phase preventer.



- f) Fuses shall be HRC type and furnished complete with fuse bases and fittings of such design as to permit easy and safe replacement of fuse element. Semi conducting device fuses shall be fast-acting. All upstream fuses shall be properly coordinated with corresponding down stream fuses.
- g) Indicating lamps shall be clustered of LEDs suitable for the duty involved. The body shall be made of polycarbonate Unbreakable lens. LEDs shall be protected by inbuilt fuse with surge suppressor or leakage voltage glow protection.. Both lamps and lens shall be replaceable from front.
- h) Meters shall be 96 x 96 mm switchboard type, 90 deg scale, antiglare glass, $\pm 1\%$ accuracy with zero adjuster on the front.
- i) Rectifier transformer for float-cum-boost charger shall be provided with $\pm 2 \times 2.5\%$ taps on the primary side.
- j) Charger shall be equipped with LCD display, so the system or particular module operation parameters can be locally or remotely viewed / monitored. Following parameters to be displayed:
 - a. Input AC voltage
 - b. Input AC current
 - c. Charging voltage,
 - d. Charging current
 - e. Load voltage
 - f. Load current
 - g. Battery voltage
 - h. Battery current
- k) MCCB shall be provided to receive incoming AC supply

4.03.04

Alarms

- a) Solid-state, audio-visual annunciation system shall be provided for battery chargers. Annunciation system shall operate on 220 V D.C.
- b) One (1) minimum twelve-points alarm facia shall be provided on each float charger panel and float-cum-boost charger panel, complete with proper actuating devices, circuitry, legends, push buttons (Accept, Reset and Test) and hooter.
- c) Each central panel shall be provided with one (1) minimum eight-point alarm facia, complete with proper actuating devices, circuitry, legend, push buttons, (Accept, Reset and Test) and hooter.



- d) The arrangement shall be such that on occurrence of a fault, the corresponding window shall light up and stay lighted until the fault is cleared and the reset button is pressed.
- e) Each time a window lights up, a master relay shall get energised to provide group alarm signals to remote control panel.
- f) The requirements of indications/alarms are given in Annexure-B.
- g) Alarms should be compatible to PLC system of FGD Plant.

4.03.05 **Meters**

Charger panel shall be provided with the following meters:

- a. Input voltmeter (0 – 500 V AC) with voltmeter selector switch.
- b. Output DC voltmeter at each charger output.
- c. Output DC voltmeter at battery output.
- d. Output DC ammeter at each charger output (0 – 150% of rated full load inverter output)
- e. Battery charging / discharging ammeter. with selector switch (for main A.C. supply)

4.03.06 **Transducers**

Each battery charger shall be provided with one (1) no. voltage transducer and one (1) no. current transducer for monitoring the DC output. Transducer shall have 4-20mA dual output.

Charger panel shall be provided with the following transducers:

- a. DC voltage transducer at each charger output.
- b. DC current transducer at each charger output.
- c.. DC voltage transducer at battery output.

4.03.07 **Controls**

The following manual controls shall be provided on the front of each charger panel :-

- a. Charger ON/OFF push button.



- b. Selection of float or boost charge in case of float-cum-boost charger.
- c. Voltage setters for setting the output of float/ equalizing / boost charge. Setting shall be independent of each other so that setting of one voltage shall not require resetting other.
- d. Ground fault detection switch with indicating lamps.
- e. Current limit setter/ charging rate.
- f. Under/ Over voltage relay including battery earth fault monitoring relay.
- g. Acknowledge-Reset-Test push buttons for annunciation system. The color of reset buttons shall be BLACK.

4.03.08 Lamp/Space heaters/receptacles

a. The charger panels shall be provided with :

- i) Internal illumination lamp with door switch, the lamp shall be located in the ceiling and guarded with protective cage.
 - ii) Space heater with thermostat control
 - iii) 3 pin 6A receptacle with plug
 - iv) Communication plug
- b) Lamp, heater and receptacle circuits shall have individual ON-OFF switch fuse units/MCCBs and shall be suitable for 240V AC supply.

4.03.09 Wiring/Cabling

- a. The panels shall be completely wired-up. All wiring shall be routed through wiring troughs.
- b. Internal wiring of the panels shall be done with 1100 V grade PVC insulated cables with stranded copper conductor of 2.5 mm² for control and current circuits and 1.5 mm² for voltage circuits.
- c. Each wire shall be identified, at both ends, with interlocking type permanent markers bearing wire numbers as per Bidder's Wiring Diagrams. AC / DC wiring shall have separate color-coding.
- d. Wire termination shall be made with crimping type connectors with insulating sleeves. Wires shall not be spliced between terminals.
- e) All spare contacts of relays, timers, auxiliary switches and other devices shall be wired up to the terminal block.

- f) Gland plate shall be of 3 mm thick, non-magnetic material and suitable for single-phase cable entry from bottom. Cable terminal board with cable lugs and double compression cable glands shall be provided in each panel for termination of incoming and outgoing cable.

4.03.10 Terminal Block

- a) 1100V grade, multi way terminal block complete with mounting channel, binding screws and washers for wire connections and marking strip for circuit identification shall be provided for terminating the panel wiring. Terminals shall be stud type, suitable for terminating 2 nos. 2.5 mm² stranded copper conductor and provided with acrylic insulating cover.
- b) Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished. Separate terminal blocks shall be used for AC/ DC wiring termination.
- c) Terminal blocks shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.
- d) Terminal blocks used for interface with DDCMIS via termination cabinet shall be suitably sized to facilitate proper termination of interconnecting cables.

4.03.11 Grounding

- a) The charger panels shall have fully rated ground bus with two ground terminals, one at each end.
- b) Each terminal shall comprise two bolt drilling with G.I. bolts, nuts and bimetallic washers for connecting to 50x6 mm G.I. flat. Ground bus shall be bolted to the panel structures, effectively grounding the entire assembly. The cases of meters, relays and switching devices shall be grounded through sheet steel structure.
- c) Wherever, the schematic diagrams indicate a definite ground at the panel, a single wire for each circuit thus grounded shall be run independently to the ground bus and connected thereto.

4.03.12 Tropical protection

- a) All equipment accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects and corrosion.
- b) Screens of corrosion resistant material shall be furnished on all ventilating louvres to prevent entry of insects.

4.03.13 Painting



- a) The sheet metal of the panels shall be thoroughly cleaned by chemical agents (7-tank process) as required to produce a smooth clean surface free of scales, grease and rust.
- b) Both interior and exterior surfaces of the panels shall be powder coated and finished with two(2) coats of paints of approved shades.
- c) The paint shall be carefully selected to withstand tropical heat, rain etc. The paint shall not scale off or crinkle or removed by abrasion due to normal handling.
- d) Sufficient quantity of touch up paint shall be furnished for application after installation at site.

4.03.14

Name Plate

- a) Nameplates shall be provided for each panel and for each equipment/device mounted on it.
- b) The material shall be anodised aluminium/lamicoid, 3 mm thick, with white letters on black background.
- c) Nameplates shall be held by self-tapping screws. The size of nameplates shall be approximately 20 mm x 75 mm for equipment and 40 mm x 150 mm for panels.
- d) Nameplates for panels shall be provided both on the front rear and also inside of the panels.
- e) Control and meter selection switches shall have integral nameplates. Nameplates for all other devices shall be located below the respective devices both inside & outside of panel.
- f) Instruments and devices mounted on the face of the panels shall also be identified on the rear with the instrument/ device number. The number may be painted on or adjacent to the instrument or device case.
- g) Caution notice on suitable metal plate shall be affixed at the back of each panel.
- h) Bus bar clamp-on sensor, 2 x 4 In. (50 x 101mm) opening-maximum D current : 50A

4.04.00

Battery Discharge Resistor Unit

- a. It shall be designed to perform periodic discharge tests. The Resistor Unit shall be made specially to check initial battery performance, guarantee smooth operation of back up system during emergencies and improve overall health and life of Battery system.



- b. Resistor Unit shall be an assembly consisting of copper-nickel alloy wire grid elements supported by stainless steel tie rods. The resistor bank shall have adequate trimming facility (coarse and fine) to maintain a constant current against falling voltage during discharge operation. An ammeter shall be provided on the unit to monitor discharge current of battery.

5.00.00 TESTS

5.01.00 All equipment and components thereof shall be subject to shop tests as per relevant IS standards. The above tests shall include but not be limited to:

5.01.01 Following type tests on two cells of the battery shall be carried out by the Bidder, even if the Bidder submits type test certificates for Purchaser's review and approval.

- a) Discharge performance test at low temperature
- b) Ampere hour & watt-hour efficiency test
- c) Endurance test.

5.01.02 Following minimum tests shall be performed on each battery charger.

- a) Dielectric tests.
- b) Voltage regulation check from 0 to 100% load with $\pm 10\%$ input voltage variation.
- c) Ripple content measurement.
- d) Functional tests.
- e) Heat run test on current limiting value.

5.01.03 All other routine tests shall be carried out on each equipment as per relevant standard.

5.02.00 Tests Witness

5.02.01 Tests shall be performed in presence of Owner's representative, if so desired by the Owner.

5.02.02 The supplier shall give at least seven (7) days' advance notice of the date when the tests are to be carried out.

5.03.00 Test Certificates

5.03.01 Certified reports of all the tests carried out at the works shall be furnished in six (6) copies for approval of the Owner.





5.03.02 The equipment shall be dispatched from works only after receipt of Owner's written approval of the test reports.

5.03.03 Bidder shall submit type test reports for the type tests as per relevant standards on identical equipment in type and rating. Reports older than five (5) years shall not be acceptable.

5.03.04 In case the type test reports are not submitted or the reports are not approved by the Purchaser, the Bidder shall conduct the type tests on the offered equipment at Bidder's risk and cost within the schedule specified herein. No deviation in this regard is acceptable.

5.03.05 Routine test certificates for components like contactors, relays, instruments, SCR / PWM transistors, Diodes, Condenser, Potentiometer, semi-conductors, push buttons etc. shall also be furnished for Owner's review and approval.

6.00.00 DRAWINGS, DATA & MANUALS

6.01.00 Drawings, Data and Manuals shall be submitted with the bid and in quantities and procedures as specified in general Conditions of Contract and/or elsewhere in this specification for approval and subsequent distribution after the issue of Notice to Proceed.

6.02.00 To be submitted with the Bid

6.02.01 Proposal sheets duly filled in.

6.02.02 Dimensional Battery room layout drawing.

6.02.03 General Arrangement drawing of Charger panels & Discharge Resistor Unit.

6.02.04 Typical foundation plan.

6.02.05 Bill of material.

6.02.06 Battery cell voltage characteristics and data for different discharge rates.

6.02.07 Battery Sizing calculation in the format of IEEE

6.02.08 Type test certificates as per requirement of this specification.

6.02.09 List of makes of various items / components shall be submitted for Purchaser's approval.

6.02.10 Leaflets and catalogues of different equipment and accessories including write up on features of different components along with data sheets, curves, tables etc.

6.03.00 To be submitted for Purchaser's Approval and Distribution





- 6.03.01 Guaranteed technical particulars and quality assurance plan.
- 6.03.02 Battery and Charger sizing calculation.
- 6.03.03 Sizing calculation of charger main equipment, viz. SCRs, rectifier transformer etc.
- 6.03.04 Fault current calculation for battery & battery charger.
- 6.03.05 Dimensional battery layout drawings in plan & sections.
- 6.03.06 Take-off terminals connection details.
- 6.03.07 Dimensional general arrangement drawings of Battery charger clearly showing device dispositions, cable entry, space requirements etc.
- 6.03.08 Charger foundation plan and loading.
- 6.03.09 Sectional views of battery charger panels.
- 6.03.10 Charger schematic diagram along with write-up and wiring diagrams with wire no., equipment / device no. etc.
- 6.03.11 Detailed bill of materials.
- 6.03.12 Test reports.
- 6.03.13 Transport / shipping details such as method of packaging, dimension & weight of package, part list etc.
- 6.03.14 Any other relevant drawing or data necessary for satisfactory installation operation and maintenance.
- 6.03.15 Instruction manuals on Battery, Battery Charger and Battery discharge resistor unit.
- The manual shall clearly indicate the salient features of each equipment, storage and installation method, operation and maintenance procedure, check-up and tests to be carried out before commissioning of the equipment and during maintenance.
- 6.04.00 The Bidder may note that the drawings, data and manuals listed are minimum requirement only. The Bidder shall ensure that all the necessary write-ups, curves and information required to fully describe the equipment offered are submitted with his bid.



ANNEXURE-A

RATINGS & REQUIREMENTS

1.0	BATTERY	:	Lead Acid
1.1	Application	:	FGD Plant
1.2	Design Ambient temperature	:	
	a. Maximum	:	50 °C
	b. Minimum	:	5 °C
1.3	Type	:	Plante
1.4	Nos. of Cells per Battery	:	To be decided by the bidder
1.5	Battery nominal voltage	:	2 V
1.6	Battery capacity at 27°C	:	To be decided by the bidder
1.7	Proposed Method of working	:	
	a. Float charging (normal)	:	2.25 Volt / cell.
	b. Boost charging (after complete discharge)	:	2.75V / cell
1.8	Intermediate tapping	:	As required
1.9	Mounting	:	Wooden racks
1.10	Terminal Connection	:	Through single core fire survived cables. Actual size of cable shall be informed to the successful bidder.

NOTE: Items 1.4, 1.6 & 1.7– Bidder to justify with details, if his recommended values are different from the values specified in this specification.



2.0 BATTERY CHARGER

2.1	Charger	:	Float and Float-cum-boost
2.2	Type	:	Solid-state, full wave, fully controlled with microprocessor based AVR, three-phase bridge, suitable for continuous duty application.
2.3	Enclosure	:	Sheet steel enclosure, IP-52.
2.4	Ambient Temperature	:	50°C
2.5	A.C. Input		
	a) Supply	:	415 V, 3 phase, 50 Hz, 4 wire.
	b) Voltage variation	:	$\pm 10\%$
	c) Frequency variation	:	+5 % to -5%
	d) Combined volt and frequency variation	:	10% (absolute sum)
	e) Short-circuit level	:	50 KA r.m.s. symmetrical.
	f) System earthing	:	Solidly earthed.
2.6	D.C. Output		
	a) Float charger	:	(Maximum Continuous DC load + float charging battery) plus 25% margin. Output voltage adjustable between 230-240 V.
	b) Boost charger	:	Restoring fully discharged battery to full charge condition in 8 Hours for Lead-Acid battery/ 5 hours for Ni-Cd battery, with 25% margin over maximum charging rate. O/p voltage adjustable between 260-285 V
2.7	Performance Requirements		
	a)		The output voltage of the charger shall be regulated within $\pm 1\%$ of the set value for any load variation from 0 to 100% and A.C. input voltage and frequency variations as indicated above in 2.5.



- b) The ripple content in charger DC output shall be limited to 1% (rms) with or without battery.

3.0 DISCHARGE RESISTOR BANK

3.1	Type	:	Portable
3.2	Construction	:	Sheet steel enclosed,
3.3	Resistor material	:	Copper-nickel alloy/stainless steel
3.4	Enclosure Protection Class	:	IP30
3.5	Cooling	:	Natural air-cooled
3.6	Rating	:	To meet the functional requirement C10 (Lead-Acid), C5(Ni-Cd) discharge rate
3.7	Control	:	Using rotary switches for step control of current against falling voltage with ON-OFF facility

ANNEXURE-B

FITTINGS & ACCESSORIES (BATTERY)

1.0 BATTERY

Each set of battery shall be equipped with fittings and accessories as listed below.

1	One battery log book.
2	Two copies of printed instruction sheet.
3	One no. cell testing voltmeter (3-0-3 volts) complete with leads.
4	One no. rubber syringe type hydrometer suitable for specific gravity reading.
5	Three nos. pocket thermometer.(Digital type)
6	One no. thermometer (0 to 100 degree C) with specific gravity correction scale.
7	One set cell bridging connector.
8	Two nos. each Electrolyte resistant plastic funnels and plastic jugs
9	Battery racks suitable for accommodating the cells coated with paint.
10	insulator (with 5% extra), rubber pad etc. for rack.
11	Two nos. plastic filling bottle for filling up.
12	One pair of spanners.
13	Requisite quantity of electrolyte with 10% extra in non-returnable containers.
14	Two pairs of rubber hand gloves.
15	Two nos. cell lifting straps.
16	One set of inter cell, inter tie and inter bank connectors as required for complete installation.
17	Self adhesive PVC stickers for cell numberings
18	Goggles.

NOTE: Any other accessories if required for satisfactory operation of the complete battery system shall also be included in Bidder's offer and to be supplied accordingly.

2.0 LIST OF ALARMS (indicative)

2.1 Following list of alarm / annunciation shall be provided at each charger.

- a) A.C. supply failure
- b) DC system under voltage
- c) DC system over voltage.
- d) D.C. System ground
- e) Charger overload
- f) SCR fuse blown
- g) Filter fuse blown



h) D.C. output fuse blown

- 3.0 Initiating contacts wired to two terminals at battery charger panel shall be provided for group annunciation "Battery Charger Trouble" of the events mentioned above, at PLC. Separate contacts shall be provided for "Battery earth fault" annunciation at PLC system.
- 4.0 Initiating contacts for all alarm points shall also have electrically separate spare set of contacts wired to the terminal block for future use.
- 5.0 All alarm contacts shall be rated 0.5A at 220V DC and 5 Amp. at 240V AC.
- 6.0 In addition to the alarm points mentioned above, any other alarm point, if required for battery charger, shall be provided.
- 7.0 Charger panel shall also have the following minimum indications:
 - a. Charger power supply ON (at all three phases)
 - b. Charger DC output healthy.
 - c. Control supply ON.
 - d. DC supply healthy.
 - e. Float / boost charger in operation (in float-cum-boost charger)



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

**VOLUME: II-F
SECTION - XIII
CABLES**



Development Consultants Pvt. Ltd.

**Vol. II-F/Section-XIII
Cables**



**Tender Specification
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VOLUME: II-F

SECTION-XIII

CABLES

1.00.00 SCOPE OF SUPPLY

1.01.00 Power and Control Cables shall cover the entire requirement of FGD Package. The cables shall be furnished in accordance with this specification and Annexure.

Other cables including special cables, if any, which are necessary as per proven engineering practice for satisfactory & trouble-free operation of the entire cable system of the FGD plant shall also be within the scope of supply. These shall include all such cables for electrical integral with mechanical equipment systems and sub-systems.

1.02.00 Cable shall be furnished in accordance with this specification and the following annexures:

a)	H.V. Power cables	:	Annexure – I
b)	L.V. Power Cables	:	Annexure – II
c)	Control Cables	:	Annexure – III
d)	Standard Cable Sizes	:	Annexure – IV

1.03.00 All relevant drawings, data and instruction manuals

2.00.00 CODES & STANDARDS

2.01.00 All cable and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.

2.02.00 Cable and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

2.03.00 The electrical installation shall meet the requirements of Indian Electricity Rules as amended up-to-date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

3.00.00 DESIGN CRITERIA





- 3.01.00 The Cables shall be used for connection of power and control circuits of the auxiliary electrical systems.
- 3.02.00 Cables will be generally laid on ladder type trays or drawn through rigid PVC/GI /HDPE pipe/conduits or directly buried in ground depending on layout requirement.
- 3.03.00 For continuous operation at specified rating, maximum conductor temperature shall be limited to the permissible value as per relevant standard and / or this specification which one is more stringent.
- 3.04.00 The insulation and sheath materials shall be resistant to oil, acid and alkali and shall be tough enough to withstand mechanical stresses during handling.
- 3.05.00 The outer sheath of power and control cables shall have rodent and termite repulsion treatment.

4.00.00 SPECIFIC REQUIREMENTS

4.01.00 General Description

All Cables shall be furnished in strict compliance with ratings and requirements and sizes as given in Annexures to this Specification.

4.02.00 Drum Length and Tolerance

The cables shall be supplied in non-returnable packing steel drum for 3.3/11kV power cables, wooden drums for 415/240V power and control cables, each containing minimum 500meters length of larger sizes of cable unless specifically asked for. For smaller sizes of cables, each drum shall contain 1000 meters length of cable. Allowable tolerance on individual drum length is $\pm 5\%$.

4.03.00 Total Quantity Variation

Total supplied quantity shall not vary by more than $\pm 2-1/2\%$ of total quantity for ordered length for all types of cables.

4.04.00 Non-Standard Length

Owner may accept non-standard lengths up to 5% of the total ordered quantity. However, the Bidder shall be required to obtain Owner's approval before packing the Cables on drums. Non-standard lengths shall not be less than 100 meters in any case.

4.05.00 Cable identification

Cable identification shall be provided by embossing on every meter on the outer sheath the following:

- a) Manufacturer's name or trade mark



- b) Voltage grade
- c) Year of manufacture
- d) Type of insulation, e.g. XLPE/PVC/HR85 etc.
- e) No. of core and size of cables.
- f) Type of improved fire performance, e.g. FR/FR-LSH
- g) IS number

4.06.00 Packing

4.06.01 Cables shall be supplied in non-returnable drums. The drums shall be of heavy construction. All wooden parts shall be manufactured from seasoned wood. All ferrous parts used shall be treated with suitable rust preventive finish or coating to avoid rusting during transit or storage.

4.06.02 Cable shall be wound and packed on drums in such a manner that it shall be properly sealed and firmly secured to the drum. The ends of each length shall be sealed before shipment.

4.06.03 The cable drums should carry the following details in printed form:

- a) Manufacturer's name or trademark
- b) Type of cable & voltage grade
- c) Year of manufacture
- d) Type of insulation e.g. XLPE
- e) No. of core and size of cables
- f) Cable code
- g) Length of cable on drum
- h) No. of length on drum, if more than one
- i) Direction of rotation, by arrow
- j) Approx. gross mass.
- k) IS number and ISI mark

4.07.00 Selection Criteria





- 4.07.01 In cable sizing the following are to be taken into consideration.
- a) Short circuit current and duration
 - b) Continuous current.
 - c) Installation conditions.
 - d) Voltage drop under normal running and starting condition.
 - e) Grouping factor and laying method.
- 4.07.02 Apart from above, consideration shall also be given to limit the cable to some standard sizes instead of using too many types.
- 4.07.03 The standard cable sizes, capacities, derating factors, etc. as given in IS / IEC shall be generally followed.
- 4.07.04
- a) For breaker protected circuits minimum size shall be determined by short circuit rating and system short circuit current withstand time shall be considered as 0.2 secs. System short circuit current withstand time for Incomers and Tie feeders shall be considered as 1 sec.
 - b) For motor circuits the selection of size shall be made ensuring that the cable shall withstand a short circuit fault directly following a second hot start.
- 4.07.05 For fuse protected circuit, the conductor size shall depend on full load current subject to voltage drop not exceeding 3%. For practical purposes, the minimum size chosen is as below:
- a) Aluminium : 16 Sq. mm.
 - b) Copper : 2.5 Sq. mm.
- All drives of small rating where terminations with 16 Sq. mm. cables are not feasible, shall have copper cable.
- 4.07.06 Multicore control cables shall generally have spare conductor (s) in accordance with the following chart:

Conductors required	Cables
1 or 2	1-3/C
3 or 4	1-5/C
5 or 6	1-7/C
7 to 8	1-9/C
9 or 10	1-12/C
Above 10	Two or more of above cables



4.07.07 Separate cables for each type of following services / functions as applicable shall be used for each feeder. Same multicore cable using different services shall not be acceptable.

- a) Power.
- b) Control, interlock and indication.
- c) Metering and measuring.
- d) Alarm and annunciation.
- e) C.T. Cables.
- f) V.T. Cables.

4.08.00 Selected sizes of power and control cables are given in Annexure-VI.

5.00.00 TESTS

5.01.00 Shop Tests

The Cables shall be subject to shop tests in accordance relevant IS/IEC standards to prove the design and general qualities of the Cables as below: -

5.01.01 Routine tests on each drum of cables.

The following minimum tests shall be carried out as routine tests on each and every drum length of cable, as per IS 7098 (Part 2) / 1985, in addition to other tests.

- a) High Voltage Test

5.01.02 Acceptance Test

The following test shall be carried out as Acceptance Test in the presence of Owner's Inspecting Engineer on samples taken from the delivery lot. One drum out of every 10 number of drums or less shall be selected at random sampling basis in each lot for the Acceptance Tests which shall be carried out at manufacturer's/supplier's cost:-

- a) High Voltage Test
- b) Conductor Resistance Test
- c) Tensile / wrapping test.
- d) Partial discharge test (In screened cables).
- e) Insulation Resistance/Volume resistivity test
- f) Measurement of thickness of insulation and sheath and other dimensions
- g) Tensile strength & elongation at break for insulation & sheath.
- h) Hot set test on XLPE insulation

- i) Flammability test as per Swedish standard SS:424-15-75 Class-F-3 (Swedish Chimney test)/IS:10810
 - j) Acid gas generation test as per IEC-754-1/IS:10810.
 - k) Smoke density test as per ASTM-D-2843/1977/IS:10810
 - l) Oxygen index test as per ASTM-D 2863/1977/IS:10810
 - m) Temp. index test as per ASTM-2863/77/IS:10810
 - n) Test for Rodent and termite repulsion property
- 5.01.03 Type tests on each type of cable, size and batch inclusive of measurement of armour D.C. resistance of power cables as per relevant IS.
- 5.02.00 **Additional Tests**
- Following additional acceptance tests shall also be performed on each type of cables having outer sheath with improved fire performance (Type FRLSH):
- 5.02.01 Oxygen index test
- The Oxygen index shall not be less than 29.
- 5.02.02 Temperature Index Test
- The measured value of temperature index shall be 21 at a temperature of 250°C
- 5.02.03 Flame Retardance test on single cable and on bunched cables
- After the test, there should be no visible damages on the test specimen within 300mm from its upper end.
- After burning has ceased, the cables should be wiped clean and the charred or affected portion should not have reached a height exceeding 2.5 meter above the bottom edge of the burner, measured at the front and rear of the cable assembly.
- 5.02.04 Halogen acid gas evolution test
- The level of HCL evolved shall not exceed 20 per cent by weight
- 5.02.05 Smoke density test
- The cables shall meet the requirements of light transmission of minimum 40% after the test.
- 5.02.06 **Test for rodent & termite repulsion property**
- The test shall be carried out to note the presence of rodent and termite repelling chemical in PVC compound. Normal procedure is that a few chippings of the PVC compound are slowly ignited in a porcelain dish or crucible in a muffle furnace at about 600°C. The resulting ignited ash is boiled with a little ammonium acetate solution (10%). A drop of aqueous sodium



sulphide solution is placed on a thick filter paper and it is allowed to soak. The spot is touched with a drop of above extract. A black spot indicates the presence of anti-termite & rodent compound.

5.03.00 Test Witness

Tests shall be performed in presence of Owner/'s representative if so desired by the Owner. The Contractor shall give at least thirty (30) days' advance notice of the date when the tests are to be carried out .

5.04.00 Test Certificates

5.04.01 Certified reports of all the tests carried out at the works shall be furnished for approval of the Owner.

5.04.02 Test reports shall be completed with all details and shall also contain IS specified limit values, wherever applicable, to facilitate review.

5.04.03 The cables shall be dispatched from works only after receipt of Owner/Purchaser's written approval of the test reports.

6.00.00 DRAWINGS, DATA & MANUALS

6.01.00 To be furnished after award of contract

- a) Manufacturer's catalogues giving cable construction details and characteristics.
- b) Cable current ratings for different types of installation, inclusive of derating factors for ambient temperature, grouping etc.
- c) Write-up on Manufacturer's recommended method of splicing, jointing, termination etc. of the cables.
- d) Type test report on all specified cables.
- e) Proposal Data as per Annexure.
- f) Confirmed cable data
- g) Test reports

6.02.00 To be submitted for Owner/Purchaser's Approval and Distribution

6.02.01 Guaranteed Technical Particulars.

6.02.02 Quality assurance plan.

6.02.03 Shop Test reports.





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- 6.02.04 Instruction manuals.
- 6.02.05 The manual shall clearly indicate method of laying, termination, check-ups and tests to be carried out before commissioning.
- 6.03.00 The bidder may note that the drawings, data and manuals listed herein are minimum requirement only. The bidder shall ensure that all other necessary write-up, information, etc required to fully describe the cable are to be submitted with the bid.





ANNEXURE-I

H.V. POWER CABLES 3300V & 11000 V GRADE

3300/3300V & 11000/11000V grade 90°C continuous rating under normal condition and 250°C short time rating under short circuit condition XLPE insulated FRLSH sheathed heavy duty power cable suitable for use in 3300V & 11000V non-effectively earthed system conforming to following requirement and in line with IS 7098, IS 8130, IS 5831 and IS 3975.

DESCRIPTION	SPECIFICATION
Conductor	Stranded and compacted aluminium conductor of grade H2 and class 2 for all sizes, generally conforming to IS: 8130 shall be provided.
Conductor Screen	Cross linked semi-conducting compound extruded in the same operation as the insulation
Insulation	Cross linked polyethylene (XLPE) of natural color, extruded over screened conductor. This shall be conforming to IS: 7098 Part-2 (1985).
Insulation Screen:	All cables shall be provided with insulation screening. The insulation screening shall consist of extruded cross linked semi-conducting compound in combination with a layer of lapped copper tape of thickness not less than 0.1 mm.
Core Identification	Three (3) core cables, core identification shall not be done with different coloring of XLPE insulation, but with natural color with colored strips applied on the cores or by numerals printing on the cores.
Inner Sheath	Three (3) core cables, after laying up of cores, shall be provided with extruded FRLSH PVC compound inner sheath conforming to type ST2 of IS: 5831/1984. Such inner sheath shall be provided by pressure extrusion process without filler. However, if in the process, the centre filler is required, the same shall be provided and material of centre filler shall be the same as inner sheath material. Extruded FRLSH PVC compound conforming to type ST2 inner sheath shall also be provided for single core cables.
Armour	For Single Core Cables: - Armour shall be of Non magnetic material consisting of single hard drawn aluminium round wires conforming to H4 grade of IS: 8130 / 1984. For three (3) core cables: - The armouring shall be of galvanised steel wire / Strip.
Overall Sheath Drum	Extruded FRLSH PVC compound conforming to type ST2 of IS: 5831. Conforming to IS-10418 (Steel Drum)

Note: For sizing of 11 kV incoming cable to FGD Switchgear from Station Transformer bidder shall consider the full load current of the Station Transformer as current carrying capacity of the cable.





ANNEXURE-II

L.V. POWER CABLES 1100 V GRADE

1100 V grade, 90°C continuous rating under normal condition and 250°C short time rating under short circuit condition XLPE insulated FRLSH sheathed heavy duty, power cable conforming to following requirement and in line with IS 7098, IS 8130, IS 5831 and IS 3975.

1.1	Conductor	:	Stranded and compacted plain aluminium of grade H2 and Class 2/stranded, high conductivity annealed plain copper generally conforming to IS: 8130.
1.2	Insulation	:	Extruded Cross-Linked polyethylene (XLPE) conforming to IS:7098 (Part-3)
1.3	Core Identification	:	By color coding
1.4	Inner Sheath	:	Extruded FRLSH PVC compound conforming to type ST2 of IS: 5831 for multicore cable. Single core cables shall have no inner sheath.
1.5	Armour	:	Galvanised single round steel wire armour for twin and multicore cables. Non-magnetic hard drawn aluminium single round wire conforming to H4 grade for single core cables.
1.6	Overall Sheath	:	Extruded FRLSH PVC compound conforming to type ST2 of IS: 5831.
1.7	Drum	:	Conforming to IS-10418 (Wooden drum)

ANNEXURE-III

CONTROL CABLES

1.0	1100 V grade 70°C continuous rating under normal condition and 160°C short time rating under short circuit condition PVC insulated FRLSH sheathed control cable conforming to following requirement and in line with IS:1554, IS:8130, IS:5831 and IS:3975.		
1.1	Conductor	:	Stranded, non-compacted & circular, high conductivity annealed plain copper, generally conforming to IS: 8130.
1.2	Insulation	:	Extruded PVC compound conforming to type A of IS: 5831.
1.3	Core Identification	:	By color coding and numbering at interval of 100mm or less
1.4	Inner sheath	:	Extruded FRLSH PVC compound conforming to type ST1 of IS: 5831 for multicore cables. Single core cables shall have no inner sheath. Filler shall be of same material as of inner sheath i.e. ST1.
1.5	Armour	:	Galvanized single round steel wire for twin and Multi-core cables.
1.6	Overall sheath	:	Extruded FRLSH PVC compound conforming to type ST1 of IS: 5831.
1.7	Drum	:	Conforming to IS: 10418 (Wooden drum)



ANNEXURE-IV

1.1KV GRADE COPPER CONDUCTOR FS POWER CABLES

1100V, copper conductor, heat resisting insulation, extruded inner sheath of low smoke and very low halogen content fire resisting material, single layer of copper wire armour for single core / single layer of round galvanized steel wire for multicore, outer sheath of low smoke and very low halogen content fire resistant material, suitable for minimum temperature of 750 deg.C for 3 hours. The cables shall be in compliance with IEC-60331, Part 11

1.1KV GRADE COPPER CONDUCTOR FS CONTROL CABLES

1100V, copper conductor, heat resisting insulation, extruded inner sheath of low smoke and very low halogen content fire resisting material, single layer of copper wire armour for single core / single layer of round galvanized steel wire for multicore, outer sheath of low smoke and very low halogen content fire resistant material, suitable for minimum temperature of 750 deg.C for 3 hours. The cables shall be in compliance with IEC-60331, Part 11.



ANNEXURE-V

FLEXIBLE TRAILING CABLES (AS APPLICABLE)

1100V Grade

1100 V Grade trailing cable shall be plain copper of Class-5 of IS-8130, heat resistant elastomeric compound based on EPR insulation, inner sheath of heat resistant elastomeric compound PCP sheath, nylon cord reinforcement and heat resistant, oil resistant and flame retardant heavy duty elastomeric compound FRLS CSP outer sheath.

ANNEXURE-IV

STANDARD CABLE SIZES (Only for Reference)

Sl. No.	Cable Size	Conductor	Insulation
1.0	HT Cables		
1.1	1 core 70 Sq. mm	AL	XLPE (FRLSH)
1.2	3 core 150 Sq. mm	AL	XLPE (FRLSH)
1.3	3 core 185 Sq. mm	AL	XLPE (FRLSH)
1.4	3 core 300 Sq. mm	AL	XLPE (FRLSH)
1.5	1 core 500 Sq. mm	AL	XLPE (FRLSH)
1.6	1 core 630 Sq. mm	AL	XLPE (FRLSH)
2.0	LT Power Cables		
2.1	2 core 2.5 Sq. mm.	CU	XLPE (FRLSH)
2.2	3 core 2.5 Sq. mm.	CU	XLPE (FRLSH)
2.3	4 core 4 Sq. mm.	CU	XLPE (FRLSH)
2.4	2 core 10 Sq. mm.	AL	XLPE (FRLSH)
2.5	3 core 10 Sq. mm.	AL	XLPE (FRLSH)
2.6	2 core 16 Sq. mm.	AL	XLPE (FRLSH)
2.7	3 core 16 Sq. mm.	AL	XLPE (FRLSH)
2.8	4 core 16 Sq. mm.	AL	XLPE (FRLSH)
2.9	3 core 25 Sq. mm.	AL	XLPE (FRLSH)
2.10	2 core 35 Sq. mm.	AL	XLPE (FRLSH)
2.11	3 core 35 Sq. mm.	AL	XLPE (FRLSH)
2.12	4 core 35 Sq. mm.	AL	XLPE (FRLSH)
2.13	3 core 50 Sq. mm.	AL	XLPE (FRLSH)
2.14	3 core 70 Sq. mm.	AL	XLPE (FRLSH)
2.15	4 core 70 Sq. mm.	AL	XLPE (FRLSH)
2.16	3 core 95 Sq. mm.	AL	XLPE (FRLSH)
2.17	3½ core 95 Sq. mm.	AL	XLPE (FRLSH)
2.18	3 core 150 Sq. mm.	AL	XLPE (FRLSH)
2.19	3 core 185 Sq. mm.	AL	XLPE (FRLSH)
2.20	3½ core 185 Sq. mm.	AL	XLPE (FRLSH)

Sl. No.	Cable Size	Conductor	Insulation
2.21	3 core 240 Sq. mm.	AL	XLPE (FRLSH)
2.22	3½ core 240 Sq. mm.	AL	XLPE (FRLSH)
2.23	3 core 300 Sq. mm.	AL	XLPE (FRLSH)
2.24	3½ core 300 Sq. mm.	AL	XLPE (FRLSH)
2.25	1 core 630 Sq. mm.	AL	XLPE (FRLSH)
3.0	Control Cable		
3.1	2 core 2.5 Sq. mm.	CU	PVC (FRLSH)
3.2	3 core 2.5 Sq. mm.	CU	PVC (FRLSH)
3.3	5 core 2.5 Sq. mm.	CU	PVC (FRLSH)
3.4	7 core 2.5 Sq. mm.	CU	PVC (FRLSH)
3.5	12 core 2.5 Sq. mm.	CU	PVC (FRLSH)
4.6	16 core 2.5 Sq. mm.	CU	PVC (FRLSH)
3.7	19 core 2.5 Sq. mm.	CU	PVC (FRLSH)
4.0	Cables For Electronic Equipment Grounding		
4.1	1 core 35 Sq. mm.	CU	HR-PVC/XLPE (FRLSH)
4.2	1 core 150 Sq. mm.	CU	HR-PVC/XLPE (FRLSH)



**Tender Specification
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VOLUME: II-F

SECTION-XIV

ILLUMINATION SYSTEM



Development Consultants Pvt. Ltd.

**Vol. II-F/Section-XIV
Illumination System**



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VOLUME: II-F

SECTION-XIV

ILLUMINATION SYSTEM

1.00.00 SCOPE OF WORK

1.01.00 This section is intended to cover the design, engineering, manufacture, assembly, testing at manufacturer's works / laboratory, supply, delivery, properly packed for transport to site, for FGD plant illumination system, complete with all materials and accessories for efficient and trouble-free operation including welding system.

1.02.00 The scope of work shall also include design, engineering installation, testing, commissioning and putting into successful commercial operation of the FGD Plant lighting system supplies. The erection, commissioning and testing of the illumination system shall be carried by erection contractor appointed by bidder.

1.03.00 The major areas to be illuminated under the scope of this package are listed in Annexure-E of this section. The areas listed are however indicative only for the purpose of guidance to the seller and is subject to change during detailed engineering after finalization of plant layouts.

2.00.00 SCOPE OF SUPPLY

2.01.00 The equipment and materials within the scope of supply shall include but not limited to:

- a) Lamp and LED type lighting fixtures and related LED accessories.
- b) Lighting panels/boards: main lighting distribution boards, emergency AC lighting distribution boards, emergency DC lighting panels, street lighting panels. All panels shall be provided with energy saving system.
- c) Street light poles, flood lighting towers/poles/high mast.
- d) Ceiling fans, receptacles, switches, switchboards, portable emergency lights, portable 24V supply module including handset as maintenance equipment etc.
- e) Cables, wires, splicing/termination/connection accessories including 4 way/3 way/2 way cable junction boxes with disconnecting devices on each way.
- f) Conduit and accessories, junction and pull boxes, terminal blocks.



- g) Grounding materials and connections.
- h) All fittings, supports, brackets, anchors, clamps and connections.
- i) Steel for field fabrication of supports and brackets.

2.02.00 Carrying out of detail engineering, including detail design calculations, preparation of lighting layouts showing location of fixtures, cable, wires conduit routing, indicating number and size of wires in each conduit and preparation of cable schedule and other related drawings as detailed in subsequent clauses consider the energy saving and energy efficient illumination system.

2.03.00 Preparation of "As built" drawings at the option of owner

2.04.00 All relevant drawings, data and instruction manuals

3.00.00 CODES AND STANDARDS

3.01.00 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.

3.02.00 Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

3.03.00 The electrical installation shall meet the requirements of Indian Electricity Rules as amended up-to-date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed. In case of any discrepancy, the more restrictive rule shall be binding.

4.00.00 DESIGN CRITERIA

4.01.00 Design Basis

4.01.01 The system provides lighting and electric power supply to the limestone based Flue Gas Desulphurisation system including Gypsum Handling Area, Limestone Handling area and Absorber area, as applicable. It also provides lighting to selected areas during plant emergency conditions.

4.01.02 The system will be installed in an adverse industrial environment. Equipment in some areas will be subject to vibration, coal-dust, fly-ash, oil/water vapours as prevalent in a thermal generating plant.

4.01.03 The design shall be such as to provide minimum lighting levels as specified for different areas.



- 4.01.04 The Bidder shall carefully consider these lighting levels and layouts in making the offer and shall clearly indicate if any change is required to achieve the design lighting levels with the equipment offered.
- 4.01.05 The systems shall be suitable for operation on available power supply having characteristics as given in the annexure.
- 4.01.06 All fittings of control room / office shall be automated control with energy efficient type lighting fixture and lamps.
- 4.01.07 The FGD plant illumination area shall generally be provided with
- ❖ Main lighting system for full illumination under normal power supply conditions and shall operate from 415V/240V AC power supply tapped from respective MLDB/lighting panels.
 - ❖ Emergency lighting system for reduced illumination operated by DG supply feeders during failure of main power supply. It shall cover 20% of fixtures in the building and associated area.
 - ❖ Minimum emergency lighting system for reduced illumination during failure of main power supply with the help of 220V DC batteries/supply feeders.
- 4.01.08 Various lighting panel shall be fed directly from nearest Main Lighting Distribution board. The MLDBs shall have duplicate incomers and a bus-section and shall be fed from respective 415V switchgear/PMCC through 2x100%, 100-150KVA, Dyn11, 1:1 Dry type, isolating transformers to reduce fault level below 9kA. Each MLDB shall have outgoing feeders TPN MCCB with earth leakage current protection. The transformers may, preferably, be located inside the MLDB itself.
- 4.02.00 **System Concept**
- The lighting system shall comprise following sub-systems:
- 4.02.01 **Normal A.C. Lighting**
- a) This will be provided by A.C. lighting fixtures distributed throughout the FGD area. These lights will be ON as long as the normal A.C. supply is available.
 - b) A.C. lighting fixtures will be fed from lighting panels (LP), which in turn will be connected to main lighting distribution board (MLDB). The lighting panels shall be provided with at least 20% spare outlets.
 - c) Arrangement shall be made for automatic daylight controlling in FGD area as required.

4.02.02 **Emergency A.C. Lighting**

- a) On failure of normal A.C. Supply, emergency A.C. lighting will be provided in selected areas for safe movements and operation of important auxiliaries.
- b) Emergency A.C. lighting fixtures will be fed from emergency lighting panels (ELP) either through cable junction box or direct, which in turn will be connected to emergency AC Main Lighting Distribution Board (ACEMLDB). It should be fed from Emergency MCC and same like MLDB. The emergency lighting panels shall be provided with at least 20% spare outlets.

These lights will be kept "ON" from normal power supply source. But on failure of normal power supply these will be fed from DG. This change over of power supply will be done by automatic switching.

- c) A.C. emergency lighting fixture will account for 20% of the total lighting fixtures except In control room wherein 30% emergency lighting shall be provided shall be provided.

4.02.03 **Emergency D.C. Lighting**

- a) This will be provided by D.C. lighting fixtures located strategically in critical operating areas and emergency exits. Emergency D.C. lighting fixtures will be fed from DC lighting panels (DCLP) either through cable junction box or direct, which in turn will be connected to DC Distribution Board (DCDB).
- b) These lights will be ON all the time - normally from A.C. Supply, but on its failure from D.C. supply through automatic switching. DC emergency lighting fixtures shall account for 10% of the total fixtures provided in critical operating areas.
- c) The DC Distribution Boards will be fed from two power sources, namely -
 - i) Emergency PMCC (Unit #1).
 - ii) Emergency PMCC (Unit #2)

These lights will be ON all the time - normally from station A.C. supply, but on its failure from respective DCDB through automatic switching.

4.02.04 **Street/Area Lighting**

Time switch will be used for controlling area/outdoor lights with provision for manual override and also have the provision of proven Energy Saving Systems.

Illumination shall be provided to the roads by providing conventional lighting poles.

4.02.05 Remote Emergency Lighting

This will be provided in isolated building / area / mobile equipment viz. stacker-reclaimer [where D.C. supply is not available] by self-contained battery / automatic charger / inverter / flood light units. These portable emergency light units will be energized automatically on loss of normal A.C. supply. Battery packs for portable emergency lights shall be rated for minimum one hour duty.

4.02.06 Control Philosophy in Control Room / Offices with false ceiling only

Automatic lighting control solutions shall be provided to reduce energy usage by eliminating over-illumination. These solutions provide centralized control of lighting, allowing easy implementation of scheduling, occupancy control, daylight harvesting etc.

Occupancy sensors to allow operation for whenever someone is within the area being scanned can control lighting. When motion can no longer be detected, the lights shut off. Passive infrared sensors react to changes in heat, such as the pattern created by a moving person. The control must have an unobstructed view of the building area being scanned. Ultrasonic sensors transmit sound above the range of human hearing and monitor the time it takes for the sound waves to return. A break in the pattern caused by any motion in the area triggers the control. Ultrasonic sensors can see around obstructions and are best for areas with cabinets and shelving, restrooms, and open areas requiring 360-degree coverage. Occupancy sensors utilizing both passive infrared and ultrasonic technology shall be used to control fixtures and lamps.

In control room, luminaire with 4 pin CFL shall be preferred.

4.03.00 Ratings & Requirements

4.03.01 All equipment and accessories shall be designed for continuous operation under site conditions without exceeding permissible temperature rise as stipulated in relevant standards.

4.03.02 Switches, fuses, MCCB, miniature circuit breakers (MCB), busbar shall be fully rated for short circuit level at the point of application. MCB shall have back-up HRC fuse if its rating is less than the available short circuit current.

4.03.03 All equipment and accessories shall have proper enclosure to suit the site conditions. In hazardous areas all equipment and accessories shall have flame-proof enclosure.



- 4.03.04 Wiring from lighting panels to fixtures and from lighting panels to 5/15A receptacles shall be carried out by PVC insulated wires through G.I. Conduits.
- 4.03.05 Heavy duty XLPE FRLSH power cables as per IS 7098 will be used for connections as follows:
- a) From Main Lighting Distribution Board (MLDB) to Area Lighting Panel.
 - b) From Emergency Main Lighting Distribution Board (ACEMLDB) to Emergency Lighting Panels (ELP).
 - c) From DC Emergency Lighting Distribution Board (DCELDB) to DC Lighting Panels (DCLP).
 - d) From Street/Area lighting panel to street light poles / Flood Light Tower.
 - e) From 415V PMCC /ACDB to receptacles of 63A and above.
- 4.03.06 Inside Switchboards wiring shall be carried out with 1100V PVC stranded copper wire.
- 4.03.07 Distinctive earth terminal shall be provided either inside or outside of each equipment included under the scope of the bidder.
- 4.04.00 **Method of Calculation**
- 4.04.01 Standard Lumen method shall be adopted for interior & exterior lighting in order to calculate the number of lighting fixtures for obtaining the desired average level of illumination.
- 4.04.02 The coefficient of utilization shall be considered to take care of Lumen loss due to:
- a) Effect of room dimensions.
 - b) Absorption of light in luminaires.
 - c) Absorption of light at various room surfaces i.e ceiling wall etc.
 - d) Floor cavity, ceiling cavity.
 - e) Mounting height.
- 4.04.03 Moreover a maintenance factor shall also be considered to account for the fall of illumination due to aging, pollution like dust deposit etc. Maintenance factors to be considered for various areas shall be as follows:

Area

Maintenance factor





Control Room	0.75
Switchgear/MCC Room	0.65
General indoor area	0.60
Dusty Area	0.55

Light loss Factor

It is recommended that in interiors with fairly clean atmosphere, for example, offices, air conditioned factory interiors etc. a light loss factor of 0.8, in interiors which are prone to accumulate dust faster, for example, most in industrial interior an LLF of 0.7 and in high dirt prone interiors an LLF of 0.6 may be adopted for calculating the no. of luminaires to be installed for a particular service illuminance.

- 4.04.04 To achieve the recommended luminance relationship, it is necessary to select the reflectance of all finishes of the room surfaces. The recommended reflectance values for industrial interiors and equipment are given below for bidder's guide lines:

Reflectance Values

(For FGD / Other Auxiliary Area Except Dusty Area)

<u>Surface</u>	<u>Reflectance Percentage</u>
Ceiling	80-90
Wall	40-60
Desk and Bench tops, machines And equipment	25-45
Floor	not less than 20

For Dusty Area

<u>Surface</u>	<u>Reflectance Percentage</u>
Ceiling	50
Wall	30
Floor	10

- 4.04.05 Lux level to be considered for various areas are given in Annexure-B
- 4.04.06 Voltage drop at the fixture from the MLDB bus shall not exceed 3%.
- 4.04.07 Circuit loading of each lighting Panel shall be done as per relevant codes/Indian Standards in such a way that almost balanced loading in all the phases i.e. R, Y & B is achieved.



- 4.04.08 At least two (2) sub circuits shall be used for illumination of a particular area.
- 4.04.09 Sub circuit loading of each lighting panel shall be restricted to 2000 Watts.
- 4.04.10 The working plane shall be considered at 0.85 m from the floor level.
- 4.04.11 Calculation can be done through proven software program by maintaining uniformity ratio as per relevant IS.

5.00.00 SPECIFIC REQUIREMENTS - SUPPLY

5.01.00 Equipment and Material

- 5.01.01 Equipment and material shall comply with description, rating, type and size as detailed in this specification, drawings and annexures.
- 5.01.02 Equipment and materials furnished shall be complete and operative in all details.
- 5.01.03 All accessories, control devices, internal wiring, fittings, supports, hangers, anchor bolts etc. which form part of the equipment or which are necessary for safe and satisfactory installation and operation of the equipment shall be furnished.
- 5.01.04 All parts shall be made accurately to standard gauges so as to facilitate replacement and repair. All corresponding parts of similar equipment shall be interchangeable.

5.02.00 Lighting Fixtures

- 5.02.01 Lighting fixtures shall be designed for minimum glare. The surface finish shall be smooth, unobtrusive, scratch resistant and no bright spots are produced either by direct light source or by reflection. Fixture shall conform to latest IS / IEC and its latest amendment.
- 5.02.02 LED lamp fixtures shall be complete with all necessary wiring and accessories such as driver, ignitor, heat sink, power factor improvement capacitors (if required) etc. These shall be mounted in the fitting assembly only. The bidder shall indicate starting time of these lamps to attain full light output. Curves for starting characteristics with varying supply voltage etc. are to be furnished by the bidder.
- 5.02.03 Flood lighting shall have suitable base plate/frame for mounting on structural steel member.
- 5.02.04 Fixture shall be suitable for 20mm conduit entry and 16 SWG G.I. earth wire connection.
- 5.02.05 High bay fixtures shall have provision for vibration damper to ensure rated lamp life.

