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TECHNICAL SPECIFICATION FOR

GYPSUM DEWATERING EQUIPMENT

(Sub –Assembly of FGD Package)

TSGENCO-BHADRADRO (4 X 270 MW)

FGD PROJECT

Table of Contents

Clause No.	Description	Page No.
1.0.0	Project information	4
2.0.0	Applicable codes & regulations	4
3.0.0	Intent of specification	4
4.0.0	Qualification requirement	5
5.0.0	Technical information	5
6.0.0	Bidder's scope of work	6
7.0.0	Process description	9
8.0.0	Detailed specification	10
9.0.0	Technical requirements	14
10.0.0	Packing and forwarding	20
11.0.0	Supervision of erection, testing and commissioning	23
12.0.0	Inspection requirement	23
13.0.0	Guarantee and Liquidated Damages for Power consumption	28
14.0.0	Process flow diagram, P&I diagram	29
15.0.0	Spares, tools & tackles	31
16.0.0	Performance Guarantee	33
17.0.0	Warranty	34
18.0.0	First fill of consumables	34
19.0.0	Training	34
20.0.0	Conflict	34
21.0.0	Documentation	35
Annexure-I	Qualification requirement (provenness criteria)	36
Annexure-II	Technical datasheet	37
Annexure-III	Schedule of guarantees	45
Annexure-IV	Reference list	46
Annexure-V	List of deviations	47
Annexure-VI	Documentation	48
Annexure-VII	Piping & Instrumentation Diagram	52

Annexure-VIII	Sea worthy packing	53
Annexure-IX	Inspection and testing requirements	54
Annexure-X	Motor data sheet format	55
Annexure-XI	MOTORS, CABLES, JUNCTION BOX & INSTRUMENTS SPECIFICATION	56
Annexure-XII	Material specification (PIPING & VALVES, VACCUM BELT FILTER)	57
Annexure-XIII	GA drawing of gypsum dewatering building	58
Annexure-XIV	Painting schedule	59
Annexure-XV	Vendor list	60
Annexure-XVI	Gypsum dewatering selection parameters and MOC details	61

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CLAUSE NO.	DESCRIPTION
1.0.00	**PROJECT INFORMATION**
a)	For Project related Information Please Refer to the FGD SYSTEM DESIGN BASIS.
	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 Equipment shall follow the latest applicable Indian/ ASME/ BS EN Standards. Other standards are not acceptable.
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 Equipment along with accessories, which is to 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 confirm 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 is (4) units of 270 MW and all these unit are 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 Equipment	Two (2) Numbers (one working +one standby)
2.	Capacity of Gypsum Dewatering Equipment	40.3 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.	
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 Equipment 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 Equipment 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.	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
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)	Cloth wash pump with motor (2*100%)	Two (2) numbers (1W+1S).
11)	Cake wash pump with motor (2*100%)	Two (2) numbers (1W+1S).
12)	Companion flanges with gaskets and fasteners	One (1) set*
13)	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 One (1) number.
14)	Coupling with guards	One (1) set*
15)	INSTRUMENTS for the entire Gypsum Dewatering Equipment((Minimum Requirement for each Gypsum Dewatering Equipment as given in the P&ID)	One (1) set*
16)	Valves for the entire Gypsum Dewatering Equipment(Minimum Requirement for each Gypsum Dewatering Equipment is given in the P&ID)	One (1) set*

17)	Electrics for complete package including but not limited to	
	i. LV/HV Motors	As required for Enquiry
	ii. Cable Adapter chamber for higher size cables if required	As required .
	iii. Electric Actuators	As required for Enquiry
	iv. VFD & LCP for Vacuum Belt Filter	As required for Enquiry
	v. Cable glands, Lugs & Bimetallic washer for Power and control cables at Vendor's supplied equipment.	As required for Enquiry
18)	vi. OEM specific Local Control starter	As required for Enquiry
19)	vii. Painting	As required for Enquiry
20)	Instrumentation including but not limited to	
	i. Instruments	As required for Enquiry
	ii. Junction Box	As required for Enquiry
	iii. Instrumentation Cables	As required for Enquiry
21)	Expansion Joints at suction & discharge of each pump and also for other equipment wherever applicable	One (1) set*
22)	**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 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.	
23)	**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 also be provided to view the cooling water flow. Bearing cooling water Flow switch shall take the signal to PLC / DCS system.	
24)	**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.	
25)	Supervision of erection / commissioning of both the Gypsum Dewatering Equipment. 30 Days per vaccum belt filter.	
26)	Mandatory spares with breakup price	
27)	Painting and rust prevention during shipment and construction	
28)	Seaworthy packing & forwarding to project site-refer clause 1.0.0 for project information	
29)	Recommended spare parts (for 3 years operation) with break up price.	

30)	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 Equipment**
31)	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 Equipment 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 Equipment 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.
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 GDW Equipment 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 Equipment is envisaged . The dewatering Equipment 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.
8.0.0	**DETAILED SPECIFICATION**
1.	Bidder/Contractor shall supply two stage Gypsum Dewatering Equipment 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 Equipment with each stream sized to dewater 40.3 TPH (Wet cake) produced by the FGD units operating at design point. All other stipulations with respect to sizing and design of the dewatering Equipment, auxiliaries and other Equipment 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.	A 1 m (min.) wide platform with suitable approach shall be provided around Hydro cyclone.

7.	The hydro cylones shall be fitted with stainless steel filter to prevent blockage of cyclone by big particles
8.	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.
9.	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%).
10.	The design of Hydrocyclones shall guarantee the separation efficiency of the slurry from the absorber.
11.	The hydro cyclone Equipment shall be self-supported with structural steel framework.
12.	The design of hydrocyclones shall guarantee the separation efficiency of the slurry from the absorber
8.2.0	**Vacuum Belt Filters**
1.	The Vacuum Belt Filters shall have the following characteristics: a) Very rigid frame and rolls, no deformation whatsoever may occur. b) All rolls shall be installed perfectly horizontally c) There shall be no vacuum under the slurry deposition zone. d) Deposit thickness control and directional stability control e) The slurry shall be put on the belt in counter current relative to the rotation of the band/belt. f) 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.
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.
15.	All client end connection flanges shall be ANSI B 16.5/ AWWA
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.
8.3.1	**COMMON REQUIREMENTS FOR PUMPS (VACUUM PUMP, BELT FILTER WASH PUMPS, CLARIFIED WATER PUMPS)**
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.
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.
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.	
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.	
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**	

	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.	