5.02.06 Fixtures shall be fully wired up to respective terminal blocks, suitable for loop in and loop out connection of PVC stranded wires of following sizes:

- a) Lighting fixture : 2.5mm² Copper - Two (2) Numbers
- b) Flood Light fixture : 2x2.5mm² Copper - Two (2) Numbers

5.02.07 Reflector shall be of sheet steel or aluminium, minimum 20 SWG thick, securely fixed by fastening device of captive type.

5.02.08 **Lamp holders**

Lamp holders shall be for LED lamp. Holders shall be designed and manufactured in accordance with relevant standard to give long and satisfactory service.

5.02.09 **Capacitors**

Capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits. Capacitors shall be suitable for operation at the supply voltage as specified and shall have a value of capacitance so as to correct the power factors of its corresponding lamp circuit. Capacitors shall be hermetically sealed in a metal enclosure.

5.02.10 **Ballasts (if required)**

Ballasts shall be designed, manufactured and supplied in accordance with latest edition of IS and function satisfactorily under site condition specified. The ballasts shall be designed to have a long service life. The power loss in ballasts (if required) for LED lamps shall not be more than the specified watts as per relevant standard.

Ballasts shall be mounted using self-locking, anti-vibration fixing and shall be easy to remove without dismantling the fixtures. They shall be totally enclosed units.

The ballasts shall be of the inductive, heavy duty type, filled with thermosetting, insulating, moisture repellent polyester compound filled under pressure or vacuum. The ballast wiring shall be of copper wire. Ballasts shall be designed for maximum winding temperature rise of 550C under rated conditions. They shall be free from hum. Ballasts for LED lamps shall be provided with suitable tapping to set the voltage within the range specified. End connections and taps shall be brought out in a suitable terminal block, rigidly fixed to the ballast enclosure. Separate ballasts for each lamp shall be provided in case of multi-lamp fixtures.

5.03.00 **Lamps**

- 5.03.01 The LED lamps to be supplied shall conform to IS 9974 or latest edition. LED lamps shall be suitable for use in any position. Restrictions, if any, shall be clearly stated. The lamps shall be capable of withstanding small vibrations without breakage of connections at lead-in wires and filament electrodes.
- 5.03.02 Mercury / Sodium vapor lamp shall be color corrected type with screwed cap.
- 5.03.03 Lamps shall be suitable for use in position and capable of withstanding small vibrations. Restrictions and special features, if any shall be clearly indicated.
- 5.03.04 The Bidder shall furnish typical wiring diagrams for all fittings including all accessories. The diagrams shall include technical details of accessories i.e. ignitors, ballasts, capacitors etc.
- 5.04.00 **Lighting Panel**
- 5.04.01 Lighting panels shall be metal-enclosed, cabinet type, fabricated from CRCA sheet steel minimum 2 mm thick, suitable for either wall/column mounting on brackets or floor mounting on channel sills.
- 5.04.02 Indoor Lighting Panels shall be dust and vermin-proof, IP-52; outdoor panels shall be weather-proof with canopy, IPW-55 or better.
- 5.04.03 Lighting Panels shall be so constructed as to permit free access to the terminal connections and easy replacement of parts. Front access doors shall have padlocking arrangements.
- 5.04.04 Lighting panels shall have provision of cable entry from top and bottom, as required, with removable gland plates. Necessary double compression type brass cable glands, tinned copper/Aluminium cable lugs are to be furnished.
- 5.04.05 Two ground pads with M10 G.I. bolts and nuts shall be provided on each Lighting Panel for connection to ground conductor.
- 5.04.06 Each Lighting Panel shall be complete with designation and caution notice plates fixed on front cover and a circuit directory plate fixed on inside of the front cover. Circuit directory plate shall contain details of the points to be controlled by each circuit including the location of the point controlled, rating of the protective units and loading of each circuit.
- The plates shall be of anodized aluminium with inscriptions indelibly etched on it.
- 5.04.07 Bus bar shall be electrolytic grade hard drawn aluminium, colour coded for easy identification and designed for a maximum temperature of 85°C. Minimum size shall be 25 x 6 mm.
- 5.04.08 Incoming and outgoing circuits shall be terminated in suitable terminal blocks.
- 5.05.00 **Panel Equipment**



- 5.05.01 Each panel shall have an incoming triple pole MCCB with neutral link and a number of outgoing miniature circuit breakers (MCB).
- 5.05.02 Panel access door shall be interlocked with incoming MCCB such that the door can be opened only when the MCCB is in OFF position. Means shall be provided to defeat this interlock.
- 5.05.03 All MCCB shall be single throw, air break, heavy duty type having quick-make quick-break contacts. Contactors shall be air break electromagnetic type. Push buttons shall be push to actuate type.
- 5.05.04 MCB shall be suitable for manual closing and opening and also automatic trip on overload and short circuit.
- 5.05.05 Time switch in street lighting panels shall be electronic 24 Hrs timer type with ON-OFF time setting facility, which shall ensure respective ON-OFF operation in every 24 Hours cycle. Voltmeter/Ammeter shall be of accuracy class 2.0 or better as per IS: 1248. Voltmeter/Ammeter selector switch shall be of reputed make.
- 5.06.00 **Receptacle**
- 5.06.01 Receptacles shall be heavy duty, complete with individual plug and switch as detailed in the annexure. For Electrical room, Pump room, Control Room 16/6 Amp receptacles shall be considered.
- 5.06.02 The conduit box of the receptacle shall be provided with earthing screws with washer and nuts welded on the surface for grounding with 16 SWG G.I. wire. Arrangement shall be provided inside the conduit box for grounding of third pin.
- 5.06.03 Shrouded type plug shall be provided with corresponding matching arrangement at sockets to prevent accidental contact with finger during plug insertion.
- 5.06.04 63 Ampere three phase four pin receptacle shall be provided at each major plant maintenance area.
- 5.07.00 **Fans & Regulators**
- 5.07.01 The fan shall have three well balanced blades. Double ball bearings and shall be reasonably free from noise. Sweep shall be 1200 / 1400 mm Pedestal fans shall also be provided as per Purchaser's requirement.
- 5.07.02 Fan motor shall be totally enclosed type with copper winding and class E insulation.
- 5.07.03 Regulator shall have minimum five steps in modular size. Electronic regulator with smooth control is to be provided.

- 5.07.04 Ceiling fans shall be provided with necessary conduit wiring in the Air conditioned areas (Control rooms, office rooms etc.) also.
- 5.08.00 **Switch & Switch Board**
- 5.08.01 All switch boards/boxes shall be of bent steel construction, fabricated of 14 SWG M.S. sheet with 6mm thick color matching FRP/Non-Hygroscopic Synthetic cover with brass fixing screws.
- 5.08.02 Switch boards/boxes located in control room and office areas shall be flush mounted type on brick wall with only the switch knob projecting outside.
- 5.08.03 Switch boards/boxes shall have conduit knock outs on the sides. Adequate provision shall be made for ventilation of these boxes.
- 5.08.04 Flush type receptacles where provided shall be so located that only the plug projects outside.
- 5.08.05 Switches shall have quick-make and quick-break mechanism operated by a suitable external handle complete with position indicator.
- 5.09.00 **Lighting Poles & Flood Light Tower**
- 5.09.01 Street Light Poles
- a) Street light poles shall be swaged and welded steel pole of height 9M and 11 M above ground, complete with fixing brackets, weather-proof junction box and all other accessories.
 - b) The pole shall be coated with bituminous preservative paint on inside as well as embedded outside surface. Exposed surface shall be coated with two coats of metal primer (comprising of red oxide and zinc chromate in synthetic medium).
- 5.09.02 Flood Light Tower **(If required)**
- a) Flood light tower shall be a lattice structure with maintenance platform and approach ladder. All structural members and hardware shall be hot-dip galvanized.
 - b) Structures shall be designed for an additional load of 1500kg for maintenance crew. Deflection under maximum wind pressure shall not exceed 1 in 360. Structural design shall be as per IS-800 and subject to Owner's approval.
- 5.09.03 Lighting High Masts
- Applicable standards:
- The following shall be Reference Standards for loading of the High Mast:



- a) IS-875 (Part-III) 1987 - Code and practice for design loads for Structures.
- b) BSEN 10025/DIN 17100 - Grade of M.S. Plates.
- c) BSEN-1011 - Welding
- d) BS.ISO 1461 - Galvanizing

Structure:

Lighting High Mast shall be of continuously tapered polygonal cross section, at least 20-sided, hot dip galvanized and presenting a good and pleasing appearance and shall be based on proven In-Tension design confirming to the standards referred to above, to give an assured performance, and reliable service. The structure shall be suitable for wind loading as per IS-875 Part-III, 1987. The masts dimensions shall be as per standards.

The Mast shall be of 20M height with lantern carriage to enable raising / lowering for ease of maintenance, including the Head Frame, Double Drum Winch, continuous stainless-steel wire rope, in built power tool, luminaries, suitable lightning protection for high mast and lantern carriage of fixtures along with necessary power cables within the mast. The mast shall be delivered in three / two sections & shall be joined together by slip stressed fit method at site. No site welding or bolted joints shall be done on the mast.

High mast shall be complete with feeder pillar panel for power distribution to lighting fixtures and winch motor. Feeder pillar panel shall be outdoor type stand mounting with dust and vermin proof, IP 55 and constructed of 14 swg sheet steel. Minimum 03 nos high mast shall be considered for the FGD Plant.

5.10.00 Maintenance Equipment

- 5.10.01 The Bidder shall supply one (1) no. of wheel mounted adjustable aluminium ladder of 12M for the maintenance of street lights.
- 5.10.02 For the maintenance of lighting fixtures in other FGD area, the Bidder shall supply ladder as per requirement.

5.11.00 Special Requirement

- 5.11.01 All outdoor illumination fixtures, unless it is fed from photo cell/time switch controlled lighting panel, has to be provided with outdoor type local switches.
- 5.11.02 In all the air filtration units and air handling units, one marine type lamp (of 100 Watt approx.) shall be provided and the wiring & fixing of the same has to be done by the Bidder.

5.12.00 Lighting Cables & Wires

5.12.01 Lighting Cable shall be heavy duty, 1100 Volt grade, multicore stranded copper conductor, XLPE insulated, extruded PVC inner sheath, single round G.I. wire armoured and overall PVC sheathed with FRLSH conforming to IS 1554.

5.12.02 Lighting wires shall be 1100 Volt grade, PVC insulated, stranded conductor, single core cable conforming to IS 694, colour coded as below :

RED	for	R-Phase	BLACK	for	Neutral
YELLOW	for	Y-Phase	WHITE	for	+'Ve D.C.
BLUE	for	B-Phase	GREY	for	-'Ve D.C.

5.12.03 Minimum size of lighting wires shall be as follows:

From Lighting panel to Junction box	:	1/C x 10 sq. mm (AL)
From Junction box to lighting fixture	:	1/C x2.5 Sq.mm. (Cu)
From Junction Boxes to Flood Light Fixtures	:	1C, 2x2.5 Sq. mm. (Cu)
From Lighting Panel to 230V AC, 5/15A 1-phase receptacle	:	1C, 10 Sq. mm.(AL) (Stranded)

5.13.00 Conduits and Accessories

5.13.01 Conduits shall be rigid steel, hot-dip galvanised, furnished in standard length of 3 metres, threaded at both ends.

5.13.02 Thickness of conduits up to and including 25mm dia shall be of 16 SWG and conduits above 25mm shall be of 14 SWG. Minimum size of conduits shall be 20mm.

5.13.03 Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushings at both ends.

5.13.04 Flexible conduits shall be made with bright, cold rolled annealed and electro-galvanised mild steel strips and coated with PVC.

5.14.00 Junction Box

5.14.01 Junction boxes shall be of 16 SWG sheet steel hot-dip galvanised, dust and damp proof, generally conforming to IP-55 for indoor and glass reinforced FRP type dust and damp proof, generally conforming to IP-65



- 5.14.02 Junction boxes shall be complete with gasketed inspection cover, conduit knock out/threaded hub and terminal blocks.
- 5.14.03 Junction box for outdoor use shall be weatherproof IPW-55. For hazardous location junction box shall be flame-proof type suitable for a particular zone / gas group in compliance with IS: 2148 / IS: 13346 and shall have certification from CIMFR, Dhanbad.
- 5.14.04 Junction boxes shall have following indelible markings:
- Circuit nos. on top
- Circuit nos. with ferrules (inside) as per drawing
- DANGER sign in case of 415V circuit
- 5.15.00 **Terminals**
- 5.15.01 Multi way terminal blocks of approved type, complete with screws, nuts, washers and marking strips shall be furnished for connection of incoming/outgoing wires.
- 5.15.02 Each terminal shall be suitable for connection up to 2 nos. 10 Sq.mm stranded aluminium conductors without any damage to the conductor or looseness of connectors.
- 5.16.00 **Indication Lamp**
- Lamps shall be clustered of LED type. LED lamp shall be made in accordance with InP Technology (Aluminium Indium Gallium Phosphide Technology). The body shall be made of Poly Carbonate Unbreakable Lens. LED shall be protected by inbuilt fuse with surge suppressor or leakage voltage glow protection. LED circuit shall be PCB mounted. Intensity shall be greater than 200 mcd. All Push Button lamps shall be as per LED indicating lamp.
- 5.17.00 **Contactors**
- 5.17.01 Contactors shall be three pole, air break type, with non-bouncing silver/silver alloy contacts. Contactor duty shall be class III-category AC3 for unidirectional drives and AC4 for bi-directional and inching drives/class I - category DC2.
- 5.17.02 Each contactor shall be provided with minimum two (2) N/O and two (2) N/C auxiliary contacts rated 10 A at operating voltage. The exact requirement of contacts shall be decided by the Vendors taking into account the scheme requirements and spares.



5.17.03 Contactor starters shall comply with the requirements of IS-8544 (Part - 1) in respect of co-ordination of the characteristics of contactor, overload relay, and fuse. The type of co-ordination shall be Type - C as per IS-8544.

5.18.00 **Moulded Case Circuit Breaker (MCCB)**

5.18.01 MCCB shall be heavy duty, triple pole, load break-fault-make type conform to the duty as required. MCCB shall be provided with a common trip bar, so as to ensure opening of all phases even when fault occurs in only one phase.

5.18.02 MCCB shall have positive indication in ON and OFF position with indication on each Module.

5.18.03 The MCCB should be housed in a heat resistant moulded insulated housing. Overload and Magnetic release of MCCB shall be suitable for setting at site. The Short Circuit release shall be of minimum of $12 \times I_n$.

5.19.00 **Nameplate**

Nameplates shall be furnished for identification of devices and circuits. All switches, controls and indications shall be permanently and legibly marked in English as to clearly indicate their functions.

All lighting fixtures, receptacles, fans, junction boxes etc. shall be properly marked up indelibly with corresponding circuit numbers.

5.20.00 **Samples**

Owner reserves the right to call for samples if considered necessary and the same shall be submitted by the Bidder free and without any obligation.

6.00.00 **SPECIFIC REQUIREMENTS - SERVICES**

6.01.00 **Consumables and Hardware**

6.01.01 The Bidder shall furnish all erection materials, hardware and consumables required for the complete installation.

6.01.02 The materials shall include but shall not be limited to the following:

- a) Consumables : Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials etc.
- b) Hardware : Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.



- c) Materials : Junction boxes, terminal blocks, connectors, ferrules, lugs, brass glands, rigid/flexible conduits, cables, ground wires etc.

6.01.03 Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Bidder.

6.02.00 **Erection Tools & Tackle**

6.02.01 The Bidder shall provide all tools, tackles, implements, scaffoldings, ladders etc which are required for handling and erection of the equipment and materials.

6.03.00 **Testing Equipment**

6.03.01 The Bidder will provide such checking and testing equipment as test lamp, buzzer, 500-volt meggar, earth meggar, lux-meter etc. with other testing equipment as required.

6.04.00 **Lighting Fixtures**

6.04.01 In case of closed ceiling industrial premises generally a continuous mounting of fittings is to be preferred.

6.04.02 Floodlights (if required) shall be mounted on steel base facing the tentative direction shown on drawings. Fixing holes shall be provided with slot to turn the fixture about 5 Deg on both sides. Bolts shall be finally tightened with spring washer.

The Bidder shall supply and install the steel base for fixing the flood light on the flood light towers.

Terminal connection to the floodlight shall be made through PVC coated flexible metallic conduits.

6.04.03 The fixtures after erection shall be marked up indelibly with corresponding circuit number for easy identification of lamp circuit.

6.05.00 **Receptacles**

Receptacles shall be installed at locations not more than 50 meter or as per approved drawings.

6.06.00 **Lighting Panel**

6.06.01 Lighting panels shall be erected at the convenient locations with cable junction boxes as per approved drawing.

6.07.00 **Street Lighting Poles**

Erection of street light poles, flood lighting towers/poles/ high masts shall be at the convenient locations with cable lying as per approved drawing.

6.08.00 **Conduit System**

6.08.01 In case of unarmoured cable, all conduits shall originate from the respective lighting panel and terminate in lighting fixtures, receptacles etc.

6.08.02 Exposed conduits shall be run in straight lines parallel to building columns, beams and walls as far as practicable. Unnecessary bends and crossings shall be avoided to present a neat appearance.

6.08.03 Conduit supports shall be provided at an interval of 750mm for horizontal runs and 1000mm for vertical runs.

6.08.04 Conduits shall be clamped on to approved type spacer plates or brackets by saddles or U-bolts. The spacer plates or brackets in turn, shall be fixed to the building steel by welding and to concrete or brick work by grouting as shown on drawings.

Wooden plug inserted in the masonry or concrete for conduit support is not acceptable.

6.08.05 Embedded conduits shall be securely fixed in position to preclude any movement. In fixing embedded conduit, if welding or brazing is used, extreme care should be taken to avoid any injury to the inner surface of the conduit.

6.08.06 Spacing of embedded conduits shall be such as to permit flow of concrete between them and in no case shall be less than 40 mm.

6.08.07 Where conduits are run on cable trays they shall be clamped to supporting steel at an interval of 600 mm.

6.08.08 For directly embedding in soil, the conduits shall be coated with an asphalt - base compound. Concrete pier or anchor shall be provided where necessary to support the conduit rigidly and to hold it in place.

6.08.09 Conduits shall be installed in such a way as to ensure against trouble from trapped condensation.

6.08.10 Running threads shall be avoided as far as practicable. Where it is unavoidable, check nuts shall be used.

6.08.11 Conduits shall be kept, wherever possible, at least 300mm away from hot pipes, heating device etc. when it is evident that such proximity may impair the service life of cables.



- 6.08.12 Slip joints shall be provided when conduits cross structural expansion joints or where long run of exposed conduits are installed, so that temperature change will cause no distortion due to expansion or contraction of conduit run.
- 6.08.13 For long run, junction/pull boxes shall be provided at suitable intervals to facilitate wiring.
- 6.08.14 Conduits shall be securely fastened to junction box or cabinets, each with a locknut and insulated bushing inside the box and locknut outside.
- 6.08.15 Conduit lengths shall be joined by screwed couplers. Couplers shall be clearly cut.
- 6.08.16 Conduit joints and connections shall be made thoroughly water-tight and rust-proof by application of a thread compound which will not insulate the joints.
- White lead is suitable for application on embedded conduit and red lead for exposed conduit.
- 6.08.17 The Battery Room installation shall be made with acid fume proof conduits.
- 6.08.18 Field bends shall have a minimum radius of four (4) times the conduit diameter. All bends shall be free of kinks, indentations or flattened surfaces. Heat shall not be applied in making any conduit bend.
- 6.08.19 The entire metallic conduit system, whether embedded or exposed, shall be electrically continuous and thoroughly grounded.
- 6.08.20 Lighting fixture shall not be suspended directly from junction box in the main conduit run.
- 6.08.21 Conduits and fittings shall be properly protected during construction period against mechanical injury. Conduits ends shall be plugged or capped to prevent entry of foreign material.
- 6.08.22 After installation the conduits shall be thoroughly cleaned by compressed air before pulling in the wire.
- 6.08.23 In control rooms and office areas provided with false ceiling conduit run shall be concealed type, embedded in the walls.
- 6.09.00 **Wiring/Cabling**
- 6.09.01 Wiring shall be generally carried out by PVC wires in conduits. All wires in a conduit shall be drawn simultaneously. No subsequent drawing is permissible.

- 6.09.02 Wire shall not be pulled through more than two equivalent 90° bends in a single conduit run.
- 6.09.03 Wiring shall be spliced only at junction boxes with approved type connections or terminal strips. Maximum two wires can be connected to each way of the terminal block. Splicing of only one phase shall be done in a junction box.
- 6.09.04 For lighting fixtures, connection shall be teed off through suitable round conduit or junction box, so that the connection can be attended without taking down the fixture.
- 6.09.05 For vertical run of wires in conduit, wires shall be suitably supported by means of wooden/hard rubber plugs at each pull/ junction box.
- 6.09.06 A.C. and D.C. circuits shall not be run in the same conduit and junction boxes. Circuits fed from different transformers shall be run through different conduits and Junction boxes.
- 6.09.07 Receptacle circuits shall be kept separate and distinct from lighting and fan circuits.
- 6.09.08 Separate neutral wire shall be provided for each circuit. Wiring throughout the installation shall be such that there is no break in the neutral wire in form of switch or fuse.
- 6.10.00 **Cabling**
- 6.10.01 In outdoor areas, main runs from lighting panels shall be by means of XLPE cables, directly buried in ground if trenches are not available or laid in trenches for the underground portion and through conduit for the over ground portion.
- 6.10.02 Buried cables shall be laid and covered with sand/riddled earth, and protected from damage by bricks at sides and pre cast concrete slab at top. Buried cables shall have cable markers at 50M interval and projecting 150mm above ground. At cable bends and joints markers shall be provided.
- 6.10.03 When buried cables cross road/railway track, additional protection to be provided in form of hume/G.I. pipe.
- 6.11.00 **Grounding**
- 6.11.01 All lighting panels, junction boxes, receptacles, fixtures, conduit etc. shall be grounded in compliance with the provision of I.E. Rules.
- 6.11.02 Ground connections shall be made from nearest available station ground grid. All connections to ground grid shall be done by arc welding.



- 6.11.03 Lighting Panels shall be directly connected to ground grid by two nos. 25 x 6 mm G.I. flats.
- 6.11.04 Street lighting Pole shall be grounded at two points by two nos. 50x6 mm G.I flat risers from two (2) nos. earthing spike 40 mm dia & 3m long directly driven into ground at a depth of 1m from ground level. The junction box at each lighting pole is grounded at two (2) points from two (2) nos. earthing terminals by 16 SWG GI wire.
- 6.11.05 One 16 SWG G.I wire shall be taken up to the junction box from lighting fixtures and connected to grounding point.
- 6.11.06 A continuous ground conductor of 16SWG GI Wire shall run along each exposed metallic conduit run and bonded to it every 600 mm by not less than two turns of the same size of wire. This conductor shall be connected to each panel ground bus.
- All junction boxes, receptacles, fixtures etc. shall be connected to this 16 SWG ground conductor.
- 6.12.00 **Foundation & Civil Works**
- 6.12.01 Equipment foundations, panel foundations and all other civil work will be provided by the Bidder at the option of owner.
- 6.13.00 **Excavation and Back Filling**
- 6.13.01 The Bidder shall perform all excavation and backfilling as required for buried cable and ground connections.
- 6.13.02 Excavation shall be performed up to the required depth. Such sheeting and shoring shall be done as may be necessary for protection of the work.
- 6.13.03 The Bidder shall make use of his own arrangements for pumping out any water that may be accumulated in the excavation.
- 6.13.04 All excavation shall be backfilled to the original level with good consolidation.
- 6.14.00 **Steel Fabrication**
- 6.14.01 All supports, hangers & brackets shall be fabricated by the Bidder. Necessary steel shall be supplied by the Bidder (optional).
- 6.14.02 Steel for fabrication shall be straightened and cleaned of rust and grease. All fabrication shall be free of sharp edge.
- 6.14.03 Every effort shall be made to minimize the wastage of steel as far as practicable during fabrication. The wastage in no case shall exceed 3% of the total quantity of steel fabricated.



6.15.00 Painting

6.15.01 Street light poles shall be given two coats of aluminium paints after installation.

6.15.02 All steel fabrication shall be given two coats of red oxide primer followed by two coats of approved shade.

6.15.03 All equipment shall be given touch-up paint as required after installation.

6.16.00 Inspection & Testing

6.16.01 On completion of erection works, the Bidder shall request the Engineer for inspection and tests with minimum fourteen (14) days advance notice.

6.16.02 The Engineer shall arrange for joint inspection of the installation for completeness and correctness of the work. Any defect pointed out during such inspection shall be promptly rectified by the Bidder.

6.16.03 The installation shall be then tested and commissioned in presence of the Engineer and put on trial run for stipulated contract period.

6.16.04 All rectification, repair or adjustment work found necessary during inspection, testing, commissioning and trial run shall be carried out by the Bidder without any extra cost.

7.00.00 TESTS

7.01.00 Shop Tests

7.01.01 All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant Indian Standards at manufacturer's works.

7.01.02 Tests on lighting Distribution Boards/Panels shall include:

- a) Wiring continuity tests.
- b) High voltage and insulation tests.
- c) Operational tests.

7.02.00 Site Tests

7.02.01 Bidder shall thoroughly test and meggar all cables, wires and equipment to prove that the same are free from ground and short circuit.

7.02.02 If any ground or short circuit is found, the fault shall be rectified or the cable and/or equipment replaced.

7.02.03 All equipment shall be demonstrated to operate in accordance with the requirements of this specification.



7.02.04 Illumination in different areas are as per designed lux level should be established.

7.03.00 **Test Witness**

7.03.01 all test shall be performed in presence of Owner's representatives, if so desired by the Owner.

7.03.02 The Bidder shall give at least thirty (30) days advance notice of shop test seven (7) days advance notice of site tests.

7.04.00 **Test Certificates**

- a) Certified copies of all tests carried out at works and at site shall be furnished in requisite no. of copies for approval of the Owner.
- b) The equipment shall be dispatched from works only after receipt of Owner's written approval of shop test reports.
- c) Type test certificate on any equipment, if so desired by the Owner, (not more than 5 years from the date of contract) shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

08.00.00 DRAWINGS, DATA & MANUALS

08.01.00 Drawings, data and manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in the General Condition of Contract and/or elsewhere in this specification for approval and subsequent distribution after the issue of Letter of Intent.

08.02.00 **To be submitted with the Bid**

08.02.01 Make, type and catalogue number of lighting fixtures, lamps and accessories along with technical leaflets, data sheets, polar curves etc.

08.02.02 Typical outline drawings, showing constructional features, cable/ conduit entry, fixing arrangements etc of:

- a) Lighting Panel/receptacles/junction boxes.
- b) Street light pole.
- c) Flood light towers.
- d) High Mast

08.02.03 Technical leaflets and data sheet on each piece of equipment / device such as MCB, switch fuse, MCCB, receptacle etc.



- 08.02.04 Type test certificates on lighting fixtures and lighting panels, ballast, power cables.
- 08.03.00 **To be submitted after Award of Contract**
- 08.03.01 Detail dimensional drawing showing constructional features, cable/conduit entry, grounding, fixing arrangement etc. of:
- a) Lighting panels.
 - b) Receptacles & Junction boxes.
 - c) Street light poles.
 - d) Flood light tower along with design calculations
 - e) Lighting fixture complete with lamps and accessories.
 - f) Non-integral/separate type control gearbox for lighting fixtures, as applicable.
- 08.03.02 Data sheets for lighting panels
- 08.03.03 Data sheets for lighting fixture, lamps, accessories with light distribution curves, co-efficient of utilization charts etc
- 08.03.04 Control schematic and wiring diagram of 415V AC/220V DC lighting panel with automatic changeover from AC to DC and back to AC normal supply on restoration, 415V normal AC Street/area lighting panel with automatic ON/OFF feature.
- 08.03.05 Technical leaflets and data sheet on each piece of equipment/ device such as MCB, switch, fuse, receptacle etc. Type and routine test certificates of cables.
- 08.03.06 Lighting layouts showing the disposition of fixtures, lighting panels/boards, circuit distributions, conduit & wire routing.
- 08.03.07 Key Single Line Diagram for lighting distribution, board wise single line diagram with feeder loading, cable schedule and interconnection chart, design calculation for lighting.
- 08.03.08 AS-BUILT lighting layout and erection drawings, properly incorporating the changes/alterations/field modifications, if any, as carried out at field along with circuit distribution schemes of all lighting panels, conduit and cable routing and as acceptable to the Owner.
- 08.03.09 Any other relevant drawings, data and manuals necessary for satisfactory installation, operation and maintenance or as required by purchaser.
- 08.03.10 The Bidder may note that the drawings, data and manuals listed are minimum requirement only. The Bidder shall ensure that all other necessary write-ups,



curves and information required to fully describe the equipment offered are submitted with his bid.



ANNEXURE-A

AVAILABLE POWER SUPPLY

1.0 System Voltage

Lighting equipment and accessories shall be designed for satisfactory operation from the following power supply sources:

- 1.1 A.C. Supply : 415 Volt, 3 phase, 50 Hz, 3 wire (4 wire effectively grounded system after using suitable Lighting Transformer).

Fault Level 50KA r.m.s. symmetrical.

- 1.2 D.C. Supply : 220 V, 2 wire, ungrounded system.

Fault Level 25* KA

2.0 Permissible Variation

Equipment and accessories shall be suitable for operation over the entire range of voltage/frequency variations as listed below:

- 2.1 A.C. Supply : Voltage $\pm 10\%$

Frequency $\pm 5\%$

Combined Voltage
+ Frequency 10% (absolute sum)

- D.C. Supply : Voltage 187 to 242 Volt.

* Minimum only; actual value will be decided by the Bidder after substantiating the same by calculation.

ANNEXURE-B

AVERAGE LUX LEVEL FOR DIFFERENT AREAS

<u>Sl. No.</u>	<u>Location</u>	<u>Lux Level</u>
1.	Control Rooms (With false ceiling)	400
2.	Other control Rooms (Without false ceiling)	300
3.	Switchgear/MCC/Electrical Equipment Rooms	250
4.	Battery Room	250
5.	UPS Room	250
6.	Battery Charger & DCDB Room	250
7.	Air Washer Room	200
8.	AHU Room	200
9.	Elevator m/c Room	200
10.	Shift Charge Engineers Room (With false ceiling)	250
11.	Chemical Laboratory	300
12.	Cable spreader Area	70
13.	PLC Room (with false ceiling)	250
14.	Passage, Indoor Stair, Catwalk Tunnel, Toilet etc.	70
15.	Outdoor/Semi outdoor stairs	70
16.	Street & periphery lighting	20
17.	Office Room (Without false ceiling)	250
18.	Office Room (With false ceiling)	250
19.	General Pump House	250

- Medium bay fixtures shall be used where the room height is 8M. Otherwise high bay fixtures are to be used.



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Tuticorin, Tamil Nadu**

- Lux level for A.C. Emergency lighting in control room shall be 50 and for other areas 20 lux.
- Lux level for main road lighting shall be 20 and for secondary road shall be 10 lux.
- One no. (1) DC emergency fixture shall be provided at entry, exit and each landing of stair cases of Electrical Buildings, Control Rooms etc.
- If Lux level of any specific area is not covered in above table, Vendor shall take specific confirmation from purchaser before finalization of Bid.



ANNEXURE-C

TYPE OF FITTINGS/FIXTURES AND OTHER AUXILIARIES

1.0 LIGHTING FIXTURES & LAMPS

Each lighting fixture shall be furnished complete with associated lamp, holder and all accessories as required.

SL. NO.	FIXTURE TYPE	FIXTURE NO.	DESCRIPTION	AREA OF USE
1.1	ILD-1	BN108C LED 20S PSU CDL WH	Commercial / decorative type, Surface / pendant mounted green perform LED Batten [system flux $\geq$ 2000 lumens, 6500K color temperature, CRI $\geq$ 75, System efficacy $>$ 100lm/W] having minimum lifetime of 40,000 burning hours (at L70) with PC glossy diffuser. The luminaire shall be made up of CRCA sheet steel (IP20) with THD $<$ 10% and PF $>$ 0.9, similar to Philips make ENDURALED BATTEN "BN 108C LED 20S PSU CDL WH.	SWGR room / MCC room / Office / Toilet / Corridor / Pantry / Stores
1.2	ILD-2	SM270C LED 30S 6500 PSU WH	Decorative type, Surface / pendant mounted green perform LED Batten [system flux $\geq$ 3000 lumens, 6500K color temperature, CRI $\geq$ 80, System efficacy $\geq$ 80 lm/W] having minimum lifetime of 50,000 burning hours (at L70) .The luminaire shall be made up of CRCA sheet steel (IP20) with THD $<$ 10% and PF $>$ 0.9, similar to Philips make SMARTBRITE SM270C LED 30S 6500 PSU WH.	Office rooms / Corridor / Conference Room / Engineer's Room
1.3	ILD-3	RC869B LED 30S 6500 W30L120 D8 GR	Decorative type, recess mounted green perform LED Batten [system flux $\geq$ 3000 lumens, 6500K color temperature, CRI $\geq$ 70, System efficacy $\geq$ 100 lm/W] having minimum lifetime of 40,000 burning hours (at L70) with high purity anodized aluminium mirrors. The luminaire shall be made up of CRCA sheet steel (IP20) with THD $<$ 10% and PF $>$ 0.9, similar to Philips make SERENO "RC869B LED 30S 6500 W30L120 D8 GR".	False Ceiling areas (Control Room / Electronic Eqpt. Room / Office / Conference room / Engineer's Room / Corridor)
1.4	ILD-4	WT550C LED40S CW PSU S1 PC	Indoor, industrial, corrosion resistant type, ceiling or suspension mounting, green perform LED Batten [system flux $\geq$ 4000 lumens, 6500K color temperature, CRI $\geq$ 80, System efficacy $\geq$ 80 lm/W] having minimum lifetime of 50,000 burning hours	Battery Room / Chemical Plant / Area with corrosive atmosphere

SL. NO.	FIXTURE TYPE	FIXTURE NO.	DESCRIPTION	AREA OF USE
			(at L70) with diffuser. The luminaire shall be made up of Polycarbonate with silicone gasket material (IP65) with THD < 10% and PF > 0.9, similar to Philips make ENDURALED WATERPROOF "WT550 LED40S CW PSU S1 PC".	
1.5	ILD-5	BY415P LED145S CW NB FG PSU GR or BY415P LED145S CW WB FG PSU GR	Pressure Die cast aluminium frame (IP 65) with heat resistance toughened clear glass, Medium and High bay, dust free type, green perform LED Batten [system flux $\geq$ 14000 lumens, 6500K color temperature, CRI $\geq$ 80, System efficacy $\geq$ 100 lm/W] having minimum lifetime of 50,000 burning hours (at L70) with PMMA material lenses for effective light distribution. The luminaire shall have inbuilt surge protection with THD < 10% and PF > 0.9, similar to Philips make BY415P LED145S CW NB FG PSU GR or BY415P LED145S CW WB FG PSU GR. LM 79 and LM80 reports need to be submitted from a NABL/UL Approved Laboratory.	General Indoor area / Workshop
1.6	MC	Philips HPK225 1XSON250W E / eqv.	Medium and High bay integral luminaire with aluminium anodized reflector and toughened glass cover suitable for 1 x 250W HPMV lamp	Pump House
1.7	ILD-6	BY325P LED 100S CW PSE GR FG WB, OR BY325P LED 100S CW PSE GR FG NB	Pressure Die cast aluminium frame (IP 65) with heat resistance toughened clear glass, Medium and High bay, dust free type, green perform LED Batten [system flux $\geq$ 10000 lumens, 6500K color temperature, CRI $\geq$ 70, System efficacy $\geq$ 100 lm/W] having minimum lifetime of 50,000 burning hours (at L70) with PMMA material lenses for effective light distribution. The luminaire shall have inbuilt surge protection (> 2KV) with THD < 10% and PF > 0.9, similar to Philips make BY325P LED 100S CW PSE GR FG WB, OR BY325P LED 100S CW PSE GR FG NB LM 79 and LM80 reports need to be submitted from a NABL/UL Approved Laboratory.	General Indoor area
1.8	ILD-7	BY416P LED	Pressure Die cast aluminium frame (IP 65)	General Indoor

SL. NO.	FIXTURE TYPE	FIXTURE NO.	DESCRIPTION	AREA OF USE
		220S-CW SK60 PSU GR FG NI	with heat resistance toughened clear glass, Medium and High bay, dust free type, green perform LED Batten [system flux $\geq$ 22000 lumens, 6500K color temperature, CRI $\geq$ 80, System efficacy $\geq$ 100 lm/W] having minimum lifetime of 50,000 burning hours (at L70) with PMMA material lenses for effective light distribution. The luminaire shall have inbuilt surge protection with THD < 10% and PF > 0.9, similar to Philips make BY416P LED 220S-CW SK60 PSU GR FG NI. LM 79 and LM80 reports need to be submitted from a NABL/UL Approved Laboratory.	area
1.9	ILD-8	BY200P LED 27S CW PSU S2 PC	Integral, higher ingress protection, green perform LED Batten [system flux $\geq$ 2700 lumens, 6500K color temperature, CRI $\geq$ 80, System efficacy > 90lm/W] having minimum lifetime of 40,000 burning hours (at L70) .The luminaire shall be made up of High pressure die cast Aluminium with polycarbonate front diffuser with THD < 10% and PF > 0.9, similar to Philips make ENDURALED WELLGLASS "BY200P LED 27S CW PSU S2PC".	Dust & Vapor laden areas
1.10	JA	Bajaj BJFW-125MV / eqv.	Flame proof, weatherproof, non-integral well glass luminaire for indoor / outdoor applications suitable for 1 x 125W MV lamp.	Area with explosive atmosphere
1.11	JB	Bajaj BJFW-125MVI / eqv.	Flame proof, weatherproof, integral well glass luminaire for indoor / outdoor applications suitable for 1 x 125W MV lamp	Area with explosive atmosphere
1.12	IA	Philips NXC101 1xA60-60W-CL B22 GR/ eqv.	Weatherproof bulkhead luminaire suitable for 1 x 60W GLS lamp.	DC emergency lighting / staircase / exit point
1.13	OLD-1	BRP022 LED 21 CW MR S1 PSU GR	Pressure Die cast aluminium frame (IP 65), dust free type, green perform LED Batten [system flux $\geq$ 2100 lumens, 5500K color temperature, CRI $\geq$ 70, System efficacy $\geq$ 100 lm/W] having minimum lifetime of 50,000 burning hours (at L70). The luminaire shall have inbuilt surge	Building exterior lighting / Outdoor area lighting / Outdoor eqpt. Area

SL. NO.	FIXTURE TYPE	FIXTURE NO.	DESCRIPTION	AREA OF USE
			protection (> 2KV) with THD < 20% and PF > 0.95, similar to Philips make BRP022 LED 21 CW MR S1 PSU GR LM 79 and LM80 reports need to be submitted from a NABL/UL Approved Laboratory.	
1.1 4	OLD-2	BRP410 LED CW 072 MR FG S1 PSU GR	Pressure Die cast aluminium frame (IP 65) with heat resistance toughened clear glass, dust free type, green perform LED Batten [system flux $\geq$ 7200 lumens, 5500K color temperature, CRI $\geq$ 70, System efficacy $\geq$ 100 lm/W] having minimum lifetime of 50,000 burning hours (at L70) with PMMA material lenses for effective light distribution. The luminaire shall have inbuilt surge protection with THD < 20% and PF > 0.95, similar to Philips make BRP410 LED CW 072 MR FG S1 PSU GR. LM 79 and LM80 reports need to be submitted from a NABL/UL Approved Laboratory.	Street lighting / boundary lighting
1.1 5	OLD-3	BRP322 LED 128 CW HE MR FG S3 XT	Pressure Die cast aluminium frame (IP 65) with heat resistance toughened clear glass, dust free type, green perform LED Batten [system flux $\geq$ 12800 lumens, 5500K color temperature, CRI $\geq$ 70, System efficacy $\geq$ 100 lm/W] having minimum lifetime of 50,000 burning hours (at L70) with PMMA material lenses for effective light distribution. The luminaire shall have inbuilt surge protection with THD < 20% and PF > 0.95, similar to Philips make BRP322 LED 128 CW HE MR FG S3 XT. LM 79 and LM80 reports need to be submitted from a NABL/UL Approved Laboratory.	Street lighting / boundary lighting
1.1 6	ILD-9	SM200C LED11S 6500 PSU OD WH	Decorative type, Surface mounted green perform LED Batten [system flux $\geq$ 1100 lumens, 6500K color temperature, CRI $\geq$ 70, System efficacy $\geq$ 80 lm/W] having minimum lifetime of 40,000 burning hours (at L70) downlighter. The luminaire shall be made up of ABS material with THD < 10% and PF > 0.9, similar to Philips make	Toilet / Wash basin / staircase

SL. NO.	FIXTURE TYPE	FIXTURE NO.	DESCRIPTION	AREA OF USE
			CIRRUS MINI "SM200C LED11S 6500 PSU OD WH".	
1.1 7	ILD-10	Green LEDi DN191B LED6S	Recess, decorative vertical mounting down-lighter, green perform LED Batten [system flux $\geq$ 600 lumens, 6500K color temperature, CRI $\geq$ 70, System efficacy $\geq$ 80 lm/W] having minimum lifetime of 40,000 burning hours (at L70). The luminaire shall be made up of pressure die cast aluminium with a high efficiency diffuser with THD < 10% and PF > 0.9, similar to Philips make GREENLEDi "DN191B LED6S".	Control Room / Electronic Eqpt. Room / Conference room / Office / Engineer's Room as UPS emergency light
1.1 8	ILD-11	GreenLEDi DN193B LED12S	Decorative type, Surface mounted green perform LED Batten [system flux $\geq$ 1300 lumens, 6500K color temperature, CRI $\geq$ 70, System efficacy $\geq$ 100 lm/W] having minimum lifetime of 40,000 burning hours (at L70) downlighter. The luminaire shall be made up of pressure die cast aluminium with a high efficiency diffuser with THD < 10% and PF > 0.9, similar to Philips make GREENLEDi "DN193B LED12S".	Control Room / Electronic Eqpt. Room / Conference room / Office / Engineer's Room as UPS emergency light
1.1 9	OLD-4	BVP 120 LED 70 CW NB FG S3 XT	Pressure Die cast aluminium frame (IP 65), Compact, sturdy, dust free type, green perform LED Batten [system flux $\geq$ 7000 lumens, 5500K color temperature, CRI $\geq$ 70, System efficacy $\geq$ 100 lm/W] having minimum lifetime of 50,000 burning hours (at L70). The luminaire shall have inbuilt surge protection (> 2KV) with THD < 20% and PF > 0.95, similar to Philips make BVP 120 LED 70 CW NB FG S3 XT. LM 79 and LM80 reports need to be submitted from a NABL/UL Approved Laboratory.	Area lighting / Yard lighting / Floodlighting purpose
1.2 0	OLD-5	BVP122 LED 146 CW NB FG XTFC	Pressure Die cast aluminium frame (IP 66), Compact, sturdy, dust free type, green perform LED Batten [system flux $\geq$ 14600 lumens, 5500K color temperature, CRI $\geq$ 70, System efficacy $\geq$ 100 lm/W] having minimum lifetime of 50,000 burning hours (at L70). The luminaire shall have inbuilt surge protection (> 2KV) with THD < 20% and PF > 0.95, similar to Philips make	Area lighting / Yard lighting / Floodlighting purpose

SL. NO.	FIXTURE TYPE	FIXTURE NO.	DESCRIPTION	AREA OF USE
			BVP122 LED 146 CW NB FG XTFC. LM 79 and LM80 reports need to be submitted from a NABL/UL Approved Laboratory.	
1.2 1	OLD-6	BVP 120 LED 70 CW NB FG S3 XT	Pressure Die cast Aluminium frame (IP 65), Compact, sturdy, dust free type, green perform LED Batten [system flux $\geq$ 7000 lumens, 5500K color temperature, CRI $\geq$ 70, System efficacy $\geq$ 90 lm/W] having minimum lifetime of 50,000 burning hours (at L70). The luminaire shall have inbuilt surge protection ($> 2KV$) with THD $< 20\%$ and PF > 0.95 , similar to Philips make BVP 120 LED 70 CW NB FG S3 XT. LM 79 and LM80 reports need to be submitted from a NABL/UL Approved Laboratory.	Area lighting / Yard lighting / Floodlighting purpose
1.2 2	EX	Philips (Exit Lamp) / eqv.	Escape lighting luminaire with "EXIT" sign fitted with 1x20 FLT. Each luminaire shall be self-contained 6 volt battery, battery charger unit. Normally the luminaire shall be ON continuously through 240V AC supply. When AC supply goes OFF the in built battery & inverter system automatically takes on to ignite luminaire for duration of two & half ($2\frac{1}{2}$) hours. The battery shall be maintenance free and shall be trickle charged when 240 V AC mains supply is available.	Control Room / Electronic Eqpt. Room / Conference room / Office / Engineer's Room as UPS
1.2 3	FA	GE Evolve™ LED Outdoor Family IBERIA / eqv.	Die-cast aluminium housing, decorative luminaire using LED technology with symmetric and asymmetric light distribution, IP 65 rated for optical assembly with high brightness LED- pole mounted.	Street lighting / boundary lighting
1.2 4	Ceiling/Column/wall mounted	Bajaj BJDB 100 with 1X100W. GLS/eqv	Bulkhead luminaire with wire guard, die cast Al alloy body, heat resistant prismatic glass cover with specially designed weather proof gasket.	Emergency light- ing in dusty area with AC/DC change- over

Note 1: The supply also includes associated junction boxes, brackets, supports, hangers, and wires wherever applicable.

2.0 LIGHTING PANEL

- 2.1 LP-1 415 V A.C. Indoor type Lighting Panel with 415 V, 100A, 3 ph, 4 wire bus, one (1) no. 100A MCCB as incomer, 24 nos. 20A, 240 V, 1 pole MCBs as outgoing feeders.
- 2.2 LP-2 415 V A.C. Indoor type Lighting Panel with 415 V, 100A, 3 ph, 4 wire bus, one (1) no. 100A MCCB as incomer, 18 nos. 20A, 240 V, 1 pole MCBs as outgoing feeders.
- 2.3 LP-3 415 V A.C. Indoor Lighting panel with 415 V, 3ph, 4W bus & one 63A Switch/MCCB as incomer and 12 nos 20A , 240V 1 pole MCBs as outgoing feeder.
- 2.4 LP-4 415V A.C. Indoor type Lighting Panel with 415V, 63A, 3 ph, 4 wire bus, one (1) no. 32 A switch/MCCB as incomer, 6 nos. 20A, 240V, 1 pole MCBs as outgoing feeders.
- 2.5 SLP 415 V A.C. Outdoor type Panel with 415 V, 100A, 3 ph, 4 wire bus, one 100A /MCCB as incomer, 18 nos. 20A, 240V, 1 pole MCBs as outgoing feeders.
- The lighting panel shall be provided with 63A contactor, frequency compensated timer switch, photo-cell switch push- buttons for automatic control of street/area lighting with provision for manual override.
- 2.6 DCLP Indoor type emergency lighting panel with 240V bus, one no Fuse switch as incomer and 6 nos 16A two pole MCB as outgoing feeders.
- 3.0 RECEPTACLE
- 3.1 RA 6A, 240 V, 2 pole, 3 pin with third pin earthed, suitable for flush mounting in office areas and control room. The switch shall be also flush mounted piano type. Degree of protection shall be IP 52 (for Indoor) / IP 65 (for outdoor).
- 3.2 RB 16A, 240V, 2 pole, 3 pin with third pin earthed, wall/ column mounted, metal clad gasketed construction, 20mm conduit entry, screwed metal cover tied to it by a metal chain, weatherproof suitable for indoor/outdoor installation. Degree of protection shall be IP 52 (for Indoor) / IP 65 (for outdoor).
- 3.3 RC 63A, 415 V, 3 phase, 4 pin interlocked plug and switch with earthing contact, wall/column mounted, metal clad gasketed construction, weatherproof, suitable for loop-in/loop-out connection of 4/C-35 Sq.mm XLPE cable.

These shall be fed from AC Distribution Board/Station MCC. Degree of protection shall be IP 52 (for Indoor) / IP 65 (for outdoor).

3.4	RD	125 A, 415 V, 3 phase 5 pin interlocked plug & switch with fifth pin earthed, wall/column mounted metal clad gasketed construction, weatherproof, suitable for loop in and loop out connection of 3-1/2C -95 Sq.mm XLPE cable. These shall be fed from A.C-Distribution Board/Station MCC. Application at all Transformer Yard for Oil Filtration machines and other areas. Degree of protection shall be IP 65.
4.0	CEILING FANS	
4.1	FA	1200 mm sweep ceiling fan with regulator, down rod and canopy.
4.2	FB	1400 mm sweep ceiling fan with regulator, down rod and canopy.
5.0	LIGHTING POLES	
5.1	TA/TB	Single arm/double arm swaged and welded steel pole with junction box and all accessories.
6.0	SWITCHBOARD	
6.1	S-1	Switch board with 1-6A switch.
6.2	S-2	Switch board with 3-6A switch and 1-6A receptacle.
6.3	S-3	Switch board with 6-6A switch and 1-6A receptacle.
7.0	MISCELLANEOUS ITEMS	
7.1	M1	10 m high car wheel mounted aluminium ladder.
7.2	M2	Adjustable free-standing aluminium ladder with adjustable height as required.

ANNEXURE – D

RATINGS AND REQUIREMENTS OF LIGHTING TRANSFORMER

Type	:	Dry type, encapsulated VPI with nomex insulation
KVA rating (Minimum)	:	100 KVA
Voltage rating	:	415 V/415 V
Cooling	:	AN
P.V. Impedance	:	0.04 $\pm$ 10%
Voltage control	:	Off load tap switch/link with change of $\pm$ 5% in step of 2.5% tapping full capacity.
Vector Group	:	Dyn11
Class of Insulation	:	F (155 ⁰ C)
Maximum Temperature rise over 50 Deg C. ambient in winding by resistance	:	90 ⁰ C
Neutral	:	Solidly grounded.