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 TISCRAL / 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 TISCRAL or equivalent. In case of vertical chute (valley angle more than 80 degree) complete chute, work shall be of 20 mm thick TISCRAL 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 underall 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	

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 kindly refer to P&ID.	
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 earthling 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**	
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.	
10.0.0	**PACKING AND FORWARDING**	
1.	Proper packing to be ensured. Indigenous Supply: Gypsum Dewatering Equipment & 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 Equipment 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	

	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 : 4X 270 MW FGD** **Manuguru , KHAMMAM .** **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 b. Sling position and center of Gravity position	

	c. Storage category d. Fragile components (to be marked properly with a clear warning fo 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 COMMISSIONING**	
1.	The erection of Gyspusm Dewatering Equipment 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 &	

	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 be100% Ultrasonically tested.	
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	
		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		
			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 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 DAMAGES FOR POWER CONSUMPTION**	
I.	**POWER GUARANTEE**	

	Bidder to specify the guaranteed power consumption of per Gypsum Dewatering Equipment 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). 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 270. KW, Corresponding capacity of rated 28.5 TPH.**
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 @2,52,000.0 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 Hydrcyclone at operating point are enclosed in Annexure XVI.
14.0.2	**PROCESS PARAMETERS FOR SECONDARY HYDROCYCLONE AT OPERATING POINT**
	Process parameters for Secondary Hydrcyclone 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 need to be supplied additionally as part of main supply).
	a. Filter Cloths : 2 sets
	b. Belt : 1 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 : 2 numbers for each size and type
	h. Slurry Line pipe : 2 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 **(SPARE QUANTITY SHALL BE CONSIDERED DOUBLE THE QUANTITY OF THAT INDICATED IN QTY COLUMN)**.
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 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 CONSUMABLES:**
1.	Bidder's scope shall also include supply and filling of all chemicals, reagents, resins, lubricants, grease, filters and consumable items for operation up to commissioning including top up requirements. 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 Equipment - 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	**DOCUMENTATION**

A	DOCUMENTS TO BE SUBMITTED ALONG WITH THE OFFER
	The Bidder shall submit all documents, drawings, diagrams and all such information, which are necessary to fully understand the offer for techno – commercial 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.
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.

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.

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 (TSGENCO) 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.

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 / licenser's design, manufacturing and quality control system for such equipments duly certified by the Collaborator / licensor. Further, the Collaborator / Licenser 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.

ANNEXURE-II-TECHNICAL DATA SHEET

Sl. No	Description		Data
1.0	**GENERAL : Refer The project description**		
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
	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 (m3/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
	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 (m3/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
	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
b.	Make/Model			
c.	Type		:	Bidder to Provide
d.	No. of Pumps for each Vacuum Belt Filter		:	Bidder to Provide
e.	Rated Capacity Flow (m3/hr)		:	Bidder to Provide
	Rated Capacity Head (mWCl)		:	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 (m3/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
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 (m3/hr./mWCl)		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
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
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 ----------

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 Gypsum Dewatering Equipment at rated capacity	kW	:	Bidder to Provide
3.	Chloride content in output gypsum cake ppm		:	Bidder to Provide
4.	Moisture in output gypsum cake %		:	Bidder to Provide
5.	Equipment Availability in % (avg. target 98%) Continuous for 120 days	%		Bidder to Provide

SIGNATURE OF BIDDER ----------

NAME ----------

DESIGNATION ----------

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 ----------

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 ----------

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.	VBF Sizing 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-S curve	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
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

B) DOCUMENTS TO BE SUBMITTED AFTER CONTRACT:

Sl. 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

Sl. 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 ----------

Annexure-VII Piping & Instrumentation Diagram

Bidder to confirm to the P&ID enclosed.

SIGNATURE OF BIDDER ----------

NAME ----------

DESIGNATION ----------

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 ----------

Annexure-IX Inspection and testing requirements

Refer to various clauses of Inspection and Testing Requirements

SIGNATURE OF BIDDER ----------

NAME ----------

DESIGNATION ----------

BIDDER SIGN WITH SEAL AND DATE

Annexure-X Electrical specification

(Refer To KTPS DOC: DOCUMENT NO. e-PCT/TS/K/02/2014-15 VOL-V)

SIGNATURE OF BIDDER ----------

NAME ----------

DESIGNATION ----------

Annexure-XI INSTRUMENTS SPECIFICATION

(Refer To KTPS DOC: DOCUMENT NO. e-PCT/TS/K/02/2014-15 Vol -VI)

SIGNATURE OF BIDDER ----------

NAME ----------

DESIGNATION ----------

Annexure-XII Material specification

(Refer the MOC Documentation)

SIGNATURE OF BIDDER ----------

NAME ----------

DESIGNATION ----------

Annexure-XIII GA drawing of gypsum dewatering building

Refer to the GA drawing of GDS building enclosed.

SIGNATURE OF BIDDER ----------

NAME ----------

DESIGNATION ----------

Annexure-XIV Paint schedule

(Vendor to follow the Individual paint details as furnished in the specification. During final PO placement Paint schedule shall be submitted for approval by the end customer)

SIGNATURE OF BIDDER ----------

NAME ----------

DESIGNATION ----------

Annexure-XV Vendor List

(Vendor to propose sub –vendor list. Final acceptance of the proposed Sub vendor list shall be subjected to the Acceptance of end customer).

SIGNATURE OF BIDDER ----------

NAME ----------

DESIGNATION ----------

Annexure-XVI

(SELECTION PARAMETERS FOR GYPSUM DEWATERING EQUIPMENT; FGD SYSTEM DESIGN BASIS).

SIGNATURE OF BIDDER ----------

NAME ----------

DESIGNATION ----------

05	05.02.22	Revised the document as per comments	KMK	PR	PNR
04	30.11.21	Replied to customer comments	KMK	PR	PNR
03	22.10.21	Revised the document as per comments	KMK	PR	PNR
02	18.03.20	Revised the document as per the comments	KMK	PR	RSB
01	07.11.19	Revised the document as per the comments	KMK	PR	SKD
00	01.10.19	Fresh Issue	KMK	PR	SKD
REV	DATE	DESCRIPTION /NOTE	PRD	CHD	APD

REVISIONS

TITLE:

P&ID_FILTRATE WATER SYSTEM

OWNER/PROJECT: **TELANGANA STATE POWER GENERATION CORPORATION LTD**

BHADRADRI (4X270 MW) THERMAL POWER STATION–
FGD SYSTEM PACKAGE

CONSULTANT:

DESEIN PRIVATE LIMITED.
NEW DELHI

EPC CONTRACTOR:

BHARAT HEAVY ELECTRICALS LTD.
BOILER AUXILIARIES PLANT,RANIPET

COLLABORATOR

MITSUBISHI HITACHI POWER SYSTEMS, LTD
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

	BHEL	Date	
PREPARED BY	Kabilash	05.02.22	STATUS : *FOR APPROVAL*
CHECKED BY	Raju P	05.02.22	BHEL CUST NO : G301,G302,G303 & G304
APPROVED BY	P.Naveen	05.02.22	BHEL DOC NO : 03- FW-744-00662
			REV NO :05

THIRD ANGLE PROJECTION | No. REQ'D | A3 | DRAWING No.

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
M	ACTUATED BY MOTOR
IM	ACTUATED BY MOTOR (INCHING)
	AIR CONTROL VALVE
S	SOLENOID ACTUATOR
	SELF REGURATING VALVE
	SELF REGURATING VALVE

TRENCH SYMBOLS

SYMBOLS	NAME
A	TO ABSORBER AREA DRAIN SUMP
D	TO GYPSUM AREA DRAIN SUMP
L	TO LIMESTONE AREA DRAIN SUMP

SYMBOLS FOR PIPING PARTS & INSTRUMENT PARTS

SYMBOLS	NAME
T	STEAM TRAP
AT	AIR TRAP
	Y-STRAINER
	T-STRAINER
TS	TEMPORARY STRAINER
	REDUCER
	EXPANSION JOINT
	DUCT EXPANSION JOINT
	FLEXIBLE HOSE
	SPOOL PIECE
	VENT
	HOSE CONNECTION
	BLIND FLANGE
	REDUCING FLANGE
	CAP (BW)
	CAP (SCR)
	TRENCH
SG	SIGHT GLASS
	SILENCER
	ORIFICE
	DIAPHRAGM
M	MAGNETIC FLOW METER
	VORTEX FLOW METER
	PH METER
	FILTER
M.H. M.H. M.H. I.H.	MANHOLE
	INSPECTION HOLE
	PITOT TUBE
	SAMPLING POT
S	SAMPLING NOZZLE
RO	RESTRICTION ORIFICE
FI	ROTOMETER TYPE FLOW METER

SYMBOLS FOR VALVE OPERATION

SYMBOLS	NAME
FO	FAILURE OPEN (THE VALVE OPENS WHEN AIR OR ELECTRICITY FOR ACTUATOR FAILS.)
FC	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 CLIENT AND CONTRACTOR
CONTRACTOR | XXX	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
AA	ANTIFOAM AGENT	WCS	COOLING WATER SUPPLY
AC	COMPRESSED AIR	WCR	COOLING WATER RETURN
AF	FLUIDIZER AIR	WC	Ca(OH)2
AI	INSTRUMENT AIR	WP	PROCESS WATER
AO	OXIDATION AIR	WR	RAW WATER
AS	SEAL AIR	WW	WASTE WATER
DD	DUCT DRAIN	VG	VACUUM PUMP VENT
FS	FILTRATE SLURRY	VBG	BELT FILTER VENT GAS
GS	GYPSUM SLURRY	LD	LIMESTONE DEDUSTING
LS	LIMESTONE SLURRY	LOL	LUBE OIL (LOW PRESSURE)
FG	FLUE GAS	LOH	LUBE OIL (HIGH PRESSURE)

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 / GI PIPING	AI, LOL
BA02	Gr.304 STAINLESS STEEL / GI 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
DA60	FRP PIPING (PIPE DIA UPTO 400 NB)	GS,FS,WW,DD
DA40	FRP PIPING (PIPE DIA UPTO 400 NB)	LS, WP, WC

UNIT CODE

SYMBOLS	UNIT IDENTIFICATION
90	COMMON
10	UNIT-1 FGD SYSTEM AND AUXILIARIES
20	UNIT-2 FGD SYSTEM AND AUXILIARIES
30	UNIT-3 FGD SYSTEM AND AUXILIARIES
40	UNIT-4 FGD SYSTEM AND AUXILIARIES
50	UNIT-5 FGD SYSTEM AND AUXILIARIES

EXPRESSION OF PIPING LINE

10 - 200 - GS - 2 00 1 - AA60 - HF

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

CUSTOMER NOS: G301,G302,G303&G304

CAUTION: THIS DRAWING IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LIMITED. IT MUST NOT BE COPIED OR USED TO FURNISH ANY INFORMATION FOR MAKING OF DRAWINGS OF APPARATUS EXCEPT WHERE PROVIDED FOR, AGREEMENT WITH SAID COMPANY.

CUSTOMER: TSGENCO.

PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

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

DEPT CODE		NAME (BHEL)	DATE
M	DRN	KM.KABILASH	24.09.21
	CHD	P.RAJU	24.09.21
	APPD	PNR/ACR	24.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – SYMBOL MARK (1/2)

SCALE : NTS

BHEL DRG NO. 03-FW-000-00675 | SH 01 of 02

FILE NO: B240 – 00001 | REV NO: 00

THIRD ANGLE PROJECTION | No. REQ'D | A3 | DRAWING No.

INSTRUMENT ABBREVIATION

	FIRST–LETTER		SUCCEEDING–LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		BLANK	BLANK	BLANK
C	BLANK			CONTROL	
D	BLANK	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	BLANK		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	BLANK	MOMENTARY			MIDDLE, INTERMEDIATE
N	BLANK		BLANK	BLANK	BLANK
O	BLANK		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT(TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

INSTRUMENT SYMBOLS

SYMBOLS	NAME
	FIELD MOUNTED
	FOR CONTROL ROOM
	FOR LOCAL CONTROL PANEL
	FOR DCS
I	INTERLOCK LOGIC

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 SWITH
FLXXWA–SL	SINGLE SOLENOID WITH LIMIT SWITCH

MACHINARY SYMBOLS

SYMBOLS	NAME
	PUMP
	FAN / BLOWER
	AGITATOR (FLAT BLADE)
	AGITATOR (PROPELLOR)
	ROTARY VALVE
	CRUSHER
	BELT FEEDER
	BELT FILTER
	BALL MILL
	CYCLONE
	MIST ELIMINATOR

EQUIPMENT SYMBOLS

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

DRIVER SYMBOLS

SYMBOLS	NAME
A	AIR MOTOR
M	ELECTRIC MOTOR

OTHER SYMBOLS

SYMBOLS	NAME
	INSERT PIPE / LANCE
	CHUTE
	TRUCK

CUSTOMER NOS: G301,G302,G303&G304
CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

CUSTOMER NOS: G301,G302,G303&G304

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CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

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

DEPT CODE		NAME (BHEL)	DATE
M	DRN	KM.KABILASH	24.09.21
	CHD	P.RAJU	24.09.21
	APPD	PNR/ACR	24.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – SYMBOL MARK (2/2) | SCALE : NTS

BHEL DRG NO. 03–FW–000–00675 | SH 02 of 02

FILE NO B240 – 00002 | REV NO 00

0 1 2 3 4 5 6 7 8 9 10

THIRD ANGLE PROJECTION

No. REQ'D

A3

DRAWING No.