The secondary neutral of the transformer shall be brought out for getting a grounded 4 wire supply. Each transformer shall be routine tested and one transformer shall be type tested in accordance with relevant standard.

The transformer shall be liable for rejection if the tolerance on the quoted values of losses, impedance, temperature rise, etc. exceeds the specified values of relevant standard.

The transformer shall be mounted inside sheet steel enclosure, which shall be an integral part of Lighting Distribution Board.



ANNEXURE – E

BROAD LIST OF AREAS TO BE ILLUMINATED

Purpose of this list is to give general guidance on major areas to be illuminated. The list is however not exhaustive. Illumination of all the areas under FGD package are deemed to be included under FGD turnkey package.

1. Limestone Handling area
2. Gypsum Handling Area
3. Absorber area
4. Pipe and cable racks, Trenches and culverts

All roads under FGD System battery limit area (as shall be finalized during detail engineering), general area, Toilets falling within illumination zone identified to be covered under FGD turnkey package.



**Tender Specification
for
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**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

**VOLUME: II-F
SECTION - XV**

UNINTERRUPTIBLE POWER SUPPLY



Development Consultants Pvt. Ltd.

**Vol.II-F/Section -XV
Uninterruptible Power Supply**



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

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**VOLUME: II-F
SECTION-XV**

UNINTERRUPTIBLE POWER SUPPLY

1.00.00 SCOPE OF WORK

1.01.00 Scope of Supply

The scope of supply shall include Uninterruptible Power Supply (UPS) System: one (1) Set for FGD system. The UPS shall be of parallel redundant configuration each of 100% capacity. During normal operation both shall be running in parallel/synchronism sharing 50% load. DC source for input to the inverter shall be derived from nearest available DCDB of same system as shown in drawing no 17A08-DWG-E-0001.

- 1.02.00 a) Each set of UPS System shall comprise the following:
- | | | | |
|------|---|---|---|
| i) | 100% Static inverter banks | : | 2 |
| ii) | 100% Static switches | : | 2 |
| iii) | Manual bypass switch/breaker | : | 2 |
| iv) | Isolation Step-down transformer | : | 1 |
| v) | Voltage stabilizer | : | 1 |
| vi) | UPS A.C. Power Distribution Board
(Two incomers and one bus section) | : | 1 |
- b) One (1) set of special tools and tackle.
- c) All inter-connecting cables including those required for inter-connection within UPS equipment as mentioned a) above.
- d) Mandatory Spare parts.
- e) All relevant drawings, data and instruction manuals.

2.00.00 GENERAL REQUIREMENTS

2.01.00 Codes and Standards

- a) All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable IS/IEC except where modified and/or supplemented by this specification.
- b) Equipment and materials conforming to any other standard which ensures equal or better quality may be accepted. In such case, copies





of the English version of the standard adopted shall be submitted along with the bid.

- c) The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Codes of Practice. In addition, other rules or regulations applicable to the work shall be followed. In case of any discrepancy, the more restrictive rule shall be binding.
- d) All the equipment shall comply with Environmental Control Module (ECM) cooling system or equivalent as per international standards in addition to provide low noise operation for use in occupied spaces with an automatic condensate re-evaporation system.

2.02.00 Design Criteria

2.02.01 Design Basis

- a) UPS System provides a regulated and uninterrupted single phase A.C. power, within specified tolerances, to critical station loads during normal and emergency operation.
- b) The UPS system excluding its battery shall be installed indoors in A.C. environment.
- c) UPS system shall be compatible for satisfactory and well-coordinated operation with other related equipment as well as with input and output systems.
- d) Energizing or de-energizing any portion of the system serviced by the UPS shall not cause output changes which shall affect the operation or integrity of the remaining portions of the system in any way.
- e) The equipment shall be self-protecting against all A.C. and D.C. transients, voltage surges, and steady state abnormal voltages and currents.
- f) The circuit protection shall be coordinated with UPS short circuit capacity and protective device characteristics so that a fault on any circuit shall result in minimum loss of function.
- g) All non-interrupting components of UPS system shall be capable of withstanding the prevailing short circuit current without damage.
- h) All circuit interrupting components shall be capable of withstanding and interrupting the prevailing short circuit currents without damage.
- i) For continuous operation at specified ratings, temperature rise of the various components of UPS system shall be limited to the permissible values stipulated in the relevant standards and/or this specification.



- j) The inverters, static switches, regulating transformers and voltage stabilizers should be arranged in such a way that any equipment shall be fully isolated for maintenance without affecting in any way the operation of other panels/components.
- k) In the A.C. Distribution Board, the Bidder shall provide 20% or minimum one (1) no. spare feeder of each size and type of the outgoing feeders.

2.02.02

System Concept

- a) A D.C. power source and an A.C. power source are available to the UPS system. The system is so designed that its load shall be served without interruption as long as one of the above power sources is available within specified limit of voltage and/or frequency.

The UPS shall consist of two physically separate sets of equipment streams each consisting of the following:

- i) One set of inverter to take D.C. input from 220V FGD DCDB and to produce high quality 240V, 1Ph, 50Hz A.C. output power.
- ii) One set of static switch, synchronizing circuit to parallel the above-mentioned Inverter output and bypass stabilized raw power stream.
- iii) One UPS A.C. power distribution board with suitable no. of output feeders.

Two sets of equipment streams as mentioned above will constitute the UPS system.

One set of standby bypass stream consisting of suitable transformer, SCVS voltage stabilizer etc. to produce regulated 240V, 1Ph. 50 Hz A.C. power from new input 240V, 1Ph. 50 Hz A.C. power.

One set of synchronizing equipment and high performance static switch will parallel the above two streams and common output will be taken to loads which can accept only single non-redundant power input source.

For equipment requiring dual redundant input power source, separate cables will be taken from the individual UPS Power Distribution Boards of the above-mentioned two UPS streams.

- b) Each of the two UPS streams shall be of 100% capacity and shall normally work, each sharing 50% load. On failure of any stream, its load gets automatically transferred to the other inverter through static transfer switch.



- c) If one UPS stream is out of service for any reason then the second UPS stream shall be working with 100% UPS load.
- d) Inside each stream on failure of its inverter assembly the standby A.C. source shall back up to supply the 100% UPS load automatically through static transfer switch.

2.02.03

Layout Criteria

The UPS system shall be located indoor in Electrical Equipment Room in FGD Plant.

The inverter, static switches, and distribution panels shall be located in the UPS room.

The inverters, static switches, regulating transformers & voltage stabilizers should be arranged in such a way that any equipment can be fully isolated for maintenance without affecting in any way the operation of other panels/components.

The equipment of the two UPS streams shall be physically isolated with reasonable space between two installations.

3.00.00

SPECIFIC REQUIREMENTS

3.01.00

Static Inverter

- a) The inverters shall be static type consisting of IGBT PWM type inverter, static filters, integrated control modules including necessary oscillators, voltage regulators, current limiting and surge suppression.
- b) The inverter equipment shall include all necessary circuitry and devices to conform requirements like voltage regulation, soft start, transient recovery, protection, automatic synchronization, wave shaping etc. as specified herein.
- c) Upon transfer of full load, the inverter output voltage shall not drop below 80% of nominal voltage during the first half cycle after transfer and 90% of nominal voltage in the next half cycle. The recovery to within $\pm 2\%$ of voltage shall be in less than 50 milli-seconds.
- d) On occurrence of a fault in branch circuit, the inverter shall be capable of clearing the highest rated branch circuit fuse in 4 milli-seconds or less.
- e) The inverter shall be protected against overload, short circuit, 100% loss of load, as well as excursions, loss or restoration of D.C. input voltage and synchronizing voltage. The overload capacity shall be 125% for 10 mins, 150% for 60 secs. and 300% for 4 milli-seconds.
- f) The D.C. input current shall never exceed twice the full load current except for a short circuit within the inverter.





- g) For any value of the load and load power factor drawn by the equipment served, the inverter shall not impose on D.C. source any voltage oscillations in excess of 5 volts (RMS total all frequencies) or any current oscillations in excess of 3 percent (RMS total all frequencies) of the D.C. current at full load.
- h) The inverter will be self-protecting against A.C. and D.C. Transients, voltage surges and steady state abnormal voltage and currents likely to be encountered in the plant.

3.02.00 Automatic Synchronisation

- a) Inverter equipment shall include stable solid-state oscillator devices designed to automatically maintain the inverter output in phase and in synchronism with the stand-by A.C. source.
- b) Facility shall be provided for automatic transfer to internal oscillator operation when the stand-by source frequency is beyond specified limits and the frequency shall be automatically controlled within 50Hz plus or minus 0.5Hz when the inverter operates in this mode.
- c) Retransfer to stand-by A.C. source for synchronisation shall be automatic after the stand-by source frequency is restored to permissible limits and remains within this limit for an adjustable time delay period (up to 5 seconds).
- d) Provision shall be made for step less adjustments of synch-disconnect frequency range from 50 Hz $\pm$ 0.5 Hz to 50 Hz $\pm$ 2 Hz.
- e) Automatic adjustment of phase relationship between inverter output and stand-by A.C. source shall be gradual at a controlled slow rate, which shall not exceed one hertz per second.

3.03.00 Static Transfer Switch

- a) The static transfer switch shall be solid-state type using SCR for automatic/manual transfer of load from "inverter" to "stand-by" source and vice-versa.
- b) Stand-by source can be either of the inverter or A.C. source depending on whether both the inverters are supplying 50% load each or one of the inverter is carrying 100% load.
- c) The transfer time including sensing shall be less than 4 msec. Further the transition shall be make- before-break in both directions.
- d) The capacity of static transfer switch shall be equal to the continuous full-load capacity of the inverter. The switch shall be provided with protective devices in both normal and alternate power source.



- e) Static transfer switch shall be furnished with contact to alarm failure of the alternate source or opening of any fuse protecting the static switch.
- f) Static transfer switch shall include all necessary circuitry and devices to meet the functional requirements of transfer initiation, transfer inhibit and re-transfer back to normal as detailed below:
- g) **Transfer Initiation**
- i) The transfer of static switch from normal 'Inverter' position to 'stand-by' position shall be initiated by one of the following causes.
- Inverter failure and UPS system trouble
 - Inverter output voltage failure
 - Manual push button operation
- ii) The UPS bus shall be monitored by two voltage detectors. One fast acting circuit shall be used for detecting a complete and instantaneous voltage loss while the other slower acting averaging circuit with adjustable trip level shall be employed to detect voltage deviation beyond selected limits. Both voltage detector circuits shall automatically initiate operation of transfer switch.
- iii) The static switch shall automatic transfer the load from inverter to stand-by source when the maximum I_t capability of the inverter is reached and when the inverter output drops below 90%.
- h) **Transfer Inhibit**
- Automatic or manual transfer from inverter to stand-by A.C. source vice versa shall be inhibited when the inverter frequency is not synchronised to the alternate source.
- i) **Retransfer to Normal**
- i) The return to inverter mode shall be manual in all cases.
- ii) Manual transfer shall be initiated by push button actuation.

3.04.00 **Manual By-pass Switch**

- a) Manual by-pass switch is used to isolate any static transfer switch for maintenance or repair without interruption to the UPS load.
- b) The switch has also the facility of by-passing both the static transfer switches during start-up at the option of the operator.





- c) Switch contact shall be make-before-break type.
- d) The switch shall have current rating equal to the full load inverter current and necessary short time load carrying and interrupting capacity to meet the requirement of UPS system.
- e) Breakers may be used instead of By-pass switch maintaining the same philosophy of operation.

3.05.00 **Step-down transformer and voltage stabilizer**

- a) A three phase to single phase transformer along with associated voltage stabilizer shall be furnished with the UPS system.
- b) The transformer and stabilizer shall be sized for 100 per cent UPS load and shall coordinate with the largest branch circuit protection device for feeder short circuit current without sacrificing voltage regulation.
- c) The voltage stabilizer shall employ silicon solid state circuitry and shall maintain the specified output voltage for 0 to 100% load with maximum input voltage variation as indicated elsewhere. The make and rating shall be subject to Owner's approval.

3.06.00 **A.C. Distribution Boards**

- a) The distribution boards shall be fixed type, of modular design in freestanding gasketed sheet steel enclosure conforming to IP-54. Sheet steel thickness shall be 2mm minimum. 100% redundant AC distributed boards shall be provided for each UPS.
- b) Each module shall be housed in a separate compartment complete with individual front access door. Working height shall be limited to 1800 mm from floor level.
- c) A full height vertical cable alley shall be provided in each panel to facilitate module wiring. The alley shall be liberally sized and shall have removable cover at the front. Removable back covers shall be provided at the back of the panels.
- d) Incoming circuit shall be provided with Molded Case Circuit Breaker (MCCB) while outgoing circuits shall be provided with Miniature Circuit Breakers (MCB). The breakers shall be double pole type, capable of safely making and breaking the full load current of the associated circuit.
- e) MCCB/MCB shall have position indicator and provision of padlocking in ON & OFF positions. Further, safety interlock shall be provided so that access door can be opened only with the MCCB in OFF position.

3.07.00 **UPS Cabinets/Enclosures**





- a) The UPS system components shall be housed in a sheet steel freestanding IP-42 enclosure with all access from the front. Sheet steel thickness shall be 2 mm minimum.
- b) The enclosure shall consist of vertical cabinets housing modules in rack type sub-assemblies, connected mechanically and electrically to form a rigid, self-supporting, metal enclosed structure.
- c) The modular units shall be mounted in pull out and/or swing trays. Each module shall be capable of being easily removed to provide for the ready inspection of major solid-state devices.
- d) Vertical wiring trough shall be provided for the entire height of the UPS cabinet. Cable entry shall be from bottom only.
- e) Adequate ventilating louvers and screens shall be provided. The top of the panel shall be protected by a suitable drip cover to prevent entrance of falling liquid and foreign material.
- f) If the equipment supplied requires forced air cooling, the cooling system furnished shall meet the following requirement:
 - i) Two (2) nos. 100% cooling fans shall be provided for each vertical panel.
 - ii) Completely independent duplicate protection, control and wiring systems shall be provided for the cooling fans for redundancy.
 - iii) The cooling fans shall be powered from the output of the associated inverter. Normally one fan shall be running while the other is on stand-by.
 - iv) Each cooling fan shall be equipped with an airflow switch having an alarm contact that closes upon failure of airflow.

3.08.00

Alarms

- a) Solid state audio-visual annunciation system shall be provided for inverters and static transfer switch.
- b) Alarm facia shall be provided on each inverter panel, complete with proper actuating devices, circuitry and legends.
- c) The arrangement shall be such that on occurrence of a fault the corresponding window shall light up and stays lighted until the fault is cleared and reset button pressed.
- d) Each time a window lights up a master relay shall get energized to provide group alarm signals for remote PLC alarm system.



- e) The following alarms through potential free contacts shall be provided:
 - 1. Rectifier Trip
 - 2. Inverter Trip
 - 3. UPS battery low
 - 4. Load on Static Bypass
 - 5. Static Bypass Failure
 - 6. ACDB Incomer Trip
 - 7. UPS Fan Trip
 - 8. DC Over Voltage
 - 9. DC Under Voltage
 - 10. Earth Fault on DC
- f) Alarm contacts shall be rated 0.5 A at 220 V DC and 5A at 240 V A.C.
- g) Electrically independent, potential free alarm contacts for each of the points shall be wired up to the terminal block for Owner's use.
- h) In case of LCD display mimic of UPS system with Alarm and fault log shall be provided.

3.09.00 Lamp / Space Heaters / Receptacles

- a) The panels shall be provided with:
 - i) Internal illumination lamp with door switch.
 - ii) Space heater with thermostat control.
 - iii) 3-pin 5A receptacle with plug.
- b) Lamp, heater and receptacle circuits shall have individual switch fuse units.

3.10.00 Wiring / Cabling

- a) The panels shall be completely wired up. All wiring shall be done with flexible, 1100V grade, PVC insulated wires with stranded 2.5 Sq.mm copper conductors and routed through wiring troughs. Each wire shall be ferruled by plastic tube with indelible ink print at both end having terminal block No., terminal number as per approved wiring diagram.
- b) Panels shall have removable gland plate for cable entry. All incoming/outgoing cables shall be terminated in suitable terminal block.
- c) Control terminal blocks shall be box-clamp type, minimum 10 Sq.mm. 20% spare terminals shall be furnished.



3.11.00 Nameplate

- a) Engraved nameplates shall be provided for each panel and for each equipment/device mounted on it.
- b) The material shall be anodized aluminium / lamicoid, 3 mm thick, with white letters on black background.
- c) Nameplates shall be held by self tapping screws. The size of nameplates shall be approximately 20 mm x 75 mm for equipment and 40 mm x 150 mm for panels.
- d) Nameplates for panels shall be provided both on the front and rear.
- e) Control and meter selection switches shall have integral nameplates. Nameplates for all other devices shall be located below the respective devices.
- f) Instruments and devices mounted on the face of the panels shall also be identified on the rear with the instrument/device number. The number may be painted on or adjacent to the instrument or device case.
- g) Caution notice on suitable metal plate shall be affixed at the back of each panel.

3.12.00 Grounding

- a) Normal 3-phase A.C power supply shall be grounded at the source. For grounding other than this, isolation transformer shall be furnished with the U.P.S.
- b) The inverter D.C. input and A.C. output shall be electrically isolated from each other and from cabinet ground.
- c) Panels shall have fully rated ground bus with two ground terminals, one at each end.
- d) Each terminal shall comprise two-bolt drilling M10 G.I. bolts and nuts to receive station ground connection of 50 x 6mm G.S. flat.
- e) Separate electronic grounding shall be provided for each UPS system.

3.13.00 Tropical protection





- a) All equipment accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus insects and corrosion.
- b) Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent the entrance of insects.

All the PCBs of Power supply, control, protection feed back etc. shall be provided with conformal coating

3.14.00 Painting

- a) The panels shall be finished with two coats of synthetic enamel paint. The panels shall have a matt finish to prevent any glare from surface due to illumination.

4.00.00 TESTS

4.01.00 All equipment and components thereof shall be subject to shop tests as per relevant IEC/BIS Standards. The tests shall include, but shall not be limited to:

4.02.00 Tests on UPS System

- a) Type & routine test for various components.
- b) Burning test on PCBS - Assembled PCBS shall be tested at 70°C for 72 hours in loaded condition.
- c) Rapid temperature cycling test at 70°C and 0°C for 30 minutes at each temperature - 5 such cycles.
- d) Functional tests to demonstrate compliance with all specified requirements and published. Specifications such as frequency, regulation, voltage regulation, current limiting, fuse clearing capability of inverters, demonstration of phase and frequency control of inverter for synchronization with range of adjustments transfer and retransfer of static switches under influence of under voltage and over current, tests on chargers, batteries and other system component to confirm compliance with specification.

4.03.00 Type test certificates of not older than five (5) years from date of contract of any equipment shall be furnished. Otherwise, the equipment shall have to be type tested, free of charge, to prove the design.

5.00.00 DRAWINGS, DATA & MANUALS

5.01.00 To be submitted with the Bid

Drawings, Data and Manuals shall be submitted with the bid and for approval/ reference and subsequent distribution after the issue of Letter of Intent in





quantities and procedures as specified in General condition of contract and/or elsewhere in this specification.

- 5.01.01 UPS panels layout drawing with dimensions
- 5.01.02 General Arrangement drawing of UPS panels
- 5.01.03 Bill of Material
- 5.01.04 Schematic drawing of UPS circuits
- 5.01.05 Technical leaflets on:
 - a) UPS System
 - b) Inverter
 - c) Static Switch
 - d) Manual bypass Switch
- 5.01.06 Duty cycle diagram and battery sizing calculation in the format of IEEE Standard
- 5.01.07 Sizing calculation of UPS system, charger main equipment, viz. SCRs, rectifier transformers etc.
- 5.01.08 Type test certificates for similar equipment not older than five (5) years from date of contract.
- 5.02.00 **To be submitted after Award of Contract**
- 5.02.01 Dimensional UPS diagram in plan & section.
- 5.02.02 Connection details of take-off terminals.
- 5.02.03 Dimensional general arrangement drawings of UPS clearly showing device dispositions, cable entry, space requirement, etc.
- 5.02.04 Sectional views of UPS System panels
- 5.02.05 Panel foundation plan and loading
- 5.02.06 UPS system schematics and wiring diagrams
- 5.02.07 Test reports
- 5.02.08 Detailed bill of materials
- 5.02.09 Any other relevant drawing or data necessary for satisfactory installation, operation, and maintenance



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Tuticorin, Tamil Nadu**

5.02.10 Cable schedule & Inter-connection charts

5.02.11 Instruction manuals of UPS system

The manual shall clearly indicate method of installation, check-ups, and tests to be carried out before commissioning of the equipment.

5.03.00 The Tenderers may note that the drawings, data and manuals listed above are minimum requirement only. Tenderers shall ensure that all other necessary write-ups, curves and information required to fully describe the equipment offered are submitted with their bids.





ANNEXURE-A

RATINGS & REQUIREMENTS

1.00.00 STATIC INVERTER

1.01.00	Application	:	UPS System for control system, PLC and other essential loads
1.02.00	Type	:	Static IGBT PWM type
1.03.00	Duty	:	Continuous
1.04.00	Enclosure	:	Sheet steel, IP42
1.05.00	Cooling	:	Natural convection or forced cooling using redundant fans.
1.06.00	Ambient temperature	:	50°C maximum 5°C minimum
1.07.00	Inverter capacity	:	To be decided by the Bidder
1.08.00	Overload capacity	:	300% for 4 msecs. 150% for 60 secs 125% for 10 mins 110% for continuous
1.09.00	Voltage		
	a) Inverter input	:	187V to 242V
	b) Nominal output	:	240V, 50Hz, 1-phase
1.10.00	Voltage Regulation:		
	a) Steady state (0-100% load at all input voltages and all power factors)	:	± 1.5%
	b) Transient voltage (On application or removal of 100% load)	:	± 10%
	c) Time to recover from transient to normal voltage	:	50 milliseconds.
1.11.00	Wave form:		
	a) Nominal frequency	:	50 Hz



- b) Frequency range for all conditions of input supplies, loads and temperature occurring simultaneous or in any combination (automatically controlled) : ± 0.5 Hz.
- c) Synchronisation limits (for maintenance of synchronism between inverter and standby A.C source) : 49 Hz to 51 Hz (factory set)
- d) Field adjustment range for (c) above : 50 ± 0.5 Hz to 50 ± 2 Hz
- e) Total Harmonic Content : 5% maximum at rated load
- f) Harmonic content for any single harmonic : 3% maximum
- 1.12.00 Rated output current at rated output voltage with current limit not operating
- a) Current : 200%
- b) Duration : 100 milliseconds.
- 1.13.00 Efficiency at full load (Watt output/watt input) : 80% or better.
- 1.14.00 SCR derating from peak voltage and peak rating : 50%
- 2.00.00 **STATIC SWITCH**
- 2.01.00 Type : Solid-state, SCR
- 2.02.00 Duty : Continuous
- 2.03.00 Enclosure : Sheet Steel, IP42
- 2.04.00 Cooling : Natural convection or forced cooling using redundant fans.
- 2.05.00 Ambient Temperature : 50°C
- 2.06.00 **Capacity**
- a) Continuous : Equal to full load capacity of the inverter.



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	b) Overload	:	300% for 4 msecs. 150% for 60 secs 125% for 10 mins 110% for continuous
	c) Peak	:	1000% of continuous rating for 5 cycle.
2.07.00	Normal Voltage	:	240V, 50 Hz, 1-phase.
2.08.00	Transient Voltage Tolerance	:	340V peak above the nominal line voltage.
2.09.00	Transfer Time	:	less than 4 msecs.
3.00.00	MANUAL BY-PASS SWITCH/BREAKER		
3.01.00	Type	:	Maintained, make before break.
3.02.00	Voltage	:	600V
3.03.00	Rated Current	:	To meet the system requirement
4.00.00	DISTRIBUTION BOARDS		
4.01.00	Type	:	Fixed, Modular.
4.02.00	Enclosure	:	Sheet Steel, IP54
4.03.00	Mounting	:	Free standing (can be attended from both front & back)





**Tender Specification
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**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME: II-F

SECTION-XVI

**CABLING, GROUNDING AND
LIGHTNING PROTECTION SYSTEM**



Development Consultants Pvt. Ltd.

**Vol. II-F/Section-XVI
Cabling, Grounding & Lightning Protection**



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VOLUME: II-F

SECTION-XVI

CABLING, GROUNDING AND LIGHTNING PROTECTION SYSTEM

1.00.00 SCOPE OF WORK

1.01.00 The Scope of Work covers complete and efficient design, engineering, testing at manufacturers works, supply, transportation erection, testing and commissioning of lightning protection system, all cabling and electrical grounding works. The scope shall broadly cover, but not be limited to:

1. Limestone Handling Area
2. Gypsum Handling Area
3. Absorber Area
3. All auxiliary buildings (including electrical rooms of respective buildings) and structures within the FGD package like Limestone preparation building, Absorber pump house, Gypsum De-watering building, FGD Control building, etc. as detailed in the Lead Specification & Plot Plan.
4. Overhead cable trestle and pipe cum cable trestle, if any.
5. All electrical equipment as described in Volumes II-F.

The scope of work shall also include all civil and structural works necessary for successful installation and commercial operation of all electrical equipment to be erected under this specification.

2.00.00 SCOPE OF SUPPLY

2.01.00 The scope of supply shall include but not be limited to the followings:

2.01.01 Timely procurement and transportation to site in properly packed condition of all materials and miscellaneous items required to complete the erection work under this specification.

These materials and miscellaneous items shall include but not be limited to the following:

- a) Galvanized steel pre-fabricated cable trays, coupler plates, nuts, bolts & washers, reducers, covers, wall brackets, hanger clamps, straight run, elbows, bends, etc.





- b) Galvanised steel rigid/flexible conduits and accessories, ferrules, lugs, glands, terminal blocks, galvanised sheet steel junction boxes, cable fixing clamps, nuts & bolts etc. as required.
- c) Cable termination and jointing kits as necessary.
- d) All necessary erection materials, consumables and sundry items including arc welding rods to complete the installation for satisfactory and trouble free operation.
- e) Mild steel rods for grounding conductor, grounding electrode, column & structure grounding, risers etc.,
Mild steel rod for vertical air terminals,
Materials for electronic grounding,
Galvanized steel flats for horizontal air terminals, for down conductors and for large equipment grounding
Galvanized wire (8SWG) for small equipment grounding.
- f) Any item of works or erection materials which have not been specifically mentioned but are necessary to complete the work involved shall be deemed to be included in the scope of this specification and shall be furnished by the Bidder without any extra charge to the Purchaser.

Scope of Services

- 2.02.00 The scope of Cabling, Grounding and Lightning Protection Systems includes but is not limited to the following:
- 2.02.01 Furnishing of all erection tools and tackles, testing equipment, implements, supplies, hardware and transport for timely and efficient execution of the erection work. Hydraulic jacks or motorized jacks necessary for lifting of heavy equipment shall be provided by the contractor.
- 2.02.02 Transport vehicles necessary for efficient transportation of equipment from stores to site of erection and excess materials back to stores.
- 2.02.03 A general list of the outdoor and indoor Electrical Equipment with accessories for complete assembly, erection and connection, testing and commissioning, putting into successful and satisfactory commercial operations by the contractor and as applicable in a FGD plant is given below. Since plant configuration varies from project to project, actual equipment and accessories shall also be guided by other specification documents.
 - a) 220/11.5/11.5kV Station Transformer
 - b) HT Aux. Transformers for FGD system
 - c) L.T. Transformers (dry)
 - d) Lighting Transformers





- e) Neutral Grounding Resistor Cubicles
 - f) 3.3Kv & 11kV Busducts
 - g) 415 V Busduct
 - h) 11kV & 3.3kV Switchgears
 - i) 415 V Switchgears, Switchgear cum MCCs.
 - j) Motor Control Centres, A.C./D.C. Distribution boards, Main lighting distribution boards and miscellaneous items.
 - k) Battery and Battery Chargers, Uninterrupted Power Supply Panels
 - l) Electrical Control Desks/Panels, Relay Panels, Data logger Panels etc.
 - m) Miscellaneous Local Panels.
 - n) All electrical equipment and systems integral with mechanical equipment, systems and subsystems.
 - o) Any other equipment, not mentioned herein but required for the completing the Plant shall be deemed included in the scope.
- 2.02.06 Erection work of equipment shall be carried out in a neat and efficient way so as not to impair their normal functioning in any way.
- 2.02.07 Pre-commissioning checks as well as commissioning of different equipment shall be carried out as per guidance of actual manufacturer's supervisor and or as per written instructions in Erection Manuals. In case of any site related problem in commissioning activities, contractor shall seek advice of the OE.
- 2.02.08 All erection work under this specification shall be carried out strictly in accordance with the approved drawings.
- 2.02.09 Erection work shall also be performed with respect to the following items:
- a) Cable trays and accessories
 - a) Power cables
 - b) Cables laid directly buried in ground
 - c) Control, instrument and special cables
- 2.03.00 All materials and accessories to be supplied by the Bidder shall be brand new ones of reputed make.
- 2.04.00 Necessary drawings, data sheets and Technical leaflets on each piece of material.

3.00.00 GENERAL REQUIREMENTS





3.01.00 Codes and Standards

- 3.01.01 All cable and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.
- 3.01.02 Cable and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.
- 3.01.03 The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

3.02.00 Erection Schedule

- 3.02.01 The entire erection work shall be carried out in a phased manner. A schedule of the work showing the sequence of erection shall be submitted by the tenderer for this purpose.
- 3.02.02 The erection schedule, as approved by the Owner's Engineer shall be strictly followed by the Bidder. If, for any reason beyond the control of the Bidder, the work is held-up then the Bidder shall bring it to the notice of the Owner's Engineer without any delay.

4.00.00 DESIGN CRITERIA

4.01.00 Grounding System

- 4.01.01 The main objectives of grounding system are to:
- a) Provide safety to personnel from contact of dangerous potential caused by ground fault.
 - b) Ensure sufficient grounding current for effective relaying.
 - c) Stabilize circuit potential with respect to ground.
 - d) The grounding system shall be designed in compliance with the IEEE-80/ IEEE- 665 considering fault current of 50kA for 1 sec. and shall be subject to approval of the Owner.
 - e) Major items of equipment, such as switchgear, transformer, motor, relay panels and control panels etc shall have integral ground buses or connection points which shall be connected to the underground grid.
 - f) Electronic panels and equipment, where required, shall be grounded utilizing an insulated ground wire connected in accordance with the manufacturer's recommendations. Where practical, electronics ground loops shall be avoided. Where this is not practical, isolation



transformers shall be furnished. All indoor and outdoor electrical equipment and associated non-current carrying system, metal works, support structures, buildings columns, fence, neutrals, masts, arrestors, etc shall be connected to the plant ground system.

- g) Instrumentation cable screens shall be single point bonded to the instrument earth network to minimize the effects of electrical interference.
- h) For Signal/case/intrinsically safe signal, grounding of control room instruments, separate earth pit not connected to main ground grid shall be used. Control cabinets shall be connected to this separate earth pit.
- i) A grounding conductor (steel wire armour in case of cables with outer sheath) shall be routed parallel to all power conductors operating above 240 volts.
- j) All ground wires installed in conduits shall be uninsulated.
- k) Embedded grounding grid made of GI flat at basement/grade slab as well as upper floor/suspended slabs shall be provided.
- l) In addition mild steel ground pads at different locations i.e. on wall/floor/ceiling inside the buildings/tunnels/trenches shall be provided. These pads will be in turn connected to below ground level earth mat through galvanized steel flat or riser. Each ground pad shall have provision for connection of at least two GI flats.
- m) Treated earth pit shall be provided for system earthing at locations where transformer neutrals are grounded. Two pits shall be provided for each neutral.
- n) Dedicated treated earth pit shall be provided for lightning protection system.
- o) Clean earthing for instrumentation shall be provided with dedicated earthing system and separate treated earth pits as required.
- p) Connection between the equipment earth lead and the grid conductor shall be welded. For rust protection, the welds shall be treated with zinc chromate primer and coated with zinc rich paint.

4.01.02 All electrical equipment, non-current carrying metal parts, structures, building steel, lightning protection system, Transformer neutrals shall be connected to FGD package ground grid.

The major aspects to be considered for grounding system design are given below:

4.01.03 **Ground Grid Conductor**

- i) Ground grid conductor of mild steel rod shall be used.
- ii) The minimum conductor section is determined on the basis of ground fault current. This section is then increased by an allowance to account for the soil corrosion loss of 0.3 mm per year over the design life of 30 years. However, the minimum size shall be 1x40 mm dia mild steel conductor.

4.01.04 **Underground Grid**

- i) The ground grid mesh is designed to keep the touch and step voltages within safe limits as per recommendation of IEEE 80 & IEEE665.
- ii) The ground grid conductors will be buried in earth at a minimum depth of 1000 mm. The length of ground conductors below earth will be sufficient to ensure a ground resistance less than 0.5 ohm.
- iii) The ground grid conductor will be so laid as to provide short and direct connection to building steel and major electrical equipment.
- iv) Ground rods shall be provided at the points where system neutrals/lightning protections are connected to the ground grid.
- v) All ground grid conductor connections will be welded type.
- vi) FGD building /area shall be connected with the Main Plant ground grid at least at two (2) points.
- vii) For test pits, the electrode will be 100 mm dia. Heavy duty C.I. pipe with perforations. Electrodes installed in test pits will have disconnecting facilities

4.01.05 **Above Ground Connections**

- i) Galvanized steel flats shall be used for all connections above earth.
- ii) Inside building, ground conductors will be run for each floor supported on building steel and/or cable trays. These ground conductors in turn will be connected to the station ground grid through riser (at least two) coming up along building columns/cable shafts.
- iii) Two separate and distinct ground connections will be provided for each electrical equipment in compliance with I.E. Rules.
- iv) All connections above ground will be welded type except connection to equipment/structures which shall be bolted type.

4.01.06 **Equipment Ground Lead**

Equipment ground connections will be sized to carry the available ground fault current. Considerations shall also be given to mechanical ruggedness of the connections and to limit the number of sizes.



- 4.01.07 Electronic Equipment Grounding
- i) Internal ground connection of electronic panels shall be insulated from the enclosure, frame, chassis and to be terminated to an insulated ground bus.
 - ii) Insulated ground bus of all electronic panels shall be connected by insulated wire to an insulated common electronic ground bar.
 - iii) All connection made above shall be in the form of a radial distribution system without any parallel ground paths.
 - iv) Electronic equipments and systems, metal enclosures of all electronic panels shall be connected to a grounding system with which is isolated and separate from the electrical equipment grounding system.
- 4.01.08 The minimum conductor sizes for connection of various equipment and structures shall be as given in the attached Notes and Details for Grounding & Lightning Protection Systems.
- 4.01.09 Entire erection of grounding work shall be carried out in such a way as to be capable of withstanding the intended services of carrying full short circuit level currents to ground mat without any damage/deformation.
- a) Galvanised steel flats shall be used for all connections above earth.
 - b) Inside building, ground conductors shall be run for each floor supported on building steel and/or cable trays. These ground conductors in turn shall be connected to the main ground grid through riser (at least two) coming up along building columns/cable shafts.
 - c) Two separate and distinct ground connections shall be provided for each electrical equipment in compliance with I.E. Rules.
 - d) All connections above ground shall be welded type except connection to equipment/structures, which shall be bolted type.
- 4.02.00 **Lightning Protection System**
- 4.02.01 The main purposes of lightning protection system are to:
- a) Provide protection to structures from lightning strokes.
 - b) Provide a low resistance-conducting path to lightning discharge.
- 4.02.02 Lightning protection shall be provided for auxiliary buildings of FGD area and other structures as required.
- 4.02.03 Lightning protection shall also be provided for building / structures where the overall rise factor exceeds 10^{-6} as per IS: 2309.





4.02.04 For metal structures which are electrically continuous down to the ground level, no lightning protection is required except adequate grounding connections.

4.02.05 **System Design**

- a) Air termination network with down conductors and earthing electrodes shall be provided on the basis of IS Code of Practice.
- b) Horizontal air termination shall be so laid out that no part of the roof shall be more than 9 meters from the nearest conductor.
- c) Shielding angle for one vertical air termination shall be 45 degrees. For more than one rod, shielding angle between the rods shall be taken as 60 Degrees.
- d) Down conductors shall run along the outer surfaces of the building and shall have a test joint about 1500 mm above ground.
- e) An earth electrode shall be provided at the connection point of the down conductor with the station ground.
- f) Galvanised steel rods and flats shall be generally used for air termination and connections. All connections shall be welded type.
- g) All other ancillary items in connection with the work described above shall be furnished to complete the work irrespective of whether such items may have been specifically mentioned or not.

4.02.06 All materials and accessories to be supplied by the Bidder shall be brand new ones of reputed make.

4.03.00 **Cabling System**

4.03.01 Erection of cabling work shall be carried out in such a way as to provide a reliable and assured electric power supply system to all FGD auxiliaries.

4.03.02 Cable routing shall be done on unit basis as far as possible.

4.03.03 Cables shall generally be laid on cable trays overhead supported from building steel/structures. Cables shall be run in concrete trenches in those electrical rooms at ground level, which are without any spreader room below.

4.03.04 For inter plant connections, the cables shall be routed through an overhead cable bridge pipe cum cable bridge. For isolated but long outdoor cable route with very few cables of 3/4 nos., the cables may be directly buried subject to Owner's approval.

4.03.05 For underground crossing of railways, road etc. additional protection shall be provided in form of hume pipe or concrete encased rigid steel conduits (duct bank).





- 4.03.06 A.C. and D.C. circuit shall not be run in same cable. Further, separately fused circuit shall run in separate cables.
- 4.03.07 Cables for redundant equipment system shall be run in separate trays, as far as possible.
- 4.03.08 Erection of cabling work shall be executed keeping in view all necessities and requirements.
- 4.03.09 Suitable embedded steel inserts shall be provided on wall/floor/ ceiling surfaces for welding of cable tray bracket in order to make the cable tray system withstand horizontal/vertical accelerations due to seismic forces for indoor trays and also wind load for outdoor trays in addition to normal tray cable loadings.
- 4.03.10 All erection work to be carried out under this specification shall conform to the notes and details given in Annexure-A to this specification.

5.00.00 SPECIFIC REQUIREMENTS - SUPPLY

5.01.00 Equipment and Material

- 5.01.01 Equipment and material shall comply with description, rating, type and size as detailed in this specification, drawings and annexures.
- 5.01.02 Equipment and materials furnished shall be complete and operative in all details.
- 5.01.03 All accessories, fittings, supports, hangers, anchor bolts etc. which form part of the equipment or which are necessary for safe and satisfactory installation and operation of the equipment shall be furnished.
- 5.01.04 All parts shall be made accurately to standard gauges so as to facilitate replacement and repair. All corresponding parts of similar equipment shall be interchangeable.

5.03.00 Conduits and Accessories

- 5.03.01 The contractor shall provide and install all conduits, mild steel pipes, flexible conduits, rigid PVC pipes, etc. complete with accessories like tees, bends, adopters, locknuts, pull boxes, conduit plugs, caps, etc as required for the cabling work. Conduits shall be furnished in standard length of 5 metres, threaded at both ends.
- 5.03.02 Conduits diameter upto and including 25mm size shall be of 16 SWG and conduits above 25 mm diameter shall be of 14 SWG. Minimum diameter of conduits shall be 20 mm.
- 5.02.03 Conduits shall be made of hot-dip galvanized steel with an organic corrosion resistant ID coating. In chemical handling areas, battery room, etc., the



exterior surface shall be further coated with chromate and polymer for better resistance to corrosion. Conduits, fittings & accessories shall have ISI mark.

5.02.04 For sizes above 63 mm, hot dip galvanized - both on inside and outside - steel pipes with necessary fittings & accessories shall be provided and installed by the contractor. The pipes and fittings shall be of heavy duty class with relevant ISI mark.

5.02.05 Flexible conduits complying to relevant IS and made with bright, cold-rolled, annealed and electro-galvanized mild steel strips shall be used between embedded conduits/pipes and the motor terminals. It shall also be used between fixed conduit and any equipment with vibration or equipment requiring regular removal.

5.02.06 Non-metallic conduits made of HDPE outer jacket with friction-reducing permanent internal lining shall generally be used for control & instrumentation cables in some areas where cable trays do not exist and where the runs are straight ones Necessary fittings & accessories as may be required for the installation shall also be provided.

5.03.00 **Junction Boxes**

5.03.01 Technical requirement for both non-metallic type and galvanized steel Junction Boxes are given below. Unless the choice is specifically mentioned in the General / Lead Electrical Specification or elsewhere in the tender document, galvanized steel Junction Boxes shall be offered.

5.03.02 Non-metallic Junction Boxes

- a) Material of the Junction Boxes shall be halogen-free and silicon-free, glass fibre-reinforced polycarbonate for outdoor use and/or for cable sizes more than 50 sq.mm. Material shall be ABS/ polycarbonate for indoor use and/or for cable sizes upto 50 sq. mm. Junction boxes for use with fire-survival cables shall be of Duro-plast / powder-coated metal.
- b) Material of all non-metallic junction boxes shall be fire retardant and self-extinguishing in accordance with UL 94 V0. It should be tested at Glow Wire test for 960° C.
- c) Boxes shall be suitable for continuous operation at an ambient temperature range of -10° C to +80° C.
- d) The impact strength of polycarbonate enclosures/boards i.e. the degree of protection against mechanical shock load shall be in accordance with EN 50298-98 for IK 08 (5 Joule).
- e) Degree of protection shall be IP 66 to EN 60529. Junction boxes shall have integrally embedded gaskets made of Polyurethane.
- f) Allowing a minimum of 20% spare terminals after complete termination, the terminal board for control and instrumentation JB's shall have 6 / 12 / 24 / 36 / 48 ways.
- g) Doors shall have stainless steel quick fastening screws.

- h) The boxes shall be complete with all brackets/fasteners as required for installation on walls, columns and structure.

5.03.03 Steel Junction Boxes

- a. Junction boxes with IP 55 degree of protection, shall comprise of a rectangular parallelepiped case constructed from cold rolled sheet steel of minimum thickness 2mm. Top of the box shall be arranged to slope towards the rear of the box. Gland plate shall be 3mm thick sheet steel with neoprene/synthetic rubber gaskets. All junction boxes shall be of adequate strength and rigidity, hot dip galvanized as per relevant IS, and suitable for mounting on wall, column, structures etc. The boxes shall be complete with M8 earthing stud and all brackets/fasteners as required for installation.
- b) No. of Ways: 6 / 12 / 24 / 36 / 48 with 20% spare terminals after termination.
- c) Outdoor JB's shall be similar but with a canopy at the top.
- d) Doors shall be hinged and lockable and shall be made of the same material as the case. The doors shall have industrial heavy-duty hinges. The doors shall be easily but firmly lockable with quick release fastener.

5.03.04 **The junction boxes shall have the following indelible markings:**

- Circuit nos. on top by white-stenciled paint at site.
- Circuit nos. with ferrules (inside) as per approved drawing.
- Danger sign in case of 415 V circuit.

5.04.00 **Terminals**

5.04.01 Multiway terminal blocks of approved type, complete with screws, nuts; washers and marking strips shall be furnished for connection of incoming/outgoing wires.

5.04.02 Each control cable terminal shall be suitable for connection of 2 nos. 2.5 sq.mm. stranded copper conductors without any damage to the conductor or looseness of conductors.

5.05.00 **Cable Termination & Straight Through Joints**

5.05.01 Bidder shall supply cable termination and jointing kits in requisite quantity for H.T. Power Cables, L.T. Power, Control Cables, Instrumentation Cables, etc. along with all accessories & consumables required for making termination and joints complete. Those shall be of proven design and make which have already been extensively used and type tested.



5.05.02 Components shall be pre-moulded type, taped type or heat-shrinkable type. 11kV, 6.6kV and 3.3kV grade joints and terminations shall be type tested as per IS: 13573.

5.05.03 Kits shall be complete with the aluminium solderless crimping type cable lugs and ferrule as per DIN standard.

5.06.00 **Cable Glands**

Cable shall be terminated using double compression type cable glands. Cable glands shall conform to BS 6121 or to EN 50262. Ingress Protection rating for cable glands with seal, when offered conforming to EN 50262, shall be minimum IP 66 in line with BS. Cable glands shall be made of tinned brass gland, double compression type complete with necessary armour clamp and tapered washer, etc. Rubber components shall be of neoprene or better synthetic material and of tested quality. Cable glands shall match with the sizes of different H.V./L.V./Control cables supplied/erected.

5.07.00 **Cable Lugs**

All cable lugs shall be Cd plated copper. Cable lugs shall be suitable for termination of different cross-sections of H.V./L.V./Control/Instrumentation cables and shall be of following types :

- i) Aluminium tubular terminal end for solderless crimping to aluminium conductors.
- ii) Copper tubular terminal end for solderless crimping to copper conductors.

Solderless crimping of terminals shall be done by using corrosion inhibiting compound. The cable lugs shall suit the type of terminals provided on the equipment. Lugs for control/instrumentation cables shall be PVC insulated/sleeved type.
- iii) 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.

5.08.00 **Cable Clamps and Straps**

5.08.01 Trefoil clamps for single core cables shall be pressure die-cast aluminium or fibre glass or nylon with necessary G I fasteners. Trefoil clamps shall have adequate mechanical strength to forces generated by peak value of maximum system short circuit current.

5.08.02 Cable clamps required for multicore cables on vertical run shall be made up of 25x3mm size aluminium strip. For clamping the multicore cables, self-





locking, de-interlocking type fire-resistant nylon clamps/straps of sufficient strength shall be used.

5.09.00 Consumables and Hardware

5.09.01 The Bidder shall furnish all erection materials, hardware and consumables required to complete the installation.

5.09.02 The materials shall include but not be limited to the following :

Consumables : Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials etc.

Hardware : Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.

5.09.03 Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Bidder.

5.10.00 Testing Equipment

5.10.01 The major testing equipment that are required to be arranged by the Bidder for site testing are listed below:

a) Insulation Tests

i) Power operated Meggar - 1 KV and 10 KV grade

ii) Hand operated Meggar - 1 KV grade

b) Hand driven earth Resistance Meggar, range 0-1/3/30 ohms.

c) High potential testing set - roller mounted type

d) Tong testers of suitable ranges.

e) Contact resistance measuring set for micro-ohms.

f) Torque wrench of various sizes.

g) Multi meters, test lamp, field telephone with buzzer set, different gauges etc.

5.10.02 The list of equipment is indicative only. Any other test equipments required shall be arranged by the Bidder.

6.00.00 METHODS AND WORKMANSHIP

6.01.00 All work shall be installed in a first class, neat workmanlike manner by mechanics/electricians skilled in the trade involved.

6.02.00 The erection work shall be supervised by competent supervisors holding relevant supervisory license from the Government.

6.03.00 All details on installation shall be electrically and mechanically correct.





6.04.00 The installation shall be carried out in such a manner as to preserve access to other equipment installed.

7.00.00 INSTALLATION

7.01.01 Installation work shall be carried out in accordance with good engineering practices and also as per manufacturer's instructions/ recommendations where the same are available.

7.01.02 Equipment shall be installed in a neat workmanlike manner so that it is level, plumb, square and properly aligned and oriented.

7.01.03 Cable installation work shall mean erection of cable trays/racks, supports, hangers, junction boxes, conduits, laying of cables either in ground or on trays inside trenches tunnels/overhead trays in conduits etc. dressing and clamping, jointing and termination inclusive of supply of necessary jointing/termination kits, lugs, glands, ferrules, tapes etc. and other accessories, grounding of cable armour. In case of direct laying in ground, all excavation work, necessary back-filling, supply of bricks and protective concrete slabs, removal of excess earth shall be part of the installation work.

7.01.04 Grounding installation work shall mean erection, jointing/brazing/welding, connection and painting, testing of ground conductors including supply of necessary steel/copper.

7.01.05 Lightning protection system installation work shall mean erection, jointing, welding, connection and painting, testing of air termination network, down conductors, shielding masts, connection to ground grid, electrodes, risers, horizontal conductors etc. of lightning protection system.

7.02.00 Cable Trays

7.02.01 Pre-fabricated cable trays and accessories shall be assembled & erected at site. Adequate spaces shall be provided to facilitate installation of cable system and to allow routine inspection and modification after installation.

7.02.02 Cable trays either inside concrete trenches or inside buildings and racks inside cable shafts shall be aligned and leveled properly. All tray runs shall be installed parallel to the trench/building walls and floors except otherwise noted in the approved drawings.

7.02.03 As far as practicable, cable trays shall be supported from one side only in order to facilitate installation and maintenance of cables from the other side.

7.02.04 The cable trays shall be supported in general at a span of not exceeding 1.5 metres horizontally and 1.0 metre vertically.

7.02.05 Sufficient spacing not less than 250 mm shall be provided between trays and maintained to permit adequate access, for installing & maintaining the cables..





- 7.02.06 Complete cable tray support structure after installation shall be inspected/ tested for welding strength, straightness, accuracy, use of proper sizes and compliance to drawings.
- 7.02.07 Complete cable tray and accessory installation work shall be inspected/tested for proper alignment, leveling, use of proper accessories, high quality workmanship etc.
- 7.02.08 The Bidder shall remove the RCC/steel trench covers whenever required and shall again place the same in their positions after the erection work in the particular area is completed or when further work is not likely to be taken up for some time.
- 7.02.09 Whenever any pipe/conduit/cable tray emerges out or enters into a building care should be taken to ensure that no water enters into the building.
- 7.02.10 Cable trays in areas subject to excessive coal dust, oil spillage, mechanical damage or accessible to personal contact shall be provided with raised sheet metal tray covers, installed on upper tray in horizontal run and front in vertical run.
- 7.02.11 Cable trays/racks shall be so arranged that they do not obstruct or impair clearances of passage way.
- 7.02.12 Cable tray/conduit system shall be so designed as to accommodate maximum pulling tension and minimum bending radius of cable.
- 7.02.13 Cable tray/conduit system shall be constructed to prevent drainage of water into equipment or building.
- 7.02.14 Cable tray/conduit system shall be electrically continuous and grounded.
- 7.02.15 Different voltage grade cables shall be laid in separate trays when trays are run in tier formation. Power cables shall normally be on top trays and control/instrumentation cable on bottom trays.
- 7.02.16 Trenches
- i) PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.
 - ii) No subzero level cable vault/trenches shall be provided below control building/switchgear rooms in FGD areas.
- 7.03.00 **Cable and Conduits**
- 7.03.01 The Bidder shall install, terminate and connect up all cable and conduits as per drawings and cable schedules.



- 7.03.02 The drawings shall be strictly followed except where obvious interference occurs. In such cases, the routing shall be changed as directed and/or approved by the Engineer.
- 7.03.03 Approximate lengths of cable and conduit runs shall be shown by the Bidder in the cable schedule for guidance only. Before commencement of work the Bidder shall take actual measurements and prepare his own cable-cutting schedule to reduce wastage to a minimum.
- 7.03.04 The Bidder shall also maintain and submit when requested, a record of cable insulation value when drawn from store, after laying, before and after termination/jointing.
- 7.03.05 Where direct heat radiation exists, heat isolating barriers, shall be adopted for cabling system.
- 7.03.06 Cabling/wiring in offices, laboratories, control rooms etc. shall be taken through concealed G.I. or rigid PVC pipes as directed by the Owner's Engineer.
- 7.03.07 At certain places where hazardous fumes/gasses may cause fire to the cables, cable trenches after installation of cables shall be sand filled.
- 7.04.00 **Conduit and Accessories**
- 7.04.01 Conduit/pipes shall be used only in short lengths in certain areas where required and/or as directed by the Engineer.
- 7.04.02 The Bidder shall furnish all conduits complete with accessories as required.
- 7.04.03 Conduits shall be flexible type in general. However, rigid type steel conduit if required shall also be supplied by the Bidder.
- 7.04.04 Except for inside an enclosure wherever the cable enters or leaves the conduit, the conduit end shall be sealed by suitable sealing compound, having fire withstand capability.
- 7.04.05 The entire metallic conduit system, when embedded or exposed shall be electrically continuous and grounded.
- 7.04.06 Where it is possible for water or other liquids to enter conduits, sloping of conduit runs and drainage of flow points shall be considered.
- 7.04.07 Pull boxes shall be installed between termination points where required to facilitate cable pulling, but at a maximum interval of 30 meters.
- 7.04.08 Conduits shall be firmly fastened within 900 mm of each junction box/pull box/cabinet/fitting etc. Conduits shall be supported at least every 2000 mm.
- 7.05.00 **Cables: Storage and Handling**



- 7.05.01 Cable drums shall be stored on hard and well-drained surface so that they may not sink. In no case shall the drum be stored on the flat, i.e., with flange horizontal.
- 7.05.02 Rolling of drums shall be avoided as far as practicable, for short distance, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum.
- 7.05.03 In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cable.
- 7.05.04 For unreeling the cable, the drum shall be mounted on jacks or on cable wheel. The spindle shall be strong enough to carry the weight without bending.
- 7.05.05 The drum shall be rolled on the spindle slowly so that the cable should come out over the drum and not below the drum.
- 7.05.06 While laying cable, cable rollers shall be used at an interval of 2000 mm. The cables shall be pushed over the roller by a gang of people positioned in between rollers over a suitable distance. Care shall be taken so that kinks and twists or any mechanical damage does not occur in cables. Only approved cable pulling grips or other devices shall be used. Cables shall not be dragged on ground or along structure while laying out from cable drums.
- 7.05.07 Cable shall not be pulled from the end without having intermediate pushing arrangement. Bending radius of the cable during installation shall not be less than what is specified by the manufacturer.
- 7.05.08 Empty cable drums shall be returned to the Owner.
- 7.06.00 **Cable Laying**
- 7.06.01 Cable shall generally be installed in ladder type prefabricated trays except for some short run in rigid/flexible conduit for protection or crossings.
- 7.06.02 Cables laid on trays and risers shall be neatly dressed and clamped with self-locking type fire resistant nylon ties at an interval of 750 mm for horizontal and vertical runs, in case of both power, control and instrumentation cables.
- 7.06.03 All single core power cables for 3 Ph. AC circuits shall be laid in trefoil formation and suitably clamped with self-locking type fire resistant nylon ties at an interval of 750mm.
- 7.06.04 L.T. multicore power cables with cross-sectional area of 95 sq.mm and above and all H.T. multicore power cables and shall be clamped individually by self-locking type fire resistant nylon ties.
- 7.06.05 L.T. power cables of cross sectional area less than 95 sq.mm and all control and Instrumentation cables shall be clamped in bunches with self-locking type fire resistant nylon ties. The number of cable in one bunch shall not exceed eight (8).





- 7.06.05 Prior to laying of cables inside the indoor and outdoor trenches, the Bidder shall properly clean the trenches.
- 7.06.06 In outdoor areas, buried cables shall be laid and covered with sand/riddled earth and protected from damage by bricks at sides and precast slab at top.
- 7.06.07 When buried cables cross road/railway track, adequate protection shall be provided in the form of hume/ galvanised iron pipes laid at a minimum depth of 1 meter below ground.
- 7.06.08 After completion of installation and prior to connection, all power cables shall be subjected to a high potential test.
- 7.07.00 **Cable Fire Sealing**
- 7.07.01 Cable/cable tray openings in walls and floors or through pipe sleeves from one area to another or from one elevation to another within the unit shall be sealed by a fire proof sealing system (FPSS) of minimum 2 Hrs rating. The FPSS shall effectively prevent the spread of fire from the flaming to non-flaming side of a fire.
- 7.07.02 Wherever the cables/cable trays pass through walls/floors, fire proof cable penetration seals rated for two hour shall be provided. This shall be by suitable block system using individual blocks with suitable framework or by silicon RTV foaming system. In case foaming system is offered, damming board, if used, shall not be considered for fire rating criteria. Any of the system offered shall be of proven type as per BS: 476 (Part-20) or equivalent standard.
- In order to prevent fire propagation through cable penetrations, after laying, dressing & clamping of cables, all the openings shall be properly sealed by using Fire Stop Mortar Seal and Fire Retardant Cable coating compound. Also the cable runs both before and after the fire scale shall be suitably sprayed with anti-fire propagation liquid.
- 7.08.00 **Cable Laying in Trenches**
- 7.08.01 RCC cable trenches with removable covers shall be provided by the Contractor. Cables shall be laid in 3 or 4 tiers in these trenches RCC covers of trenches in process area shall be effectively sealed to avoid ingress of chemicals etc. Removal of concrete covers for purposes of cable laying and reinstating them in their proper positions after the cables are laid shall be done by the Contractor at no extra cost.
- 7.08.02 For cable trays are laid in trench in more than two tiers a space of minimum 600 mm shall be available for maintenance. In case two or more tiers of cable trays are running parallel along both sides of trench walls there shall be space of minimum 600 mm between them.



- 7.08.03 Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cable leaving trenches shall be coiled and provided with a protective pipe or cover till such times the final termination to the equipment is completed.
- 7.08.04 Prior to laying of cables inside both indoor and outdoor trenches, the Contractor shall properly clean inside of those trenches.
- 7.08.05 When cables are laid in multiple tiers, spacing between individual tiers shall be as approved by Site Engineer.
- 7.08.06 As each row of cables is laid in place every cable shall be given on insulation test in the presence of Site Engineer. Any cable, which proves defective, shall be replaced before the next groups of cables are laid.
- 7.08.07 All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/lined trench.
- 7.08.08 Where cables rise from trenches to motor, control station, lighting panels etc., they shall be taken in G.I. Pipes for mechanical protection up to a minimum of 150mm above grade.
- 7.08.09 Cable ends shall be carefully pulled through the conduit, to prevent damage to these cables. Where required, approved cable lubricant shall be used for this purpose. Where cable enters conduit the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.
- 7.08.10 Following guide of the pipe fill shall be used for sizing the pipe size:-
- a) 1 cable in pipe - 53% full
 - b) 2 cables in pipe - 51% full
 - c) 3 or more cables - 40% full
- 7.08.11 After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/'PUTTI' for sealing purpose. Alternatively G.I. Lids or PVC bushes shall be employed for sealing purposes. The cost for the same shall be deemed to have been included in the installation of G.I. pipe and no separate payment shall be allowed.
- 7.08.12 Where cables pass through foundation walls or other underground structures, the necessary ducts or openings shall be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures, the electrical Contractor shall determine their location and obtain approval of the Site Engineer before cutting is done.
- 7.09.00 **Cable Tags & Markers**



- 7.09.01 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedules. Cables and conduits shall be tagged at their entrance, bends, every 30.0M and exit from any equipment, junction box. When a cable/conduit passes through a wall, tags shall be fitted on both sides of the wall.
- 7.09.02 The tags shall be of aluminium with the number punched on it and securely attached to the cable by not less than two turns of 16 SWG G.I. wire. For single core cable the wire shall be of non-magnetic material.
- 7.09.03 Location of cable joints, if any, shall be clearly indicated with cable marker with an additional inscription 'cable-joint'.
- 7.09.04 Contractor shall furnish and install all tags and markers stated above.
- 7.09.05 For buried cable, the marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change of direction.
- 7.10.00 Cable Termination and Connection**
- 7.10.01 Termination and connection of cables shall be done strictly in accordance with manufacturer's instruction, drawings and/or as directed by the Engineer.
- 7.10.02 Work shall include all clamping, fitting, fixing, soldering, tapping, compound filling, cable jointing, crimping, shorting and grounding as required for the complete job. All equipment required for all such operations shall be of Contractor's procurement. Furnishing of all consumable materials such as soldering material, electrical tape, sealing material as well as cable jointing kits shall be included in the offer.
- 7.10.03 Cable joint kits for all cables shall be supplied by Contractor under this specification. Responsibility for proper termination shall lie on the contractor. Guarantee for termination shall also have to be given by Contractor.
- 7.10.04 The equipment will be generally provided with blank bottom plates for cable/conduit entry and cable end box for power cables.
- 7.10.05 The bidder shall perform all drilling, cutting on the blank plate and any minor modification work required to complete the job.
- 7.10.06 If the cable end box or terminal enclosure provided on the equipment is found unsuitable and requires major modification, the same shall be carried out by the contractor.
- 7.10.07 Control/instrumentation cable cores entering control panel/ switchgear/ MCC, etc. shall be neatly bunched and served with PVC perforated tape to keep it in position at the terminal block.
- 7.10.08 The bidder shall put ferrules on all control cable cores in all junction boxes and at all terminations. The ferrules shall carry terminal numbers as per drawings. All ferrules shall be coloured, plastic & interlocked type.





- 7.10.09 Spare cores shall be similarly ferruled, crimped with lug and taped on the ends. Spare cores shall be ferruled with individual cable number.
- 7.10.10 Termination and connection shall be carried out in such a manner as to avoid strain on the terminals.
- 7.10.11 All cable entry points shall be properly sealed and made vermin and dust proof. Unusual opening, if any, shall be effectively closed. Sealing work shall be carried out with approved sealing compound having fire withstand capability for at least three hours.
- 7.10.12 Strips and special tools like manually or pneumatically driven gun/pistol for termi point/equivalent connection shall be supplied by the Contractor.
- 7.11.00 **Cable Joints**
- 7.11.01 Cable shall be installed without joints as far as practicable.
- 7.11.02 If however jointing becomes necessary, it shall be made only by qualified cable joiner and strictly in accordance with manufacturer's recommendation.
- 7.12.00 **Grounding**
- 7.12.01 The Bidder shall carry out the interconnection among various peripheral earthing grids/mats, steel structures, lightning protection system as well as grounding of all electrical equipment, etc. The grounding work shall be carried out as per provisions of I.E. rules Indian standards and enclosed grounding and lightning protection notes and details.
- 7.12.02 Grounding shall be done by conductors of adequate sizes (size shall be selected by the bidder with supporting calculation, if not specified) and the same shall be connected to the risers of main ground mat.
- 7.12.03 For fabricated cable trays, a separate ground conductor (50x6 mm G.S. flat) shall run along the entire length of each route of cable tray being suitably clamped on the cable tray. Individual cable trays of each section shall be connected to above ground conductor through 50x6 mm G.S. flat to maintain continuity of ground path.
- 7.12.04 All ground conductor connections shall be made by electric arc welding/ brazing unless otherwise specified. Ground connections shall be made from nearest available station ground grid risers. The rods/connection shall be coated with cold galvanizing /weather resistance anti corrosive paints.
- 7.12.05 All ground conductors shall be painted black for easy identification.
- 7.12.06 Equipment ground connections, after being checked and tested by the Engineer, shall be coated with anti-corrosive paint.

- 7.12.07 Whether specifically shown or not in Project drawings, all conduits, trays, cable armour and cable end box, electrical equipment such as motors, switchboards, panels, cabinets, junction boxes, lockout switches, fittings, fixtures, etc. shall be effectively grounded.
- 7.12.08 If there is no provision to ground the L.T. transformer neutral at transformer end, to make an effectively earthed 415V system the neutral bus of all 415V distribution boards shall be connected to ground grid at two different and distinct points.
- 7.12.10 **Ground Electrode**
- Ground electrodes are to be fabricated and driven into the ground by the side of mat conductor. All connections to the conductors shall be done by arc welding process.
- Ground electrodes shall be 40 mm dia and 3 metre long M.S. rod. These are to be fabricated and driven into the ground by the corners of ground conductor to be laid along the periphery of the building. All connections to the conductors shall be done by arc welding process.
- 7.12.11 **Risers**
- Risers are required for connecting the equipment and structures with the ground mat. These will be 1x40 mm dia (minimum) M.S. rod. laid from ground mat to above ground level properly clamped or supported along the outer edge of the concrete foundation. Connection to the ground mat shall be done by arc welding and the other end is to be kept free at least 300 mm above grade level/concrete floor level unless otherwise shown.
- 7.12.12 **Column Grounding**
- All columns are required to be grounded by 1x40 mm dia (minimum) M.S. rod from ground mat. Laying, supporting along with foundation, connecting at ground mat are within the scope of this specification. At least 300 mm length of the above rods shall be left free above the grade level/concrete floor level for connection with columns.
- 7.12.13 **Electronic Equipment Grounding**
- Internal ground connection of electronic panels shall be insulated from the enclosure, frame, chassis and to be terminated to an insulated ground bus.
- Insulated ground bus of all electronic panels shall be connected by insulated wire to an insulated common electronic ground bar.
- All connection made above shall be in the form of a radial distribution system without any parallel ground paths.



Electronic equipments and systems, metal enclosures of all electronic panels shall be connected to a grounding system with which is isolated and separate from the electrical equipment grounding system. Separate Earth pit shall be made by 3M X 3M MS Rod.

7.13.00 Painting

7.13.01 Contractor shall paint steel fabrications at site with two (2) coats of red oxide primer and two (2) coats of battleship grey (shade no. 632 of IS:5) synthetic enamel paint. In case a different kind of primer or a finish shade is mentioned in the Lead/General Specification due to specially corrosive atmosphere, the same shall be followed.

7.14.00 Galvanizing

7.14.01 Galvanizing shall be uniform, clean, smooth, continuous and free from acid spots. Should the galvanizing of the samples be found defective, the entire batch of steel has to be re-galvanized, at Contractor's cost. The amount of zinc deposit shall not be less than 610 grams per square metre of surface area. Additionally, the thickness of the zinc deposit at any spot shall not be less than 75 microns. The Owner reserves the right to measure the thickness of zinc deposit by appropriate instrument and reject any component which shows thickness of zinc at any location less than 75 microns.

7.15.00 Excavation and Back Filling

7.15.01 The Bidder shall perform all excavation and backfilling to the original level with good consolidation as required for buried cable and ground connections. Sheet piling and shoring shall be done as necessary for protection of the work.

7.15.02 Contractor shall make his own arrangements for pumping out any water that may be accumulated in the excavation.

7.16.00 Steel Fabrication

7.16.01 All racks, trays, supports, hangers & brackets wherever necessary shall be fabricated by the Bidder.

7.16.02 Steel for fabrication shall be straightened and cleaned of rust and grease. All fabrication shall be free of sharp edge and burns so as not to cause any damage to personnel or cables.

7.17.00 Cleaning up of Work Site

7.17.01 The Bidder shall, from time to time, remove all rubbish resulting from execution of his work. No materials shall be stored or placed on passage or drive ways.





7.17.02 Upon completion of work, the Bidder shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use.

8.00.00 TESTS

8.01.00 Shop Tests

8.01.01 All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant Indian Standards at manufacturer's works.

8.01.02 Tests on panels/junction boxes shall include:

- a) Wiring continuity tests.
- b) High voltage and insulation tests.
- c) Operational tests.

8.02.00 Site Tests

8.02.01 Bidder shall thoroughly test and meggar all cables, wires and equipment to prove the same are free from ground and short circuit.

8.02.02 If any ground or short circuit is found, the fault shall be rectified or the cable and/or equipment replaced.

8.02.03 All power cables after installation and prior to connections shall be subjected to High Potential tests. Also the insulation resistance values shall be measured both before and after Hipot test for comparison. The leakage current shall also be measured during the Hipot test at site.

Cable cores shall be tested for:

- a) Physical damage
- b) Continuity
- c) Correctness of connections as per relevant wiring diagram
- d) Insulation resistance to earth
- e) Insulation resistance between conductors
- f) Proper earth connections of cable glands, cable boxes, cable armour, screens etc.

8.02.04 All equipment shall be demonstrated to operate in accordance with the requirements of this specification.

8.03.00 Test Certificates





- 8.03.01 Type test certificate on any equipment, if so desired by the Owner, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

9.00.00 DRAWINGS, DATA & MANUALS

9.01.00 To be submitted with the Bid

- 9.01.01 Make, type and catalogue number of different electrical items and accessories along with technical leaflets, data sheets etc.
- 9.01.02 Typical General arrangement drawings showing constructional features, fixing arrangement of pre-fabricated cable trays.
- 9.01.03 Bill of Materials for cable trays and accessories, conduits & accessories.
- 9.01.04 Layout of Grounding system and lightning protection system showing connection and other details along with backup design calculations and detailed write up.
- 9.01.05 Bill of materials for grounding and lightning protection system.
- 9.01.06 Drawing showing details of equipment grounding.

9.02.00 To be submitted after Award of Contract

- 9.02.01 Make, type and catalogue number of cable termination kits, joints and accessories.
- 9.02.02 Detail dimensional drawings showing constructional features, grounding, fixing arrangement etc.
- 9.02.03 Bill of Materials for Pre-fabricated cable tray and accessories, Conduits & accessories.
- 9.02.04 Dimensional G.A. drawings and data sheets for different equipment and items supplied under this specification.
- 9.02.05 Layout drawing of Grounding system and Lightning protection system showing connection details along with backup design calculation and detailed write up.
- 9.02.06 Bill of material for grounding system and lightning protection system.
- 9.02.07 Drawing showing details of equipment grounding system.



ANNEXURE - A

**NOTES AND DETAILS
FOR
CABLING SYSTEM**

1.00.00 GENERAL

1.01.00 These notes and details shall be read and construed in conjunction with Specification and the drawings meant for cable tray details and supporting arrangements in Trench, Racks etc., enclosed elsewhere. In case of conflict between these notes and drawings, the latter shall prevail.

1.02.00 The Cabling System installation work shall conform to the requirements of the latest revisions of the following standards/codes

- a) Indian Electricity Rules, 1956, with up to date amendment.
- b) I.S. Code of Practice

2.00.00 CABLE ROUTING/LAYING

2.01.01 Cables shall generally be laid on ladder type cable trays either in trenches or overhead supported from building steel/structures except in some cases cables may have to be laid underground and for short runs in conduits for protection or crossing.

2.01.02 For interplant connections, the cables may be routed through an overhead cable bridge or cable trenches/tunnels selection being dependent on site constraints. Directly buried cable shall be avoided as far as possible. Owner's prior approval shall be taken for exceptional cases, where buried cables cannot be avoided.

2.01.03 For underground crossing of railways, roads etc. hume pipes shall be used and shall be laid at a depth of minimum 1000 mm such that cables shall not be damaged.

2.01.04 The cable racks in dust prone areas shall be supported from available structure in vertical configuration with suitable cover to avoid deposition of lignite dust as far as practicable.

2.01.05 Different voltage grade cables shall be laid in separate trays when trays are arranged in tiers. Power cables shall be on top trays and Control/Instrumentation cables on bottom trays, and it is recommended that trays for cables of different voltage levels be stacked in descending order with higher voltage level above.

2.01.06 Cables for redundant equipment/system shall be run in separate trays in separate route.





- 2.01.07 Cables from two different services viz. supply from station board and supply from unit board shall be fully segregated to prevent simultaneous damage due to fire in one of the services.
- 2.01.08 Low level signal cables and other special Instrumentation and Control cables shall run in separate trays. In general, a minimum of 1500 mm clearance shall be maintained between these cables and noise generating equipment (large motors, generators, transformers etc.).
- 2.01.09 The cable spreaders of each unit shall be compartmentalized by provision of fire proof partition wall.
- 2.01.10 The floor of the cable spreader rooms shall have to be made water proof so that water does not percolate to lower levels in the event of fire fighting operations. Adequate arrangement for efficient drainage of water shall be provided. The cable raceways should also be suitably curved to avoid water entry through this place.
- 2.02.00 **Cable Trays/Supports**
- 2.02.01 Cable trays and covers shall be pre-fabricated type, constructed from minimum 14 SWG sheet steel for trays and 16 SWG for covers and hot-dip galvanized after fabrication.
- 2.02.02 Cable tray supports shall be cantilever type for each installation. All supports and hardware shall be hot-dip galvanized. Support shall be fixed with bolts and no welding shall be done on the galvanized parts.
- 2.02.03 Standard cable tray width shall be 600 mm. However, trays with 450, and 300, 150 mm width may be used in some places considering the requirement and space restrictions. For instrumentation and control purpose, some perforated type cable trays of width 150 and/or 100mm may be used particularly in low space area and 600, 450, 300 mm perforated trays may be used depending on site requirement.
- 2.02.04 Cable trays shall be ladder type with 250 mm rung spacing, 100 mm depth and rung width not less than 50 mm.
- 2.02.05 All weld for cable tray supports shall have a minimum throat thickness of 6 mm.
- 2.02.06 Cable trays in areas subjected to excessive lignite dust, or mechanical damage shall have hot-dip galvanised sheet metal tray cover installed on front tray in vertical run and inverted 'V' type on upper tray in horizontal run.
- Where covers are used on trays containing power cables, consideration should be given to ventilation requirements. Areas where corrosive chemicals are likely to be handled, cable tray and covers shall be epoxy painted.
- 2.03.00 **Conduits**



- 2.03.01 Conduits shall be rigid steel coated type; minimum size of conduit shall be limited to 19mm.
- 2.03.02 Steel conduits with interior coating of silicon epoxy ester for ease of wire pulling shall be seamed by welding and flo-coat metal conduit/hot-dip galvanized. These shall be supplied in standard length of 5M with minimum wall thickness as specified in IS: 9537 Part-II. In chemical handling areas, Battery room etc., the exterior surface shall be further coated with chromate and polymer for better resistance to corrosion.
- 2.03.03 Conduit runs shall be supported at an interval of 750 mm for vertical run and 1000 mm for horizontal run.
- 2.03.04 Conduits shall be sized so that conduit fill (ratio of total cable area to conduit area) shall not exceed the following:
- | | | |
|-------------------|---|-----|
| One Cable | : | 53% |
| Two Cable | : | 31% |
| Three Cables & Up | : | 40% |
- 2.03.05 Conduit runs shall be provided with necessary bends as required.
- 2.04.00 **Installation**
- 2.04.01 The Bidder shall install, terminate and connect up all cables and conduits with supporting arrangements as per drawings, cable schedules and interconnection chart/drawings.
- 2.04.02 The HV power cables of 11 KV/3.3 KV shall be laid in trays or racks as follows:
- In single layer only.
 - 3 core cables to be laid giving one diameter gap of the largest diameter adjacent cable.
 - Single core cables to be laid in trefoil formation with a spacing equal to diameter of the trefoils.
- 2.04.03 1100V grade power cables shall be laid in single layer in trays.
- 2.04.04 1100V grade power cable shall be laid giving one diameter gap of the largest diameter adjacent cable.
- 2.04.05 Control and Instrumentation cables can be laid up to a maximum of three layers in each tray.
- 2.04.06 The trays shall be run with a vertical spacing of 300 mm for overhead cable trays as well as inside cable trenches. A minimum of 225 mm clearance shall be provided between the top of tray and beams, cold piping, 500 mm clearance for hot piping/object to facilitate installation of cables in tray.





- 2.04.07 Adequate pull boxes shall be provided in conduit run to facilitate cable pulling in long runs and also to ensure that there shall be no more than 270 Deg. bends between pull points.
- 2.04.08 Cable tray/conduit system shall be installed to accommodate cable manufacturer's recommended maximum pulling tension and minimum bending radius.
- 2.04.09 All openings in the floor and wall for cable access shall be sealed after installation of the cable system with non-inflammable materials, as follows:
- i) Fire stop/Penetration seal shall be installed in the cable spreaders and cable raceways.
 - ii) Similarly in the trenches fire stop/penetration seals shall be provided at suitable interval to avoid spread of fire.
 - iii) For all H.V., L.V., Relay and Control panels, Control desk, instrumentation panels, battery charger, D.C. Dist. boards and other miscellaneous panels, fire-stops should be provided below base plate.
- 2.04.10 All floor/wall openings for cable entry to the electrical equipment and accessories shall be sealed with non-inflammable materials, after completion of cable installation. Thickness of such materials shall be equal to the thickness of floor/wall unless specified otherwise.
- 2.04.11 The portion of galvanized steel, which, if required, undergoes any welding at site shall be coated with two (2) coats of cold galvanizing anti-corrosive paint after welding.
- 2.04.12 The cables shall be coated with fire protection coating as specified elsewhere.
- 2.05.00 **Identification**
- 2.05.01 The complete cabling system shall be properly identified. Methods for identification of cabling system shall be furnished to the successful tenderer and the Bidder shall strictly adhere to the said methods.
- 2.05.02 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.
- 2.05.03 Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanized iron plate, projected above ground level.
- 2.05.04 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry, at each bend and at every thirty (30) metres in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, MCC, control & relay panels etc. wherever required for cable identification, such as where a number of cables enter together through a gland plate.





ANNEXURE – B

**NOTES & DETAILS
FOR
GROUNDING & LIGHTNING PROTECTION**

1.00.00 GENERAL

1.01.00 These notes and details shall be read and construed in conjunction with grounding and lightning protection drawings and specification. In case of conflict between these notes and drawings, the latter shall prevail.

1.02.00 The grounding and lightning protection system installation work shall conform to the requirements of the latest editions of the following standards/codes:

- a) Indian Electricity Rules, 1956.
- b) National Electrical Code, 1985.
- c) Code of Practice for Earthing (IS: 3043)
- d) Protection of Buildings and Allied Structures against Lightning (IS: 2309)
- e) IEEE 80

2.00.00 GROUNDING SYSTEM

2.01.00 Main Grounding Mat/Grid

2.01.01 The main ground grid shall be buried in earth at a minimum depth of 1000 mm below finished grade level unless stated otherwise. The size of ground grid conductor shall be bare 40 mm dia. mild steel rod.

2.01.02 A minimum earth coverage of 300 mm shall be provided between the ground grid conductor and the bottom of trenches, tunnels, underground pipes, foundations, railway tracks etc. The ground grid conductor shall be re-routed in case it fouls with equipment foundations.

2.01.03 In some cases, it may happen that the construction work of cable trench, foundation and laying of underground pipes are being taken up after the grounding mat has been laid. It may be required to cut a portion of grounding conductor to avoid fouling with cable trench, equipment foundations, underground pipes etc. In this case, the ground conductor shall be properly rerouted and rejoined/reconnected with the main grounding mat during the construction/laying of above underground objects and good electrical continuity of grounding conductor shall be ensured.

2.01.04 Grounding conductors crossing the road may have to be laid at greater depth to suit the site conditions.





- 2.01.05 Grounding conductor around the building shall be buried in earth at a minimum distance of 1200 mm from the outer boundary of the building.
- 2.02.00 **Grounding Electrodes**
- 2.02.01 The ground electrodes shall be 40 mm dia, 3000 mm long mild steel rod. These shall be fabricated and driven into the ground by the side of grounding mat conductors and connected to the ground mat conductors.
- 2.03.00 **Risers**
- 2.03.01 All risers/pigtail from the ground grid shall be 40 mm dia mild steel rod and shall be projected 300 mm above grade level/concrete floor level unless otherwise shown.
- 2.04.00 **Earthing Conductor**
- 2.04.01 50 x 6 mm galvanized steel flats shall be run as main earthing conductors above ground along building columns, walls, steel structure, etc. for equipment and other structures earthing.
- 2.04.02 These earthing conductors shall be interconnected between them and to the main ground grid through risers/pigtail. The connection between earthing conductor and riser shall be made above ground.
- 2.04.03 Earthing conductors along their run on column, wall etc. shall be supported by suitable welding/clamping at intervals set exceeding 750 mm.
- 2.04.04 Earthing conductors shall be embedded in concrete floor of the building without having direct contact with the reinforcement rods.
- 2.04.05 At the crossing of building walls, floors etc. the earthing conductor shall be passed through galvanized conduit sleeves. Both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.
- 2.05.00 **Grounding of Equipment and Structures**
- 2.05.01 All indoor and outdoor electrical equipment and associated non-current carrying metal works, supporting structures, building columns, fence, system neutrals, lightning masts/arresters shall be connected to the main ground system.
- 2.05.02 Two separate and distinct ground connections shall be provided for grounding electrical equipment frameworks in compliance with I.E. rules.
- 2.05.03 All Electrical equipment shall be furnished with two (2) separate ground pads with tapped holes, bolts and spring washers. The connection between these ground pads and the grounding grid shall be made by short and direct earthing conductors free from kinks and splices.



- 2.05.04 Miscellaneous devices such as junction boxes, pull boxes, pushbutton stations, lockout switches, cable end boxes, lighting fixtures, receptacles, switches etc. shall be effectively grounded whether specifically shown or not.
- 2.05.05 The transformer neutrals, earthing terminals of lightning arresters, coupling capacitor shall be directly connected to rod electrodes through riser which in turn, shall be connected to main grounding mat.
- 2.05.06 Grounding mat comprising closely spaced conductors shall be provided below the operating handles of isolator and circuit breaker operating box located in outdoor high voltage substation. The operating handles shall be properly bonded with flexible conductors.
- 2.05.07 Metallic conduits and pipes shall not be used as earth continuity conductor. These shall be grounded at both ends.
- 2.05.08
- a) The cable trays inside the cable trenches shall be grounded thru' one (1) no. 40 mm dia M.S. Rod at an interval of ten (10) metres. One end of this rod is connected with riser from grounding mat and the other end which is projected inside the cable trench shall be connected with one (1) 50 x 6 mm G.S. flat which runs horizontally along the cable trench. This earthing conductor shall be securely attached to each tray section of cable tray/trays forming a solidly grounded tray system through 50 x 6 mm G.S. flats.
 - b) A continuous 50 x 6 mm G.S. flat earthing conductor shall run along the supporting structure of overhead cable trays/cable shafts. This earthing conductor shall be attached to each section of cable tray/trays through 50 x 6 mm G.S. flats.
- 2.05.09 Fence within the ground grid shall be bonded to the plant ground system at regular interval not exceeding ten (10) metres. Fence gate shall be separately grounded with flexible connection to permit movement.
- 2.05.10 The street lighting poles, junction boxes mounted on the poles, flood light supporting structures etc. shall be connected to ground grid at minimum two points.
- 2.05.11 The steel columns, metallic stairs, hand-rail etc. of the building where electrical equipment are located shall be connected to the nearby ground mat by earthing conductor. Electrical continuity shall be ensured by bonding the different sections of handrails and metallic stairs.
- 2.05.12 The railway tracks (if applicable) within plant area shall be bonded across fish plates and the rail tracks shall be connected to grounding grid at different locations. The rail tracks leaving the plant boundary shall be made electrically discontinuous from the rail tracks inside the plant area by providing suitable arrangements at fish plate joints.
- 2.05.13 The overhead crane rails shall be grounded at both ends. In addition all joints shall be bonded to provide electrical continuity.





2.05.14 The flexible earthing connection of jumpering wire shall be provided where flexible conduits are connected to rigid conduits to ensure continuity.

2.06.00 Earthing of Cable

2.06.01 The metallic sheaths, screens and armour of cables shall be earthed at both switchgear/MCC/DB and equipment ends.

2.07.00 Jointing and Connection

2.07.01 All ground conductor connections below ground level shall be done by electric arc welding with low hydrogen content electrode. The contact surfaces shall be thoroughly cleaned to provide good electrical continuity.

2.07.02 The bending of the large diameter ground conductor where necessary shall be done by gas heating.

2.07.03 The projected portion of riser/pigtail above ground shall be coated with two coats of bitumen paints (anti-corrosive paints) with a minimum thickness of 1 mm after connection.

2.07.04 The connections between the riser/pigtail and earthing conductors (galvanised steel flats) and between the earthing conductors above ground level shall be made by electric arc welding.

2.07.05 The portion of galvanised steel flats, which undergoes welding at site, shall be coated with two (2) coats of cold galvanising anti-corrosive paint after welding.

2.07.06 The earthing connections to equipment grounding pads/terminals and some removable structures shall be bolted type with GI bolts and nuts. The contact surfaces shall be thoroughly cleaned (to free from scale, paint, enamel, grease, rust) before connection to ensure good electrical contact.

2.07.07 Equipment/structures ground connections after properly checked and tested shall be coated with weather resistant paints/cold galvanising paints.

2.08.00 The sizes and materials of ground conductors used in grounding system are listed below :

	DESCRIPTION	SIZE	MATERIAL
a)	Main Grounding Grid Conductor	40 mm dia Rod	Mild Steel
b)	Riser/Pigtail From Grounding Grid/Mat	40 mm dia Rod	- Do -
c)	Electrode	40 mm dia Rod 3000 mm long.	- Do -
d)	Conductor used for connection of various equipment/structures as listed below		





**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

i)	11 kV/3.3kV Equipment	75 x 10 mm Flat	Galvanised Steel
ii)	Structures, Bus Duct, Control Panels, Cable Trays etc.	50 x 6 mm Flat	- Do -
iii)	415V Power Control Centres, Motor Control Centres, Distribution Boards etc.	50 x 6 mm Flat	- Do -
iv)	Local Panels, Lighting Panels	35 x 6 mm Flat	- Do -
v)	Motors :		
	Above 90 kW	50 x 6 mm Flat	- Do -
	Above 30 kW Upto 90 kW	35 x 6 mm Flat	- Do -
	Above 5 kW Upto 30 kW	25 x 3 mm Flat	- Do -
	Upto 5 kW	8 SWG Wire	Galvanised Iron
vi)	Miscellaneous Items, viz. Push Button Station, Junction Boxes etc.	8 SWG Wire	- Do -

3.00.00 LIGHTNING PROTECTION SYSTEM

3.01.0 Air Terminations

- 3.01.01 The vertical air terminal rods shall be installed at the roof of buildings to protect from lightning strokes.
- 3.01.02 The vertical air terminal shall be made of 20 mm dia galvanized steel rod. The projected length of the rod shall be as required to protect the object (on which the rod is fixed) from lightning stroke.
- 3.01.03 The air terminal rod shall be properly fixed on the top of the building/structure to withstand very high wind pressure. In case the air terminal rod is embedded at the top of roof of building: the portion embedded inside the concrete shall not touch the reinforcement bars and shall be duly insulated from them.
- 3.01.04 All the vertical air terminal rods shall be electrically connected together by means of horizontal conductors of size 50 x 6 mm galvanized steel flats.
- 3.01.05 The shielding angle for one vertical air termination shall be 45 degrees. For more than one rod, shielding angle between the rods shall be taken as 60 degrees.





- 3.01.06 Horizontal air termination (i.e. G.S. Flat conductor) shall be so laid that no part of the rod shall be more than nine (9) metres from the nearest roof conductor.
- 3.02.00 **Shielding Masts**
- 3.02.01 The shielding mast for lightning protection shall be installed at the top of steel columns cap plates of power house building.
- 3.02.02 The shielding mast shall be made of galvanised steel pipe and the height of the same shall be decided considering the zones to be protected.
- 3.02.03 Each shielding mast shall be connected to grounding grid by a down conductor 50 x 6 mm. Galvanised steel flat run along the building column. In addition all building columns joints shall be electrically bonded.
- 3.03.00 **Down Conductors**
- 3.03.01 The down conductors shall be 50 x 6 mm galvanised steel flats. The sizes of down conductors and horizontal conductor provided for lightning protection of conveyer gallery shall be 25 x 3 mm galvanised steel flats. One end of this shall be connected with air terminal rod/horizontal conductor at the top of roof/structure and other end connected to the nearest 40 mm dia. mild steel rod riser from ground electrode.
- 3.03.02 Each down conductor shall have an independent earth termination. In no case conductors of the lightning protection system shall be connected with the conductor of grounding system above ground level.
- 3.03.03 The connection between each down conductor and rod electrode (by means of 40 mm mild steel rod riser) shall be made via test link located at approximately 1500 mm above ground level.
- 3.03.04 The down conductor shall be laid straight and sharp bends shall be avoided as far as practicable. These shall be cleated on outside of the building wall and column/structure at about 750 mm intervals unless stated otherwise in the drawing.
- 3.03.05 At all supports for down conductor along the column/wall of the buildings; the portion embedded inside the building concrete should not touch the reinforcement bars.
- 3.03.06 All exposed metallic parts of the buildings shall be bonded to the down conductors. Such parts shall include ladders, balconies, conduits etc.
- 3.03.07 The down conductors shall be protected at the ground level against mechanical injury by means of non-metallic pipes, viz. PVC pipes filled with bituminous compound.
- 3.04.00 **Electrodes (for Lightning Protection)**



- 3.04.01 The electrodes shall be 40 mm diameter 3000 mm long mild steel rod. These shall be driven into the ground.
- 3.04.02 All the electrodes shall be interconnected by means of one (1) 40 mm dia mild steel rod which shall be laid under ground at a minimum depth of 1000 mm below finished grade level unless stated otherwise. This ground mats/electrode in turn shall be connected to main grounding grid.
- 3.05.00 **Riser (for Lightning Protection)**
- 3.05.01 All risers connected to grounding mat shall be 40 mm mild steel rods and shall be projected 300 mm above grade level unless stated otherwise.
- 3.06.00 **Jointing & Connection**
- 3.06.01 All ground conductor connections below ground level shall be done by electric arc welding with low hydrogen content electrode.
- 3.06.02 The projected portion of riser above ground shall be coated with two (2) coats of bitumen paints (anti-corrosive paints) with a minimum thickness of 1 mm after connection.
- 3.06.03 The joints in the lightning conductors shall be kept to a minimum and there shall be no joint in the underground portions of conductors.
- 3.06.04 All the joints shall be done by arc welding process overlapping of the conductors at straight joints shall not be less than 150 mm. The contact surfaces shall be cleaned properly before jointing.
- 3.06.05 The portion of galvanized steel flats, which undergoes welding at site, shall be coated with two (2) coats of cold galvanising anti-corrosive paint after welding.
- 3.06.06 The bolted joint of the test link shall be covered with thick coating of bitumen paint after successful testing.
- 3.06.07 The air terminal rods and shielding mast shall be coated with weather resistant anti-corrosive paint (zinc chromate followed by two coats of aluminium paint).
- 3.06.08 The steel to copper connection shall be brazed type.
- 3.07.00 **Lightning Protection of Other areas (if required)**
- 3.07.01 The lightning protection of other areas, if required shall be provided with horizontal conductors (25 x 3 mm G.S. Flat) run along the length of these areas. This conductor shall be connected to riser and grounding electrode (40 mm dia G.S. Rods) at an approximate interval of 30 mm through two down conductors (each 25 x 3 mm G.S. Flats).
- 3.08.00 The sizes and materials of earthing conductors to be used in lightning protection system are listed below:



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DESCRIPTION		SIZE	MATERIAL
a)	Vertical Air Termination	20 mm dia Rod	Galvanised steel
b)	Horizontal Conductor	i) 50 x 6 mm Flat	- Do -
		ii) 25 x 3 mm Flat	- Do -
c)	Down Conductors	i) 50 x 6 mm Flat	- Do -
		ii) 25 x 3 mm Flat	- Do -
d)	Riser From Electrode/ Grounding Mat	40 mm dia Rod	Mild Steel
e)	Electrode for Lightning Protection	40 mm dia Rod 3000 mm long	- Do -

NOTE :

In addition to above, all materials as required such as G.I. pipes of appropriate length, diameter and thickness shall be provided for lightning masts of FGD package plant area.





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VOLUME: II-F

SECTION - XVII

**ERECTION INDOOR AND OUTDOOR
ELECTRICAL EQUIPMENT**



Development Consultants Pvt. Ltd.

**Vol. II-F/Section-XVII
Erection Indoor & Outdoor Elec Equip.**



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VOLUME: II-F

SECTION-XVII

ERECTION INDOOR AND OUTDOOR ELECTRICAL EQUIPMENT

1.00.00 SCOPE OF WORK

- 1.01.00 The scope of work shall cover complete and efficient erection, testing and commissioning and putting into successful commercial operation of all Outdoor and Indoor electrical equipment supplied under FGD (Flue Gas Desulphurisation) Package contract.
- 1.02.00 The scope of work shall also include all civil and structural works necessary for successful installation and commercial operation of all electrical equipment to be erected under this contract.

2.00.00 SCOPE OF SUPPLY

- 2.01.01 The work involves timely procurement and transportation to site in properly packed condition of all hardware, materials and miscellaneous items required to complete the erection job under this specification.

Miscellaneous steel structures, mounting of local panels, push button stations etc. shall be supplied. Any material or accessory, which may not have been specifically mentioned but which is usual and/or necessary shall be supplied.

- 2.01.02 All hardware, materials and accessories to be supplied by the Bidder shall be brand new ones of reputed make.
- 2.01.03 Spare Parts
- 2.01.04 All relevant drawings, data sheet and technical leaflets on each piece of devices.

2.02.00 Scope of Services

The work includes but is not limited to the followings:

- 2.02.01 Furnishing of all erection tools and tackles, testing equipment, implements, supplies, consumables and hardware for timely and efficient execution of the erection work. Hydraulic jacks or motorized jacks necessary for lifting of heavy equipment shall be provided by the Bidder.
- 2.02.02 Transport vehicles necessary for efficient transportation of equipment from Owner's stores to site of erection and excess materials back to owner's stores.





2.02.03 Complete assembly, erection and connection, testing and commissioning, putting into successful and satisfactory commercial operations of the Outdoor and indoor Electrical Equipment and accessories listed below but not limited to:

A. FGD Package System

- a) Station Transformers
- b) Unit Auxiliary Transformer
- c) L.T. Transformers
- d) Lighting Transformers
- e) Neutral Grounding Resistor Cubicles
- f) 11000/3300 V Busduct
- g) 415 V Busduct
- h) 11000 V Switchgear
- i) 3300 V Switchgear
- j) 415 V Switchgears, Switchgear cum MCCs.
- k) A.C/D.C Distribution boards, Main lighting distribution boards and miscellaneous items.
- l) Battery and Battery Chargers, Uninterrupted Power Supply
- m) Electrical Control Desks/Panels, Relay Panels, Data logger Panels etc.
- n) Miscellaneous Local Panels.
- o) Illumination system
- p) All electrical equipment and systems integral with mechanical equipment, systems and subsystems.

2.02.04 The entire erection work shall be carried out in a phased manner. A schedule of the work showing the sequence of erection shall be submitted by the tenderer for this purpose.

2.02.05 The erection schedule, as approved by the Owner's Engineer shall be strictly followed by the Bidder. If, for any reason beyond the control of the Bidder, the work is held-up then the Bidder shall bring it to the notice of the Owner's Engineer without any delay.





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- 2.02.06 All erection work of equipment shall be carried out in a neat and efficient way so as not to impair their normal functioning in any way.
- 2.02.07 The pre-commissioning checks as well as commissioning of different equipment shall be carried out as per guidance of actual manufacturer's supervisor and or as per written instructions in Erection manuals. In case of any site related problem in commissioning activities, Bidder shall seek advice of owner's Engineers.
- 2.02.08 All erection work under this specification shall be carried out strictly in accordance with the approved drawings.
- 2.02.09 In order to avoid concentration of stresses, all sharp edges of clamps, connectors etc. shall be rounded off.
- 2.03.00 **Methods and Workmanship**
- 2.03.01 All work shall be installed in a first class, neat workmanlike manner by mechanics/electricians skilled in the trade involved.
- 2.03.02 The erection work shall be supervised by competent supervisors holding relevant supervisory license from the Government.
- 2.03.03 All details on installation shall be electrically and mechanically correct.
- 2.03.04 The installation shall be carried out in such a manner as to preserve access to other equipment installed.
- 2.04.00 **Consumables and Hardware**
- 2.04.01 The Bidder shall furnish all erection materials, hardware and consumables required for the completion of the installation.
- 2.04.02 The materials shall include but not be limited to the following:
- a) Consumables : Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials etc.
 - b) Hardware : Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.
 - c) Materials : Junction boxes, terminal blocks, connectors, ferrules, lugs, brass glands, rigid/flexible conduits, cables, ground wires etc.
- 2.04.03 Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Bidder.





2.05.00 **Testing Equipment**

2.05.01 The major testing equipment that are required to be provided by the Bidder are listed below:

- a) Insulation Tester :
 - i) Power Operated Megger -1 KV and 10 KV Grade
 - ii) Hand Operated Megger – 1 KV Grade
- b) Hand driven Earth Resistance Meggar, range 0 - 1/3/30 Ohms.
- c) High Potential Testing Set - roller mounted type for LV, HV & EHV equipment
- d) Tong testers of suitable ranges
- e) Contact resistance measuring set for Micro-ohms.
- f) Torque wrench of various sizes
- g) Multi-meters, test lamp, field telephone with buzzer set, spirit level, different gauges etc.
- h) Insulating oil-testing set of range 0 - 60 KV.
- i) Stream line filter for transformer.
- j) Current Transformer for primary injection set
- k) Relay testing and checking bench

2.05.02 Other test equipment as required shall be arranged by the Bidder.

2.06.00 **Installation - General**

2.06.01 Installation work shall be carried out in accordance with good engineering practices and also manufacturer's instructions / recommendations where the same are available.

2.06.02 Equipment shall be installed in a neat workmanlike manner so that it is level, plumb, square and properly aligned and oriented.

2.06.03 All erection work shall be carried out in strict compliance with manufacturer's instructions and shall include all necessary adjustments, checks and measurements.

2.06.04 All internal wiring of the equipment which has been left incomplete because of shipping split or which requires minor modifications shall be carried out by the Bidder.





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- 2.06.05 The Bidder shall record results of all erection tests and measurements. The Bidder shall submit copies of those test results to the Owner for his reference and record.
- 2.06.06 The storage and installation of all electrical equipments with all its accessories shall be carried out in strict compliance with manufacturer's instructions. Extreme care shall be taken to avoid ingress of moisture and foreign particles into the transformer tank.
- 2.07.00 **Steel Fabrication**
- 2.07.01 All racks, supports, hangers and brackets wherever necessary shall be fabricated by the Bidder.
- 2.07.02 Steel for fabrication shall be straightened and cleaned of rust and grease. All fabrication shall be free of sharp edges.
- 2.08.00 **Painting**
- 2.08.01 The Bidder shall paint all racks, supports and miscellaneous steel fabrication with two (2) coats of red oxide primer and two (2) coats of synthetic enamel paint of approved shade.
- 2.09.00 **Foundation & Civil Works**
- 2.09.01 Equipment foundations, equipment mounting structure foundation, panel foundations and other civil work shall be provided by the Bidder.
- 2.09.02 The Bidder shall check these foundations before commencement of erection to ensure their suitability.
- 2.09.03 All final adjustment of foundation levels, chipping and dressing of foundation surfaces, setting and grouting of anchor bolts, sills, inserts and fastening devices shall be carried out by the Bidder including minor modification of civil work as may be required for erection.
- 2.10.00 **Cleaning up of Work Site**
- 2.10.01 The Bidder shall, from time to time, remove all rubbish resulting from execution of his work. No materials shall be stored or placed on passage or drive ways.
- 2.10.02 Upon completion of work, the Bidder shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use.

3.00.00 TESTS

3.01.00 Site Tests





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- 3.01.01 Bidder shall thoroughly test and meggar all cables, wires and equipment to prove the same are free from ground and short circuit after erection and installation at site.
- 3.01.02 If any ground or short circuit is found, the fault shall be rectified or the cable and/or equipment replaced but repair of cable is not permitted.
- 3.01.03 All equipment shall be demonstrated to operate in accordance with the requirements of this specification.
- 3.01.04 All equipment shall be subject to High Potential test.
- 3.01.05 All protective relays shall be checked for correctness of operations.
- 3.01.06 All current transformers shall be subjected to Primary Injection test.
- 3.01.07 Generator Bus-duct Polarization Index (P.I. value) shall be measured
- 3.02.00 **Pre-commissioning Tests at Site**
- 3.02.01 The installation of different type of equipment and accessory shall be tested by the Bidder after completion of his erection work with an advance notice to the Engineer concerned so that he may witness the same also.
- 3.02.02 The test result of any installation or equipment or its parts, if considered unsatisfactory to the Engineer, the concerned installation/equipment and its accessories shall be properly rectified and tested again to the satisfaction of the Engineer by the Bidder at his own cost.
- 3.02.03 The site tests to be carried out by the Bidder on completion of installation/erection of equipment are broadly listed in Annexure-A for ready reference by Bidder.
- 3.02.04 The major testing equipment which shall be necessary for carrying out pre-commissioning tests at site are already listed in this specification.

4.00.00 DRAWINGS, DATA AND MANUALS

- 4.01.00 To be submitted with the Bid
- 4.01.01 Make, type and catalogue number of different equipment and accessories along with technical leaflets, data sheet curves etc.
- 4.01.02 Type test certificates.
- 4.02.00 To be submitted after Award of Contract





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- 4.02.01 Dimensional drawings and data sheets for different equipment supplied under this specification.
- 4.02.02 Technical leaflets and data sheet on each piece of equipment/device.





ANNEXURE – A

**SCHEDULE OF PRE-COMMISSIONING TESTS OF
TRANSFORMER & ELECTRICAL EQUIPMENT**

1.	Power Transformer	
	Pre-commissioning Tests	
a.	The following test shall be carried out a site as minimum requirements before energizing of a transformer. All tests which may not have been specifically mentioned here but necessary for commissioning and any tests, which have been specifically asked for by the purchaser shall be done by Bidder at no extra cost:	
b.	IR test on each winding to ground and between windings	
c.	Turns ratio test on each tap	
d.	Polarity and vector group test	
e.	Measurement of winding resistance of HV & LV windings for all taps by Kelvin bridge	
f.	IR, wiring and operational tests on all control devices in control cabinet, oil level indicator, winding and oil temp. indicators, cooling fan etc.	
g.	Checking of earthing with respect to transformer tank (flexible from top cover to tank) other parts, neutral and tank to electrodes of Las (for Las located near to transformer)	
h.	Testing of buchholz relay for alarm and trip conditions	
i.	For bushing CTs, tests applicable shall be as for current transformers.	
j.	Setting of oil/winding temperature indicators, level gauge and checking of alarm/trip circuits.	