FILTRATE
03-FW-738-00663 SH1
FROM VACUUM RECEIVER A
00 HTM 02 BB 001

FILTRATE
03-FW-738-00663 SH2
FROM VACUUM RECEIVER B
00 HTM 02 BB 002

SECONDARY HYDROCYCLONE A/B O/F
03-FW-745-00665
FROM WASTE WATER PUMP A/B
00 HTM 05 AP 001/002

03-FW-738-00663 SH3
FROM GYPSUM AREA DRAIN SUMP PUMP A/B
00 HTT 01 AP 001/002

FILTER WASHING WATER
03-FW-738-00663 SH1
FROM VACUUM BELT FILTER A
00 HTM 01 AT 001

FILTER WASHING WATER
03-FW-738-00663 SH2
FROM VACUUM BELT FILTER B
00 HTM 01 AT 002

GYPSUM SLURRY
03-FW-738-00661
FROM SECONDARY HYDROCYCLONE A
00 HTM 02 AT 001

GYPSUM SLURRY
03-FW-738-00661
FROM SECONDARY HYDROCYCLONE B
00 HTM 02 AT 002

GYPSUM SLURRY
03-FW-738-00659
FROM PRIMARY HYDROCYCLONE A
00 HTM 00 AT 001

GYPSUM SLURRY
03-FW-738-00659
FROM PRIMARY HYDROCYCLONE B
00 HTM 00 AT 002

00-200-FS-4101-DA60
00-200-FS-4201-DA60
00-80-FS-4521-DA60
00-100-FS-7121-DA60
00-150-FS-4103-DA60
00-150-FS-4203-DA60
00-150-GS-4442-DA60
00-150-GS-4452-DA60
00-250-GS-4071-DA60
00-250-GS-4072-DA60

00HTT07AA220

00-250-LS-4431-DA60

00HTM04CL011
00HTM04CL012
00HTM04CL013
00HTM04CL101

LI 200 M.H.
LICA
LT

NOTE A009

00 HTM 01 AM 001

00 HTM 03 BB 001

M.H.

00HTM04AA311
NC 200

NOTE A006
NOTE A004

FILTRATE WATER TANK LEVEL SIGNAL
03-FW-213-00651 SH1
FILTRATE RETURN CONTROL

FILTRATE WATER TANK LEVEL SIGNAL
03-FW-213-00651 SH2
FILTRATE RETURN CONTROL

FILTRATE WATER TANK LEVEL SIGNAL
03-FW-213-00651 SH3
FILTRATE RETURN CONTROL

FILTRATE WATER TANK LEVEL SIGNAL
03-FW-213-00651 SH4
FILTRATE RETURN CONTROL

00-150-FS-4325-DA60
00HTM04AA158
ZSH
RO
NOTE A011
03-FW-213-00651 SH1
FROM ABSORBER (UNIT-1)
10 HTD 00 BB 001

00-250-FS-4321-DA60
03-FW-213-00651 SH4
TO ABSORBER (UNIT-4)
40 HTD 00 BB 001

00HTM04CP524
00HTM04CP522
PI PT FT

NOTE B002
ZSL
00HTM04AA210
25x50 50 NC CC01 DA60

00-250-FS-4321-DA60

10 00-25-WP-8530-CC01
00HTM04CT002
FT
03-FW-751-00673 SH1
STRAIGHT STRAIGHT PROCESS WATER

8
ZSH ZSL NOTE B002
00HTM04AA203
00HTM04AA207
00HTM04AA204
00HTM04AA208
25x50 50 NC DA60 CC01
00HTM04AA209
NOTE A011
NOTE A006
00-250-FS-4302-DA60
00-250-FS-4304-DA60
00HTM04CP507
00HTM04CP508
00HTM04CP020
00HTM04CP019
PI PT

7
00 HTM 03 AP 001
EX-4040
EX-4020
00-250-FS-4301-DA60
6
00HTM04AA201
NOTE A008
00HTM04AA206
NOTE A230
00-25-WP-8707-CC01
NOTE A001
M

00 HTM 03 AP 002
00-250-FS-4303-DA60
00HTM04AA205
00-25-WP-8709-CC01
00-25-WP-8706-CC01
00-25-WP-8708-CC01

NOTE A001
MOTOR PID ARE NOT SHOWN.

NOTE A004
TO PREVENT NONFUNCTIONING OF SLURRY TANK PUMP SUCTION VALVE DUE TO SOLID SEDIMENTATION, THE SHAFT OF BUTTERFLY VALVE SHOULD BE INSTALLED HOLIZONTALLY AND UPPER HALF OF THE DISC SHOULD BE TURN INTO TANK INSIDE. SUCTION VALVES SHALL BE MOUNTED ON NOZZLE DIRECTLY AS LONG AS ACTUATOR DOES NOT COLLIDE WITH TANK CASING.

NOTE A006
DISCHARGE OF DRAIN AND OVERFLOW LINE SHALL HAVE 45 DEG INCLINATION TOWARD FLOW DIRECTION OF TRENCH FOR SMOOTH FLOW.

NOTE A008
TEMPORARY STRAINER SHALL BE INSTALLED AT THE PUMP SUCTION FOR THE TERMS OF PRE-COMMISSIONING.

NOTE A009
THERE SHOULD BE CERTAIN DISTANCE BETWEEN NOZZLES FOR INFLUENT LINE AND PUMP SUCTION NOZZLE AS LONG AS THERE IS NO INSERT PIPE.

NOTE A011
RO SHALL BE INSTALLED IN VERTICAL LINE.

NOTE A014
THE DRAIN NOZZLE SHALL BE EMBEDDED IN THE TANK BASE, AND IT SHALL BE DIRRECTED TO TRENCH SO THAT SLURRY IN THE TANK CAN BE DRAINED OUT COMPLETELY.

NOTE B002
OPEN AND CLOSE CONTACT SWITCHES ARE FOR REFERENCE ONLY. IN CASE THAT THERE IS CUSTOMER'S SPECIFICATION, THEY SHOULD BE DECIDED BASED ON IT.

NOTE A230
THIS WATER LINE IS FOR MECHANICAL SEAL QUENCHING. WATER DRAIN SHALL BE DISCHARGED TO TRENCH THROUGH PUMP DRAIN PAN AND PIPING.

VENDOR BHEL

NOTE: 2. Process Parameters
– Flow – m3/hr
– Pressure – Kg/cm2 (Design Pressure)
– Temp – Deg C (Design Temp)

00 HTM 03 BB 001
FILTRTATE WATER TANK A

00 HTM 01 AM 001
FILTRATE WATER TANK AGITATOR A

00 HTM 03 AP 001/005
FILTRATE WATER PUMP A/E

CUSTOMER NOS: G301,G302,G303&G304

CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

	DEPT CODE		NAME (BHEL)	DATE
BHARAT HEAVY ELECTRICALS LIMITED, UNIT: BOILER AUXILIARIES PLANT, RANIPET:632 406.	M	DRN	KM.KABILASH	28.09.21
		CHD	P.RAJU	28.09.21
		APPD	PNR/ACR	28.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – GYPSUM DEWATERING SYSTEM FILTRATE WATER TANK

SCALE : NTS

BHEL DRG NO. 03-FW-744-00662 SH 01 OF 01

FILE NO B240-00431

REV NO 01

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WRITE UP ON FILTRATE WATER TANK

Purpose:

This write up describes the equipment associated with filtrate water system and defines the associated control system.