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k.	Checking of cooler control and remote fan operation (where applicable)	
l.	Checking of OCTC/OLTC operation.	
m.	Checking of Pressure relief valve for trip contacts.	
n.	Check insulators for cracks.	
o.	Checking for oil leakage and arresting of leakages (if any)	
p.	Checking of operation of all valves	
q.	Checking for open position of all the valves (except drain and filter valves)	
r.	Filtration of oil by using line filter vacuum pump and heater set.	
s.	BDV tests on oil samples from top, bottom and from OLTC tank.	
t.	Checking of oil for acidity, water content, tan delta etc. as per IS:335.	
u.	Measurement of magnetizing current and no load loss at 415V	
v.	Checking of silica gel breather	
w.	Checking of arcing horn gaps on bushings	
x.	Checking of noise level at no load and at full load	
y.	Conducting magnetic balance test.	
z.	Checking of other points given in manufacture's commissioning manual.	
aa.	Checking and calibration of remote winding/oil temp. indicators, tap position indicators, annunciation system (where relay panel is there)	





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bb.	Measurement of tan delta of each winding, oil, busing.	
cc.	Check of no break contact of OLTC contacts.	
dd.	Checking of oil resistivity, surface tension and dissolved gas analysis	
ee.	Impedance voltage measurement at least on three tap position	
ff.	Sweet frequency response analysis test as special test.	
2.	Neutral Grounding Resistors	
a.	Measurement of resistance	
b.	IR test by HV megger between terminal and earth.	
c.	Checking of earth connection for terminal and for body	
d.	Check for isolator operation and continuity of aux. contacts (if applicable)	
e.	Check for temp. rise of enclosure and current flow in the resistances.	
3.	Isolated Phase Bus Ducts / Segregated Phase Busduct	
a.	IR measurement before and after HV Test	
b.	HV Test	
c.	Checking tightness of bolts with torque wrench	
d.	Checking for phase sequence marking	
e.	Check for clearances between phase to phase and phase to earth.	
f.	Check for minor damages and cracks in supporting insulators and bushings after cleaning.	





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g.	Checking for inspection openings and accessibility for replacement of insulator etc.	
h.	Check tightness of earthing connections on enclosure	
i.	Checking of silica gel breather (if there)	
j.	Checking of working of space heater	
l.	Milli volt drop test.	
4.	HT Switchgears	
a.	IR Test before and after HV test	
b.	H.V. Test	
c.	Functional test for all feeders	
d.	Testing and calibration of all meters	
e.	Checking and calibration of overload relays and protective relays as per supplier commissioning manuals.	
f.	Check operation of contactors from local and remote points	
g.	Checking of interlocking between incomers / bus coupler and other feeder	
h.	Test to prove interchangeability of similar parts.	
i.	Tests to prove correct operation of breakers at minimum and maximum specified control voltages	
j.	Checking operation of RC circuit (if there) for tripping of circuit breaker after disappearance of control voltage.	
k.	Checking of earthing connection for neutral earth bus, cable armour location of E/F CT etc., as per the scheme.	





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I.	Check test , services and draw-out position of all the breakers and operations of mechanical flag indicators and electrical indication lamps.	
m.	Check functioning of various electrical schemes like auto-changeover signaling etc.	
n.	Contact pressure test.	
o.	Testing of CT as per CT testing details enclosed above.	
p.	Breaker: i) IR value checking with breaker ON Phase to phase & phase to earth and between phase in off position	
	ii) Measurement of contact resistance and timing.	
5.	Transformer (Dry Type)	
a	IR test on each winding to ground and between windings.	
b	Turns ratio test on each tap	
c	Polarity and vector group test	
d	Check insulators for cracks.	
e	Measurement of magnetizing current and no load loss.	
f	Measurement of PI value.	
g	Conducting magnetic balance test	
h	Checking of other points given in manufacturer's commissioning manuals.	
6.	LT Switchgear / PMCC / MCC	
a	IR test before and after HV test.	
b	HV test with 2.5 kV megger	





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c	Functional test for all feeders	
d	Testing and calibration of all meters.	
e	Checking and calibration of overload relays and protective relays as per supplier commissioning manuals.	
f	Check operation of contactors from local and remote points.	
g	Checking of interlocking between incomers / buscoupler and other feeders.	
h.	Test to prove interchangeability of similar parts.	
i	Tests to prove correct operation of breakers at minimum and maximum specified control voltages.	
j	Checking operation of RC circuit (if there) for tripping of circuit breaker after disappearance of control voltage.	
l	Checking of earthing connection for neutral earth bus, cable armour location of E/F CT etc., as per the scheme.	
m	Check test, services and draw-out position of all the breakers and operations of mechanical flag indicators and electrical indication lamps.	
n	Check functioning of various electrical schemes like auto-changeover signalling etc.	
o	Contact pressure test.	
p	Testing of CT as per CT testing details enclosed above	
q	Breaker	
7. PDB/ACDB / DCDB / MLDB etc		
a	IR test before and after HT test.	





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b	HV test by HV megger.	
c	Checking for functions of components for each module.	
d	Checking for interchangeability of similar components.	
e	Checking of tightness of earth connection.	
f	Testing and calibration of all indicating meters.	
g	Check output of each feeder after energisation.	
8	Non Segregated Phase Busduct	
a	IR measurement before and after HV test.	
b	HV test.	
c	Checking tightness of bolts with torque wrench.	
d	Checking for phase sequence marking.	
e	Check for clearances between phase to phase and phase to earth.	
f	Check for minor damages and cracks in supporting insulators and bushings after cleaning.	
g	Checking for inspection openings and accessibility for replacement of insulator etc.	
h	Check tightness of earthing connections on enclosure.	
i.	Checking of silicagel breather (if there).	
J	Checking of working of space heater.	
k	Milli volt drop test	





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9.	AC Motors (including slip rings motor)	
a	IR test of stator and rotor windings.	
b	Heating of both windings upto the permissible temp. limit from heating curve (only for HT motors).	
c	Ensure that checking / testing of associated switchboard, cables, relays / meter interlockings as mentioned in relevant chapters are completed.	
d	Check tightness of cable connection.	
e	Winding resistance measurement of stator and rotor.	
f	Checking continuity of winding.	
g	Check tightness of earth connections.	
h	Check space heaters and carryout heating of winding (if required).	
i.	Check direction of rotation in decoupled condition during kick start.	
j	Measure no load current for all phases.	
k	Measurement of temperature of body during No-load and load conditions.	
l	Check for tripping of motor from local / remote switches and from electrical / technological protection including differential protection.	
m	Checking of vibration (if required)	
n	Checking of noise level (if required).	
o	During load running, measurement of stator and bearing temperatures (if applicable) for every half an hour interval till saturation comes.	
p	Checking tightness of foundation bolts.	





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q	Check operation of speed switch (if there).	
r	Check continuity of temp. detectors.	
s	Check alignment, paralleling of shafts, level of lubricating oil etc. as per manufacturer's manual.	
t	Check contact of slip ring brush and measure brush pressure (150-200 gm/sq.cm).	
u	For CACW drive check cooling water and system / piping, availability of pressure cleaning and pressure testing of pipelines etc.	
v	Check for polarisation index of stator windings R10 / R1 by motorised megger. (The value should not be less than 2.0). R60/R10 absorption co-efficient shall not be less than 1.5	
w	Dielectric test (only for HT motors).	
X	Measurement of open circuit rotor winding voltage for slip ring motor.	
10	Motors (DC) If required	
a	IR measurement and heating the winding as per heating curve.	
b	Check for earth connection.	
c	Winding resistance for field and armature.	
d.	Check running of drive at minimum and maximum specified voltage.	
e	Check auto start of drive on failure of AC supply (if applicable).	
f	Check operation of overload relay.	





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g	Measure vibration.	
h	Check temperature rise on body of drive after required period of continuous running.	
i	Measure load currents and no load currents (if possible).	
j.	Check direction of rotation.	
k.	Check continuity of winding.	
l	Measurement of RPM.	
11	For actuator drives following shall be checked / tested.	
a	Visual and dimensional	
b	Hydraulic pressure for valves	
c	IR and operation of limit switches	
d	Winding resistance	
12	CRANE/HOIST	
a	Check IR of all drives, panels and other equipment	
b	Check & clean surface of shop leads(if there)	
C	Check earthing system and earthing of all metallic part	
d	Measurement of no load and load currents for all drives	
e	Observations on speed of hoisting/lowering for main and aux.hoists & brake.	
f	Measurement of deflection at full load and as per mechanical requirement at overload for main hoist.	
g	Checking for operations of all limit switches	





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h	Testing & calibration of indication meters	
i	Check condition of painting and arrange repainting (if required)	
J	Calibration of overload relays through secondary injection	
k	Checking tightness of panel junction boxes fixing arrangement	
l	Checking of contacts and operation of master controllers for all motions at all positions	
m	Checking of rotor resistance values at each steps.	
n	Checking of scheme and cable connections (control and power)	
13.	Cables & Cable Supporting Structures	
a	Checking of continuity / phasing and IR values for all the cables before and after HV test.	
b	HV test and measurement of leakage current after termination of cable kits (for HT cables).	
c	Checking of earth continuity for armour.	
d	Check for mechanical protection of cables.	
e	Check for identification (tag number system) distance placement of cable marker, cable joint etc. as per the cable layout drawing.	
f	Check earthing of cable structures.	
g	Check safe head room in gallery area.	
h	Check clearance from ventilation duct and light fittings for cable structures.	





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i	Check proper fixing of cable structures.	
j	Check for proper drainage and removal of water (if any).	
14	Battery & Battery Chargers	
a.	Checking for completion of civil / ventilation requirement of battery room	
b.	Checking of adequacy of charger output/ requirement wrt current required for battery charging as per the manual	
c.	Check availability of safety devices, water and first aid box.	
d.	Check polarity of connections between battery and charger	
e.	Visual inspection test for level and leakages	
f.	Checking of layout as per approval drawing	
g.	Checking of IR value from positive to earth and negative to earth.	
h.	Checking of voltage per cell and total voltage between positive negative and earth to positive / negative and also tap cell voltage (as applicable)	
i.	Checking of tightness of connectors on each cell	
j.	Checking of capacity test and hourly measurement of specific gravity and voltage for each cell.	
15.	Battery Charger	
a.	IR Test	
b.	HV Test	
c.	Checking voltage ratio of boost and float mode transformers	





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d.	Checking for charging mode of batteries constant current and constant voltage mode.	
e.	Load test on chargers by running of DC drives and by liquid resistance system.	
f.	Checking of tightness of earthing connections	
g.	Check for all alarm condition	
h.	Checking and calibration of all indicating meters	
i.	Check functional operation of charger, auto/manual change over from float to boost and boost to float etc.	
j.	Checking and setting of all relays	
k.	Check AC ripple in boost and float mode after charging	
l.	Check polarity of cables connected to battery.	
m.	Uninterruptable Power Supply	
n.	Visual check	
o.	IR value by megger	
p.	Current limit test	
q.	Ripple test	
r.	Supply variation	
s.	Functional test	
t.	Capacity test wrt time	
16	DG Set	
a	Measurement of the insulation resistance of the stator and rotor windings to the frame and between phases, and measurement of the polarization index and measurement of insulation resistance for RTDs.	
b.	Measurement of the DC resistance of all windings and embedded temperature detectors.	





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c.	High voltage test at 80% of previous high voltage test value	
d.	Measurement for the insulation resistance of bearings	
e.	Capacitance measurement and dissipation factor between the winding and body.	
f.	Rotor impedance measurement at standstill and at different speeds	
g.	Phase sequence & shaft voltage measurement	
h.	Open circuit and short circuit tests	
i.	Measurement of temperature rise at the rated load.	
j.	Performance capability of the machine	
k.	Operational tests on all interlocks protection & alarms	
l.	AMF Panel	
m.	Functional test	
n.	IR Tet	
o.	High Voltage Test	
17	Indoor Lighting	
a	Check dressing of cable.	
b	Measurement of lux level at various places.	
c	Check accessibility for replacement of lamps.	
d	Checking for black spots or poor visibility near operating and indicating equipments.	
e	Check for mechanical protection of cables.	
f	Checking for adequacy of emergency DC light.	





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g	Checking for starting system of periphery lighting.	
h	Check for auto switching of battery supply on failure of AC.	
i	Checking of earthing of light panel, socket boards light fittings.	
j	Checking of type of fittings wrt specification at various locations.	
k	Check adequacy of support of fittings.	
l	Check water tightness of outdoor located panels.	
18.	Outdoor Lighting System	
a	Check lux level of general lighting.	
b	Check for visibility of insulators, bushings and indicating instruments of transformers, breaker and isolator cabinets etc. during night.	
c	Check for adequacy of escape light during night after failure of general light.	
d	Check for proper painting of lighting supporting structures.	
e	Check for automatic switching of light	
f	Check for earthing connections on light fittings and other control accessories.	
g	Check for mechanical protection of cables.	
h	IR measurement of lighting cables.	
19.	Earthing	
a	Check tightness of all earth connections.	
b	Check earthing of all metallic equipments, cable trays, busbar	





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	supporting structures, building column (if steel all elect equipments, pipe lines etc. as per the drawing / specification)	
c	Measurement of earth resistance for each electrode.	
d	Measurement of total earth resistance.	
e	Measurement of earth loop resistance for E/F path of biggest LT drive.	
20.	Lightning Protection	
a	Check continuity of all the earth strips / shield wire.	
b	Check tightness of all connections.	
c	Measure earth resistance of each electrode and combined system.	
21	Miscellaneous	
a	Checking of continuity of the system.	
b	Checking of phase sequence from overhead line consumer end.	
c	Checking safe accessibility of all operating points	
d	Check availability of emergency lighting	
e	Check availability of control aux. supply.	
f	Ensure availability of first aid box, firefighting equipment, earth discharge rods, rubber mats, rubber glove.	
g	Check oil drainage system for transformer oil	
h	Check filling of gravels in transformer pits.	
i	Check working of ventilation system for battery room transformer room	





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j	Check for safe movement of operators control room / switchgear etc., wrt proper illumination, escape light uncovered openings provision of hand railings in stairs etc.	
k	Check proper covering of cable channels.	
l	Placement of shock treatment chart, danger boards provision of boards indicating 'Man on work' Do not switch ON' 'Do not switch OFF'. 'EARTHED' etc.	
m	Provision of route map at gallery entry points for indication of escape.	
n	Check proper dressing of cables, mechanical protection of cables, and placement of cable markers.	

NOTE:

Apart from the tests listed herein and also as mentioned elsewhere in the specification, if any other test (tests) is (are) necessary as per relevant standards, CBIP recommendations, Code of Practice, Manufacturer's recommendations etc., the same shall have to be carried out by the Bidder without any implication within the quoted price.





**Tender Specification
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**VOLUME: II-F
SECTION-XVIII
VARIABLE FREQUENCY DRIVE**



Development Consultants Pvt. Ltd.

**Vol. II-F/Section-XVIII
Variable Frequency Drive**



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VOLUME: IIF

SECTION-XVIII

VARIABLE FREQUENCY DRIVE

1.00.00 SPECIFIC REQUIREMENTS

Variable frequency drives shall be provided as per technological requirement. The following paragraphs define the requirements of variable speed drives.

- 1.01.00 One spare VFD panel similar in all respect to other VFD panels to be provided and erected for each unit. In case of major failure in any of the VFD panels, Power & Control Cables shall be removed from the defective VFD panel and connected to the spare VFD panel.

2.00.00 TECHNICAL PARTICULARS

System shall be load commutated inverter type, 12-pulse design, having two channels (each channel with six pulse design) for each motor. The VFD and accessories shall comply with the particulars as per the technical requirements specified in Data Sheet-A

3.00.00 CODES & STANDARDS

- 3.01.00 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS), IEC, ANSI & NEMA Standards except when otherwise stated herein or in the driven equipment specification.
- 3.02.00 Equipment and material conforming to any other standards, which ensure equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.
- 3.03.00 The electrical installation shall meet the requirements of Indian Electricity Rules as amended up-to-date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed

4.00.00 PERFORMANCE REQUIREMENTS

- 4.01.00 The system shall be energy efficient, designed as standard product and shall provide very high reliability, high power factor, low harmonic distortion and low vibration/wear/ noise.
- 4.02.00 The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the drive motor, with input supply variation of $\pm 10\%$ and frequency variation of $\pm 5\%$. It shall be capable of



withstanding the thermal and dynamic stresses and the transient mechanical torque, resulting from short circuit.

- 4.03.00 The drive system shall be designed to operate in one or more of the following operating modes as to suit characteristics of the driven equipment
- i) Variable torque changing as a function of speed i.e. speed squared
 - ii) Constant torque over a specific speed range
 - iii) Constant power over a specific speed range where the torque decreases when speed increases
- 4.04.00 The drive controller shall be equipped with microprocessor based digital regulator with programmable functions. The power control regulator logic shall provide for an acceleration/deceleration current limit curve and shall be capable of field be separately programmable from 0.1 to 20 seconds.
- 4.05.00 Each channel and motor rating shall be rated to meet driven equipment requirements. The system shall be designed for linear continuous speed control from required range of driven equipment rated speed and shall be of a modern proven design and fully compatible with excitation system offered.
- 4.06.00 The Total Harmonic Distortion (THD) of the voltage and current at inverter output shall be as per IEC 61800-4 and it shall be considered in the design of the motor.
- 4.07.00 Harmonics at the supply side of the drive system at primary of the main input transformer shall be restricted within the maximum allowable levels of current and voltage distortion as per recommendations in the latest edition of IEEE-519.
- 4.08.00 The overload capacity of the controller shall be 150% of rated current of motor for one minute for constant torque applications, and 115% of rated current for one minute for variable torque application at rated voltage. If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload. If the load demand exceeds the current limit for more than one (1) minute, the drive shall shut down to prevent overheating of the motor and damage to the drive.
- 4.09.00 During operation, the system shall be capable of developing sufficient torque under all load condition to respond to a 20% alteration in speed set point within a time limit up to 60 seconds
- 4.10.00 The integrator action of the speed set point alteration shall be independently adjustable for both an upward and downward alteration. The minimum time interval between set point adjustments by the distributed control system shall be considered as 10 second.
- 4.11.00 The drive shall trip in case the speed exceeds 105% of the maximum operational speed or reduces to 95% of the minimum operational speed for more than 10 second.



- 4.12.00 Maximum noise level from the drive at 1meter distance, under rated load with all normal cooling fans operating shall not exceed 85dBA.
- 4.13.00 Variable frequency drive shall be arranged so that it can be operated in a circuit mode, disconnected from the motor for startup adjustment and troubleshooting/ maintenance.
- 4.14.00 Voltage at motor neutral terminal shall be floating and neutral shall be insulated adequately for Load Commuted Inverter (LCI) operation.
- 4.15.00 The drive system shall ensure following
- a) Harmful VFD induced harmonics which can create motor heating are eliminated.
 - b) VFD induced torque pulsation are limited to maximum 1% (even at low speed) so there is minimal stress to the equipment
 - c) Motor is protected from dv/dt stresses.
 - d) No appreciable increase in motor audible noise.
- 4.16.00 Electrical performance of the system shall comply to IEEE, IEC and equivalent international standard

5.00.00 CONTROL REQUIREMENT

- 5.01.00 The system shall operate on constant V/f supply with required voltage boost capability in low frequency mode of operation.
- 5.02.00 Short time voltage dip up to 20% of nominal voltage (e.g. in case of a large motor start up connected to the same bus as VFD) shall not cause the control system to stop functioning and shall not trip the drive system.
- 5.03.00 The system shall also be equipped with a facility which will restart the system in case of voltage dip over 20% or power interrupter for less than 2 seconds, with recovery of the voltage to its normal value. The drive shall have the facility to block this feature, if required by operator. Upon restart the converter shall be capable of synchronizing onto a rotating motor and develop full acceleration torque within 10 seconds.
- 5.04.00 The power controller shall be controlled to always start the motor in the forward direction. Logic shall be provided to prevent the motor from being started in the reverse direction.
- 5.05.00 The drive motor shall be speed controlled corresponding to 4-20mA or 0-10V reference input signal. Unless otherwise specified, upon complete loss of the users speed reference signal, the drive shall automatically run at constant speed as at 8-100% of the last speed reference available prior to the loss of signal.



5.06.00 It shall be possible to vary the speed of the drive in either manual or auto mode.
Auto/manual selection shall be from VFD panel unless otherwise specified.

- With the selector switch in “manual” mode, the operator shall be able to set the speed through keypad, mounted on front of the drive panel or from speed increase/decrease push buttons from the field. Motor operated potentiometer shall be provided as a speed set point device.
- With selector switch in “auto” mode, speed of the motor shall be controlled from a 4-20mA signal, from owner’s PLC system. Necessary equipment like protocol converter as required for interfacing with PLC shall also be provided in the drive panel.

5.07.00 The required provision for the interface with remote PLC located at control room shall be either through hardwired connection (with potential free contacts and transducers as described elsewhere in this specification).

5.08.00 Drive system shall have provision for interface with upper level automation such as substation monitoring system or electrical control system.

5.09.00 The closed loop control feedback for the drive system having output transformer shall be tapped from the secondary side of the output transformer.

6.00.00 PANEL CONSTRUCTION

6.01.00 The panel shall include suitable semi conducting power devices (line commuted thyristors/Diodes/IGBT). Modules with protective devices, reactors (if required), filters (if required), control circuit, control accessories, indication and annunciation etc, the construction of the panel shall provide effective protection against electromagnetic emissions and shall meet design requirement of integrated standards

6.02.00 Upstream breaker “ON/OFF/TRIP” indications and remote breaker closing and trip push button shall be provided on the front door.

6.03.00 Safety Interlock shall be provided so that power cabinet can’t be opened unless the upstream breaker is disconnected, safety-grounding switch is closed and DC link capacitor is discharged. Power source breaker can only be closed once the earthing switch is open and panel door is closed with lock defeat facility.

6.04.00 Duplicate control supply with automatic changeover shall be provided. Protection shall be provided against AC/DC transients, voltage surge etc. of power and control device.

6.05.00 The drive shall be housed in sheet steel panels fabricated with 2mm thick cold rolled sheet steel. The panel shall be suitable for indoor installation, if not otherwise specified. The panel shall be free standing with degree of enclosure protection as IP-42. The maximum operating height shall be 1800mm approximately.



- 6.06.00 Bolted un-drilled gland plate shall be provided at bottom. Clamp type terminals shall be used for connection of all wires up to 10mm² and terminal for higher sizes shall be bolted type suitable for cable lugs. Minimum space for power cable termination shall be 600mm clear from bottom of the cable gland plate.
- 6.07.00 Bus bars shall be of electrolytic copper, color coded separately for AC and DC system. All the live parts shall be sleeved/ shrouded to ensure complete safety to personnel intending to carry out routine inspection by opening the panel doors. All the equipment inside the panel and on the doors shall be provided with suitable nameplate.
- 6.08.00 All the switches, component and accessories which are essential for normal and emergency operation shall be mounted on the door and shall be operable externally. All the analog instruments, where provided, shall be switchboard type, back connected; 72x72mm. Scale shall have red mark indicating maximum permissible operating rating.
- 6.09.00 Each panel shall be provided with illuminating lamp/11W CFL with switch and fuse. 6/16A, 240V power socket with switch and fuse shall be provided. Each panel shall have space heater with switch fuse and variable setting thermostat.
- 6.10.00 Copper earth bus of min. 50x6 mm size shall be provided in the panel with provision for connection to plant earth grid. All the non-metallic components/parts shall be connected to the main earth bus bar. Separate earth bus bar and stud for electronic control system as required shall be provided.
- 6.11.00 All the metal parts shall be treated so as to ensure efficient anti-corrosive protection. Hard wares shall be zinc passivated or electrogalvanised. Panel enclosure and structure supports shall be thoroughly cleaned and degreased to remove mill scale and rust etc. External surface shall be painted RAL – 5015 with two coats of synthetic enamel paint.
- 6.12.00 All panels shall be of same height so as to form a uniform line-up, to give good aesthetic appearance.
- 6.13.00 All the control wiring shall be enclosed in plastic/metal channel. Each wire shall be identified at both ends by self-sticking wire marker tapes of PVC ferrules. Power and control wiring inside the panel shall be done with BIS approved, PVC insulated, fire retardant, copper conductor wire. 1.5mm² size wire shall normally be used provided the control fuse rating is 10 Amps or less and 2.5mm² size for control fuse rating above 16A for electrical circuits and 0.7 mm² for electronic circuits. All wires shall be ferruled and terminals shall be properly numbered, minimum 20% spare terminal shall be provided.
- 6.14.00 All electronic modules and components shall be accessible from front of panel only. Modular assemblies for both the system control electronic equipment and power electronic equipment shall be used.
- 6.15.00 All low voltage compartment and cabling shall be electrically and physically separated from the high voltage compartment.



6.16.00DC link capacitor and pre charging and discharging circuit shall be preferably mounted in the rear of the panel.

6.17.00Suitable removable type hooks shall be provided for lifting the panel.

6.18.00Perspex type transparent insulating material shall be used for covering live compartments.

6.19.00Drive keypad, operator control panel required for control, monitoring and measurements shall be supplied and installed outside the panel on the front door. It shall be accessible for operation without opening the front door and shall be non-removable type.

6.20.00All the equipment shall be complete with cable glands, lugs etc. and cable glands shall be single or double compression type for indoor and outdoor equipment respectively.

7.00.00 COOLING

7.01.00The drive panel shall be naturally cooled type as per manufacturer's standards. If unavoidable, forced type cooling system shall be provided. Cooling system shall include well-dimensioned panel, adequate cooling airflow path, module cooling fan and if necessary, panel-cooling fan shall be considered. Vendor shall ensure that the panel dimensions and the flow paths have been designed for continuous running at the specified ambient without overheating. For fan cooled drives, redundant ventilating fans (N+1) shall be provided.

7.02.00Necessary starters shall be provided within the VFD panels for the ventilation fans, any other auxiliary motor etc. The system provided shall be interfaced with drive starting and shut down such that safety interlocks such as start permit from cooling system to drive and trip signal from cooling system to drive in case of cooling system failure etc., shall be incorporated in the overall sequence logic.

7.03.00MCB for motor space heater, auxiliary power supply if required for local panel, drive panel space etc. shall be included and mounted in easy accessible location.

8.00.00 EQUIPMENT/COMPONENT SPECIFICATION

8.01.00Motor

- i) The motor shall be suitable for operation with a solid-state power supply consisting of an adjustable frequency inverter for speed control.
- ii) The motor shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.
- iii) The Motor shall be designed to operate continuously at any speed over the range 20-100 % of rated speed.



- iv) The permitted voltage variation should take into account the steady state voltage drop across the AC drive and all other system components upstream of the motor.
- v) Motors required to be transferred to DOL, by-pass mode shall be rated for specified variations in system line voltage and frequency. Starting current of motor in DOL, bypass mode shall be limited to value in motor specifications.
- vi) The motor shall be constructed to withstand torque pulsations resulting from harmonics generated by the solid-state power supply.
- vii) The motor insulation shall be designed to accept the applied voltage waveform, within the V_{peak} and dv/dt limits as per IEC-61800-4.
- viii) The drive manufacturer shall be solely responsible for proper selection of the motor for the given load application and the output characteristics of the drive.

Other details shall be as given in specification of Electric motors, Volume-IIF, Section-II.

8.02.00 POWER TRANSFORMER

Indoor dry type/Outdoor ONAN type, and shall be suitable for rating complying with system details. Other details as given in sub-section of LT Transformer Specification, Volume-IIF.

08.03.00 POWER CONVERTER

- i) The static power shall consist of a line side power converter for operation as a rectifier and a load side power converter for operation as a fully controlled inverter. Power converter shall be fast switching, most efficient and low loss type.
- ii) Adequate short circuit and over voltage protection shall be provided for the converter and inverter system.
- iii) All power converter devices shall include protective devices, snubber networks and dv/dt networks as required.
- iv) The current rating of the converter's semi-conductor components shall not be less than 120% of the nominal current flowing through the elements at full load of the VFD through the whole speed range.
- v) All power diodes shall be of silicon type with minimum V_{bo} rating as 2.5 times the rated operating voltage.
- vi) The power converter circuit shall be designed so that motor can be powered at its full nameplate rating continuously without exceeding its

rated temperature rise due to harmonic currents generated by the inverter operation.

- vii) The conversion devices and associated heat sinks shall be assembled such that individual devices can be replaced without requiring the use of any special precautions/tools.
- viii) The cooling system of the electronic components, if provided, shall be monitored and necessary alarms shall be provided to prevent any consequential damage to the power control devices.
- ix) Offered system shall also take in account the distance between drive panel and motor and system shall include all material and accessories to make system suitable for a distance of 350m.

8.04.00 **DC LINK REACTOR**

- i) Smoothing reactors for the DC link shall be designed to sufficiently decouple the rectifier and inverter portion of the converter and to limit fault currents in this circuit.
- ii) Reactor shall be air-core type, natural cooling and housed in a separate enclosure in ventilated room
- iii) Reactor shall be suitable for withstanding earth fault continuously and for operation with the non-sinusoidal current wave shapes and DC components under all operational conditions of the system without exceeding its temperature limits.
- iv) Noise level shall not exceed value specified in NEMA TR-1

8.05.00 **OUTPUT FILTER**

VFD output current waveform should be inherently sinusoidal at all speeds, with harmonic limits as specified in this specification. Output filter shall be provided if required. Output filter capacitors shall be provided with discharge circuits to ensure that all residual stored charge is reduced to less than 50 V DC within 300 seconds after a loss of AC voltage. All capacitor shall be maintenance free and self-healing type.

The VFD system shall inherently protect motor from high voltage dv/dt stress, independent of cable length to motor. Output filter shall be an integral part of the VFD system and included within the VFD enclosure.

8.06.00 **BYPASS FEATURE**

- i) Bypass breaker / contactor-HRC fuse complete with protection, annunciation and metering shall be provided.
- ii) All Variable frequency drives (VFD) having bypass feature shall have motor protection relay along with necessary control and metering etc.



Switching scheme shall be such that in case of drive mal-operation, the motor could be taken on bypass control manually, while the drive could be attended by opening its isolation devices.

- iii) Safety interlock between inverter and bypass breaker/contactors shall be provided such that closing of healthy device is inhibited in case of external fault.

8.07.00 **CT/PT/METERS**

As required for the system offered and shall be suitable for variable frequency operation.

8.08.00 **LOCAL MOTOR CONTROL STATION**

- i) The local motor control station is to be installed in the field near the motor. Components and accessories that are required in the local motor control station may be mounted on the local field mounted panel envisaged for the driven equipment.
- ii) Meters in the local control station shall be suitable for 4-20mA transducer outputs and shall be calibrated for the actual motor current. Further, the drives with bypass facility, the meters shall be capable of reading bypass full load and starting currents, as well as the drive current.

09.00.00 **PROTECTION, CONTROL, METERING, INDICATION AND ANNUNCIATION**

09.01.00 The system vendor shall provide all the necessary system control, protection; alarm equipment and metering for the entire drive system and its auxiliary equipment.

09.02.00 Automatic sequence control shall include start-up of cooling system, auxiliary system of the motor, interlock checking, automatic start and run-up of drive, planned and emergency shutdown. The same shall be processed through microprocessor-based system.

09.03.00 **OPERATOR CONTROL PANEL**

- i) Each drive shall be equipped with a front mounted operator control panel consisting of a backlit alphanumeric display and a keypad with keys for parameterization and adjusting parameter which shall be limited to Start/Stop, Local/Remote, Auto/Manual, Increase/Decrease, menu navigation and protection and measurement parameter selection, etc. Also local operation during maintenance should be possible & the same shall be provided inside the panel.
- ii) All parameter names, fault messages, warnings and other information shall be displayed in complete English words or standard English abbreviations to allow the user to understand what is being displayed

without the use of a manual or cross-reference table. This shall also be used for the modification of all electrical values, configuration parameters, drive menu parameters, application and activity function access, faults, local control, adjustment storage, self-test and diagnostics. Keypad shall be operable with password for changing the protection setting, safety interlock etc. However the parameters such as measurements, setting, and mode of drive etc. Shall be allowed to be viewed without any password.

- iii) Operator console shall have facility / port to connect external hardware such as Lap-Top etc. Console shall have facility for upload and download of all parameter settings from one drive to another identical drive for startup and operation.
- iv) Drive system control also have facility to receive tripping signal from upstream breaker for tripping and also provision for closing upstream breaker after all required process parameters are achieved.
- v) User-friendly software for operation and fault diagnostic shall be loaded in the drive system panel before commissioning.

09.04.00**PROTECTIVE FEATURES**

The system offered shall incorporate adequate features, properly coordinated for the drive control and for motor but not limited to the following:

- i) Incoming line surge protection.
- ii) Under / Over voltage protection.
- iii) Phase loss, phase reversal protection.
- iv) Programmable Over current Protection and under load protection.
- v) Inverter fault.
- vi) Over frequency operation.
- vii) Ventilation loss.
- viii) Over temperature of equipment.
- ix) Over speed of motor.
- x) Specific motor protection, including motor winding, bearing temperatures, over current, Overload, negative phase sequence, locked rotor and earth fault protections etc.
- xi) System Earth fault protection.
- xii) Over and under frequency, rotor earth fault, field failure protection for synchronous motor

- xiii) Additional protection for drive system

09.05.00 **CONTROL**

The following controls shall be provided as a part of the operators control Panel or through separate switches.

- i) Start/Stop
- ii) Speed Control (Raise/lower)
- iii) Auto/Manual/Test mode
- iv) Local/Remote
- v) Emergency Stop
- vi) Start/Stop for by pass starter (where specified)
- vii) Trip-Remote Breaker
- viii) Sequential switching of filters

09.06.00 **INDICATORS**

Vendor shall provide indications as required for normal operation and for easy maintenance, which shall be limited to the following indications:

- i) Motor running
- ii) Motor stopped
- iii) VFD System Fault
- iv) System ready to start
- v) AC mains ON
- vi) Motor over speed
- vii) Rectifier output 'ON'
- viii) Motor zero speed
- ix) Rectifier breaker trip

Above indications may be provided as a part of the operator control panel, i.e., door mounted keypad or through hardwired indicating lamps/LEDS.

Potential free contacts of items i-iv shall be wired separately for remote indications in PLC/DCS system.

09.07.00 **METERING**

Digital display of the following parameters shall be as a part of the Operator Control Panel, selected by the operator.

- i) Input AC voltage
- ii) Input AC frequency
- iii) Input AC current
- iv) Output voltage
- v) Output current VFD / Bypass
- vi) Output frequency
- vii) Motor thermal state
- viii) Drive thermal state
- ix) Motor speed
- x) Motor energy meter
- xi) DC Link voltage
- xii) Hour Run

Necessary transducer shall be provided with 4-20mA output for indicating motor speed and motor current in PLC/DCS unless otherwise specified for other parameters.

09.08.00 **AUDIO-VISUAL ANNUNCIATIONS**

- i) The system shall incorporate audio-visual annunciations for protection, for various fault conditions, for the Drive motor, Supply cables, DC Reactor and the Converter, output transformer etc.
- ii) Alarms shall also be included for the failure of various auxiliaries together with identifications of the failing unit, loss of cooling system, various protections devices provided for converter transformer etc.
- iii) Audio-visual window annunciations shall be provided on the front of the panel. All annunciations as required for normal and satisfactorily operation of the drive system shall be included as per vendor standards. These annunciations can be part of operator console panel or separately mounted type.



- iv) Vendor shall include audio-visual alarm as required for normal operations and maintenance of the system but not limited to the following :
1. Rectifier fuse failure
 2. Main AC failure
 3. Inverter fuse failure
 4. Inverter overload
 5. Inverter high temperature
 6. Cooling system failure
 7. Motor failed to start
 8. Transformer failure
 9. Battery monitoring healthiness
 10. Communication and measurement system unhealthy
 11. Motor temperature high
 12. Harmonic filters monitoring

Common potential free contacts shall be provided for above annunciations and these shall be wired up to terminal block for owner's use for remote alarm and monitoring.

09.09.00 FAULT DIAGNOSTIC

Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including shut down of the system shall be available for a period of minimum 4 days (96 hours) after a shut down even though no supply would be available to the system. The system may be totally de-energized for maintenance or otherwise. It shall be possible to retrieve the record of events prior to tripping of the system or de-energisation. Auxiliary supply to the system components or to the electronics (firmware) for the diagnostics / display shall be taken care by the manufacturer for this purpose.

10.00.00 EXTERNAL POWER SUPPLY FOR AUXILIARY AND CONTROL CIRCUIT

Auxiliary power supply for devices external to VFD module, space heater supply for Motor, VFD panel space heater, auxiliary power supply for transformers, cubicle 11W CFL lamps etc. shall operate on 240 volts single phase AC provided by purchaser.

All control circuit shall operate at maximum voltage of 240V AC



Vendor shall include supply of all control transformers, protective devices, required accessories etc. and any other control supply voltage as required for the system shall be derived from the power supply made available by other.

11.00.00 PAINTING

- 11.01.00 All metal surfaces shall be thoroughly cleaned and de-greased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under-surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. The under-surface shall be made free from all imperfections before undertaking the finishing coat.
- 11.02.00 After preparation of the under surface, the panel shall be provided with epoxy based powder coating. Panel finish shall be free from imperfections like pinholes, orange peels, runoff painted.
- 11.03.00 All unpainted steel parts shall be zinc passivated, cadmium plated or suitably treated to prevent rust and corrosion. If these parts are moving elements, then these shall be greased.
- 11.04.00 Final paint shade shall be RAL - 5015

12.00.00 INSPECTION, TESTING AND ACCEPTANCE

- 12.01.00 During fabrication, the drive shall be subject to inspection by owner, or by an agency authorized by the owner, to assess the progress of work, as well as to ascertain that only quality raw material is used. The manufacturer shall furnish all necessary information concerning the supply to owner's inspectors.
- 12.02.00 All tests shall be carried out at the manufacturer's works under his care and expense. The tests shall be witnessed by an inspector of the owner or an agency authorized by the owner. Prior notice of minimum of 4 weeks shall be given to the inspector for witnessing the test.
- 12.03.00 The routine test shall be conducted on all the drive system. However type test shall be performed on one system of each rating and type unless otherwise agreed between purchaser and manufacturer. For the purpose of testing, drive system shall include input/output transformer (where applicable), switchgears, converter, filters etc.
- 12.04.00 The routine and type tests to be performed on the drive system shall be as follows :

Routine Tests

- a. **Visual Inspection**

It involves checking of the various equipment/components fault diagnostic unit, wiring, terminals, earthing ratings etc, in line with the approved drawings and visual inspection shall not be limited to the following;

- i) Dimensions and door layout Vis-à-vis the approved drawings
 - ii) Degree of protection of cubicles
 - iii) Simulation facility of control signals for testing purposes
 - iv) Memory function of fault diagnostic
 - v) Voltage/Current rating power semiconductor elements
 - vi) Cable termination size and number of terminals, cable-supporting etc.
 - vii) Accessibility of components
 - viii) External signals and indication/alarm signals on converter
 - ix) Earthing of cubicles and cubicle doors
- b. Insulation Test
 - c. Light load and functional test
 - d. Load characteristics test
 - e. Load duty test
 - f. Checking of Auxiliary devices
 - g. Checking the properties of the control equipment
 - h. Checking the protective devices
 - i. Checking of control and functional requirements
 - j. High voltage test
 - k. Shaft current/bearing insulation
 - l. Automatic restart/re-acceleration

Type Tests

- a. Allowable full load current versus speed
- b. Efficiency
- c. Temperature rise



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- d. EM Immunity
- e. EM Emission
- f. Current sharing
- g. Voltage division
- h. Line side current distortion content
- i. Power factor
- j. Audible noise
- k. Torque pulsation
- l. Motor vibration
- m. Dynamic performance
- n. Current limit and current loop test
- o. Speed loop test capability to ride through voltage less than 80%
- p. Test capability to restart the system and resynchronize converter onto running motor after a voltage interruption

Type test certificate (not older than 5 years from date of contract) from independent testing agency for similar equipment can be accepted for d, e, f, j, k and l.

13.00.00 DATA SHEET-A

Sl. No.	Description	Unit	Specification Requirement
1.0	Type of drive		Inverter (IGBT based PWM controlled) AC drives
2.0	Manufacturer		*
3.0	Application		Fans/Pumps
4.0	Type of Motor/Model No. of the VFD		VFD shall be considered as per the technological requirement
5.0	Rating of drive	kW	Squirrel cage induction motor
6.0	Quantity		*
7.0	Rated power factor		*
8.0	Efficiency		*
9.0	Rated output voltage	kV	*
10.0	Full load current	kA	*
11.0	Type of duty		a)100% continuous b) 150% overload for 1 minute in





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Sl. No.	Description	Unit	Specification Requirement
			24 hours
12.0	Quadrants of operation		*
13.0	Full wave rectification		12 pulse
15.0	Power supply system		
	a) Input power supply		415V, 3 ph, 50Hz
	b) Variation in voltage		+10%
	c) Variation in frequency		+5%
	d) Combined voltage & frequency variations		10%
	e) System fault level	kA	50 kA 1 sec
	f) Type of earthing		Solidly earthed
15.0	Location		Indoor
16.0	Type of cooling		*
17.0	Input and output cables		
	a) Size & type		*
	b) Entry		Bottom
18.0	Dimensions		*
19.0	Degree of protection		IP42
20.0	Power loss ride through time	Sec.	2
21.0	Control characteristics		
	a) Control Method		Drive level control using digital system.
	b) Output freq. range		*
	c) Frequency accuracy		0.01%
	d) Frequency resolution	Hz	0.001
	e) Speed regulation		0.5% of max. speed
	f) Speed range		*
	g) Accelerate/decelerate time		*
	Harmonic limitations		
22.0	I) Voltage harmonics		
	a) Source side		Maximum 5%
	b) Load side		Maximum 5%
	II) Current Harmonics		
	a) Source side		
23.0	i) 5 th		Maximum 30%
	ii) 7 th		Maximum 20%
	iii) 11 th		Maximum 10%
25.0	Miscellaneous		
	a) Soft-start		Yes
	b) Flying restart		Yes
	c) Auto restart		Yes
25.0	Kinetic buffering		Yes (Preferably for a backup time of 2 sec.)
Note	** indicated above shall be filled by the Contractor		
	*** Contractor shall furnish the data after placement of order		



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VOLUME: II-F
SECTION - XIX
STATION TRANSFORMER



Development Consultants Pvt. Ltd.

**Vol. II-F/Section-XIX
Station Transformer**



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VOLUME: II-F
SECTION-XIX
STATION TRANSFORMER

1.00.00 SCOPE OF SUPPLY

1.01.00 220 / 11.5 / 11.5/ 11KV, 63 / 31.5 / 31.5 MVA FGD Station Transformer : One (1) No.

MVA rating of station transformer, as indicated above, shall be considered as the minimum requirement for the project.

Station Transformer offered by the bidder shall be sized according to the maximum demand at most stringent condition plus minimum 10 % margin. Bidder shall furnish sizing calculation for owners/consultant review/ approval.

Capitalization cost of ST shall be determined as per Volume-I.

1.01.01 Specification shall be same as the existing Station Transformers. (Name Plate details of existing transformer is attached as Annexure-F)

Sl.No	Item Description	Qty	Unit
01	FGD POWER TRANSFORMER 50/63 MVA, 220 KV/11.5/11.5/11 KV, 3 phase, 4 winding, Z=12.5%, ONAN / ONAF, outdoor, YNyn0yn0d11, with –10% to +10% On-load tap changer in step of 1.25%, HV bushing suitable for ACSR conductors, LV air insulated cable end box with disconnect chamber, HV Neutral with porcelain bushing, LVN air insulated cable box with disconnecting chamber, tertiary bushings suitable for open delta formation and delta corner earthing, Marshalling box cum Cooling Control panel, hydraulic jacks, double compression brass cable glands and tinned copper lugs, and other accessories as per enclosed specification including 10% spare oil.	1	Nos.
02	Neutral Grounding Resistor 16.6 ohms, 400 A (30 Sec) Neutral grounding resistor comprising of Feral grids in min. 3mm thick sheet steel enclosure in IP55 construction, on one meter high GI fabricated steel mounting structure, suitable for outdoor installation, as per specification, for 11 KV system neutral earthing. Each NGR shall be provided with 1 no. single pole. manually operated 400A, 11 kV isolator for NGR isolation in a segregated/partitioned compartment as part of the NGR enclosure	2	Nos
03	Earthing of transformers, NGR and interconnection to earthing main mat for Transformer yard.	Lot	1
04	Power & Control Cables	Lot	1



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05	11kV kV cables	Lot	1
06	Cable trays and accessories	Lot	1
07	Mandatory Spares-Item wise	Lot	1
08	Civil works	Lot	1

1.02.00 Each transformer shall be furnished complete with:-

- a. OLTC & RTCC
- b. Fittings and accessories
- c. Cooling & Auxiliary equipment
- d. First filling of oil (including 10% extra in non-returnable drums)
- e. Protection & metering devices

1.03.00 On-line dissolve gas monitoring system as per Annexure-E

1.04.00 Remote Tap Changing Control Panel (as per Annexure-F)

1.05.00 Mandatory Spares (as per Annexure-G)

1.06.00 All relevant drawings, data and instruction manuals.

Any equipment/items though not specifically mentioned above but which are required to make the transformers complete in all respects for their safe, efficient, reliable and trouble free operation shall be supplied by the Contractor, unless they are specifically excluded elsewhere in this specification.

1.07.00 Civil works like transformer foundations, fire protection walls, transformer oil pits etc.

1.08.00 The existing rail road from ICT to be connected to FGD 63MVA Transformer for future movement of Transformer to repair bay.

2.00.00 CODES AND STANDARDS

2.01.00 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.

2.02.00 Equipment and material conforming to any other standard which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

2.03.00 The electrical installation shall meet the requirements of Indian Electricity Rules as amended upto date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.





3.00.00 DESIGN CRITERIA

3.01.00 The transformer will be used to supply power to FGD and RO plant loads. The high voltage winding will be connected to the 220kV Switchyard. The low voltage windings will be connected to the 11kV FGD Switchgears.

3.02.00 The transformer will be installed in hot, humid and tropical atmosphere. All equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.

3.03.00 The transformer shall be capable of continuous operation at rated output under the following condition:

- a. Voltage variation : $\pm 10\%$
- b. Frequency variation : + 3% to -5%
- c. Combined voltage and frequency variation absolute sum) : 10%

3.04.00 The transformer shall be capable of withstanding the short circuit stresses due to a terminal fault on one winding with full voltage maintained on the other winding for minimum period of two (2) seconds.

3.05.00 The transformer shall be free from annoying hum or vibration. The design shall be such as not to cause any undesirable interference with radio or communication circuits.

3.06.00 The noise level shall be limited to the value specified by NEMA Standard Publication No. TR-1-1993 when measured in accordance with conditions outlines in ANSI/IEEE C57.12.90-1999/IS13964/CBIP publication.

3.07.00 The transformer design shall be such that transformer cooling performance is not affected by its proximity to firewalls, building walls and other transformers.

3.08.00 Harmonics

The transformer will be designed with particular attention to the suppression of harmonics, especially the third and fifth.

3.09.00 Magnetic circuit

3.09.01 The Transformer cores will be 3 limbed core type, constructed from high grade, low loss, high permeability, cold rolled non-ageing grain oriented silicon steel laminations. Thickness of laminations will be 0.3 mm or less.

3.09.02 The coils will be manufactured from electrolytic copper conductor of suitable grade and fully insulated for rated voltage. Insulation will be of Class A. The coils will be so designed to ensure uniform current distribution and minimum loss.



- 3.09.03 Surface insulation of laminations will be rust resistant and have high inter-laminar resistance. Insulation will withstand annealing temperature as high as 850 degrees centigrade. The insulation will be resistant to the action of hot oil.
- 3.09.04 The insulation structure for the core to bolts and core to clamp plates will be such as to withstand a voltage of 2000V AC for one minute. The completed core and coil assembly of core type units will be so assembled that the axis and the plane of the outer surface of the coil stack will not deviate from the vertical plane by more than 25 mm.
- 3.09.05 Whenever the CRGO sheets are punched or sheared into laminations, laminations will be annealed in a non-oxidizing atmosphere to relieve stresses and restore the original magnetic properties of CRGO sheets. The laminations will be free of all burrs and sharp projections.
- 3.09.06 The design of magnetic circuit will be such as to avoid static discharges, development of short circuit paths with in itself or to the earthed clamping structure and production of flux components at right angles to the plane of the laminations which may cause local heating.
- 3.09.07 Oil ducts will be provided where necessary to ensure adequate cooling. The winding structure and major insulation will not obstruct the free flow of oil in such ducts.
- 3.09.08 All steel sections used for supporting the core will be hot or sand blasted after Fabrication.
- Flanges to be shorted with copper or steel plate to avoid eddy current passage through bolts.
- 3.09.09 The finally assembled core and coil assembly will be rigidly fixed to the tank to avoid shifting during transport, handling and short circuits. Adequate provision will be made for lifting the complete core and coil assembly.
- 3.09.10 The supporting framework of the cores will be so designed as to avoid the presence of pockets, which prevent complete emptying of the tank through the drain valve, or cause trapping of air during filling.
- 3.10.00 **Windings**
- 3.10.01 Transformer will be suitable for earthed, isolated / non- effectively earthed neutral system as specified.
- 3.10.02 All insulating material will be of proven design.
- 3.10.03 Coil will be so insulated that impulse, switching and power frequency Voltage stresses are minimum. Insulation levels conform to relevant standards.
- 3.10.04 The coil clamping arrangement and the finished dimensions of any oil ducts will be such as not impede the free circulation of oil through the ducts.





- 3.10.05 The windings and connections of all transformer will be braced to withstand shocks which may occur during transport or due to short circuits, repeated peak loads and other transient conditions during service.
- 3.10.06 Windings will be subjected to a shrinkage treatment before final assembly, so that no further shrinkage occurs during service. Adjustable device will be provided for taking up any possible shrinkage of coils in service.
- 3.10.07 The conductors will be transposed at sufficient intervals in order to minimise eddy currents and equalise the distribution of currents and temperature along the windings.
- 3.10.08 Coil clamping rings will be of steel or of suitable insulating material. Axially laminated material other than Bakelite paper will not be used.
- 3.10.09 Completed core and winding assembly will be dried in full vacuum to eliminate presence of moisture. After drying process, the full assembly will be impregnated with oil immediately.
- 3.10.10 No strip conductor wound on edge will have a width exceeding six times its thickness.
- 3.10.11 The winding material will be copper.
- 3.10.12 Windings will not have sharp bends, which might damage insulation and/or produce dielectric stresses.
- 3.10.13 Coil will be supported using dried and high-pressure compressed wedge type insulation spacers at frequent intervals.
- 3.10.14 All insulating materials used will be compatible with transformer oil, under all service conditions.
- 3.10.15 For FGD transformer, the winding of each phase of the LV & tertiary windings will be brought out to the terminal chamber.
- 3.10.16 All threaded connections will be locked. Leads from the winding to the terminal board and bushings will be rigidly supported to prevent injury during short circuits/vibration.
- 3.10.17 Permanent current carrying joints in the windings and leads will be welded or brazed.
- 3.10.18 Clamping bolts for current carrying parts inside the transformer will be compatible with oil under all service conditions.
- 3.11.00 **Stabilizing winding**

Delta connected, stabilizing winding where specified will be designed considering the following;

- 3.11.01 Max fault current likely to flow in stabilizing winding, due to various external faults likely to occur in service.
- 3.11.02 For calculating the fault current in the stabilizing winding, solidly earthed system will be considered, even if resistance/reactance earthed system is envisaged.
- 3.11.03 Short circuit withstand capability will be as applicable to the complete transformer. Max. fault current as applicable to the stabilizing winding design will be considered for this purpose.
- 3.11.04 Delta connection of stabilizing winding will be closed externally through a copper link of adequate cross section. Delta ends will be brought out through fully insulated outdoor bushing or as specified. One corner of the delta winding will be earthed.

3.12.00 **Connectivity of Existing 220KV (207Bay) Protection panel:**

The relay panel in 207 bay of GIS shall be modified to suit the Power Transformer. The following relays and modification to be made and a set of mandatory spare relays to be provided.

1. Voltage selection relay 75A- TYPE: MVAJM14 D1EB1032A
Make: AREVA
2. Voltage selection relay 75B- TYPE: MVAJM14 D1EB1032A
Make: AREVA
3. Main differential protection, HV REF, HV Over flux protection 87T/64R/99 (make: SIEMENS model- 7UT613)
4. Siemens make TMU relay for Tap changer operation and monitoring (make: SIEMENS)
5. Transformer Trouble Trip relay 30AB- TYPE: MVAAM21
Make AREVA
6. Transformer Trouble Trip relay 30CD- TYPE: MVAAM21
Make AREVA
7. Transformer Trouble Trip relay 30EF- TYPE: MVAAM21
Make AREVA.
8. Transformer Trouble Trip relay 30GH- TYPE: MVAAM21
Make AREVA.
9. HV O/C & E/F Protection 50/51N-Make SIEMENS Model: 7SJ80



10. 64R/51N-LV1 REF Protection Relay with stand by E/F Protection-Make: SIEMENS Model: 7SJ80
11. 64R/51NLV 2 REF Protection Relay with stand by E/F Protection-Make: SIEMENS Model: 7SJ80
12. Test Terminal Blocks for all Relays
13. Relay configuration with existing SIEMENS SCADA substation Automation System
14. Required wiring between existing 400/220KV GIS switch yard system relay and LCC panels RA, RB panels at switchyard control SCADA control room to LCC panel at 207 bay is fully in contractor's scope.
15. Required configuration required for existing SCADA system and relays, BCU with M/s. SIEMENS SCADA network and relays is fully in contractor's scope. The Operation and real time monitoring of FGD 207 Bay is to meet out the all the required parameter already existing in 220 KV Transformer feeder to be configured in 207 Bay IEDs and communicated with existing SCADA.

4.00.00 SPECIFIC REQUIREMENTS

4.01.00 Tanks

- 4.01.01 The tank shall be fabricated from good commercial grade low carbon steel of adequate thickness. Transformer tank shall be conventional type only. 2 stage Rapid pressure rise relay outside tank shall be provided with Alarm & Trip Indication.
- 4.01.02 The tank wall shall be reinforced by stiffener to ensure rigidity so that it can withstand without any deformation (a) mechanical shock during transportation, (b) oil filling by vacuum, c) Short circuit forces and (d) continuous internal pressure of 35 kN/m² over normal hydrostatic pressure of oil.
- 4.01.03 All removable covers shall be provided with weatherproof, hot oil resistant, resilient gaskets. The design shall be such as to prevent any ingress of water into or oil from the tank.
- 4.01.04 The tank shall be provided with one set of bi-directional flanged wheels for rolling the transformer parallel to either center line over 1676 mm rail gauge. In case more than two rails are required to be provided the rail gauge of 1676 mm shall be maintained between two adjacent rails. Suitable locking arrangement shall be provided for the wheels to prevent accidental movement of transformer.
- 4.01.05 Jacking pads, lifting eyes and pulling lugs shall be provided to facilitate movement of the transformer. All heavy removal parts shall be provided with eye bolt for ease of handling.



- 4.01.06 Manholes/hand-holes of sufficient size shall be provided for access to leads, windings, bottom terminals of bushings and taps.
- 4.01.07 Suitable guide shall be provided in the tank for positioning the core and coil assembly.
- 4.02.00 **Not Used**
- 4.03.00 **Tappings / Tap switch**
- 4.03.01 Tappings as specified in the annexure will be provided on the higher voltage winding of each transformer and will be arranged so as to maintain as far as possible the electromagnetic balance of the windings
- 4.03.02 The transformer shall be capable of operation at its rated MVA on any tap provided the voltage does not vary by more than $\pm 10\%$ of the rated voltage corresponding to the tap.
- 4.03.03 The winding including the tapping arrangement shall be designed to maintain electromagnetic balance between HV and LV windings at all voltage ratios.
- 4.03.04 Separate Conservator with Oil Temperature and Oil Surge Relay with contacts shall be considered for OLTC.
- 4.04.00 **On-Load Tap Changer (OLTC)**
- 4.04.01 Transformer with motor driven on load tap changer will be provided as per design criteria. The OLTC switch contacts shall be located in a separate oil-filled chamber complete with its own oil preservation system, Oil Surge relay, shut-off valves, oil level gauge, gas vent, drain valve with plug, oil sampling device, inspection window with view glass etc. The transformer design shall permit inspection and maintenance of the tap changer without unloading the transformer.
- 4.04.02 OLTC mechanism and associated controls will be housed in an outdoor weatherproof cabinet conforming to IP55 class of enclosure protection. The finish will match with that of the transformer on which it is mounted. Internal illumination lamp and thermostat-controlled space heater will be provided in the cabinet.
- 4.04.03 The tap change equipment shall be so designed that if the mechanism is stuck in an intermediate position, the transformer shall be capable of delivering full load without any injury.
- 4.04.04 The OLTC gear shall be suitable for local and remote electrical control and local manual control. Necessary step position indicating instruments or equipment for local indication and for remote indication including transducers shall be provided. Further, there shall be provision of automatic operation through voltage sensing relay wherever specified.



4.04.05 The hand cranking arrangement shall be such that it can be operated at standing height from ground level. Further the mechanism shall be provided with a tap position indicator and an operation counter.

4.04.06 **Control Features**

On load tap changer will be provided with the following controls:

- Local hand operation
- Local manual electrical operation
- Remote auto/manual electrical operation through SAS based on IEC 61850 protocol

4.04.07 **Operational Requirements**

- a) Tap changers will be suitable for bi-directional power flow.
- b) Where specified, tap changer will be suitable for parallel operation of Transformers. It will have independent / parallel operation and auto/manual modes of control.
- c) Once a switching sequence has started, it will always be completed. Even in case of failure of control / auxiliary power supply moving contacts of tap changer will not stop in an intermediate position.
- d) The tap changing equipment will be so designed that if the mechanism is struck in an intermediate position, the transformer will be capable of delivering full-load continuously without any injury and should have alarm facility.
- e) Electrical operation of OLTC from local or remote control panel will cause one tap movement only until the control switch is returned to the 'off' position between successive operations.
- f) Emergency stopping provision will be provided at the transformer and remote tap changer control panel.
- g) Mechanical stop of approved design will be provided to prevent over running of the mechanism under any condition.
- h) Tap changer motor and control circuit will be provided with Mechanically and Electrically interlocked Contactors, Thermal Overload relays, with single phasing preventer, MCCB / motor protection circuit breaker with built in short circuit and over load released.

- i) Main contacts, switching contacts and transition contacts will be silver faced copper contacts. Max. Temperature rise of the contacts will not exceed 20 degree at 150% of rated current of transformer.
- j) Tap changer will be suitable for connection to neutral end or line end of the winding as specified.
- k) A five-digit counter will be fitted to the tap changing mechanism to indicate the number of operations completed by the equipment.
- l) Driving Motor will be squirrel cage induction motor suitable for 415V, 3-phase, 50Hz.

4.04.08 Interlock shall be provided to ensure the following :-

- a. Positive completion of tap changing step once initiated.
- b. Blocking of reverse tap change command during a forward tap change already in progress until the mechanism rests and vice-versa.
- c. Cutting out of electrical circuit during manual operation. Interrupt the electrical supply to the drive motor when the manual operation device is engaged.

4.04.09 The tap changing gear shall have local selector switches with RTCC-Local-Remote Test-Central positions. Provisions of various modes of operation of the tap changers of transformers, like individual operation (Master / follower operation for 3 off 1- Ph. Bank), remote/local operation; operation from voltage regulating relays(where specified), etc. and for various interlocks shall be kept in the Remote Tap Changer Cubicle (RTCC) as well as local OLTC cabinet. Necessary equipment switches, relays, etc., shall be provided in these panels.

4.04.10 The construction and other details of the RTCC shall be as per Annexure-E.

4.04.11 **Annunciation**

Facia type annunciation scheme operating on DC supply, incorporating flasher, test/ accept / reset push buttons, DC hooter will be provided for each OLTC for audio and visual indication of the following abnormal operating conditions in OLTC transformer operation.

- Tap position.
- Tap position in progress.
- Tap changing delayed.
- Failure of AC auxiliary -supply.
- Failure of OLTC operation.

- Failure of OLTC operation on auto mode.
- Out of step operation.
- Tripping of tap changing motor
- Control supply failure.
- Buchholz relay operated.

The faults and status of the OLTC will be made available individually for Substation Automation System.

4.04.12 **Accessories**

The following accessories will be provided for each OLTC. The accessories will be of reputed make, approved by the owner.

- a) Conservator with oil level gauge with min. and max. level markings, exclusively for diverter and switch oil.
- b) Buchholz relay/surge relay with potential free alarm and trip contacts rated for 0.5 A, 220 volts DC. The contacts will be hand reset type.
- c) Silica gel Breather with oil seal. The breather will be at a height of 1.5 m from ground level.
- d) Provision for taking oil samples from the bottom of diverter switch without opening the diverter switch assembly.
- e) Drain plug and oil filling plug for conservator.
- f) Special tools required for dismantling diverter switch at site.
- g) 5 Digit operation counter to indicate number of tap changing operations completed by the equipment. The counter will reset automatically after reaching max. value.
- h) Local mechanical tap position indicator.
- i) Dust, vermin and weather proof, transformer mounted outdoor type cast aluminium enclosure with lockable door to house drive motor, OLTC local control equipment and accessories toughened glass window will be provided for tap position operation counter, ON/OFF tap changing in progress indicators. It will be fully wired and inter connected to all accessories located on the transformer.
- j) 240 volts AC space heater in tap changing gear at transformer.

4.04.13 **TESTS**

- i) The following routine tests will be conducted on each OLTC along with the transformer.

Routine tests:

- a) Manual operation for 40 times in normal manner through the complete cycle when the transformer is unexcited, followed by 10 operations in normal manner through the complete cycle when the transformer is charged with rated volts on open circuit.
 - b) Electrical operation in remote / local modes
 - c) Checking of interlocks
 - d) Checking for functioning of proper voltage regulation as per setting
 - e) Auxiliary circuits insulation tests.
 - f) PF withstand voltage test between any two adjacent contacts of tap changer.
- ii) Test certificate for type tests as indicated in clause 8.1 of IS-8468-1977 will be furnished for identical OLTC.

4.05.00 **Insulating oil**

4.05.01 The transformer shall be filled with mineral insulating oil suitably inhibited to prevent sludging The insulating oil shall conform to IS 12463.

4.05.02 First filling of oil along with 10% excess shall be furnished for each transformer. Oil shall be supplied in non-returnable containers suitable for outdoor storage.

4.05.03 Oil preservation shall be by means of bellows/ diaphragm sealed conservator tank with silica gel breather to avoid direct connection between atmosphere and transformer oil. It shall be complete with level gauges, pipes, drain valve, Buchholz relay with shut-off valves at both sides etc. The level gauges shall be so placed that same can be readable standing from ground. Necessary device shall be kept to provide annunciation in the event of rupturing of bellow.

4.06.00 **Bushing**

4.06.01 Bushing rated 52 KV class and above shall be resin impregnated porcelain (RIP) only. Bushing rated below 52KV voltage class shall be solid porcelain or oil communicating type.



- 4.06.02 Bushing shall be provided with test terminal for measurement of loss factor (tan-delta) and capacitance.
- 4.06.03 Bushings shall be provided with terminal connectors of approved type and size.
- 4.06.04 Bushing location shall provide adequate phase and ground clearances.
- 4.06.05 All bushing (Both Phase side as well as Neutral) shall be provided with bushing type current transformer (CT).
- 4.07.00 **Conservator**
- 4.07.01 Conservator will be Air cell Type.
- 4.07.02 Conservator will be located in such a position as not to obstruct the electrical connections to the transformer. The conservator volume will be sufficient to maintain the oil seal from ambient temperature of 5° Centigrade to oil temperature of 90° Centigrade, with oil level varying within min. and max. Levels.
- 4.07.03 150 mm dial type magnetic level gauge with alarm and trip connection will be provided. In addition, prismatic type oil level gauge with min. and max. Levels marked will also be provided. Taps or valves will not be fitted to the oil gauge.
- 4.07.04 Conservator will be provided with filling plug, sump and drain valve of 15mm size for conservator of dia 650mm and 25mm size for conservator above 650mm diameter. Valve for shutting off oil to the transformers will be provided.
- 4.07.05 Conservator will be designed so that it can be completely drained by means of the drain valve provided when mounted as in service. One end of conservator will be bolted into position so that it can be removed for cleaning purposes. If the sump is formed by extending the feed pipe into the conservator vessel the extension will be for at least 25 mm. Oil filling hole with cap will be provided.
- 4.07.06 A silica gel breather with inspection window and oil seal will be mounted at 1.4 meter above transformer base with suitable supports and connected to the conservator.
- 4.07.07 Separate conservator will be provided for OLTC
- 4.08.00 **Buchholz relay**
- 4.08.01 All transformers will be provided with double float buchholz relay fitted in the pipe connecting the tank and the conservator pipe and will have the following dimension,
- 80 mm dia for ratings above 10 MVA.



In addition, oil surge relay will be provided for OLTC.

- 4.08.02 Pipe will be arranged at a rising angle of 3 to 9 degrees to the horizontal, up to the buchholz relay. Valves will be provided on either side of relay after providing necessary length of straight pipes.
- 4.08.03 The relay will have pet cocks at the top and bottom, drain plug, inspection windows, calibrated scale to indicate gas present, built in test facility and terminal box with oil tight brass gland.
- 4.08.04 The relay will have electrically separate; potential free self reset contacts for alarm and trip. Contacts will be rated to make, carry & break 0.5 Amp. at 220 V DC. The contacts will be wired to marshalling box. The relay will conform to IS: 3637 (1966).
- 4.08.05 Copper pipe of dia 5mm will be connected from the relay test cock to a valve located about 1.25M above ground level to facilitate sampling of gas when the transformer in service.
- 4.09.00 **Valves and connections**
- 4.09.01 Valves will be of forged carbon steel up to 50 mm size and of gunmetal or of cast iron bodies with gunmetal fittings for sizes above 50 mm. They will be of full way type with screwed ends and will be opened by turning counter clockwise when facing the hand wheel. There will be no oil leakage when the valves are in closed position.
- 4.09.02 All valves will be provided with an indicator to show clearly the position of the valve. Oil sampling valves will be provided at top and bottom of the main tank and these will not be fitted on the filter valves. Non-return valves in pump scheme will be provided. All transformers will have bottom drain valve, top and bottom filter valves suitable for connecting to oil filtration unit. All Screwed valves will be provided with pipe plugs for protection.
- 4.09.03 Each transformer will be provided with following valves on the tank:
- (a) Two filter valves on diagonally opposite corners, suitable for connecting to oil filtration unit.
 - (b) Oil sampling valves not less than 8 mm, at top and bottom of main tank with provision for fixing PVC pipe.
 - (c) One 15 mm air release plug at all required locations.
 - (d) Valves between radiators and/or coolers.
 - (e) Two plugged pipe outlets for applying vacuum.
 - (f) Drain valve so located as to completely drain the tank to oil choke pit through necessary pipes and with locking arrangements.

- (g) Shut off valves between OLTC and its conservator.
- (h) Valves for connecting Online DGA / Monitoring System.

4.10.00 Joints and gaskets

All gaskets used for making oil tight joints will be of proven material such as granulated cork-bonded synthetic rubber or synthetic rubber gaskets compatible with oil.

4.11.00 Explosion vent/pressure relief device

- 4.11.01 Pressure relief device will be provided for FGD Transformers. Pressure relief device provided will be of sufficient volume for rapid release of any pressure that may be generated within the tank and which might result in damage to the equipment. The device will operate at a static pressure of less than the hydraulic test pressure for transformer tank. Means will be provided to prevent ingress of rainwater.

4.12.00 Temperature Indicators

- 4.12.01 150 mm dial type top oil and winding temperature indicator for the HV & LV windings will be provided for all transformers. Further additional terminals of winding temperature indicator for Automatic Control of Blowers will be provided.

- 4.12.02 Each thermometer will have potential free NO alarm contact and trip contact. No multiplying contactor / relay will be used. Temperature setting of each contact will be independently adjustable at site. A manual reset type max. Temperature indicator will be provided for each thermometer.

The temperature-sensing element mounted in pockets of oil on the top cover of the transformer will be connected to the indicating elements through capillary tube.

- 4.12.03 Each winding temp indicator will have temperature Sensing element, image coil and bushing mounted current transformer.

- 4.12.04 Each thermometer will be provided with remote temperature Indicator along with associated Accessories. The remote temperature Indicating signals will be wired to Transformer relay.

- 4.12.05 The local winding temperature indicator will be provided with necessary contacts for automatic starting and stopping of cooling fans, alarm and trip functions. Settings for closing and opening contacts will be independently adjustable.

- 4.12.06 All contacts will be rated to make 0.5A (min) and break 0.2 A (min) at 220 DC. All contacts will be wired to marshalling box.

4.12.07 In addition to the above winding temperature indicators/controllers will be provided, for control of forced cooling system of the transformer.

4-20mA signal for oil and winding temperature will be made available for interfacing with SAS.

4.13.00 **Terminal Arrangements**

4.13.01 The physical position of the terminals and the markings shall be as per relevant IS/IEC unless otherwise required to suit the layout.

4.13.02 High voltage terminals shall be brought out thru' top cover mounted bushings for connection to overhead ACSR Moose conductors.

4.13.03 High voltage winding neutral shall be brought out thru' top cover mounted bushing. Two ground conductors 75x10 G.I. flats shall run from neutral bushing to the bottom of the tank for connection to station ground. These shall be mounted on insulators having voltage grade that of neutral bushing.

4.13.04 Low voltage terminals shall be brought out thru' side wall mounted bushing to a detachable cable end-box with disconnect link.

4.13.05 Low voltage winding neutral shall be brought out thru' side wall mounted bushing to a detachable cable end-box with disconnect link.

4.13.06 The cable-end box shall be self supporting, air filled type complete with all hardware such as gland plate, brass glands, tinned copper lugs, armour clamps, etc.

4.13.07 In general, the arrangement shall be such as to permit removal of transformer without dismantling the bus duct /cable connection.

4.14.00 **Cooling System**

4.14.01 The transformer cooling system ONAN/ONAF.

(a) The transformers shall be provided with two (2) nos. 60% capacity cooling units, each complete with adequate number of radiator banks, cooling fan and other accessories.

(b) Each cooling unit shall be provided with at least two (2) no. stand-by fan for ONAF cooling. The cooler scheme should be such that any fan in a cooling unit can be used as standby.

4.14.02 Transformer fitted with multiple cooling units but without having stand-by cooling unit/s, it shall be able to deliver its rated output not exceeding specified temperature rise and calculated hot-spot temperature of 140 degree centigrade under following conditions:

a) for 20 minutes after failure of the blowers of one unit



- b) for 10 minutes in the event of failure of the cooler units
- 4.14.03 The radiators shall be detachable type with top and bottom isolation valves to permit the removal of the same without drainage of oil from the tank.
- 4.14.04 All fans shall have safety guard.
- 4.14.05 Convenient means shall be provided to remove or replace any fan with the transformer in service.
- 4.14.06 Complete control for fans inclusive of all switches, fuses, starters, relays and wiring shall be furnished. Each motor circuit shall have over load and short-circuit protection.
- 4.14.07 Fan motor controls will be actuated automatically from winding temperature indicator contacts. Provision shall however be kept for manual operation from local cooler control panel and remote from DCS/ SCADA.
- 4.15.00 **Remote Tap Changing Control Panel cum Transformer Cooler Control Panel.**
- 4.15.01 The transformer cooler control panel shall be used for control, interlocking, metering and indication of cooler control system of transformer and shall be installed outdoor near the transformer coolers.
- 4.15.02 Control shall be done from Transformer Cooler Control Panel (local) and Remote Cooler Control Panel / DCS/ SCADA. Necessary interface for controlling from Remote Cooler Control Panel / DCS/ SCADA. with necessary hardware & software as required shall be provided. The Interface & co-ordination are included in Bidder's scope.
- 4.15.03 Transformer Remote Cooler Control Panel may be clubbed with Remote Tap Changing Control Panel (RTCC) / Microprocessor based numerical RTCC. Then the combined panel shall be installed indoor and shall have features as specified in Annexure-E.
- 4.15.04 Cooler Control panels shall be of CRCA sheet steel construction with protection class of IP-52 for indoor and IP-55 for outdoor installation.
- 4.15.05 The frames and load bearing panels shall be fabricated of not less than 2 mm thick sheet steel. The doors and covers shall not be less than 1.6mm thick. All access doors shall be provided with channel rubber/ neoprene gaskets all round.
- 4.15.06 The operating height shall be limited from 750mm to 1800mm. The total height of the panel and its depth shall be matched with adjacent panel.
- 4.15.07 The operating handle shall have locking arrangement. The panels shall be complete with floor channel sills, vibration damping pads and stainless steel kick plates.



- 4.15.08 All instrument, relays, switches, etc. mounted on the front face of the panel shall be flush or semi flush type. Switch contacts shall be silver faced and rated at least 10 Amp at operating voltage. Push buttons shall have required number of contacts.
- 4.15.09 Panel shall be provided with internal illumination lamp with door switch, space heater with thermostat one 5A, 3 pin receptacles with plug.
- 4.15.10 The annunciation system shall be solid-state type with optical isolation for input signals. It shall be complete with its own power supply, audible alarms, acknowledge, reset, and test buttons and other necessary accessories.
- 4.15.11 The control panels shall be fully wired up at factory. All spare contacts of relays and switches shall be wires upto the terminal blocks.
- 4.15.12 The panel shall have provision of cable entry from bottom. Bottom gland plate shall be 3mm thick.
- 4.15.13 50 x 6 mm copper ground bus shall be provided on the panel extending along the entire length of the assembly. The ground bus shall have two-bolt drilling with GI bolts and nuts at each end to receive Owner ground connection of 75x10 mm G.I. flat.

4.16.00 **Interfaces**

Bidder shall consider following interfaces in general for Owner's remote operation, indication and alarm from DCS/SCADA. However, Bidder shall note that the interfaces shall be based on the bidder's offered system and shall be ultimately decided during detail engineering:

- a) Provision of connection in OLTC circuit for Owner's following remote mounted equipment:

- Raise - Lower control switch
- Status indication for following:
 - Motor drive unit OLTC power supply healthy
 - Motor drive unit OLTC control supply healthy
 - Tap change in progress
- Annunciation for:
 - Mechanism stuck
 - Supply failure motor circuit motor drive unit OLTC
 - Supply failure control circuit motor drive unit OLTC
 - Oil surge relay operated

- b) Provision of connection in cooler control circuit for Owner's following remote mounted equipment:



- Auto-Off-Manual selector switch
 - OFF-ON selector switch for fan control
 - Status indication for following:
 - Cooling group 1 selected fans ON
 - Cooling group 1 stand-by fan ON
 - Cooling group 2 selected fans ON
 - Cooling group 2 stand-by fan ON
 - Cooler control position in Local
 - Cooler control position in Remote
 - Cooler control supply ON
 - Cooler control supply OFF
 - Annunciation for:
 - Fan failure cooling group 1
 - Fan failure cooling group 2
 - Cooler control supply fail
- c) Requirement of provision at the OLTC local panel of necessary 4-20mA signal for tap position indication so that analog signal can be extended to remote DCS/SCADA.
- d) Provision of necessary 4-20mA signal for Remote Winding Temperature Indication so that signal can be extended to remote DCS/SCADA System.
- e) Potential free contacts required from relay for SCADA purpose.
- WTI alarm
 - WTI trip
 - OTI alarm
 - Buchholz alarm
 - Buchholz trip
 - MOG alarm
 - OSR trip
 - Main PRV trip
 - OLTC PRV trip
 - Tap change stuck up
 - OLTC out of step
 - OLTC motor supply fail
 - DC supply fail
 - OLTC control supply fail
 - Over voltage relay operated
 - Under voltage relay operated
 - Tap changer on SCADA/ LOCAL
 - Tap changer on AUTO / MANUAL



- Inter-trip to breaker from Relay
- Fan Control

4.17.00 **Marshalling Box**

4.17.01 A sheet steel, weatherproof, IPW55, marshalling box shall be provided for the transformer. The box shall contain all auxiliary devices except those which must be located directly on the transformer.

4.17.02 All terminal blocks for cable connection shall be located in this box.

4.17.03 The marshalling box shall be provided with cubicle lamp with door switch, space heater with thermostat and removable cable gland plate.

4.18.00 **Wiring**

4.18.01 All control, alarm and indication devices provided with the transformer shall be wired upto the terminal blocks.

4.18.02 Wiring shall be done with flexible, 1100V grade PVC wires in conduit or PVC armored cable. Minimum wire size shall be 2.5 mm² copper. Not more than two wires shall be connected to a terminal. 10% spare terminals shall be provided.

4.18.03 Multi-way terminal block complete with mounting channel, binding screws and washers for wire connections and marking strip for circuit identification shall be provided for terminating the panel wiring. Terminals shall be stud type, suitable for terminating 2 nos. 2.5 mm² stranded copper conductor and provided with acrylic insulating cover. Terminals for C.T. secondary leads shall have provision for shorting and grounding.

4.18.04 All devices and terminal blocks shall be identified by symbols corresponding to those used in applicable schematic or wiring diagram. Each wire shall be identified, at both ends, with interlocking type permanent markers bearing wire numbers as per Bidder's Wiring Diagrams. AC / DC wiring shall have separate color-coding.

4.18.05 Wire termination shall be made with crimping type connectors with insulating sleeves. Wires shall not be spliced between terminals.

4.19.00 **Grounding**

4.19.01 The grounding pads, located on the opposite sides of the tank, shall be provided for connection to station ground mat.

4.19.02 Grounding pad shall have clean buffed surface with two tapped holes, M10 G.I. bolts and spring washers for connection to 75x10 mm G.I. flat.

4.19.03 Ground terminals shall be also provided on marshalling box to ensure its effective earthing.



- 4.19.04 For continuity of earth connection, all gasketed joints shall be provided with braided copper wire jumpers.
- 4.20.00 **Auxiliary Supply**
- 4.20.01 A.C. supply will be made available to the transformer by two separate feeders one normal and the other standby.
- 4.20.02 Isolating switch fuse unit shall be provided for each of the incoming supply along with automatic changeover scheme to switch on to the standby source in case of failure of the normal supply.
- 4.21.00 **Auxiliary Equipment**
- 4.21.01 Neutral bushing current transformers and phase bushing current transformers shall be furnished when specified in the annexure.
- 4.21.02 The arrangement shall be such that the C.T. can be removed from the transformer without removing the tank cover.
- 4.21.03 CT secondary leads shall be wired upto the terminal blocks.
- 4.22.00 **Painting**
- 4.22.01 All steel surfaces shall be thoroughly cleaned by sand blasting or chemical agents as required, to produce a smooth surface free of scales, grease and rust.
- 4.22.02 The internal surfaces in contact with insulating oil shall be painted with heat resistant insulating varnish which shall not react with and be soluble in the insulating liquid used.
- 4.22.03 The external surfaces, after cleaning, shall be given a coat of high quality red oxide or yellow chromate primer followed by filler coats.
- 4.22.04 The transformer shall be finished with two coats of battle ship grey (IS Shade # 632) synthetic enamel paint unless otherwise specified.
- 4.22.05 The paints shall be carefully selected to withstand tropical heat, rain etc. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.
- 4.22.06 Sufficient quantity of touch up paint shall be furnished for application after installation at site.
- 4.22.07 If it is considered necessary, the transformer may be given a further coating at site. The Bidder shall therefore indicate the type and quality of the paint with full specification for this purpose.
- 4.22.08 All supporting structures and hardware shall be hot dip galvanized.

Under carriage



The under carriage of the transformer will be provided with detachable steel flanged wheels. Flanged wheels will be spaced to allow specified rail gauge. Wheels will be provided with suitable bearings, which will resist rust and corrosion and will be equipped with fittings for lubrications. Unless otherwise approved, it will be possible to swivel the wheels in two directions, at right angles to or parallel to the main axis of the transformer, thereby permitting movement in two directions. The wheels will be swiveled after jacking the transformer and they will be lockable in the two positions.

4.23.00 Transportation

4.23.01 Transformer tank shall be dispatched filled with oil or pure dry inert Nitrogen gas depending upon the transport weight limitations. A positive pressure of 2 to 2.5 Psi at temperature of 36°C approximate shall be kept. In case the tank is filled with oil, sufficient space is left above the oil to take care of the expansion of the oil. The space is filled with pure dry air or inert gas under atmospheric pressure.

The temperature and pressure at the time of gas filling shall be marked on a tag. A graph showing pressure vs. temperature shall be attached for reading pressures at different temperatures. Necessary valves, two stage pressure regulators, filled up Nitrogen cylinder etc. along with other accessories required shall be provided with the tank for intermittent replenishment during transportation.

4.24.00 Impact Recorder

Impact recorder / indicator shall be provided to monitor the impact experienced by the transformer during transport. The impact recorders shall be rigidly attached to the transformer to record all impacts withstood by the transformer during all movement and travel from the factory to the terminal point, including initial loading and final unloading. Sweep Frequency Response Analysis (SFRA) Test shall be conducted at Factory before loading for dispatch and also at site after unloading (dispatch) and both the signature analysis reports shall be provided for comparison. Provisions shall be made to ensure that these impact recorders will function properly and continuously during the entire period of shipment, including loading and unloading, and to ensure that the Owner will receive all recorded data. Instructions for interpreting recorded data shall also be provided.

4.25.00 Earthing arrangements**4.25.01 Internal Earthing arrangements**

All metal parts of the transformer with the exception of individual core laminations, core bolts and associated individual clamping plates will be maintained at some fixed potential by earthing.

4.25.02 Core clamping structure earthing

The top main core clamping structure will be connected to the tank body by a copper strip of adequate cross section. The bottom clamp structure will also be connected to the tank by one or more of the following methods.

- a) by connection through vertical tie rods of the top structure.
- b) by direct metal to metal contact with tank base maintained by the weight of the core and windings.
- c) by connection to the top structure on the same side of the core as the main earth connection to the tank.

4.25.03 Earthing of coil clamping rings

Where coil-clamping rings are metal at earth potential, each ring will be connected to the adjacent core clamping structure on the same side of the transformer as main earth connections.

4.25.04 Earthing of magnetic circuit

Magnetic circuit will be earthed at one point only. This will be brought out of the tank cover through a suitably rated bushing and earthed through a removable link. This bushing will be clearly identified with inscription plate. When the magnetic circuit is divided into pockets by cooling ducts parallel to the planes of laminations or by insulating material above 0.25 mm thick, tinned copper strip bridging pieces will be inserted to maintain electrical continuity between pockets.

4.25.05 Earthing of bushing CT's

Where Bushing CT's are provided, secondary winding will not be earthed inside. Both ends of winding will be fully insulated and terminated outside in weatherproof terminal box. One end of CT secondary will be earthed in the terminal box. Magnetic core of CT's will be earthed.

4.25.06 Size of Earth connection

All earth connections, except those from the individual coil clamping rings will be done by copper conductor with min cross section of 80 sq. mm copper. Connections inserted between laminations of different sections of core will not be less than 20 sq. mm.

4.25.07 Neutral Earthing

For all Transformers LV neutral terminal will be brought out through top cover mounted neutral bushing in cable box with disconnecting chamber to connect the NGR by suitable cable through cable trench.

Other end of the NGR will be connected to earth pits through suitable GI flats. These will be connected to main earth grid

4.26.00 Lifting and haulage facilities

Lifting lugs will be suitable for lifting the transformer with oil. Minimum of 4 jacking pads, in accessible position will be provided to raise or lower the complete transformer with oil using hydraulic or screw jacks.

5.00.00 TESTS**5.01.00 Routine Tests**

During manufacture and on completion, all transformers shall be subjected to the routine tests in accordance with latest IEC 60076 and its different parts.

In addition, the following tests shall be performed on each transformer:

5.01.01 Measurement of Insulation Resistance**5.01.02 Dielectric tests**

- i) Switching impulse withstand voltage test, transformer winding $U_m > 170 \text{ kV}$
- ii) Lightning impulse withstand voltage test, transformer winding $U_m > 72.5 \text{ kV}$
- iii) Separate-source withstand voltage test
- iv) Induced AC over voltage withstand test

5.01.03 Transformer tank with coolers shall be tested for leaks with normal head of oil plus 35 KN/m^2 for a period of 8 hours. If any leak occurs, the test shall be conducted again after all leaks have been repaired.**5.01.04 During fabrication stage, the tank shall be pressure tested with air at a pressure corresponding to twice the normal head of oil or normal pressure plus 35 KN/m^2 whichever is lower for a period of one hour.**

Also the tank designed for full vacuum shall be tested for maximum internal pressure of 3.33 KN/m^2 for one hour.

The permanent deflection of flat plates shall not exceed CBIP specified figures on release of excess pressure of pressure test and on release of vacuum.

5.01.05 After assembly, each core shall be pressure tested for one minute at 2KV (r.m.s.) A.C. between all bolts, side plates, structural steel works and the core.**5.01.06 The wiring for auxiliary power and control circuitry shall be subjected to withstand one minute power frequency test with 2.0KV (r.m.s.) to earth.****5.01.07 Dielectric special tests as per IEC60076-3****5.01.08 Determination of capacitances windings-to-earth and between windings**



- 5.01.09 Frequency Response Analysis test (This test shall also be undertaken by the manufacturer at site after transformer is installed.)
- 5.01.10 Measurement of acoustic sound level
- 5.01.11 Measurement of power consumption of fans
- 5.01.12 Measurement of zero sequence impedance(s) on three-phase unit
- 5.01.13 Measurement of dissipation factor (tan delta) of insulation system capacitances

5.02.00 **Type Tests**

Following type tests shall be performed on one transformer in accordance with relevant standard:

- i) Lightning impulse withstand voltage test, transformer winding $U_m \leq 72.5$ kV
- ii) Temperature rise test.

- 5.02.01 At fabrication stage, the tank designed for full vacuum shall be tested for maximum internal pressure of 3.33KN/m² for one hour.

5.03.00 **Special Tests**

Following special tests shall be performed in accordance with relevant standard:

- i) Lightning impulse test on neutral terminal
- ii) Long duration induced AC voltage test (ACLD) transformer winding $72.5 < U_m \leq 170$ kV
- iii) Short-circuit withstand test
- iv) Measurement of the harmonics of the no-load current
- v) Determination of capacitances windings-to-earth and between windings
- vi) Test with lightning impulse chopped on the tail
- vii) Measurement of acoustic sound level
- viii) Measurement of power consumption of fans and pumps
- ix) Measurement of zero sequence impedance(s) on three-phase unit
- x) Determination of transient voltage transfer characteristics

Note: The tests, if required, shall be carried out by mutual agreement between the purchaser and the supplier. The number and selection of tests



shall also be decided during the agreement and accordingly to be indicated in the specification.

5.04.00 **Tests on Transformer bushings**

5.04.01 Routine tests as per IS: 2099

- a) Measurement of dielectric dissipation factor (Tan- Delta) and capacitance at ambient temperature.
- b) Dry power frequency voltage withstand test.
- c) Measurement of Partial discharge quantity
- d) Power frequency voltage withstand test of tap insulation.
- e) Pressure test on liquid filled and liquid insulated bushings.
- f) Tightness test at flange or other fixing device.

5.04.02 **Type tests**

- a) Wet power frequency voltage withstand test.
- b) Dry and Wet switching impulse voltage withstand test.
- c) Temperature rise test
- d) Thermal stability test.
- e) Thermal short time current withstand test.
- f) Dynamic current withstand test
- g) Cantilever load withstand test.

Test for all other accessories and auxiliary equipments will be as per relevant IS.

The type test certificates for similar equipment shall be supplied by the vendor. In case a type test certificate for similar equipment is not available, the same will be conducted in presence of the purchaser or his representative.

5.05.00 **Miscellaneous**

All component parts and auxiliary equipment such as oil, bushings, C.Ts etc. shall be routine tested as per relevant Indian Standards.

5.06.00 **Test Certificates**

- 5.06.01 Certified reports of all the tests carried out at the works shall be furnished in six (6) copies for approval of the Owner/Purchaser.



5.06.02 The equipment shall be dispatched from works only after receipt of Owner/Purchaser's written approval of the test reports.

5.06.03 Type test certificates of not older than five (5) years from date of contract on any equipment, if so desired by the Owner/Purchaser, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

6.00.00 SPECIAL TOOLS & TACKLES

6.01.00 A set of special tools & tackle which are necessary or convenient for erection, commissioning, maintenance and overhauling of the equipment shall be supplied.

6.02.00 The tools shall be shipped in separate containers, clearly marked with the name of the equipment for which they are intended.

7.00.00 SPARES

7.01.00 The Bidder shall submit a list of **recommended spare parts** for three (3) years satisfactory and trouble-free operation, indicating the itemized price of each item of the spares. The final quantity shall be decided during placement of order.

7.02.00 The Bidder shall quote and supply **mandatory spare parts** as per the list attached in Annexure-G.

7.03.00 Each list shall be complete with specification, make, identification number, unit rate, quantity etc.

8.00.00 DRAWINGS, DATA & MANUALS

8.01.00 Drawings, Data and Manuals shall be submitted with the bid and for approval and subsequent distribution after the issue of Letter of Intent in quantities and procedures as specified in General condition of contract and/or elsewhere in this specification

8.02.00 To be submitted with the Bid

8.02.01 Typical general arrangement drawings showing disposition of cooler banks, fittings, terminal arrangement etc.

8.02.02 Transport/shipping dimensions and weights, space required for handling parts for maintenance.

8.02.03 Technical leaflets on major components and fittings.

8.02.04 Write-ups on OLTC, oil preservation and cooling system.

8.02.05 Type test certificates including short circuit test report of a similar transformer (as per the guidance for identification of a similar transformer as defined in



Annexure-A of IEC 60076-5). The type test certificates shall not be more than 5 years old.

- 8.03.00 **To be submitted for Approval and Distribution**
- 8.03.01 Dimensional general arrangement drawing showing disposition of cooler banks and various fittings.
- 8.03.02 Transport/shipping dimensions with weights, wheel base detail, un-tanking height, etc.
- 8.03.03 Foundation plan & loading.
- 8.03.04 Terminal arrangements and Bus Duct flange details.
- 8.03.05 Flow diagram of the cooling system showing the number of cooling banks, fans etc.
- 8.03.06 Control schematics and wiring diagrams.
- 8.03.07 Cooler Control Scheme.
- 8.03.08 GA of Marshalling Box, Cooler control panel, OLTC cabinet, RTCC panel as applicable.
- 8.03.09 Rating and Diagram Plate.
- 8.03.10 Cable Interconnection Diagram and Cable schedule.
- 8.03.11 Drawings of major components like bushing, CTs, etc.
- 8.03.12 Quality Assurance Plan.
- 8.03.13 The following calculations shall be furnished
- a) Curve for Watts/Kg of CRGO and flux density Calculation
 - b) Calculation for No load loss.
 - c) Calculation for load loss
 - d) Calculation for Auxiliary loss
 - e) Cooling surface area of Radiator Bank
 - f) Cross Sectional Area of Core
 - g) Cross sectional area of conductor for all winding.
- 8.03.14 Test certificates of transformer and auxiliary equipment.
- 8.03.15 Any other relevant drawing or data necessary for satisfactory installation, operation and maintenance or as required by purchaser.



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- 8.03.16 Instruction manuals on transformer and its various fittings.
- The manual shall clearly indicate method of installation, check-ups and tests to be carried out before commissioning of the equipment.
- 8.04.00 The Bidder may note that the drawings, data and manuals listed are minimum requirement only. The Bidder shall ensure that all other necessary write-ups, curves and information required to fully describe the equipment offered are submitted with his bid.



ANNEXURE – A

SYSTEM DATA

1.0 Standard voltage levels

Standard voltage levels used in this project are as given in the table and the same will be adopted by the respective equipment suppliers.

Sl. No.	Description	Voltage level	
1	Station supply	i)	220KV, 3 phase, 3 wire, 50Hz, effectively earthed
		ii)	11 kV, 3 phase, 3 wire, 50Hz, Resistance Earthed.
2	Metering	110V, PT secondary voltage	
3	Control and Protection	220 V, DC 2–wire, Unearthed	

2.0 System Earthing

220KV system is effectively earthed.

11KV system is resistance earthed. Resistors will be connected to the Star point of the concerned transformers.

3.0 Fault Levels

220KV System	-	40KA
11KV System	-	40KA



ANNEXURE – B

RATINGS AND REQUIREMENTS

1.0	Application	:	Station Transformer
2.0	Service	:	Outdoor, step down
3.0	Type	:	Oil immersed, three winding transformer
4.0	Reference standard	:	IS 2026 & IEC 60076
5.0	Rated MVA at no load voltage & Principle tap		
	ONAN	:	50 MVA
	ONAF	:	63 MVA
	Tertiary winding (ONAF rating)	:	21 MVA
6.0	Rated voltage ratio (line to line)	:	
	HV	:	220 KV
	LV1	:	11.5 KV
	LV2	:	11.5 KV
	LV3	:	11 KV
7.0	Number of phases of each unit (1-Ph or 3-PH unit)	:	3-Ph Unit
8.0	No. of phases	:	3
9.0	Rated frequency	:	50 Hz
10.0	Cooling system		
10.1	Type of Cooling & respective power Value % of rated power	:	ONAN/ONAF 80% / 100%
10.2	Cooling liquid	:	Mineral Oil (IS:335)
10.2	Nos. of cooling units & each capacity	:	2 X 60 %
11.0	Temperature rise		
11.1	Design ambient temperature	:	50 degree Centigrade
11.2	Max. Temperature rise above design ambient at rated MVA & principle tap.		
	a) in oil by thermometer (top oil)	:	50 °C
	b) in winding by resistance	:	55 °C



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- c) Hot spot temperature : 105 °C
- 12.0 Insulation level (SI : Switching Impulse Voltage,
LI : Lightning Impulse Voltage, AC : Short duration
induced & separate source AC withstand Voltage)
- HV- (SI/LI/AC) : -KVp/1050KVp/395KVrms
- HV Neutral- (LI/AC) : 170KVp/70KVrms
- LV- (LI/AC) : 75KVp/28KVrms
- LV Neutral – (LI/AC) : 75KVp/28KVrms
- 13.0 Vector group : Ynyn0yn0d11
- 14.0 Percentage impedance voltage at 75°C :
At rated current, frequency, principle tap
- Between HV-LV1 : 12.5% (on 63 MVA base)
- Between HV-LV2 : 12.5% (on 63 MVA base)
- Between LV1-LV2 : 25% Approx.
- 15.0 Parallel operation of transformer : Yes, continuously
- 16.0 Type of taps provided : OLTC, full capacity (manual)
- 16.1 Taps provided on : H.V. winding
- 16.2 Range of taps/steps : ± 10% @ 1.25% / 16 (1-17step)
- 16.3 Method of Tap charge control-
- a) Manual local : Yes
- b) Electrical local : Yes
- c) Electrical Remote : Yes
- d) Automatic : No
- 16.4 Type of Remote Tap : Microprocessor
Change Controller : based numerical type
- 17.0 Type of tank construction : Conventional tank with cover
(bell type or conventional tank with cover)
- 18.0 Radiator : Detachable, separately mounted
type
- 19.0 Type of Oil preservation system : As per specification
- 20.0 System earthing -
- H.V. : Effectively Earthed
- L.V. : Non – effectively Earthed





21.0 Terminal arrangement -

H.V.	:	ACSR Moose conductor			
L.V.	:	Cable end box with air chamber			
H.V. Neutral	:	Porcelain bushing suitable for connection of 2 nos. 75 X 10 GI flat			
L.V. Neutral	:	Connected to NGR 1C Al. XLPE cable			
22.0 Transformer bushing	:	HV	HV-N	LV	LV-N
22.1 Voltage class KV(r.m.s.)	:	245	36	17.5	17.5
22.2 Material	:	RIP -----Porcelain-----			
22.3 Creepage distance mm	:	7595	1116	543	
22.4 Min. Ph-Ph clearance mm	:	2350		280	
22.5 Min. Ph-Gr clearance mm	:	2150		140	
22.6 Current rating	:	120% of the current rating rating of respective winding.			
22.7 Impulse withstand voltage (KVp)	:	1050	170	95	
22.8 Power frequency withstand voltage (KVrms)	:	460	70	38	
23.0 System fault Level					
HV Side	:	40 KA (r.m.s.)			
LV Side	:	40 KA (r.m.s.)			
24.0 External terminal Short Circuit withstand capability of Transformer on any tapping for 3 phase and line to ground fault across LV winding	:	Not less than 3 second			
25.0 Max. Flux density in any part of core & Yoke at 110% rated voltage	:	1.9 T			
26.0 Max. current density of conductor of coil of HV and LV winding	:	2.5 A/sq.cm			
27.0 Max. Noise level in accordance with Conditions specified in NEMA Std. TR-1 (measured 4ft from the transformer at a height	:	As per NEMA Std. TR1			





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of 5ft above the floor at rated voltage & load)

28.0	Winding insulation category		
	HV	:	Non Uniform / Uniform
	LV	:	Uniform
29.0	Winding data		
	a) No of windings	:	Four
	b) Winding material	:	Copper
	c) Winding connection (HV/LV)	:	Star/Star/Star/Delta
	d) Vector group (HV, LV)	:	YNyn0yn0d11
30.0	Core Laminations		
	a) Type	:	CRGO
	b) Material	:	Silicon Steel
	c) Thickness, mm (max. permissible)	:	0.3 mm
31.0	WTI required for		
	HV winding	:	Yes
	LV winding	:	Yes
32.0	Auxiliary supply	:	415V±10% 3 ph. 50 Hz ± 5%
		:	220V +10%, -15% 2 wire DC
33.0	Transformer mounting		
	i) Roller/Flanged wheel	:	Flanged wheel
	a) Distance between flanged wheel axis parallel to HV-LV	:	1676 mm Rail gauge
	b) Axis perpendicular to HV-LV	:	1676 mm Rail gauge
	c) Flanged wheel (removable)	:	Removable
34.0	Bushing Current Transformers		
	a) Location	:	On the tank cover and accessible without removing the tank cover or active part.
	b) Application/Rating/Quantity	:	Refer Annexure-D
35.0	Overloading as per IS 6600	:	required
36.0	Painting		
	a) Interior	:	As per specification requirement
	b) Exterior	:	Shade 632 of IS 5

(*) - The rating is minimum requirement only. Actual Rating shall be decided by the Bidder during detail engineering.



ANNEXURE – C

FITTINGS AND ACCESSORIES

Transformer shall be equipped with following fittings and accessories as marked as :-

1. Oil conservator with filler cap, drain plug, plain oil level gauge and alarm contacts for rupturing of bellows/diaphragm.
2. Oil preservation system complete with accessories.
3. Air release plugs and valves.
4. Pressure release device with trip contacts. Explosion vent, if provided, should be double diaphragm type.
5. 150 mm dial magnetic oil level gauge with low level alarm contacts
6. 150 mm dial oil temperature indicator with maximum reading pointer and electrically separate contacts for trip and alarm and embedded temperature detectors (PT-100) with suitable output for remote indication (data logging).
7. 150 mm dial winding temperature indicator with maximum reading pointer and electrically separate sets of contacts for trip, alarm and cooler control and embedded temperature detectors (PT-100) with suitable output for remote indication (data logging).
8. Remote winding temperature indicator with a separate detector element.
9. Thermometer pockets in tank, conservator, top and bottom radiator header
10. Double float Buchholz relay with gas release cock, shut-off valve on either sides with separate sets of contacts for trip and alarm.
11. Filter valve with threaded adopter (top and bottom).
12. Drain valve with threaded adopter.
13. Sampling valve (top & bottom).
14. Necessary valves for detachable cooler units.
15. Jacking pads, handling and lifting lugs.
16. Cover lifting eyes.
17. Bi-directional flanged wheels and skids.
18. Clamping device with bolts & nuts for cable & insulator.
19. Hand-hole of sufficient size for access to interior of the tank.



20. Two-grounding pads on tank each frame.
21. Ladder with safety device for access to the top of transformer tank.
22. Weather proof marshalling box for housing control equipment and terminal connections.
23. H.V. and L.V. bushing terminal connectors.
24. Rating and terminal marking plates.
25. Cooler units complete with valves, fans, supporting structure with fixing and foundation bolts, etc as required and Cooler Control panel.
26. Tap-changing gear complete with tap position indicator, operation-counter etc. For OLTC gear (where specified), oil surge relay (OSL) with shut-off valve and Local control cabinet and Remote (RTCC) panel. RTCC panel shall be microprocessor based numerical type where specified.
27. On-line dissolved gas analyser and monitoring system (hydrogen and water monitor) (having communicable ports for both local and remote communication), with sensors.
28. Caution Plate for directed oil flow
29. CT terminal Box
30. Valve position indicating plate
31. Silica gel breather for conservator
32. Inspection cover for Bushing, OLTC, Tank

Note: All indication, alarm, trip contacts provided shall be rated for 0.5A at 220 V D.C. and 5A at 240 V A.C.