Equipment List:

S. No.	Description	Item No.	Capacity	Qty
1.	Filtrate water tank	00 HTM 03 BB 001	88 m3	1
2.	Filtrate water pump	00 HTM 03 AP 001/002	Flow:205 m3/Hr Head: 35 m LC	1W +1S
3.	Filtrate water Tank Agitator	00 HTM 01 AM 001	-	1

Operation Write Up:

Filtrate water tank receives filtrate water from following sources

- Filtrate in Vacuum Receiver is fed to Filtrate Water Tank by gravity.
- Filtrate from belt/cloth washing water, which contains higher suspended solids, are fed to Filtrate Water Tank.
- Waste Water Hydro-cyclones underflow is fed to Filtrate Water Tank.
- A part of filtrate in waste water tank is pumped to Filtrate Water Tank.

Filtrate water in filtrate water tank is recycled to absorber tank by batch operation.

Drain and overflow from all tanks in Gypsum dewatering area is sent to Gypsum area drain sump via trench by gravity. Gypsum area drain sump pumps are deisgned to transfer the slurry from Sump to Filtrate water tanks.

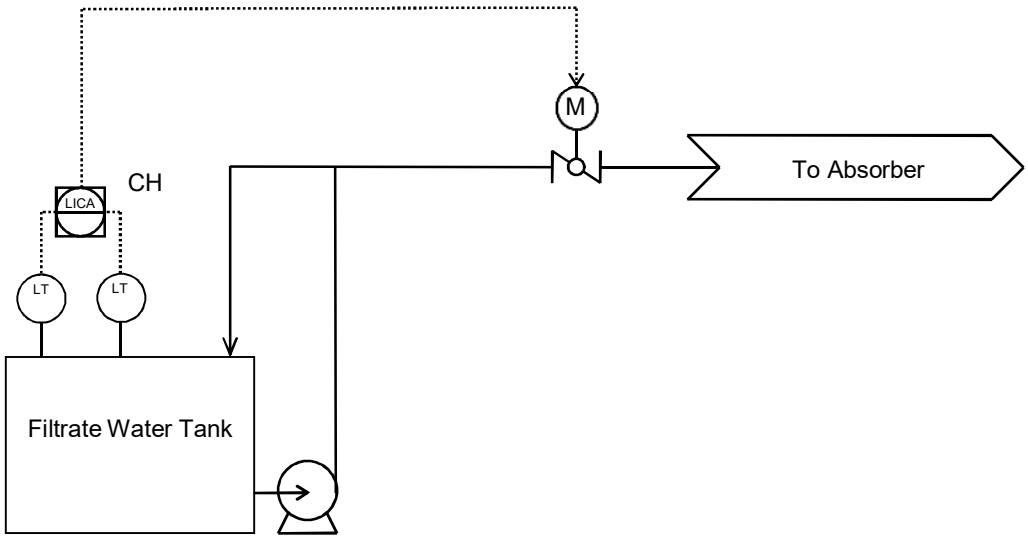
Details of Batch Operation: Absorber return valve near to the absorber (KKS Code: 10/20/30/40HTD02AA132) will open, Once the level in Filtrate sump reaches to CH and the valve will be kept open till the sump level reaches CL. Valve will be closed once the sump level reaches CL and will be kept closed till the sump level again reaches to CH. (please refer sump level set points in annexure I) As the slurry sent in batches (i.e. CH to CL) from filtrate water sump to absorber it is called Batch Operation.

Control Write Up:

Filtrate tank level is controlled to keep the level between CL-CH.

The filtrate tank level usually is controlled between CL and CH by the filtrate feed to absorber tank by batch operation.

Filtrate Water Tank Level Control



When the level in Filtrate water tank reaches CL, Feed valve to absorber is closed. When the level in Filtrate water tank reaches CH, Feed valve to absorber is opened. When the level in Filtrate water tank reaches LL stop command is initiated for Filtrate water pump & agitator for Protection.

1.3 Flushing control:

Start Command:

When the filtrate water Pump start command is given,

i. Suction drain valves closes. After the valves is closed completely,
ii. Line drain valve closes and simultaneously
iii. The suction valve is opened. And simultaneously absorber feed valve opens
iv. After a time delay T1, the Filtrate water feed Pump is started.
v. After a Time delay of T2 from the Pump start the discharge valve is opened.
vi. After this, the Pump continuously runs till stop command is initiated.

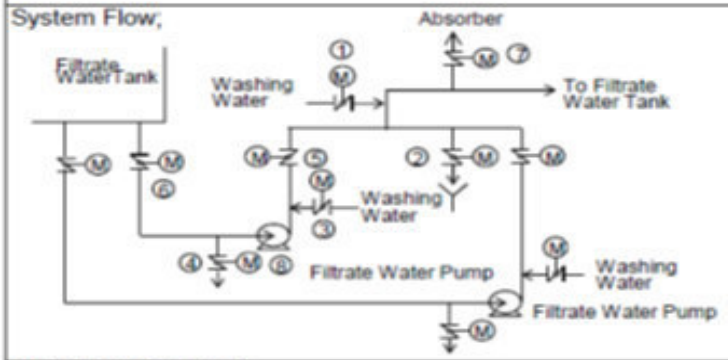
Stop Command:

When the Filtrate water Pump stop command is given,

i. The discharge valve closes .After the valve is closed completely,
ii. The pump is stopped and simultaneously the suction valve closes.
iii. After the suction valve and Absorber feed valve is closed completely, the suction drain valve starts to open & simultaneously the line drain valve is also opened and
iv. With a time delay T3, the pump flushing valve is opened.
v. After a time delay T4, the Line drain valve and pump flushing valve is closed. And simultaneously line washing valve is opened.
vi. After Time delay of T6 Line washing valve closes and line drain valve opens.