ANNEXURE – D

AUXILIARY EQUIPMENT

Transformer shall be provided with phase (where specified) and neutral bushing current transformers as specified as indicated below :-

	HV PHASE SIDE BCT	HV NEUTRAL SIDE BCT		LV PHASE SIDE BCT		LV NEUTRAL SIDE BCT	
Application	Restricted E/F	Restricted E/F	Standby E/F	Differential	Restricted E/F	Restricted E/F	Standby E/F
Current Ratio	200/1 A	200/1 A	500/1 A	2000/1 A	2000/1 A	2000/1 A	400/1A
Class	PS	PS	5P20	PS	PS	PS	5P20
Burden, VA	TBD	TBD	20 VA			TBD	20 VA
Knee point voltage, V	≥ 500V	≥ 500V	TBD	≥ 500V	≥ 500V	≥ 500V	TBD
Excitation current at $V_k/2$, ma	Not more than 20mA	Not more than 20mA	TBD	Not more than 20mA	Not more than 20mA	Not more than 20mA	TBD
Secondary resistance at 75oC	Less than 2 ohms	Less than 2 ohms		Less than 2 ohms	Less than 2 ohms	Less than 2 ohms	TBD
Rated frequency Hz	50	50	50	50	50	50	50
Voltage class KV	245	36	36	12	12	12	12

TBD: To be decided by the bidder

ANNEXURE – E

ON-LINE DISSOLVED HYDROGEN AND WATER MONITOR

1.0 ON-LINE CONDITION MONITORING

The Station transformer shall be fitted with online DGA equipment. The terminals shall be wired up to the Common marshalling box to enable remote alarm/trip and status information and possible connection to a LAN system. The On line DGA monitoring equipment shall be able to monitor H₂, CO, C₂H₄ and C₂H₂.

1.1 TECHNICAL PARAMETERS

The system shall meet the following technical parameters:

a)	Detection & measurement of gases	H ₂ , CO, C ₂ H ₂ , C ₂ H ₄ with 100% sensitivity to H ₂ & C ₂ H ₂
b)	Accuracy (maximum)	H ₂ : ±10% or ± 5 ppm (whichever is greater) CO: ±10% or ± 10 ppm (whichever is greater) C ₂ H ₄ : ±10% or ± 3 ppm (whichever is greater) C ₂ H ₂ : ±10% or ± 1 ppm (whichever is greater) Moisture: ± 2% RH
c)	Oil temperature range of sensor	10 ⁰ C to 100 ⁰ C
d)	Sensor attachment degree of protection	Minimum IP55
e)	Minimum detection sensitivity to C ₂ H ₂	2 ppm

1.2 GENERAL TECHNICAL REQUIREMENTS OF DGA

- a) The system offered shall be suitable for online monitoring of dissolved gases in oil filled power transformer. It shall at least measure dissolved gases such as H₂, CO, C₂H₄ & C₂H₂ with 100% sensitivity to H₂ & C₂H₂ and moisture.



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- b) The system shall be suitably be fitted to transformer in accessible location to be decided by bidder with owner's approval. Bidder shall provide necessary adopter /fittings for this purpose. The attachment shall be provided with an oil sampling port to facilitate oil collection for manual off-line DGA by owner. All software/hardware/cables/PC for monitoring from control room shall be in the scope of the bidder. The supplier shall also provide a suitable calibrating arrangement for each online DGA. The software for remote monitoring in owner's control room shall facilitate real time data logging & also historical data/trend display.
- c) The system shall have microprocessor, watchdog and clock system complete with LCD display unit and keypad. The function is to show Gas level, hourly/daily trend.
- d) The equipment shall have MODBUS TCP/IP protocol. For remote indications on DCS/ SCADA, analogue output of 4-20 mA, serial output RS 232 /RS 485 shall be made available.
- e) Potential free alarm contacts for high gas concentration (user programmable) of each gas shall be wired up to transformer Marshalling Box. These will be used by owner for alarm in control room and in DCS/ SCADA. Also real time data of each gas shall be provided at owner's control room. All required cable, software, hardware & cable laying for the above communication shall be in the scope of bidder.



ANNEXURE – F

REMOTE TAP CHANGING CONTROL PANEL

- 1.0 Remote Tap Changing Control Panel (RTCC) / Microprocessor based numerical RTCC shall be installed indoor. The construction and other details of the RTCC shall be as per following:
- 2.0 **Construction**
- 2.1 Panel shall be of CRCA sheet steel construction with protection class of IP-52.
- 2.2 The frames and load bearing panels shall be fabricated of not less than 2 mm thick sheet steel. The doors and covers shall not be less than 1.6mm thick. All access doors shall be provided with channel rubber/ neoprene gaskets all round.
- 2.3 The operating height shall be limited from 750mm to 1800mm. The total height of the panel and its depth shall be matched with adjacent panel.
- 2.4 The operating handle shall have locking arrangement. The panels shall be complete with floor channel sills, vibration damping pads and stainless steel kick plates.
- 2.5 All instrument, relays, switches, etc. mounted on the front face of the panel shall be flush or semi-flush type. Switch contacts shall be silver faced and rated at least 10 Amp at operating voltage. Push buttons shall have required number of contacts.
- 2.6 Panel shall be provided with internal illumination lamp with door switch, space heater with thermostat one 5A, 3 pin receptacles with plug.
- 2.7 The annunciation system shall be solid-state type with optical isolation for input signals. It shall be complete with its own power supply, audible alarms, acknowledge, reset, and test buttons and other necessary accessories.
- 2.8 The control panels shall be fully wired up at factory. All spare contacts of relays and switches shall be wires up to the terminal blocks.
- 2.9 The panel shall have provision of cable entry from bottom. Bottom gland plate shall be 3mm thick.
- 2.10 50 x 6 mm copper ground bus shall be provided on the panel extending along the entire length of the assembly. The ground bus shall have two-bolt drilling with GI bolts and nuts at each end to receive Owner/Purchaser's ground connection of 75x10 mm G.I. flat.

3.0 **Features:**



- 3.1 The following minimum components shall be provided in the RTCC panel. Any other feature desired for proper and safe operation of equipment shall be provided. All indicating lamps shall be LED type.
- a) Voltage regulating relay for auto operation where specified.
 - b) Auto-manual selector switch where auto operation specified
 - c) Selector Switch for master follower solo operation.
 - d) Raise-Lower control switch
 - e) Necessary relays and accessories.
 - f) Tap position indicator
 - g) Indication lamps for “Tap change in Progress” and “Control supply healthy”.
 - h) Red lamp to indicate master position
 - i) Cooler operation indication
 - i) Annunciations for:
 - Tap position in progress
 - Mechanism stuck
 - Control supply failure
 - Tap changer A.C. supply failure
 - Oil surge relay operated
- 3.2 Provisions shall be kept in the RTCC for serial link communication with the DCS/ SCADA dedicated for FGD system.
- 3.3 Microprocessor based numerical RTCC where specified shall meet the following minimum requirement:
- a. Same product must be in at least 50 successful installations in India for similar power transformers.
 - b. SCADA compatible on IEC61850/IEC103 protocols with large backlit LCD display to show important parameters like voltage, current, tap position etc.
 - c. Suitable for flush/surface mounting.



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- d. Facility to make Auto/Manual and Local/Remote selections. Manual voltage control shall be possible with the device.
- e. Accept at least 4 selectable set point voltage commands from DCS/SCADA.
- f. Shall have in-built facility to block OLTC operation when under voltage/over voltage or under current/over current conditions arise.
- g. Shall have multiple methods as option for voltage compensation.
- h. Shall have in-built feature to make parallel regulation on at least Master-Follower principle of at least 3 transformers working in parallel without need for any other devices.



MANDATORY SPARES

1.	HV bushing	1 Nos
2.	LV bushing	1 Nos
3.	HV neutral Bushing	1 Nos
4.	Lv neutral Bushing	1 Nos
5.	Bushing CT (HV for winding temperature indicator)	1 sets
6.	Bushing CT (LV for winding temperature indicator)	1 sets
7.	Neutral Bushing CT (HV)	1 sets
8.	Neutral Bushing CT (LV)	1 sets
9.	Complete set of gaskets	1 set
10.	Cooler fan with motor	2 nos
11.	Valve of each type	1 set
12.	Magnetic oil level gauge with contacts	1 No
13.	Pressure relief device with contacts	1 No
14.	Winding temperature indicator with all accessories	1 No
15.	Dial type Oil temperature indicator	1 No
16.	OLTC motor	1 No
17.	Silica gel breather	1 No
18.	Prismatic Oil level gauge	1 No
19.	Contactor (1 no for each type and size. Bidder to indicate the type and contactor forming 1 set)	1 set
20.	Buchholz relay for transformer	1 No
21.	Buchholz relay for OLTC	1 No
22.	Radiator bank of 60% capacity	1 No
23.	Thermostat for transformer marshalling box	1 No

ANNEXURE-H



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3 - Phase Station Transformer to standard: IS-2026

Type : STATION TRANSFORMER	Serial - No.: 12071- 0	Year of manufacture : 20	Standard : IS 2026	Frequency : 50 Hz
Type of cooling : ONAN/ONAF	Insulation level			
Vector group : YNyn0yn0(d11)	Testing voltage (kV)			
Temperature rise :	Um (Nominal rated)			
Oil : 50 °C	AC (Power frequency)			
Windings : 55 °C	LI (Lightning impulse)			

Nominal power	Nominal voltage				Nominal current			
ONAN ONAF	(kV)				ONAN / ONAF (AMPS)			
(MVA)	HV	LV1	LV2	LV3	HV (50/63 MVA)	LV1 (25/31.5 MVA)	LV2 (25/31.5 MVA)	LV3 (16.66/21.0 MVA)
50 63	220	11.5	11.5	11.0	131.22 - 165.34	1255.14 - 1581.48	1255.14 - 1581.48	504.87 - 636.40

% Imp. voltage	HV/(LV1+LV2)	HV/LV1 & HV/LV2	LV1/LV2	HV/LV3	On - Load tap changer
Tap - no	63 MVA	31.5 MVA	31.5 MVA	63 MVA	Type: M III 500 Amps Y 10 19 3W, Easun-MR Make
Tap - 1					Rated Voltage: 123 kV , Rated current: 500 A
Tap - 9					Variation: +10 % TO -10% of HV, No. of steps: 16
Tap - 17					Step Voltage: 1589.6 V; Control voltage: 110 V AC

High Voltage					
Position	Voltage(kV)	Current (A)		Tap selector connection	Change over connection
		ONAN	ONAF		
1(MAX.)	242.00	119.30	150.30	2-12	3-4
2	239.25	120.66	152.03	2-11	
3	236.50	122.06	153.80	2-10	
4	233.75	123.50	155.61	2-9	
5	231.00	124.97	157.46	2-8	
6	228.25	126.48	159.36	2-7	
7	225.50	128.02	161.30	2-6	
8	222.75	129.60	163.30	2-5	
9a	220.00	131.22	165.34	2-4	3-12
9b	220.00	131.22	165.34	2-3	
9c	220.00	131.22	165.34	2-12	
10	217.25	132.88	167.43	2-11	
11	214.50	134.58	169.57	2-10	
12	211.75	136.33	171.78	2-9	
13	209.00	138.13	174.04	2-8	
14	206.25	139.97	176.36	2-7	
15	203.50	141.86	178.74	2-6	
16	200.75	143.80	181.20	2-5	3-12
17(MIN.)	198.00	145.80	183.70	2-4	

Approximate weights	
Core and winding mass	: 76800 kgs
Tank & fittings mass	: 46000 kgs
Oil mass	: 44280 kgs
Total transformer mass	: 167080 kgs
Transport mass(Dry Nitrogen Filled):	106000 kgs
Total oil quantity	: 54000 Litres
Tank, radiators and conservator are vacuum proof	
Caution Before applying vacuum treatment refer to instruction manual.	

FOR DIAGRAM PLATE REFER DRAWING NO : TA9-XYN294001-A6568-ST, PAGE 2 OF 2

Current transformer								
Location	1V	2V & 3V	HV-NEUTRAL		LV1 & LV2-LINE		LV1 & LV2-NEUTRAL	
CT No.	CT1	CT2	CT3		CT4		CT5	
No. of cores	01	01	02		02		02	
			CORE-1	CORE-2	CORE-1	CORE-2	CORE-1	CORE-2
Ratio	184.0/2A	1581.48/2A	500/1A	500/1A	2000/1A	2000/1A	2000/1A	400/1A
Burden (VA)	20	20	20 VA		20 VA		20 VA	
Vk(Min) (Volts)	--	--	≥500 V		≥500 V		≥500 V	
Imag at Vk/2	--	--	≤20 mA		≤20 mA		≤20 mA	
Class	3	3	PS 5P20		PS		PS 5P20	
Rct at 75 degC	--	--	≤2 ohms		≤3.2ohms		≤3.2ohms	
Application	WTI	WTI	REF		Diff.		REF	

LOA No.: C0 CONTS/0028K/NTPL/TTPP/TA9/2007,Dtd: 26.09.2009
MADE BY ABB

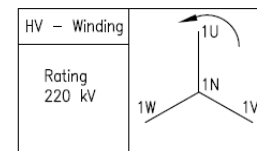
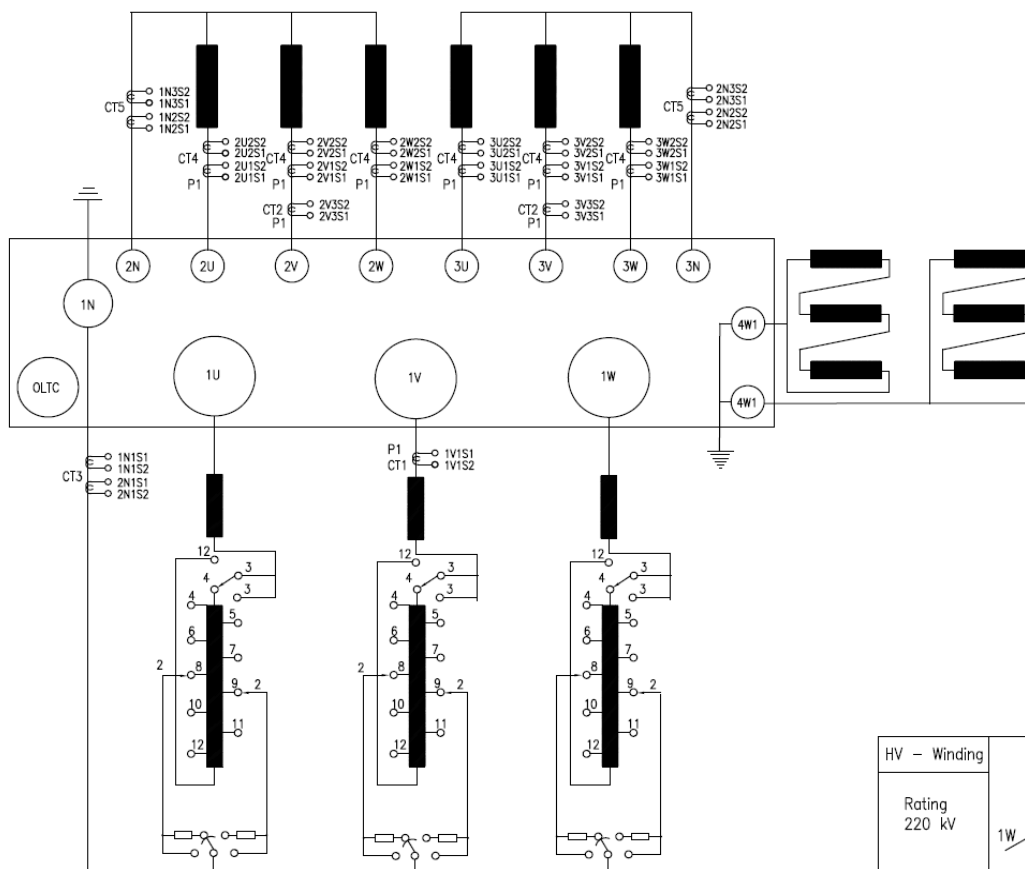
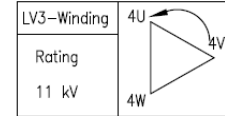
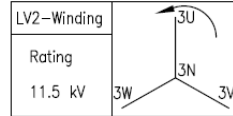
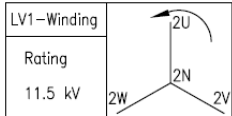


ABB

Type : STATION TRANSFORMER

Vector group : YNyn0yn0(d11)

Serial No: 12071-0



FOR RATING PLATE REFER DRAWING NO.
TA9-XYN294001-A6568-ST,PAGE 1 OF 2

LOA No.: CO CONTS/0028K/NTPL/TTPP/TA9/2007,Dtd: 26.09.2009

MADE BY ABB



VOLUME : II-A

SECTION-V

PROTECTIVE COATING AND PAINTING

1.00.00 INTENT OF SPECIFICATION

1.01.00 This specification addresses the requirements of all labour, material, and appliances necessary with reference to preparations for lining / painting, application as well as finishing of all lining / painting for all mechanical and electrical equipment, piping and valves, structures etc. included under the scope of this Flue Gas Desulphurisation Plant package.

1.02.00 The bidder shall furnish and apply all lining, primers including wash primers if required, under-coats, finish coats and colour bands as described hereinafter or necessary to complete the work in all respects.

2.00.00 CODES & STANDARDS

2.01.00 The bidder shall follow relevant Indian and international standards wherever applicable in cleaning of surface, selection of lining material / paints and their application. The entire work shall conform to the following standards / specifications (latest revision or as specified).

a)	SSPC SP 10 / NACE 2 / SA 2½	:	Near white blast cleaning
B)	SSPC PA 2	:	Measurement of dry film coating thickness with magnetic gauges.
c)	ASTM D 45	:	Method for pull off strength using portable adhesion tester.
d)	NACE RP 0274 – 2004	:	High-voltage electrical inspection of pipeline coatings.
e)	NACE SP 0188 – 2006	:	Discontinuity (holiday) testing of new protective coatings on conductive substrates.
f)	NACE RP 0169 – 2002	:	Control of external corrosion of underground or submerged metallic piping systems.





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- g) AWWA C 210 – 2007 : Liquid-epoxy coating systems for the interior and exterior of steel water pipelines.
- h) IS 3589:2001 Annexure-b : Steel pipes for water and sewage specification.
- i) AWWA C 222-2000 : Polyurethane coating for the interior and exterior of steel water pipe and fittings.
- j) IS 13213 : 2000 : Polyurethane full gloss enamel (two pack)
- k) ISC HD 20 (11902) : Polyurethane coating for interior and exterior of steel pipe and fittings.
- l) ISC HD 20 (11055) : Solvent less liquid epoxy system by application of interior and exterior surface of steel pipeline.
- m) IS 10221 : Coating and wrapping for buried piping

3.00.00 GENERAL REQUIREMENTS

- 3.01.00 The bidder shall submit a detailed written description in the form of a manual covering coating equipment, procedures, materials inspection test, and repair etc. to owner/consultant for approval.
- 3.02.00 The bidder shall also provide certificates from paint/primer manufacturer mentioning the batch numbers, date of manufacture and shelf life etc. of the materials to be used. In addition to that manufacturing quality plan (MQP) and field quality plan (FQP) shall also be submitted prior to commencement of supply of material and field application.
- 3.03.00 Paint/coating application work at site shall be done either by paint manufacturer or by their authorized applicator. The authorized applicator shall have proper training & certification from manufacturer. Applicator shall possess all the necessary specialized equipment and manpower experienced in similar job.
- 3.04.00 If necessary, the material may be heated and applied by airless spray / plural component spray system.





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- 3.05.00 Manufacturer's specific recommendation, if any, shall be followed during application of lining / paints.
- 3.06.00 In areas where there is danger of spotting automobiles or other finally finished equipment or building by wind borne particles from paint spraying, a purchaser approved method shall be adopted.
- 3.07.00 The colour scheme of the entire FGD Plant equipment and auxiliaries area, covered under this specification shall be approved by the purchaser in advance before application.
- 3.08.00 All indoor and outdoor piping, insulated as well as uninsulated will have approved colour bands painted on the pipes at conspicuous places throughout the system, as approved by purchaser.
- 3.09.00 Inside surfaces of vessels / tanks shall be protected by anticorrosive paints or rubber lining as required / specified elsewhere in the specification. External surfaces of all vessels / tanks shall be protected by anti-corrosive painting.
- 3.10.00 For vessels / tanks requiring lining and anti-corrosive painting all inside surface shall be blast cleaned using non-siliceous abrasive after usual wire brushing.
- 3.11.00 Natural rubber lining shall be provided on the inside of vessels / tanks as required / specified elsewhere in the specification, in three layers resulting in a total thickness not less than 4.5 mm.
- 3.12.00 Surface hardness of rubber lining shall be 65 +/- 5 deg. A (shore).
- 3.13.00 After the lining is completed, the vessels / tanks shall not be subjected to any prolonged exposure to direct sunlight in course of its transportation, erection etc. They shall not be stored in direct sunlight. No further lining or burning shall be carried out on the vessel, after application of the lining.
- 3.14.00 All lining projecting outside of the vessel shall be protected adequately from mechanical damages during shipment, handling storage etc.
- 3.15.00 Suitable warnings, indicating the special care that must be taken with respect to these lined vessels shall be stenciled on their outside surface with the letters at least 12 mm high.
- 3.16.00 All insulated piping shall have aluminium sheet jacketing.

4.00.00 SURFACE PREPARATION

- 4.01.00 Most metallic articles that are usually given protective coatings are heavily contaminated and require, at least, some cleaning treatment before the coating is applied. The importance of surface preparation cannot be over emphasized as many investigations have shown convincingly that the performance and durability of any protective coatings are, to a large extent governed by the thoroughness of surface preparation. Often they concluded





that careful cleaning and preparation of the surface were more important than the quality of the protective coating.

4.02.00 Surface contamination in the form of rust, scale, oil grease and dirt is often obvious. Invisible contamination may also be present and represents, on the whole, a greater hazard. Examples of the latter are soldering fluxes, perspiration in the form of hand marks, chlorides from marine atmosphere and sulfite from industrial atmosphere.

4.03.00 The following table gives a surface preparation specification in the descending order of Effectiveness:

Sl. No.	Methods of cleaning	Specifications NACE/SSPC
1.	White metal blast	NACE # 1, SSPC SP 5-63
2.	Near –white metal blast	NACE # 2, SSPC SP 10-63
4.	Acid Pickling	SSPC SP 8-63
5.	Brush Blast	NACE # 4, SSPC SP 7-63
6.	Flame Clean and Power Sanding	SSPC SP 4-63
7.	Power Tool Cleaning	SSPC SP 3-63
8.	Chip and Hand Wire Brush	SSPC SP 2-63
9.	Solvent Wipe	SSPC SP 1-63

4.04.00 The following table gives the Specifications for sand / shot / grit blasting

Sl. No.	Methods of Cleaning	Specification
1.	NACE # 1	White sand blast
2.	NACE # 2	Near-white sand blast
3.	NACE # 3	Commercial blast
4.	Pickle, phosphate treated	
5.	NACE # 1	Grit
6.	NACE # 1	Shot
7.	NACE # 4	Brush blast
8.	No surface preparation	

4.05.00 Inspection of blasted steel surface

For the purpose of inspecting the blasted steel surface with sand abrasive, the respective “Visual standards” shall be utilized.

The standards used in industry to describe surface preparation are:

- i. National association of Corrosion Engineers (NACE)
- ii. Steel Structural Painting Council (SSPC)
- iii. Swedish Pictorial Standards

White metal blast (SSPC 5-63, NACE No.1, and SA-3)

This is defined as removing all rust, scale, paint etc. to a clean white metal which has a uniform Grey white appearance. Streaks and stains of rust or





other contaminants are not allowed.

Near white metal (SSPC 10-63, NACE No.2, SA – 2.5)

This provides a surface of about 95% as clean as white metal. Light shades and streaks are not allowed.

Commercial blast (SSPC 6-63, NACE No.3, SA –2)

This type of blast is more difficult to describe. It essentially amounts to about 2/3 of a white metal blast, which allows for very slight residues of rust and paint in the form of staining.

Brush of blast (SSPC 7-63, NACE No.4 SA-1)

This preparation calls for removal of loose rust, paint, scales, etc. Tightly adherent paint, rust and scale is permitted to remain.

4.06.00 Pictorial Standards of different surface preparation to be adopted

During surface preparation operations, the surface condition obtained shall be compared with pictorial standards available for getting the specified condition. These pictorial standards are available in steel structural painting Manual (Vol. 1), "Good painting practice ", visual standards of surface cleaning sp 7,6,10 and 5 are described in page No.185 and 186 viz. Fig 9,11,12 and 13.Surface profile gauge and surface compactor could be used to check surface conditions according to NACE standard TM 01 70 of NACE.

4.07.00 PRESSURIZED WATER CLEANING METHODS

These standards provides requirements for the use of high and ultra-high pressure water jetting to achieve various degrees of surface cleanliness. This standard is limited in scope to the use of water only without the addition of solid particles in the stream. These standards define four levels of working pressure:

SSPC-SP WJ-1/NACE WJ-1:	Water-jet cleaning of metals. Clean to bare substrate.
SSPC-SP WJ-2/NACE WJ-2:	Water-jet cleaning of metals. Very thorough cleaning.
SSPC-SPWJ-3/NACEWJ-3:	Water-jet cleaning of metals. Thorough cleaning.
SSPC-SP WJ-4/NACE WJ-4:	Water-jet cleaning of metals. Light cleaning.





This cleaning standard defines 4 levels of cleanliness for visible contamination by water jetting and 3 levels for non-visible contamination, such as chlorides and other soluble salts. See the full standard for complete definitions on the level of cleanliness.

4.08.00 SPECIFICATIONS FOR COPPER SLAG BLASTING:

1. The surface shall be cleaned of all dust and heavier layers of rust by copper slag blasting the entire internal surface to photographic standard SIS: 055900- 1967.
2. The consumption rate of copper slag is 1.6 Kg/Sqm of the blasted area. This has to be ensured strictly.
3. All tools, equipment, base material, hand and power tools for cleaning, including scaffolding material, copper slag blasting equipment, air compressor, etc. shall be arranged by the contractor at site in sufficient quantity.
4. The compressor used shall be of size enough to produce displacement of 5.6 to 7.0 Cum/Min of air at a pressure of 7 Kg/sq.cm. Standard blasting equipment, hoppers, hoses nozzles and attachments shall be used to obtain best test results and to maintain safety standards. The rate of cleaning shall be about 15 sq.mt. per hour at a pressure of 7 kg/sq.cm.
5. The abrasive used shall be of the physical properties as mentioned below and shall be free from oil, loan and mud etc.
6. The blast cleaned surface shall be blasted with dry compressed air before applying primer. This should be done even if the surface appears very clean and white in colour. The white colour may be due to deposition of silicon and reflection of light on the surface.
7. Proper earthing and bonding arrangements shall be made to prevent any damage by sparks produced by static electricity. Bonding shall be done between tank and blast nozzles and hopper and air compressor also. The bonding conductor should not be less than 16 SWG single strand copper cable.
8. The time gap between blast cleaning and application of primer shall not be more than THREE hours. Blast cleaning work shall, commence from top to bottom.
9. The blast cleaning operation shall be carried out keeping the nozzle at an angle of 30 degree to the vertical in order to prevent rebounding abrasive from showing down the abrasives emerging from nozzle and from under cutting the material to be removed.
10. A blast cleaning, the percentage of bare metal obtained shall be between 95% to standards of SA 2 ½ of the Swedish standard referred above. (Pictora) surface preparation standards for painting steel surfaces).





11. Arrangements for inspection of various stages of the job shall be made available by the Contractor so that the entire sand blasted area is available for inspection. Any defective work noticed shall be immediately rectified and even reblasting shall be done if necessary.

5.00.00 PAINT APPLICATION

The coating is a unique product. It is only after application on the substrate a coating becomes valuable and useful. The manufacturer shall produce high performance liquid coatings, yet the product usefulness lies in the hands of the applicator. That is the reason why stress is given for proper and careful application as a key to the success of any coating. Protection by coating mainly depends upon three factors

- a) The material
- b) The surface preparation
- c) The application

If any one of the three is weak, protection value is affected to that extent.

High performance coatings are especially sensitive to misapplication and may fail drastically. Therefore, it is imperative that the instruction for application be followed explicitly, particularly when applying sensitive and expensive high performance coating systems.

The purpose of coating application is to develop a continuous highly adherent film with an even thickness over the substrate. To achieve this, various factors have to be considered such as type of coatings and weather conditions, application methods etc. It is advisable to avoid painting below 10°C and above 40°C, if the relative humidity is above 80%, during the rainy weather and wind velocity is above 24km/hr or else freezing will occur before the paint dries.

5.01.00 Application methods

There are a number of methods by which coatings can be applied. The two principal methods are by brush and spray. The other methods are paint pad applications, electrostatic spray, electro-coating, dipping and fluidized bed technique. The latter methods are primarily for in-plant application.

The choice of application methods depends on a number of factors. The first is the type of coating. Most of the oil-based coatings can be easily applied by brush but it is the slowest process. Spray application is the fastest for large flat surfaces. The type of surface is also a factor. For small and intricate areas, brushing is probably the best method. If the surface is used and pitted, application of the first coat by brushing is probably the best method.

Brushing can be done in almost all areas, since the liquid coating is transferred from the brush to the surface. Spraying however, causes problem with toxic solvents as well as a possible fire hazard due to fume build up.





Spraying in small, enclosed areas are usually not suggested. Clean up is also a factor. Cleaning a brush is the least difficult procedure and cleanup of spray equipment is the most time consuming and most complicated procedure.

5.02.00 Storing and handling of paints

Coating materials (paint) as they are packed at the manufacturing plant are thoroughly dispersed, with the pigments fully suspended and of a uniform consistency in terms of both texture and colour. Unfortunately, very few coatings are applied within a short time after manufacture. They may be placed in inventory at the manufacturing plant or sent to a distribution point where they will be held for a period of time. Also, the coating material may be purchased several months before its actual use and again under different conditions. Thus, coatings generally must be remixed and properly re-dispersed prior to actual application.

A pigment, which is usually heavier than the vehicle, tends to settle and may even cake at the bottom of the container. Coatings vary to a wide degree in this particular characteristic. Some may stay suspended for many years; others settle out hard at the bottom of the container. This is a defect. Paints, which gelled in the container or in which the pigment liveried (i.e. become thick and rubbery) are not satisfactory for use and cannot be practically redispersed. The formulation has to contain proper antissettling additive to avoid this defect.

The purpose of remixing and re-dispersion is to make the coating completely homogeneous, so that upon application the pigment and vehicle can produce the film that was intended by the manufacturer. In certain cases, particularly in oil-type vehicles, there may be skin on the surface of the liquid. These should be removed before re-dispersion, since they will not get redispersed into the vehicle.

5.03.00 Mixing

The mixing process is not practically easy, even if the system has not settled hard. This is often neglected by applicators, particularly in coatings, which have settled rather solidly. There have been examples of coatings that were applied with at least half of the pigment remaining at the bottom of the container un-dispersed and later thrown away with the container. This procedure does not allow for the maximum performance of coating properties and normally leads to rapid coating failure.

Mechanical mixing

It is always better to use a mechanical mixer of some type, since mechanical mixing always produces a more uniform coating and does so much more rapidly than manual mixing. Manual mixing should only be done under unavoidable circumstances and only in containers with the maximum of a 20-liter capacity.





Even when the coating has settled rather hard, the propeller-type agitator can break it up and re-disperse it to a point, which is closely equivalent to its original form. Nevertheless, care should be taken in the mixing operation, particularly to ensure that the material at the bottom and lower sides of the container has been well separated from the container and re-dispersed. Some materials form soft sediment, which clings to both the sides of the container and the bottom, making it necessary to scrape these off before they can be properly dispersed. This is usually done by manual operation. The mixing should be done in such a manner that splashing is avoided.

The speed of a mechanical mixer should be as low as possible in order to obtain the re-dispersion of the pigment in the vehicle. The coating should have a slight vortex at the surface. A large vortex tends to mix air into the coating, which can cause pinholes and air bubbles during application.

Manual mixing

If the manual mixing is necessary, the liquid portion of the coating should be separated into a clean container. The lower, thicker part of the coating can then be more readily mixed into a heavy paste, including the material, which is clinging to the sides of the container. Once the heavier material is mixed into a smooth paste, the remainder of the liquid from the second container can be remixed into the original container with the heavy material, making sure that the two are thoroughly mixed into a uniform coating. One way to do this is to pour the material back and forth between the two containers. This is called boxing. The materials should be poured back and forth several times to assure complete uniform mixing.

5.04.00 Two component coatings

In the case of two component coatings, there are two materials that must be checked to determine whether or not they are properly dispersed prior to being mixed together. Two component coatings are extremely common at the present time. They include numerous kinds of epoxy coatings, coal tar epoxy coatings, polyurethane coatings, and inorganic zinc coatings. With two component coatings, it is essential that the two components be separately and thoroughly mixed. Two component materials are designed to react chemically, so that if they are not thoroughly mixed, the chemical reaction may not take place properly. Mechanical blending of the two components is recommended to obtain a thoroughly mixed product. The two component materials often are in different colours so that a satisfactory mixing can be readily identified. The fully mixed coating should have a uniform colour and consistency.

5.05.00 Mixing dry powder and liquid

The primary example of mixing dry powder and liquid components is in the use of inorganic zinc coatings. In-organic zinc coatings are made from liquid component and dry powdered zinc. The first step is to determine whether or not the liquid component is thoroughly mixed and dispersed to a completely



homogeneous liquid. This usually is not difficult since most liquid components are lightly pigmented.

Second, stir the total contents of the powder slowly into the total content of the liquid until it becomes a well dispersed, free flowing material. In the case of inorganic zinc coatings, the manufacturers supply the liquid and the powder in two different containers in the exact amount that should be mixed. It is essential that the total powder and total liquid be used in order to obtain the desired final coating. Mixing small portions of zinc and liquid is not recommended, since correct proportions are seldom measured under field conditions.

5.06.00 Straining

Most coatings are thoroughly strained prior to being placed in their container. When the container is opened, if the contents have not settled to a hard deposit in the bottom, straining in the field may not be necessary. On the other hand, if the pigment has settled hard, if the coating has a skin on the surface, or if the product is a material such as inorganic zinc, straining is recommended. Straining prior to spraying often eliminates considerable downtime due to gun clogging by small particles those blocks the orifice in the gun.

Straining can be done with a fine fly screen with a mesh size 150µm or through nylon stocking. Nylon stocking does not contain any lint and is a very fine mesh that most coating materials can readily pass through. Mosquito netting or similar materials also are used, although they often contain some lint, which can cause problems.

5.07.00 Compatibility of different paints

While applying multicoated system of paint it is always desirable to have a first-hand knowledge of compatibility of different coating systems with one another. A general view of such information is given in the following table. This is only a general view.

Primer	Oleo resinous	Alkyd	Silicone alkyd	Vinyl	Chlorinated rubber	Epoxy (2 pack)	Urethane
Oleoresins	C	C	C	NR	NR	NR	NR
Alkyd	C	C	C	NR	NR	NR	NR
Silicone alkyd	C	C	C	NR	NR	NR	NR
Phenol resin	C	C	C	NR	NR	NR	NR
Vinyl	C	C	NR	C	C	C	NR
Chlorinated rubber	C	C	C	C	C	NR	NR
Epoxy	NR	NR	NR	C	C	C	C
Coal tar epoxy	NR	NR	NR	NR	NR	C	NR



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Zinc-rich epoxy	NR	NR	NR	NR	C	C	NR
Inorganic zinc	NR	NR	NR	C	C	C	NR
Urethane	NR	NR	NR	NR	NR	NR	C

TE: C-Normally

NOTE: C-Normally compatible; NR- Not recommended due to known or suspected problems. Certain combinations marked "NR" may be used provided a suitable tie coat is applied.

6.00.00 INSPECTION

Inspection techniques shall be applied at various stages i.e. from purchase of coating materials to paint application and evaluation of performance during service. Inspection procedures at various stages before and after the application of coating systems over the oil installations have been described below:

6.01.00 Paint composition

The type of paint system shall be selected depending upon the environmental conditions. Generally primer, undercoat and finish coats are used in protective coating system. The purchased paint materials are used in protective coating system. The purchased paint materials shall be tested for the following properties to ascertain whether the supplied paint conforms to the specifications.

- i. Type of film formers present
- ii. Type of pigments present
- iii. Thickness per coat
- iv. Volume solids
- v. Pigment volume concentration
- vi. Area coverage per liter of the paint
- vii. Specific gravity
- viii. Drying time and
- ix. Main pigment content in total pigmentation

It is the duty of the inspection engineer to get the paint system tested for the above factors. The painting operation shall be started only after the values obtained coincide with the required specification of the paint system.

It is essential to see that the surface is not wet during the application of the paint. Moreover paints should not be applied when the humidity of the environment is above 80%. The atmospheric temperature should not be below 10°C during the painting operation.



6.02.00 Procedure for testing paint samples

The following laboratory test procedures shall be adopted for the characterization of the film-formers, pigments and studying the properties of the paint.

a) Type of film-formers present

The film former shall be separated out of the paint by means of centrifuging. It is then to be analyzed using infrared spectroscopy for identifying the functional group. i.e. the type of film formers.

b) Type of pigments present

After separating the pigment from the paint and proper drying, it shall be subjected x-ray diffraction for identifying the pigment.

c) Thickness per coat

Magnetic thickness gauges are used to measure the thickness of the paint film applied over the iron-substrate. The thickness is measured in micrometer (μm). Some of the thickness gauges operating under magnetic principle are elecometer, posi test and micro test. Thickness gauges operating on eddy current principle are used to measure coating thickness over metals other than steel/magnetic substrates.

d) Volume solids

Paint is a mixture of three major components such as pigment, binder and thinner.

The pigment and film-former will remain in the paint film after the evaporation of the solvent. The pigment and film former together are called as solids. The volume of these together in the liquid paint is called as volume solids. This is determined as follows:

A known volume of the paint is taken. Let it be V1. Distilling the solvent and collecting it in a measuring cylinder determine the volume of the solvent present of the paint. Let it be V2. By subtracting V2 from V1, we can determine the volume solids.

e) Pigment volume concentration (PVC)

Pigment volume concentration is defined as

$$\text{PVC} = \frac{\text{Volume of pigment}}{\text{Volume of pigment} + \text{Volume of binder}} \times 100$$

By separating out the pigment and binder from the paint and knowing their specific gravity, we can calculate PVC.

f) Area coverage per liter of the paint



This is determined by taking a known volume of the paint and applying it over a surface. The area covered by the known volume of the paint is determined. From this value, area covered by one liter of the paint is calculated.

g) Specific gravity

For determining specific gravity, a cup of known volume is taken. The difference in weight of the cup filled with paint and the empty cup gives the weight of paint of known volume. From this, we can calculate specific gravity.

h) Drying time

i) Touch Dry

In this case, if the coated surface is touched with finger, no finger mark should be found on the coating.

ii) Hard Dry

It is the condition of coating drying very hard. Unless the coating itself is damaged with force, no pressure could mar the coating in this condition. This condition is attained usually after seven days.

i) Flow properties (viscosity) of the paint (Ford cup method)

Ford cup is the mostly used instrument for studying the flow properties of the paint. Ford cups having different orifice sizes are available in the market. The varying orifice sizes are meant for measuring the flow time of different viscosities. Generally, the most viscous liquids require bigger orifice. The results are reported simply as seconds per cup. Number

6.03.00 Spot testing procedures

The following spot tests will be useful to identify the binders (film-formers) qualitatively before application at the site.

a) EPOXY RESIN

i) Filter paper test

This test can be carried out even with paint itself. 0.5 gms of paint part (binder part) / binder is taken in a 100 ml beaker and treated with 1ml concentrated sulfuric acid. The beaker is slightly heated at 60°C for a few minutes. It is again mixed with 5ml of conc. H_2SO_4 until the colour intensity is similar to that of very dilute potassium-di-chromate solution. A drop of the solution is taken in a glass rod and is spread over a filter paper. If Bis-phenol-A-type of epoxy resin is present, a purple colour develops in 1 minute, the colour eventually turns blue.





ii) Formaldehyde Test

Few drops of the sample is dissolved in 1 to 2 ml of concentrated sulphuric acid if necessary by heating to 40°C to 50°C. One to two drops of formaldehyde solution is added in to it. An orange colour, which on dilution with water turns violet to blue indicates the presence of epoxy resins.

b) Chlorinated rubber resin

Few milligrams of the sample is allowed to stand in pyridine at room temperature for few minutes. Few drops of methanolic potassium hydroxide solution is added in to it. If chlorinated rubber resin is present in the solution, a yellow precipitate is formed which gradually darkness to a yellow-brown colour.

c) Isocyanate hardener

The aliphatic nature of isocyanate is confirmed by the following spot test. A small sample of isocyanate hardener is heated in a test tube until white fumes are evolved and these fumes are absorbed on a filter paper. One drop of a solution of 4-nitrobenzene-di-azofluoroborate in methanol (1%) on the filter paper should give any coloration, confirms the presence of aliphatic isocyanate. If any coloration is seen on the filter paper, this will confirm the presence of aromatic isocyanate

The infrared spectra of the aliphatic isocyanate will show peaks at 1370 cm⁻¹ and 2250-2350 cm⁻¹.

Physical, Chemical and Instrumental methods of paint analysis with their relevant standards are given in the following tables.

i) Physical Tests

Paint property	IS Standard	ASTM
Preparation of panels	IS 101 PART1 – SEC3	D 609
Preparation of Tin panels	IS 101 PART1 – SEC3	D 609
Viscosity (KU)	IS 101 PART1 – SEC5	D 562
Weight per Gallon	IS 101 PART1 – SEC 7	D 1475
Fineness of Grind	IS 101 PART3 – SEC 5	D 1210
Water content	IS 101 PART2 –SEC 1	D 95
Coarse particles and skins		D 185
Drying times Set to touch Dry for recoating Dry hard	IS 101 PART3 – SEC 1 & 2	D 1640
Pigment content	IS 101 PART8 – SEC 2	D 2371
Vehicle content		D 2371
Non – volatile content	IS 101 PART2 – SEC2 & PART8 – SEC –2	D 2369
Adhesion	IS 101 PART5 – SEC2	D 3359
Brushing properties	IS 101 PART1 – SEC4	



Exposure tests of paints on metals		D 1014
Salt spray resistance	IS 101 PART6 – SEC1	B 117
Accelerated weathering	IS 101 PART6 – SEC5	D 822
Leafing		D 480
Flexibility	IS 101 PART5 –SEC	D 522

ii) Chemical Tests

PAINT PROPERTY	TEST METHOD (ASTM)
Chemical resistance	D 1308
Liquid dryers	D 564
Aluminum	D 480
Aluminum silicate	D 718
Calcium carbonate	D 34
Extenders in colors	D 126
Iron oxide	D 768, D 50
Leaded zinc oxide	D 34
Red lead	D 49
Water soluble salts	D 2448, D 2455
Zinc oxide	D 34
Zinc powder	D 521
Zinc sulfide	D 34

iii)

) Instrumental Tests

Paint property	Test method (ASTM)	Instrument
Dry Opacity	A 2805	Reflectometer
Gloss	D 523	Gloss meter
Color	D 2244	Colorimeter
Vehicle Identification	D 3168 D 3271	Infrared spectrophotometer Gas chromatograph
Solvent solids Identification	D 3271	Gas chromatograph
Vehicle solids Identification	D 2621	Infrared spectrophotometer

7.00.00 SPECIFICATION OF COATING SYSTEM

7.01.00 Protective coating for steel structures

Most commonly used coating system for atmospheric zone of blast cleaned steel structures are given below:

7.01.01 System-1



**Tender Specification
for
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NLC Tamil Nadu Power Ltd.
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Tuticorin, Tamil Nadu

Coating system used for atmospheric open exposure zone is one coat of inorganic zinc-rich primer, one coat of epoxy-Glass flake filled intermediate coating and one coat of aliphatic polyurethane provides better performance in more aggressive services. The coating system for closed atmosphere is also the same system with the replacement of aliphatic urethane with aromatic polyurethane top coat. The surface preparation of this Zinc rich primer requires sand blasted surface or grid blasted surface to the Swedish Specification of Sa 2.5. The coating systems are to be applied by spray method. The specification of the system is as given below:

i. Specification of Inorganic zinc rich primer

Colour	Green Grey
Gloss Level	Matt
Volume Solids	63%
Typical Thickness (DFT)	70-80 microns
Theoretical Coverage	8.40 m ² /litre
Method of Application	Airless Spray, Air Spray
Drying Time	One Hour
Volatile Organic Compound	216 g/ Litre
Mix Ratio	Liquid Binder Base part(A) 3: Powder Zinc component part (B)1
Working Pot Life	2-2.5 hours
Shelf Life	1 year

ii. Specification for glass flake filled epoxy coating

Colour	As desired
Finish	Semi-Glossy
Type	Two packs
Application	By brush or spray
Dry film thickness/coat	100– 110 µm
Volume solids	Approx. 90 ± 2 %
Area coverage (theoretical)	8 to 9 sq.m/ litre
Surface dry	4 hrs.
Hard dry	24 hrs.
Over coating	24 hrs.
Recoatibility	24 hours.
Full cure	1 week.
Shelf life	12 months

iii. Specification for Aliphatic Polyurethane top coat for open zone

Colour	Required colour
Gloss Level	Glossy
Volume Solids	63±2%
Typical Thickness (DFT)	50-60 microns
Theoretical Coverage	8 - 9 m ² /litre
Method of Application	Airless Spray, Air Spray
Guiding data for airless spray:	
Nozzle tip (inch/1000)	15-21





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Pressure at nozzle (minimum)	150 bar/2100 psi
Drying Time	One Hour
Volatile Organic Compound	340 g/ Litre
Mix Ratio	Acrylic Polyol Base part 5: Aliphatic Isocyanate Hardener part 1
Working Pot Life	3 hours
Shelf Life	2 years

iv. Specification for Aromatic Polyurethane top coat for closed zone

Colour	Required colour
Gloss Level	Glossy
Volume Solids	63±2%
Typical Thickness (DFT)	50-60 microns
Theoretical Coverage	8-9 m ² /litre
Method of Application	Airless Spray, Air Spray

Guiding data for airless spray:

Nozzle tip (inch/1000):	15-21
Pressure at nozzle (minimum):	150 bar/2100 psi
Drying Time	One Hour
Volatile Organic Compound	340 g/ Litre
Mix Ratio	Acrylic Polyol Base part 5: Aliphatic Isocyanate Hardener part 1
Working Pot Life	3 hours
Shelf Life	2 years

7.01.01 System-2

The surface preparation is not possible through blast cleaning, then the surface is cleaned with wire brushing or power tool cleaning and coated with two coats of non aluminium epoxy mastic followed by an aliphatic polyurethane coating is recommended.

i. Specification for non aluminium Epoxy mastic paint (High build)

Colour	As desired
Finish	Semi-Glossy
Type	Two pack
Application	By brush or Airless spray
Dry film thickness/coat	100-110 microns
Volume solids	Approx. 80 ±2 %
Area coverage (theoretical)	6 to10 sq.m/litre
Surface dry	4 hrs.
Hard dry	12 hrs.
Recoatibility	24 hours.
Full cure	7 days.
Shelf life	months (or as recommended by manufacturer)

ii. Specification for Aliphatic Polyurethane top coat for open zone





**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

Colour	Required colour
Gloss Level	Glossy
Volume Solids	63±2%
Typical Thickness (DFT)	50-60 microns
Theoretical Coverage	8-9 m ² /litre
Method of Application	Airless Spray, Air Spray

Guiding data for airless spray

Nozzle tip (inch/1000):	15-21
Pressure at nozzle (minimum):	150 bar/2100 psi
Drying Time	One Hour
Volatile Organic Compound	340 g/ Litre
Mix Ratio	Acrylic Polyol Base part 5: Aliphatic Isocyanate Hardener part 1
Working Pot Life	3 hours
Shelf Life	2 years

7.02.00 Protective coating system for Pipelines without Cathodic Protection

There are a number of factors to be considered for the selection of an external pipeline coating including physical and chemical stability of the coating in the pipeline environment, adhesion, and resistance to impact. The pipeline should be cleaned and prepare the surface for painting as follows:

The pipeline surface shall be cleaned. The main objective of surface preparation is to ensure that all contamination (rust, mill scale, etc.) is removed to reduce the possibility of initiating corrosion so that a surface profile is created that allows satisfactory adhesion of the paint to be applied. The surface of the pipe is cleaned with a wire brush or power tool cleaning to get the surface of Sa 2/St 3. Thus prepared surface to be cleaned with lint free cloth, which also includes cleaning & dewatering (in case of valve chamber) and drying the surface. After preparing the surface of the pipe for painting, the primer coat, undercoat and finish coat shall be applied. The coating system recommended for the pipeline is high build epoxy mastic coating as primer followed by an epoxy glass flake filled coating with the top coat of aliphatic polyurethane. The specifications of the systems are given below:

i. Specification for Epoxy mastic paint (High build)

Colour	As desired
Finish	Semi-Glossy
Type	Two pack
Application	By brush or Airless spray
Dry film thickness/coat	100-110 microns
Volume solids	Approx. 80 ±2 %
Area coverage (theoretical)	6 to 10 sq.m/litre
Surface dry	4 hrs.
Hard dry	12 hrs.
Recoatability	24 hours.