Item	Service	
00 HTM 03 AP 001/002	Filtrate Water Pump A/B Sub Function Group	Stand-by Auto Mode (Back-up start)

System Flow;



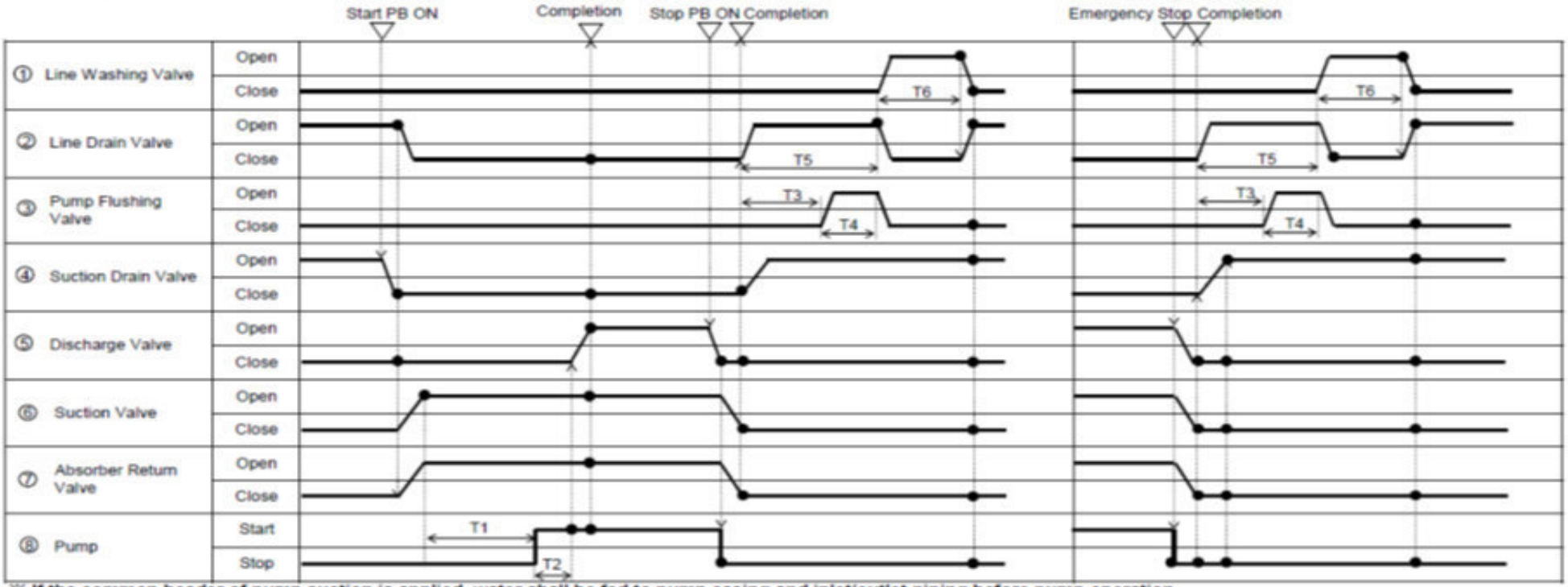
Start Permission;
- Filtrate Water Tank Level : Not LL

Stop Permission;
- N/A

Start Interlock;
- Stand-by Auto Start due to Electric Fault

Stop Interlock;
- Electric Fault
- Filtrate Water Tank Level : LL
- Related valves feed back signal missing

Start/Stop Sequence;



※ If the common header of pump suction is applied, water shall be fed to pump casing and inlet/outlet piping before pump operation.

INSTRUMENT LIST

Sl.No	KKS code	Description	Qty
01	00HTM04CL011/013	Lavel transmitter	3 Nos
02	00HTM04CL101	Level Indicator	01 No
03	00HTM04CF002	Rotametr (flow meter)	01 No
04	00HTM04CP507/508	Pressure Indicator	02 Nos
05	00HTM04CP019/023	Pressure Transmitter	05 Nos

Table 3.3 Set Point List

Pressure

No.	KKS Tag no.	Service	Range	Unit	Set Point	Value	Action	Basis	Remark
1	PIA 10/40HTA01CP001/003	BUF Inlet Pressure		kPa	HH	6.5		Mechanical design pressure of FGD inlet duct: +6.47 kpa	
					H	1.0	H ANN	Normal pressure + 1.0 kPa	
					L	−1.0	L ANN	Normal pressure − 1.0 kPa	
					LL	−1.5	INT : FGD Bypass Demper Open LL ANN	Mechanical design pressure of FGD inlet duct: − 1.47 kpa	
					△H	Later	H ANN	PT measuring range x 0.05 (5%)	
2	PIA 10/40HTA01CP007	Absorber Inlet Pressure		kPa	H	4.7	H ANN	Normal pressure + 1.0 kPa	
					L	3.7	L ANN	Normal pressure − 1.0 kPa	
3	PDIA 10/40HTE02CP001	Mist Eliminator Differential Pressure		kPa	H	(*1)	H ANN	(Design pressure of ME +0.10kPa(Dirty)) x 1.1^2	
4	PIA 10/40HTY08CP002	Instrumentation Air Pressure		MPa	H	0.8	H ANN	Design Pressure	
					L	(*1)	L ANN	Minimum pressure of solenoid valve +0.5 MPa	

※1 : Will be provided later based on the vendor information.

Table 3.3 Set Point List

Temperature

No.	Tag no.	Service	Range	Unit	Set Point	Value	Action	Basis	Remark
1	TIA 10/40HTA01CT001/003	FGD Inlet Temperature		deg.C	HH	300	Interlock	Maximum temperature in AH mechanical trip condition	Emergency Spray valve open
					H	290	H ANN	Maximum temperature in AH mechanical trip condition – 10 deg.C	
					△H	(*1)	H ANN	TE measuring range × 0.05 (5%)	prevention for meter deflection
2	TIA 10/40HTA01CT005/007	FGD Outlet Temperature		deg.C	HH	70	Interlock	Heat-resistant value of Absorber internal material	Emergency Spray valve open
					H	65	H ANN	Heat-resistant value of Absorber internal material – 5 deg.C	
					△H	(*1)	H ANN	TE measuring range × 0.05 (5%)	prevention for meter deflection

※1 : Will be provided later based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	LICA 10/40HTD02CL001/003	Absorber Level		m	HH	7.0	Overflow	Normal Level + 1.0 m	
					H	6.3	H ANN	CH Level + 0.2 m	
					CH2	6.3	Start Permission for 1st Absorber Circulation Pump	The value that does not drop to L level after startng pump.	
					CH	6.1	Absorber make-up water supply stop	Normal Level + 0.1 m	
					N	6.0		Design Level (Normal Level)	
					CL	5.9	Absorber make-up water supply start	Normal Level - 0.1 m	
					L	5.7	L ANN	CL Level - 0.2 m	
					LL1	4.2(*1)	INT : Absorber Recirculation Pump Stop LL1 ANN		Pump Protection
					LL2	3.2(*1)	INT : Absorber Agitator Stop LL2 ANN	(Agitator installation Level :1.6m) + (Impeller dia.:1.6m)	Agitator Protection
					LL3	1.5(*1)	INT : Absorber Bleed Pump Stop LL3 ANN		Pump Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
2	LICA 00HTM04CL007/009	Belt Filter Washing Tank Level		m	HH	3	Over flow	Top level - 0.5m	
					H	2.8	H ANN	HH Level - 0.2 m	
					CH	2.6	Make-up water supply stop	H Level - 0.2 m	
					CL	1.4	Make-up water supply start	L Level + 0.2 m	
					L	1.2	L ANN	LL Level + 0.2 m.	
					LL	1.0(*1)	INT : Pump Stop LL ANN	(Suction pipe center)+2.5 x (Suction pipe Dia.)	Pump Protection
					△H	0.2	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
3	LICA 00HTM04CL011/013	Filtrate Water Tank Level		m	HH	5.1	Over flow	Top level - 0.5m	
					H	4.9	H ANN	HH Level - 0.2 m	
					CH	4.7	Absorber Return Valve Open	H Level - 0.2 m	
					CL	1.6	Absorber Return Valve Close	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
4	LICA 00HTM04CL001/003	Primary Hydrocyclone Feed Tank Level		m	HH	6.5	Over flow	Top level - 0.5m	
					H	6.3	H ANN	HH Level - 0.2 m	
					CH	6.1	Hydro-cyclone Feed start	H Level - 0.2 m	
					CL	1.6	Hydro-cyclone Feed Stop	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump Protection Agitator Protection
					△H	0.6	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
4	LICA 00HTM04CL003/005	Secondary Waste Water Hydrocyclone Feed Tank Level		m	HH	5.5	Over flow	Top level - 0.5m	
					H	5.3	H ANN	HH Level - 0.2 m	
					CH	5.1	Hydro-cyclone Feed start	H Level - 0.2 m	
					CL	1.5	Hydro-cyclone Feed Stop	L Level + 0.2 m	
					L	1.3	L ANN	LL Level + 0.2 m.	
					LL	1.1(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
5	LICA	Waste Water Storage Tank		m	HH	6.5	Over flow	Top level - 0.5m	

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
	00HTM04CL013/015	Level			H	6.3	H ANN	HH Level - 0.2 m	
					CH1	6.1	Filtrate Water Tank Feed Start	H Level - 0.2 m	
					CL1	5.6	Filtrate Water Tank Feed Stop	CH1 Level - 0.5 m	
					CH2	2.1	Waste Water Treatment Feed Start	CL2 Level + 0.5 m	
					CL2	1.6	Waste Water Treatment Feed Stop	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
7	LICA	Mill Circuit Tank Level		m	HH	Later(*1)	HH ANN	To be finalize by BHEL based on vedor information.	Silo & Bag Filter Protection
	00HTK05CL001/003				H	Later(*1)	H ANN	To be finalize by BHEL based on vedor information.	
	00HTK05CL004/006				L	Later(*1)	L ANN	To be finalize by BHEL based on vedor information.	
					LL	Later(*1)	LL ANN	To be finalize by BHEL based on vedor information.	
8	LICA	Limestone Slurry Storage Tank		m	HH	11.5	Over flow	Top level - 0.8m	
	00HTK05CL021/023	Level			H	11.3	H ANN	HH Level - 0.2 m	
					CH	10.8	Wet Limestone Grinding Mill stop	H Level - 0.5 m	
					CL	4.4	Wet Limestone Grinding Mill start		
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
9	LIC	Absorber Area Drain Sump		m	HH	3.5	Over flow	Top level - 0.5m	
	10/40HTT07CL001/003	Level			H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN		Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
10	LIA 00HTT07CL001/003	Aixiliary Absorbent Tank Level		m	HH	10.1	Over flow	Top level - 0.8m	
					H	9.9	H ANN	HH Level - 0.2 m	
					L	4.4	L ANN	LL1 Level + 0.2 m	
					LL1	3.4(*1)	INT : Agitator Stop LL1 ANN		
					LL2	2.0*1)	INT : Pump Stop LL2 ANN		Pump Protection
11	LICA 00HTT07CL001/003	Gypsum Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump protection Agitator Protection
12	LICA 00HTT07CL004/006	Limestone Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
13	LICA	Process Water Tank Level		m	HH	4.9	Over flow	Top level - 0.5m	
	00HTQ08CL001/003				H	4.7	H ANN	HH Level - 0.2 m	
	00HTQ08CL004/006				CH	4.5	Make-up water supply stop	H Level - 0.2 m	
		`			CL	4.0	Make-up water supply start	CH Level - 0.5 m	
					L	1.5	L ANN	LL Level + 0.2 m.	
					LL	1.3(*1)	INT : Pump Stop LL ANN		Pump Protection
					△H	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
14	LICA	Emergency Water Tank Level		m	HH	3	Over flow	Top level - 0.5m	
	10/40HTQ08CL021/023				H	2.8	H ANN	HH Level - 0.2 m	
					CH	2.6	Make-up water supply stop	H Level - 0.2 m	
					CL	2.4	Make-up water supply start	CH Level - 0.2 m	
					L	0.5	L ANN	Bottom + 0.5 m	

※This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL shall add set point for unit equipment and finalize the list according to the vender information.

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Others

No.	KKS Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	AICA	Absorber pH		–	H	6.5	H ANN	Normal pH + α	
	10/40HTD02CQ001/003				N	Later	Set point for pH control	Commissioning adjustment value	
					L	Later	L ANN, Set point for minimum pH	Commissioning adjustment value	
2	DICA	Absorber Density		wt.%	H	35	H ANN	Normal Density + 5 wt.%	Pump & Belt Filter Protection
	10/40HTM01CD001/003				CH	32	Absorber Slurry Bleed Start	Normal Density + 2 wt.%	
					N	30	Set point for Density Control	Design Density	
					CL	28	Absorber Slurry Bleed Stop	Normal Density – 2 wt.%	
					L	25	L ANN	Normal Density – 5 wt.%	
3	AICA	FGD Outlet SO2		mg/Nm^3	H	100	H ANN	Design FGD Outlet SO2 concentration	
	10/40HTA01CQ005				N	Later	Set point for SO2 control	Commissioning adjustment	

※This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL will add set point for unit equipment and finalize the list according to the vender information.

03	05.02.22	Replied to the customer comments	KMK	PR	PNR
02	22.10.21	Revised the document as per the customer comments	KMK	PR	PNR
01	18.03.20	Revised the document as per the customer comments	KMK	PR	RSB
00	19.11.19	Fresh Issue	KMK	PR	SKD
REV	DATE	DESCRIPTION /NOTE	PRD	CHD	APD

REVISIONS

TITLE:

P&ID_VACUUM BELT FILTER & ACCESSORIES

OWNER/PROJECT: **TELANGANA STATE POWER GENERATION CORPORATION LTD**

BHADRADRI (4X270 MW) THERMAL POWER STATION–
FGD SYSTEM PACKAGE

CONSULTANT:

DESEIN PRIVATE LIMITED.
NEW DELHI

EPC CONTRACTOR:

BHARAT HEAVY ELECTRICALS LTD.
BOILER AUXILIARIES PLANT,RANIPET

COLLABORATOR

MITSUBISHI HITACHI POWER SYSTEMS, LTD
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

	BHEL	Date	
PREPARED BY	Kabilash	05.02.22	STATUS : *FOR APPROVAL*
CHECKED BY	Raju P	05.02.22	BHEL CUST NO : G301,G302,G303 & G304
APPROVED BY	P.Naveen	05.02.22	BHEL DOC NO : 03-FW-738-00663
			REV NO :03

THIRD ANGLE PROJECTION | No. REQ'D | A3 | DRAWING No.