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Full cure	7 days.
Shelf life	12 months (or as recommended by manufacturer)

- ii. Specification for glass flake filled epoxy coating
- | | |
|-----------------------------|----------------------|
| Colour | As desired |
| Finish | Semi-Glossy |
| Type | Two packs |
| Application | By brush or spray |
| Dry film thickness/coat | 100– 110 μ m |
| Volume solids | Approx. 90 $\pm$ 2 % |
| Area coverage (theoretical) | 8 to 9 sq.m/ litre |
| Surface dry | 4 hrs. |
| Hard dry | 24 hrs. |
| Over coating | 24 hrs. |
| Recoatibility | 24 hours. |
| Full cure | 1 week. |
| Shelf life | 12 months |

- iii. Specification for Aliphatic Polyurethane top coat for open zone

Colour	Required colour
Gloss Level	Glossy
Volume Solids	63 $\pm$ 2%
Typical Thickness (DFT)	50-60 microns
Theoretical Coverage	8-9 m ² /litre
Method of Application	Airless Spray, Air Spray

Guiding data for airless spray:

Nozzle tip (inch/1000):	15-21
Pressure at nozzle (minimum):	150 bar/2100 psi
Drying Time	One Hour
Volatile Organic Compound	340 g/ Litre
Mix Ratio	Acrylic Polyol Base part 5: Aliphatic Isocyanate Hardener part-1
Working Pot Life	3 hours
Shelf Life	2 years

7.03.00 Protective coating for all other surfaces

The surface shall be cleaned with wire brushing or by power tools (St3). These structures will be protected by three layer system of Epoxy zinc rich primer followed by Glass Flake filled epoxy and aliphatic polyurethane finish coat. The specifications of the coating system are given below:

- i. Specification for Epoxy Zinc rich primer

Colour	Grey
Finish	Matt
Type	Two pack
Application	By brush or spray





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Pigment (Main)	Zinc dust (30-40% by wt. of the total pigments.)
Type of epoxy	Condensation product of bisphenol-A and Epoxide equivalent Epichlorohydrin with terminal Epoxide groups 450-500
Curing agent	Polyamide (amine value 210-230)
Dry film thickness/coat	50-60 μ m
Volume solids	55 $\pm$ 2% (volume)
Area coverage (theoretical)	11 to 14 sq.m/litre
Surface dry	2-3 hrs.
Hard dry	24 hrs.
Re-coatability	24 hours.
Full cure	5 days.
Shelf life	6 months under sealed conditions

ii. Specification for Epoxy glass flake paint

Colour	As desired
Finish	Semi-Glossy
Type	Two packs
Application	By brush or spray
Dry film thickness/coat	100-110 μ m
Volume solids	Approx. 90 $\pm$ 2 %
Area coverage (theoretical)	8 to 9 sq.m/ litre
Surface dry	4 hrs.
Hard dry	24 hrs.
Over coating	24 hrs.
Re-coatability	24 hours.
Full cure	1 week.
Shelf life	12 months

iii. Specification for aliphatic Polyurethane top coat

Colour	Required colour
Gloss Level	Glossy
Volume Solids	63 $\pm$ 2%
Typical Thickness (DFT)	50-60 microns
Theoretical Coverage	8-9 m ² /litre
Method of Application	Airless Spray, Air Spray

Guiding data for airless spray:

Nozzle tip (inch/1000):	15-21
Pressure at nozzle (minimum):	150 bar/2100 psi
Drying Time	One Hour
Volatile Organic Compound	340 g/ Litre
Mix Ratio	Acrylic Polyol Base part 5: Aliphatic Isocyanate Hardener part-1
Working Pot Life	3 hours
Shelf Life	2 years





7.04.00 Summary of Specification of Coating System

The summary of the coating system shall be as mentioned below:

Area	Surface preparation	Recommended coating scheme
Directly exposed to Sunlight- Steel structures	Copper shot blasting to Sa2.5	Scheme I
	Power tool cleaning to St3	Scheme II
Indoor –Steel Structures	Copper shot blasting to Sa2.5	Scheme III
	Power tool cleaning to St3	Scheme IV
Pipelines (over ground)	Power tool cleaning to St3	Scheme V
All other surfaces	Wire brushing / Power tool cleaning to St3	Scheme VI

7.04.01 Scheme-I: For blast cleaned structures and exposed to sunlight

For new steel structures/Existing steel structures	Exposed to sun light Outdoor)	
Surface preparation	Copper slag blasting to Sa2.5	
Primer	Zinc ethyl silicate	50 – 60µm
Undercoat	Epoxy Glass flake (high build)	100 – 110 µm
Top Coat	Aliphatic polyurethane (TiO ₂) rutile	50 – 60µm
Total dry film thickness (DFT)		200 –230µm

7.04.02 Scheme-II: For under prepared structures and exposed to sunlight

For new steel structures/Existing steel structures	Exposed to sun light (Outdoor)	
Surface preparation	Power tool cleaning St-3/Paint strippers	
Primer	Epoxy mastic(non aluminium)	100 – 110µm
Undercoat	Epoxy mastic(non aluminium)	100 – 110 µm
Top Coat	Aliphatic polyurethane (TiO ₂) rutile	50 – 60µm
Total dry film thickness (DFT)		250 –280µm

7.04.03 Scheme- III: For blast cleaned structures and not exposed to sunlight





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For new steel structures/Existing steel structures	Not exposed to sunlight (Indoor)	
Surface preparation	Blast Cleaning to Sa2.5	
Primer	Zinc Ethyl Silicate	50 – 60µm
Undercoat	Epoxy Glass flake (high build)	100 – 110 µm
Top Coat	Aromatic polyurethane TiO ₂ (rutile)	50 – 60µm
Total dry film thickness (DFT)		200 –230µm

7.04.04 Scheme-IV: For under prepared structures and not exposed to sunlight

Surface preparation	Mechanical chipping / Power tool cleaning St-3/Wire brushing St-2	
Primer	Self-priming epoxy mastic	100 – 150µm
Under coat	Self-priming epoxy mastic	100-110 µm
Top Coat	Aromatic polyurethane TiO ₂ (rutile)	50 – 60µm
Total dry film thickness (DFT)		250 –320µm

7.04.05 Scheme- V: For pipelines (above ground)

Surface preparation	Mechanical chipping / Power tool cleaning St-3/Wire brushing St-2	
Primer	Self-priming epoxy	100 – 150µm
Under coat	Epoxy Glass flake (high build)	100-110 µm
Top Coat	Aliphatic polyurethane TiO ₂ (rutile)	50 – 60µm
Total dry film thickness (DFT)		250 –320µm

7.04.06 Scheme-VI: Coating specifications for all other surfaces

Surface preparation	Power tool cleaning St-3/ Paint strippers	
Primer	Epoxy Zinc rich	50 – 60µm
Under coat	Epoxy glass flake	100-110µm
Top Coat	Aliphatic polyurethane TiO ₂ (rutile)	50 – 60µm
Total dry film thickness (DFT)		200–230µm

8.00.00 TESTING REQUIREMENTS





8.01.00 Measurement of dry film thickness

Measurement of dry film thickness of coating: coating thickness shall be in the range of $\pm 20\%$ and as per SSPC PA 2.

8.01.01 Apparatus / instrument

The instrument used for dry film thickness may be type 1 pull of gauges or type 2 electronic gauges.

8.01.02 Procedures

a) Number of measurements

For 100 square feet (9.29 square meters), five (5) spots per test area (each spot is 3.8 cm) in diameter. Three gauge readings per spot (average becomes the spot measurement).

b) If the structure is less than 300 square feet, each 100 square feet should be measured.

c) If the structure is between 300 and 1000 sq ft, select 3 random 100 square feet test areas and measure.

d) For structure exceeding 1000 square feet, select 3 random 100 square feet testing areas for the first 1000 sq ft and select 1 random 100 square feet testing area for each additional 1000 square feet

e) Coating thickness tolerance: individual reading taken to get a representative measurement for the spot are unrestricted (usually low or high readings are discarded). Spot measurements (the average of 3 gauge readings) must be within 80% of the minimum thickness and 120% of the maximum thickness.

Area measurement must be within specified range.

8.02.00 Electrical inspection (holiday) test

8.02.01 All the coated / lined pipes shall be tested with an approved high voltage holiday detector preferably equipped with an audio visual signaling device to indicate any faults, holes, breaks or conductive particles in the protective coating.

8.02.02 The applied output voltage of holiday detector shall have a spark discharge of thickness equal to at least twice the thickness of the coating to assure adequate inspection voltage and compensate for any variation in coating thickness. The electrode shall be passed over the coated surface at approximately half the spark discharge distance from the coated surface only one time at the rate of approximately 10 to 20m/min. The edge effect shall be ignored. Excessive voltage shall be avoided as it tends to induce holiday in the coated surface thereby giving erroneous readings.





- 8.02.03 While selecting test voltages, consideration should be given to the tolerance on coating thickness and voltage should be selected on the basis of maximum coating thickness likely to be encountered during testing of a particular pipe.

The testing voltage shall be calculated by using following formula. (as per NACE 0274 : 2004)

Testing voltage $v = 7900\sqrt{t} \pm 10\%$ where t = the average coating thickness, mm.

- 8.02.04 Any audio visual sound or spark leads to indicate pinhole, break or conductive particle.

- 8.03.00 Adhesion pull off test

After holiday the coated surface is subjected to adhesion pull off test as per ASTM D 4541.

- 8.03.01 Apparatus / instrument: adhesion tester consists of three basic components:

A hand wheel, a black column containing a dragging indicator pin and scale in the middle and a base containing three legs and a pulling "jaw" at the bottom and also dollies.

- 8.03.02 Prepare the test surface

Once test area is selected, test area shall be free of grease, oil, dirt, water. The area should be flat surfaces and large enough to accommodate the specified number of replicate test.

- 8.03.03 Prepare dolly (test pull stub)

The dolly is a round, two sided aluminium fixture. Both sides of the dolly looks same, however, one side sloped on top surface while flat on bottom surface. As the surface of the dolly is polished aluminium, roughen the same using a coarse sand paper.

- 8.03.04 Select an adhesive

Use araldite, a 100% solid epoxy adhesive. This adhesive requires at least 24 hours at room temperature to cure.

- 8.03.05 Attach the dolly to the surface

a) Using a wooden stick, apply an even layer of adhesive to the entire contact surface area of the dolly.

b) Carefully remove the excessive adhesive by using a cotton swab. Allow the adhesive to fully cure before performing the adhesion test.

c) Attach the dolly to the coated surface and gently push downward to





displace any excessive adhesive.

- d) Push the dolly inward against the surface, and then apply tape across the head of the dolly.

8.03.06 Adhesion test procedure

- a) Attach the adhesion tester to the dolly by rotating the hand wheel counter clockwise to lower the jaw of the device.
- b) Slide the jaw completely under the head of the dolly. Position the three legs of the instruments so that they are sitting flat on the coated surface.
- c) Slide the dragging indicator pin on the black column to zero by pushing it downward.
- d) Firmly hold the base of the instrument in one hand and rotate the hand wheel clockwise to raise the jaw of the device that is attached to the head of the dolly. The dragging indicator pin will move upward on the black column as the force is increased and will hold the reading. Apply the tension using a moderate speed. Continue to increase the tension on the head of the dolly until (a) the minimum psi/mpa/kg/cm² required by project specification is exceeded and the test is discontinued, (b) the maximum psi/mpa/kg/cm² of adhesion tester has been achieved and dolly is still attached, (c) the force applied by the adhesion tester causes the dolly to dislodge.
- e) Read the scale and record the adhesion value.

8.04.00 Coating repair

Defective coating shall be repaired in accordance with the following subsections.

8.04.01 Surface preparation

Accessible areas of pipe requiring coating repairs shall be cleaned to remove debris and damaged coating using surface grinders or other means. The adjacent coating shall be feathered by sanding, grinding or other method. Accumulated debris shall be removed by blowing with contaminant free air or wiping with clean rags.

8.04.02 Areas not accessible for coating repair such as interior surfaces of small diameter pipe shall be reprocessed and recoated.

8.04.03 Coating application

The coating system shall be applied to the prepared areas in accordance with procedure.

8.04.04 Repair inspection:





Repaired portion shall be electrically inspected using a holiday detector.

8.05.00 Welded field joints

8.05.01 Preparation

The weld joints shall be cleaned so as to be free from mud, oil, grease, welding flux, weld spatter and other foreign contaminants. The cleaned metal surfaces of the weld joint shall then be blasted or abraded using rotary abrading pads. The adjacent liquid epoxy / pu coating shall be feathered by abrading the coating surface for a distance of 25 mm.

8.05.02 Electrical inspection

After curing the coating system applied to the welding joints shall be holiday tested. Any holidays indicated by the detector shall be marked with chalk to identify the area of repair.

9.00.00 INFORMATION / DATA REQUIRED

The bidder shall submit complete list of paints and primers proposed, giving detail information, such as, chemical composition, drying time etc. And also unit rates for application of each type of paint along with supply shall be furnished.

ANNEXURE-I
MARKET AVAILABLE COATING SYSTEMS AS PER SPECIFICATION

Sl.No.	Specification	ASIAN PAINTS	BOMBAY PAINTS GRAUER & WEIL Paints	BERGER PAINTS	GRAND POLYCOTS	International Protective Coatings	KRISHNA CONCHEM
1.	Zinc Ethyl Silicate Primer	Apcosil 605 ZS	Zinc-o-sil 75	Zinc Anode 304	GP Prime 402	InterZinc 22	-
2.	Epoxy Zinc rich Primer	Apcodur CP 686			GP Prime 205	Inter Zinc 42	
3.	Self Priming Epoxy Mastic Paints	Rust-O-Cap	Pentdur Mastic 5527	Berger protecto Mastic	GP Prime guard 235	Interplus 256	-
4.	Epoxy Glass Flake Paint	Apcodur glass Flake EP	Pentadur Glass Flake 3580	Epilux Super Build ST Glass Flake Coating	GP SUPERGUA RD GLASS- FLAKE	Interzone 505	Karaikote 100 S
5.	Aliphatic Polyurethane Paint	Apcothane CP 674	Pentathane 4512 (M)	Polyuretha ne Coating	GP Bond 141	Interthane990	-
6..	Aromatic Polyurethane Paint	---	--	--	GP 131 COAT	---	



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7.	Moisture Compatible anti Corrosion system				Epilux Durebild WSE Coating		Karaikote- 6545
8.	Epoxy red oxide primer	AP CODUR Epoxy polyamide primer					
9.	Epoxy MIO Under coat	AP CODUR Epoxy MIO Under coat					
10.	Epoxy TiO2 Under coat	AP CODUR Epoxy 420HS					



Development Consultants Pvt. Ltd.

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**Vol. II-A/Section-V
Protective Coating & Painting**

**PROJECT ENGINEERING & SYSTEMS DIVISION****RC PURAM, HYDERABAD.****QUALITY & BUSINESS EXCELLENCE****INSPECTION / TC REVIEW FORMAT**

1	Vendor's Name:		5	Applicable BHEL Spec No:	
2	Project:		6	Approved Drawing No:	
3	PO No:		7	Approved Data Sheet No:	
4	Item Description:		8	Approved QAP No:	

OFFER LIST

S.No	BBU/ PO Sr. No.	Item Description	Total Qty as per PO/BBU	Qty. already accepted	Qty offered for TC review	Cumulative Qty	Balance Qty
A							
B							
C							
D							

TC REVIEW REQUISITION

BBU / PO Sr. No.	QAP Clause No.	Format of Record	Certificate No. & Date	Page No.	REMARKS
A. Item Description:					
B. Item Description:					
C. Item Description:					
D. Item Description:					
E. Item Description:					

SUPPLIER / VENDOR SIGNATURE WITH SEAL**BHEL/ BHEL's TPIA SIGNATURE WITH SEAL****Dt:****Dt:**

TD-201 Rev No. 00	Form No.		PRODUCT STANDARD PROJECT ENGINEERING & SYSTEMS DIVISION HYDERABAD	ANNEXURE- Page 1 of 3
COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED, It must not be used directly or indirectly in any way detrimental to the interest of the company. QAP GUIDELINES & FORMAT (ANNEXURE -) The QAP format and guidelines for filling up the format shall be used by vendor for preparation and submission of QAP after order placement. Note : 1. Typical /Indicative /Standard QAP(s) for equipment /package attached is reference document and to use by successful bidder in future for preparation and submission of detailed QAP for BHEL /CUSTOMER approval. 2. No deviation to Typical /Indicative /Standard QAP is acceptable.				

	Form No.	 HYDERABAD	PRODUCT STANDARD PROJECT ENGINEERING & SYSTEMS DIVISION HYDERABAD	ANNEXURE- Page 2 of 3
	<u>GUIDELINES TO VENDORS FOR PREPARATION OF QUALITY ASSURANCE PLAN</u> 1. QAP shall be made in landscape mode on A4 size paper as per the format enclosed. Font size shall be minimum 10. 2. Each page of QAP shall contain the following information. a) Vendor's name & address. b) Customer: BHEL, Hyderabad. c) Project. d) BHEL Product Standard Number/revision number as referred in P.O. e) BHEL Purchase Order Number & Date. f) Product as per P.O. description. g) QAP Number (unique and shall not repeat)/revision number/date. h) Page number and number of pages 3. QAP shall contain four parts / stages as follows. a) Raw materials and bought out items. b) In process Control / Inspection. c) Final assembly, Inspection & Testing. d) Painting, preservation & packing. 4. Under 'Component', indicate name of the component (say casing, rotor, pressure gauge, etc). 5. Under 'Characteristics', indicate appropriately (say chemical analysis, mechanical properties, NDT (UT,DP etc.), hydrostatic test, calibration check etc.) 6. Under 'Class', indicate minor, major or critical depending on the importance of characteristic. 7. Under 'Type of check', indicate appropriately (say chemical, mechanical, UT, DP etc.) 8. Under 'Quantum of check', indicate appropriately (say 100%, 10%, sample, per melt, per heat, all pieces etc.) 9. Under 'Reference document' and 'Acceptance norms', appropriate National & International standards, BHEL standards, approved drawing references etc. should be indicated. It is not correct to mention as "Vendor's internal standards or Vendor's standard practice etc.". If vendors' internal standards are referred, same shall be in line with BHEL Spec. indicated in the P.O. These may require review & approval by our Engineering dept.			
	Ref. Doc		10. Under 'Format of record', indicate appropriately supplier's test certificate, calibration certificate, lab report, inspection report etc. 11. Please refer 'Agency' in QAP format. Under P: Perform, W: Witness, V: Verify Indicate against each characteristic 1: (BHEL CQS/Nominated inspection agency), OR	

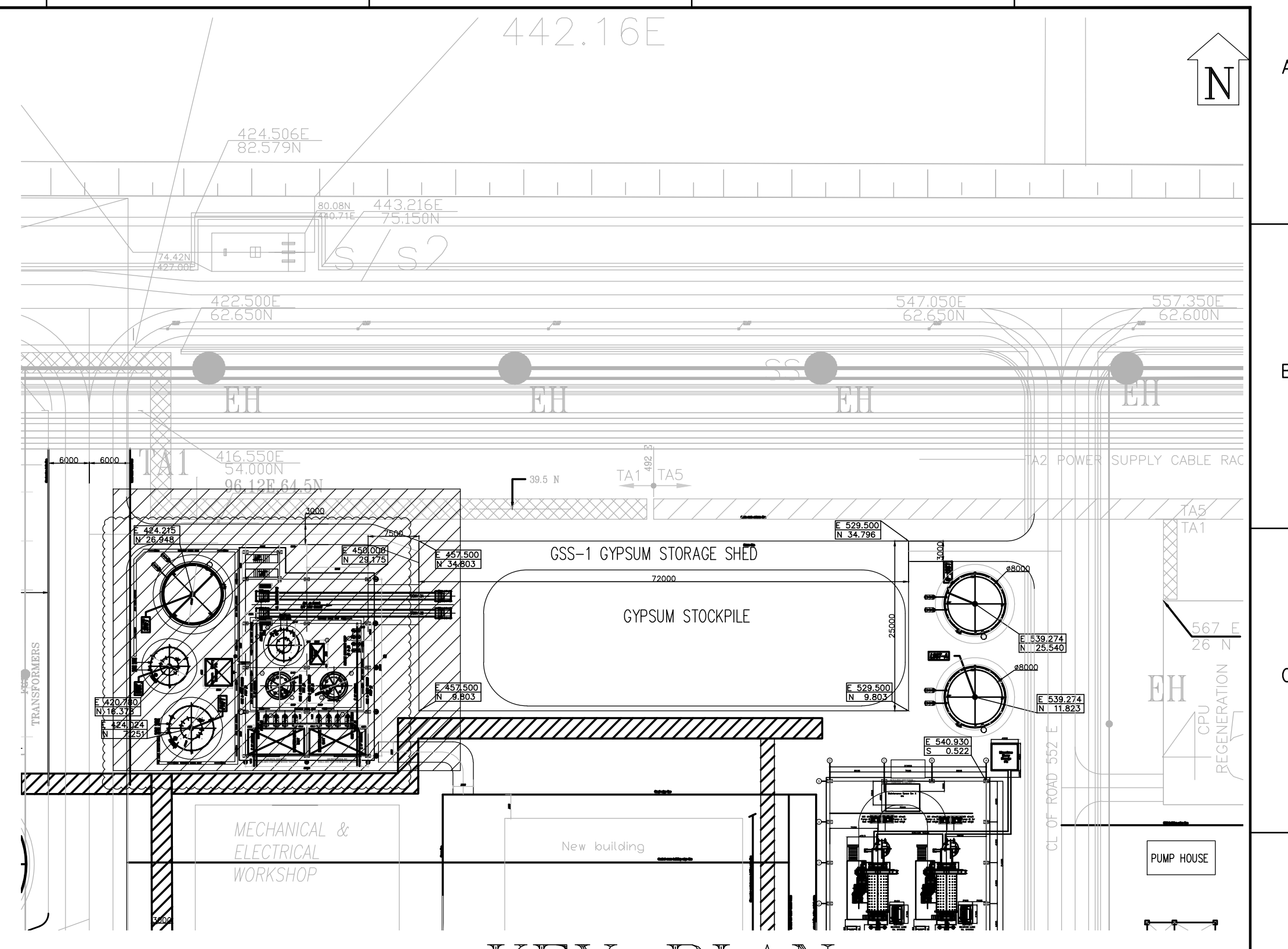
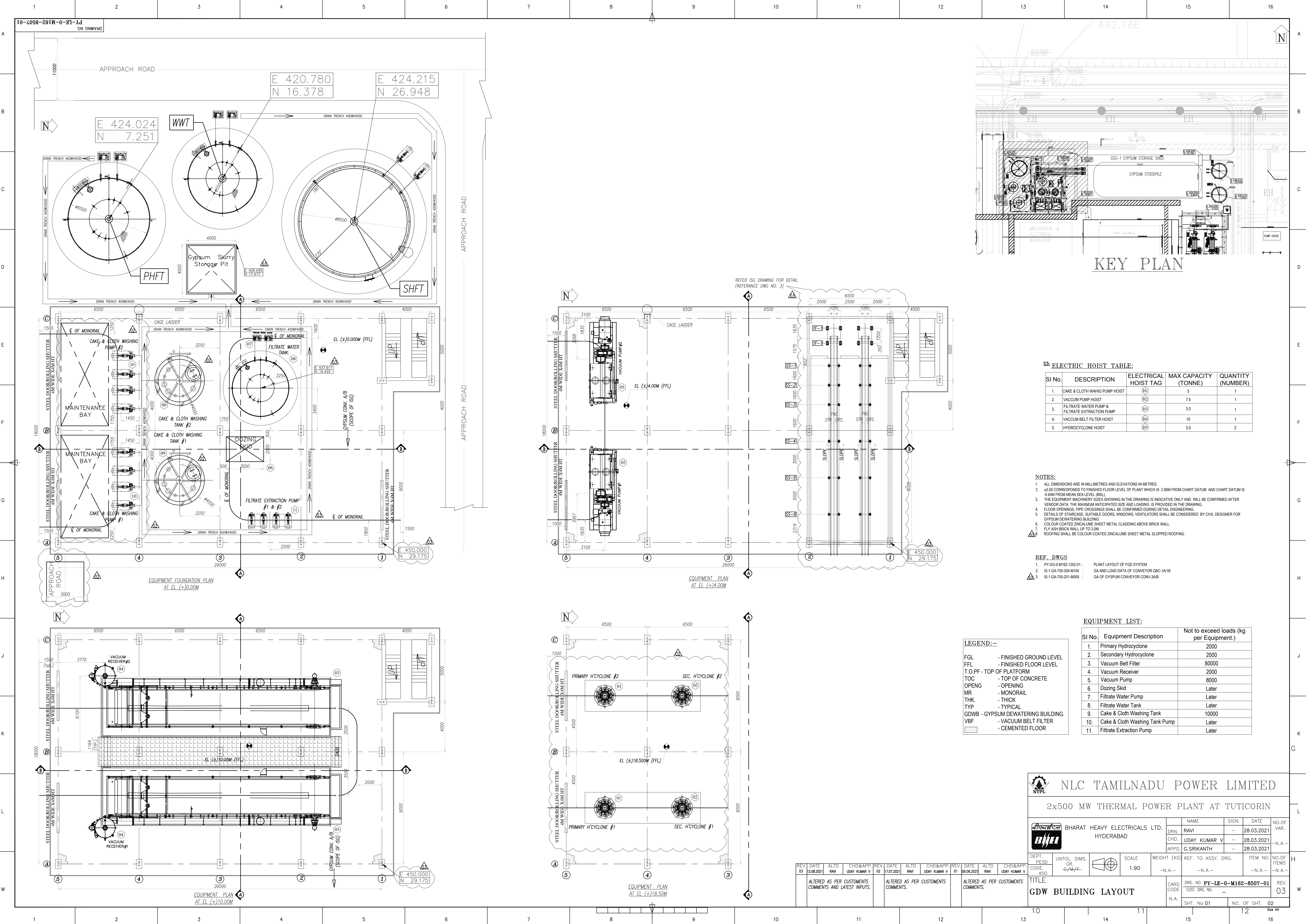
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	Form No.	 HYDERABAD	PRODUCT STANDARD PROJECT ENGINEERING & SYSTEMS DIVISION HYDERABAD	ANNEXURE-
				Page 3 of 3
COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED . It must not be used directly or indirectly in any way detrimental to the interest of the company.		2: (Vendor / Sub vendor) Note: Performing agency is normally vendor or his sub vendor (Legend 2). Where witness points are indicated in specification, P.O., Drawing etc., for such operations, under Witness (W) column use 1. Under 'Verify' column, use code 1. 12. Under 'D' please put (☐ Tick) against each characteristic where vendor proposes to submit test certificate/report etc. OR as required as per BHEL Specification. 13. Vendor's signature & stamp should be available on each page of QAP. 14. Vendor should read the BHEL Product Standard thoroughly and QAP should be made only inline and relevant to the Specification & Approved Drawings. 15. The following operations/characteristics/check points may be included (AS APPROPRIATE) a) Visual check b) Dimensional check c) Mechanical and Chemical properties. d) Surface preparation before painting (by chemical cleaning, sand blasting, shot blasting etc. as the case may be.) e) Painting check for shade, Dry Film Thickness (DFT), Adhesion/ peel off test etc. f) Check for correctness for all components mounted as per General arrangement Drawing, Bill Of Materials (BOM), etc. for range, rating, make, color, size, location as per GA, quantity, label description including tag nos., annunciator facia, loose components, accessories, spares etc. g) Verification of test certificate for protection class for the enclosures. h) Mechanical functioning of switches. i) Continuity of earthing and provision of earth points. j) Colour coding of wiring, size, tightness & dressing of wiring. k) Review of test certificates of assembled items, raw materials, internal test reports etc. l) Witness of functional checks, which may include mechanical run & electrical run, H.V.test, IR measurement, Electrical and Mechanical tests etc. m) PQR, WPS, Welder Qualification Record, welding records (fit up, DP) etc. n) Material identification (for punch marks of serial numbers, Heat No, Melt No, Inspector's stamp etc.) o) Hydraulic Pressure Test, Pneumatic Pressure Test, Liquid Penetration Examination and other Non Destructive Tests. p) Tests on Galvanised items (Visual, Hammer Test, Knife Test, Thickness, Pierce Test (Copper sulphate test), Hydrogen evaluation test, Stripping test (for Mass of Zinc coating) q) All tests as per BHEL Product Standard & approved drawings including Type tests and Routine tests on individual items and on System as a whole. r) For loose items, test certificate or COC is required. s) Packing and Preservation. 16. QAP Format enclosed. 17. Typical Manufacturing QAP is attached.		
		Ref. Doc		

VENDOR'S NAME & ADDRESS:			MANUFACTURING QUALITY PLAN						QP. NO.:				
									REV NO:		DATE:		
			CUSTOMER: PROJECT: PRODUCT:			BHEL P.O.NO.: P.O.DATE: BHEL SPEC:			REV:			PAGE 1 OF 1	
SL NO	COMPONENTS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	* D	AGENCY P W V			REMARKS
1.0	RAW MATERIALS & BOUGHT OUT ITEMS												
2.0	INPROCESS INSPECTION												
3.0	FINAL INSPECTION & TESTING												
4.0	PRESERVATION & PACKING												

VENDOR TO NOTE: THIS FORMAT IS IN MICROSOFT WORD. HEADER & FOOTER SHALL BE AVAILABLE IN EACH PAGE OF QP. QP SHALL BE IN LANDSCAPE & A4 SIZE ONLY. FONT SIZE SHALL BE MIN 10. VENDOR SHALL SIGN & STAMP IN EACH PAGE OF QP. LOI REF. & DATE ARE NOT ACCEPTABLE. P.O.NO. & DATE SHALL BE INDICATED. QP NO. SHOULD BE UNIQUE AND SHALL NOT REPEAT. ALL THE TESTS / CHECKS INDICATED IN THE BHEL SPEC. SHALL BE INDICATED IN THE QP.

LEGEND: P: PERFORM, W: WITNESS, V: VERIFICATION. INDICATE 1 FOR BHEL CQS (OR BHEL NOMINATED INSPECTION AGENCY) & 2 FOR VENDOR/SUB VENDOR AS APPROPRIATE AGAINST EACH COMPONENT /CHARACTERISTIC UNDER P, W & V COLUMNS. * FOR ITEMS MARKED ✓ (TICK) IN COLUMN 'D', TEST CERTIFICATES SHALL BE SUBMITTED TO BHEL FOR RECORDS.	PREPARED BY	APPROVED BY	APPROVED BY
	VENDOR'S SIGNATURE & STAMP	BHEL QA SIGNATURE & STAMP	CUSTOMER'S SIGNATURE & STAMP



ELECTRIC HOIST TABLE:

SI No.	DESCRIPTION	ELECTRICAL HOIST TAG	MAX CAPACITY (TONNE)	QUANTITY (NUMBER)
1.	CAKE & CLOTH WASH PUMP HOIST	(H1)	5	1
2.	VACUUM PUMP HOIST	(H2)	7.5	1
3.	FILTRATE WATER PUMP & FILTRATE EXTRACTION PUMP	(H3)	3.0	1
4.	VACUUM BELT FILTER HOIST	(H4)	10	1
5.	HYDROCYCLONE HOIST	(H5)	3.0	2

- NOTES:
- 1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS IN METRES.
 - 2. ±0.00 CORRESPONDS TO FINISHED FLOOR LEVEL OF PLANT WHICH IS 2.90M FROM CHART DATUM AND CHART DATUM IS -0.64M FROM MEAN SEA LEVEL (MSL).
 - 3. THE EQUIPMENT MACHINERY SIZES SHOWING IN THE DRAWING IS INDICATIVE ONLY AND WILL BE CONFIRMED AFTER VENDOR DATA. THE MAXIMUM ANTICIPATED SIZE AND LOADING IS PROVIDED IN THE DRAWING.
 - 4. FLOOR OPENINGS, PIPE CROSSINGS SHALL BE CONFIRMED DURING DETAIL ENGINEERING.
 - 5. DETAILS OF STAIRCASE, SUITABLE DOORS, WINDOWS, VENTILATORS SHALL BE CONSIDERED BY CIVIL DESIGNER FOR GYPSUM DEWATERING BUILDING.
 - 6. COLOUR COATED ZINCALUME SHEET METAL CLADDING ABOVE BRICK WALL.
 - 7. FLY ASH BRICK WALL UP TO 3.0M.
 - 8. ROOFING SHALL BE COLOUR COATED ZINCALUME SHEET METAL SLOPPED ROOFING.

- REF. DWGS
- 1. PY-DG-0-M162-1252-01 : PLANT LAYOUT OF FGD SYSTEM
 - 2. IS-1-GA-755-204-M104 : GA AND LOAD DATA OF CONVEYOR GBC-1A11B
 - 3. IS-1-GA-755-201-M009 : GA OF GYPSUM CONVEYOR CONV-3AB

- LEGEND:-
- FGL - FINISHED GROUND LEVEL
 - FFL - FINISHED FLOOR LEVEL
 - T.O.P.F - TOP OF PLATFORM
 - TOC - TOP OF CONCRETE
 - OPNG - OPENING
 - MR - MONORAIL
 - THK - THICK
 - TYP - TYPICAL
 - GDWB - GYPSUM DEWATERING BUILDING.
 - VBFB - VACUUM BELT FILTER
 - CEM - CEMENTED FLOOR

EQUIPMENT LIST:

SI No.	Equipment Description	Not to exceed loads (kg per Equipment.)
1.	Primary Hydrocyclone	2000
2.	Secondary Hydrocyclone	2000
3.	Vacuum Belt Filter	80000
4.	Vacuum Receiver	2000
5.	Vacuum Pump	8000
6.	Dozing Skid	Later
7.	Filtrate Water Pump	Later
8.	Filtrate Water Tank	Later
9.	Cake & Cloth Washing Tank	10000
10.	Cake & Cloth Washing Tank Pump	Later
11.	Filtrate Extraction Pump	Later

NLC TAMILNADU POWER LIMITED

2x500 MW THERMAL POWER PLANT AT TUTICORIN

BHARAT HEAVY ELECTRICALS LTD.
HYDERABAD

NAME	SIGN.	DATE	NO. OF VAR.
DRN. RAVI	—	28.03.2021	
CHD. UDAY KUMAR V	—	28.03.2021	N.A.
APPD. G.SRIKANTH	—	28.03.2021	

DEPT. P.E.S.D
CODE 450

UNTO. DIMS. GR. *G.M.F.*

SCALE 1:90

WEIGHT (KG) —N.A.—

REF. TO ASSY. DRG. —N.A.—

ITEM NO. —N.A.—

NO. OF ITEMS —N.A.—

TITLE
GDW BUILDING LAYOUT

CARD CODE N.A.

DRG. NO. **PY-LE-0-M162-8507-01**
CUST. DRG. NO. —

REV. 03

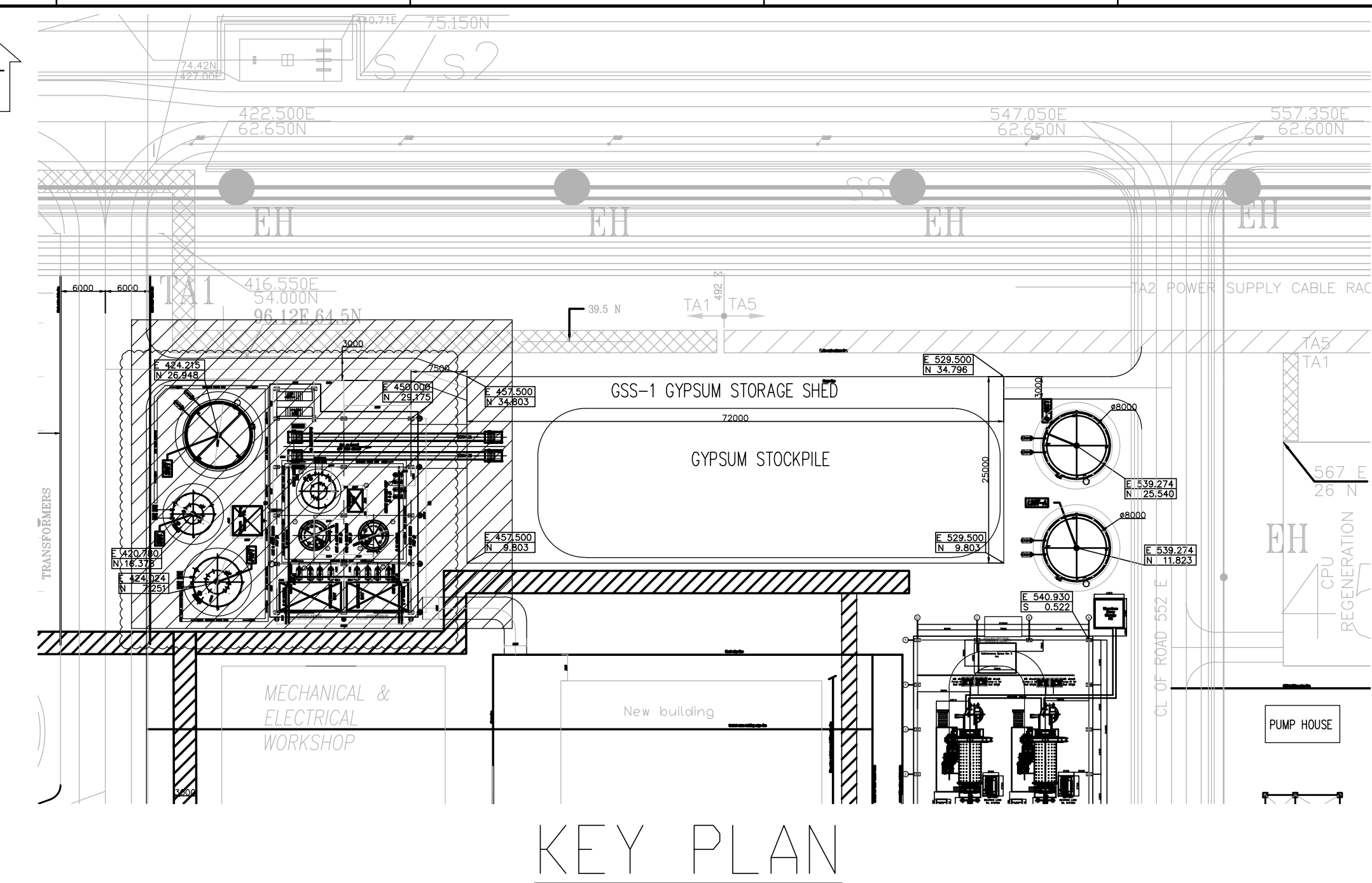
SHT. No 01

NO. OF SHT. 02

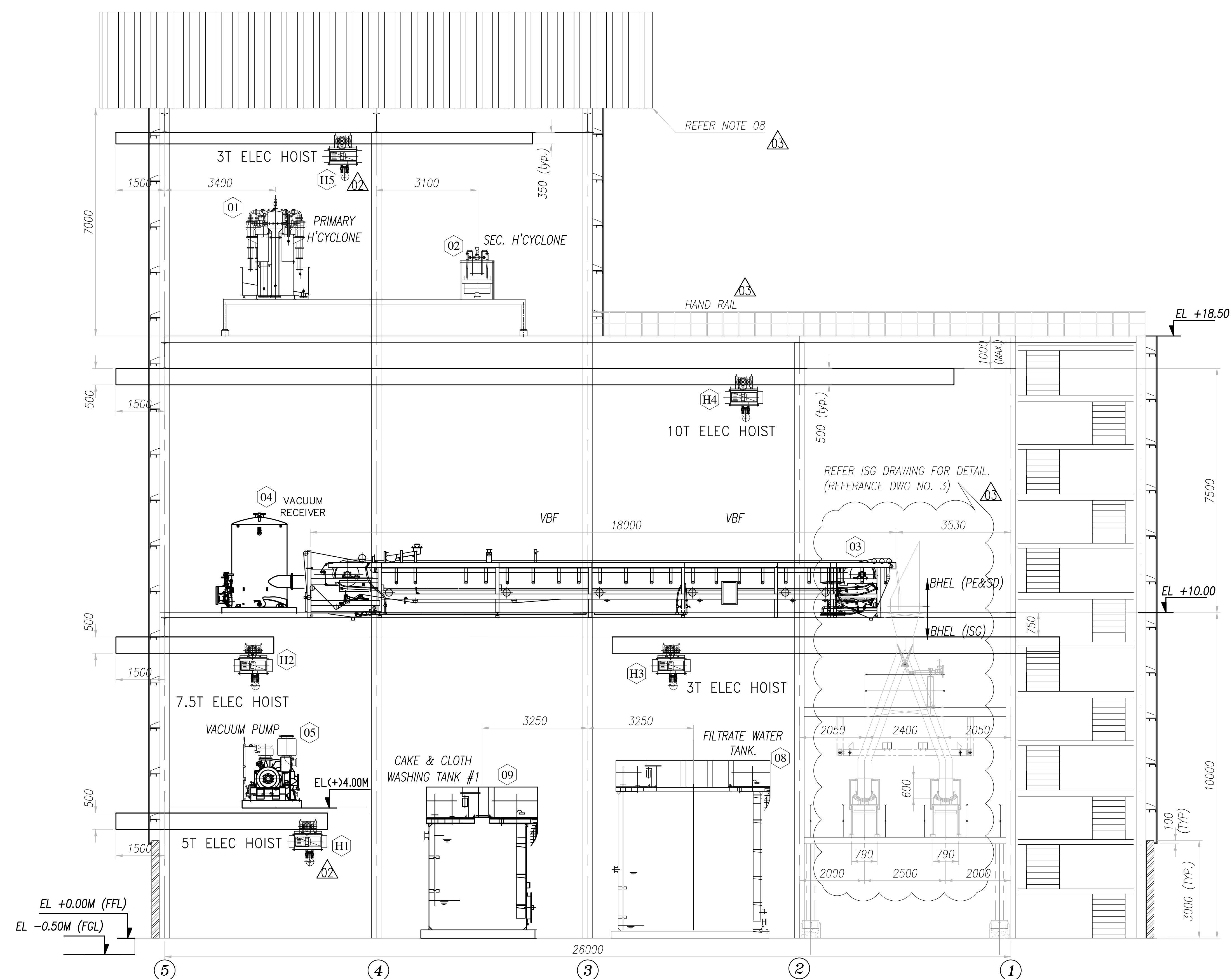
Size A0

REV.	DATE	ALTD	CHD.&APP.	REV.	DATE	ALTD	CHD.&APP.	REV.	DATE	ALTD	CHD.&APP.
03	12.08.2021	RAVI	UDAY KUMAR V	02	17.07.2021	RAVI	UDAY KUMAR V	01	09.06.2021	RAVI	UDAY KUMAR V
ALTERED AS PER CUSTOMERS COMMENTS AND LATEST INPUTS.				ALTERED AS PER CUSTOMERS COMMENTS.				ALTERED AS PER CUSTOMERS COMMENTS.			

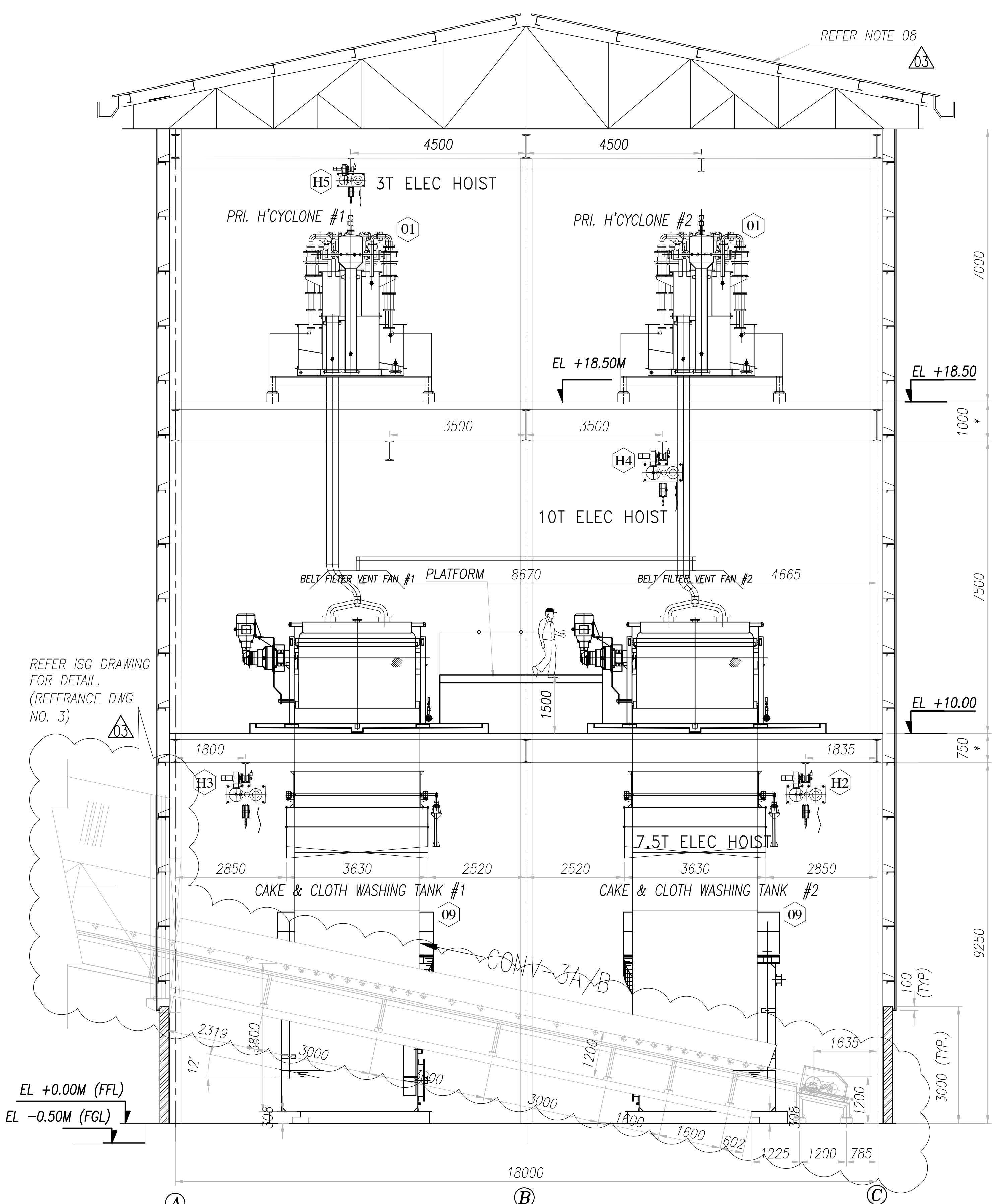
10-2058-291M-0-0-18-1d
ION 9NMW8D



KEY PLAN



SECTION - BB



NOTES:

- ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS IN METRES.
- +0.00 CORRESPONDS TO FINISHED FLOOR LEVEL OF PLANT WHICH IS 2.90M FROM CHART DATUM AND CHART DATUM IS 0.64M FROM MEAN SEA LEVEL (MSL).
- THE EQUIPMENT MACHINERY SIZES SHOWING IN THE DRAWING IS INDICATIVE ONLY AND WILL BE CONFIRMED AFTER VENDOR DATA. THE MAXIMUM ANTICIPATED SIZE AND LOADING IS PROVIDED IN THE DRAWING.
- FLOOR OPENINGS, PIPE CROSSINGS SHALL BE CONFIRMED DURING DETAIL ENGINEERING.
- DETAILS OF STAIRCASE, SUITABLE DOORS, WINDOWS, VENTILATORS SHALL BE CONSIDERED BY CIVIL DESIGNER FOR GYPSUM DEWATERING BUILDING.
- COLOR COATED ZINCALUME SHEET METAL CLADDING ABOVE BRICK WALL.
- FLY ASH BRICK WALL UP TO 0.1M.
- ROOFING SHALL BE COLOR COATED ZINCALUME SHEET METAL SLOPPED ROOFING.

LEGEND:-

FGL - FINISHED GROUND LEVEL
FFL - FINISHED FLOOR LEVEL
T.O.P.F - TOP OF PLATFORM
TOC - TOP OF CONCRETE
OPENG - OPENING
MR - MONORAIL
THK. - THICK
TYP - TYPICAL
GDWB - GYPSUM DEWATERING BUILDING.
VBF - VACUUM BELT FILTER
CEMENTED FLOOR

REF. DWGS

1. PY-DG-M162-1252-01 :	PLANT LAYOUT OF FGD SYSTEM
2. IS-1-GA-755-204-M104 :	GA AND LOAD DATA OF CONVEYOR GBC-1A/1B
3. IS-1-GA-755-201-M009 :	GA OF GYPSUM CONVEYOR CONV-3A/3B

EQUIPMENT LIST:

Sl No.	Equipment Description	Not to exceed loads (kg per Equipment.)
1.	Primary Hydrocyclone	2000
2.	Secondary Hydrocyclone	2000
3.	Vacuum Belt Filter	80000
4.	Vacuum Receiver	2000
5.	Vacuum Pump	8000
6.	Dosing Skid	Later
7.	Filtrate Water Pump	Later
8.	Filtrate Water Tank	Later
9.	Cake & Cloth Washing Tank	10000
10.	Cake & Cloth Washing Tank Pump	Later
11.	Filtrate Extraction Pump	Later

ELECTRIC HOIST TAG:

Sl No.	DESCRIPTION	ELECTRICAL HOIST TAG	MAX CAPACITY (TONNE)	QUANTITY (NUMBER)
1.	CAKE & CLOTH WASH PUMP HOIST	(H1)	5	1
2.	VACUUM PUMP HOIST	(H2)	7.5	1
3.	FILTRATE WATER PUMP & FILTRATE EXTRACTION PUMP	(H3)	3.0	1
4.	VACUUM BELT FILTER HOIST	(H4)	10	1
5.	HYDROCYCLONE HOIST	(H5)	3.0	2

REV. DATE	ALT.D	CHD&APP.	REV. DATE	ALT.D	CHD&APP.	REV. DATE	ALT.D	CHD&APP.
03.12.2021	RAW	UDAY KUMAR V	02.17.07.2021	RAW	UDAY KUMAR V	01.09.06.2022	RAW	UDAY KUMAR V
ALTERED AS PER CUSTOMERS COMMENTS AND LATEST INPUTS.			ALTERED AS PER CUSTOMERS COMMENTS.			ALTERED AS PER CUSTOMERS COMMENTS.		

NLC TAMILNADU POWER LIMITED

2x500 MW THERMAL POWER PLANT AT TUTICORIN

	BHARAT HEAVY ELECTRICALS LTD. HYDERABAD		NAME	SIGN.	DATE	NO. OF VAR.
	DRN.	RAVI	-	-	28.03.2021	-
	CHD.	UDAY KUMAR V	-	-	28.03.2021	-N.A.-
	APPD.	G.SRIKANTH	-	-	28.03.2021	-
DEPT. P.E.S.D. CODE. 450	UNTO. DIMS. GR. 4/M/F	SCALE 1:65	WEIGHT (KG) -N.A.-	REF. TO ASSY. DRG. -N.A.-	ITEM NO. -N.A.-	NO. OF ITEMS -N.A.-
TITLE GDWB BUILDING LAYOUT			CARD CODE N.A.	DRG. NO. PY-LE-0-M162-8507-01	CUST. DRG. NO. -	REV. 03
			SHT. No 02	NO. OF SHT. 02		Size A0