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
M	ACTUATED BY MOTOR
IM	ACTUATED BY MOTOR (INCHING)
	AIR CONTROL VALVE
S	SOLENOID ACTUATOR
	SELF REGURATING VALVE
	SELF REGURATING VALVE

TRENCH SYMBOLS

SYMBOLS	NAME
A	TO ABSORBER AREA DRAIN SUMP
D	TO GYPSUM AREA DRAIN SUMP
L	TO LIMESTONE AREA DRAIN SUMP

SYMBOLS FOR PIPING PARTS & INSTRUMENT PARTS

SYMBOLS	NAME
T	STEAM TRAP
AT	AIR TRAP
	Y-STRAINER
	T-STRAINER
TS	TEMPORARY STRAINER
	REDUCER
	EXPANSION JOINT
	DUCT EXPANSION JOINT
	FLEXIBLE HOSE
	SPOOL PIECE
	VENT
	HOSE CONNECTION
	BLIND FLANGE
	REDUCING FLANGE
	CAP (BW)
	CAP (SCR)
	TRENCH
SG	SIGHT GLASS
	SILENCER
	ORIFICE
	DIAPHRAGM
M	MAGNETIC FLOW METER
	VORTEX FLOW METER
	PH METER
	FILTER
M.H. M.H. M.H. I.H.	MANHOLE
	INSPECTION HOLE
	PITOT TUBE
	SAMPLING POT
S	SAMPLING NOZZLE
RO	RESTRICTION ORIFICE
FI	ROTOMETER TYPE FLOW METER

SYMBOLS FOR VALVE OPERATION

SYMBOLS	NAME
FO	FAILURE OPEN (THE VALVE OPENS WHEN AIR OR ELECTRICITY FOR ACTUATOR FAILS.)
FC	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 CLIENT AND CONTRACTOR
CONTRACTOR | XXX	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
AA	ANTIFOAM AGENT	WCS	COOLING WATER SUPPLY
AC	COMPRESSED AIR	WCR	COOLING WATER RETURN
AF	FLUIDIZER AIR	WC	Ca(OH)2
AI	INSTRUMENT AIR	WP	PROCESS WATER
AO	OXIDATION AIR	WR	RAW WATER
AS	SEAL AIR	WW	WASTE WATER
DD	DUCT DRAIN	VG	VACUUM PUMP VENT
FS	FILTRATE SLURRY	VBG	BELT FILTER VENT GAS
GS	GYPSUM SLURRY	LD	LIMESTONE DEDUSTING
LS	LIMESTONE SLURRY	LOL	LUBE OIL (LOW PRESSURE)
FG	FLUE GAS	LOH	LUBE OIL (HIGH PRESSURE)

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 / GI PIPING	AI, LOL
BA02	Gr.304 STAINLESS STEEL / GI 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
DA60	FRP PIPING (PIPE DIA UPTO 400 NB)	GS,FS,WW,DD
DA40	FRP PIPING (PIPE DIA UPTO 400 NB)	LS, WP, WC

UNIT CODE

SYMBOLS	UNIT IDENTIFICATION
90	COMMON
10	UNIT-1 FGD SYSTEM AND AUXILIARIES
20	UNIT-2 FGD SYSTEM AND AUXILIARIES
30	UNIT-3 FGD SYSTEM AND AUXILIARIES
40	UNIT-4 FGD SYSTEM AND AUXILIARIES
50	UNIT-5 FGD SYSTEM AND AUXILIARIES

EXPRESSION OF PIPING LINE

10 - 200 - GS - 2 00 1 - AA60 - HF

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

CUSTOMER NOS: G301,G302,G303&G304

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CUSTOMER: TSGENCO.

PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

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

DEPT CODE		NAME (BHEL)	DATE
M	DRN	KM.KABILASH	24.09.21
	CHD	P.RAJU	24.09.21
	APPD	PNR/ACR	24.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – SYMBOL MARK (1/2)

SCALE : NTS

BHEL DRG NO. 03-FW-000-00675 | SH 01 of 02

FILE NO: B240 – 00001 | REV NO: 00

THIRD ANGLE PROJECTION | No. REQ'D | A3 | DRAWING No.

INSTRUMENT ABBREVIATION

	FIRST–LETTER		SUCCEEDING–LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		BLANK	BLANK	BLANK
C	BLANK			CONTROL	
D	BLANK	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	BLANK		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	BLANK	MOMENTARY			MIDDLE, INTERMEDIATE
N	BLANK		BLANK	BLANK	BLANK
O	BLANK		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT(TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

INSTRUMENT SYMBOLS

SYMBOLS	NAME
	FIELD MOUNTED
	FOR CONTROL ROOM
	FOR LOCAL CONTROL PANEL
	FOR DCS
I	INTERLOCK LOGIC

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 SWITH
FLXXWA–SL	SINGLE SOLENOID WITH LIMIT SWITCH

MACHINARY SYMBOLS

SYMBOLS	NAME
	PUMP
	FAN / BLOWER
	AGITATOR (FLAT BLADE)
	AGITATOR (PROPELLOR)
	ROTARY VALVE
	CRUSHER
	BELT FEEDER
	BELT FILTER
	BALL MILL
	CYCLONE
	MIST ELIMINATOR

EQUIPMENT SYMBOLS

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

DRIVER SYMBOLS

SYMBOLS	NAME
A	AIR MOTOR
M	ELECTRIC MOTOR

OTHER SYMBOLS

SYMBOLS	NAME
	INSERT PIPE / LANCE
	CHUTE
	TRUCK

CUSTOMER NOS: G301,G302,G303&G304
CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

CUSTOMER NOS: G301,G302,G303&G304

CAUTION: THE DRAWING IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LTD.AND IS NOT TO BE REPRODUCED OR USED TO FURNISH ANY INFORMATION FOR MAKING OF DRAWINGS OF APPARATUS EXCEPT WHERE PROVIDED FOR AGREEMENT WITH SAID COMPANY.

CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

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

DEPT CODE		NAME (BHEL)	DATE
M	DRN	KM.KABILASH	24.09.21
	CHD	P.RAJU	24.09.21
	APPD	PNR/ACR	24.09.21

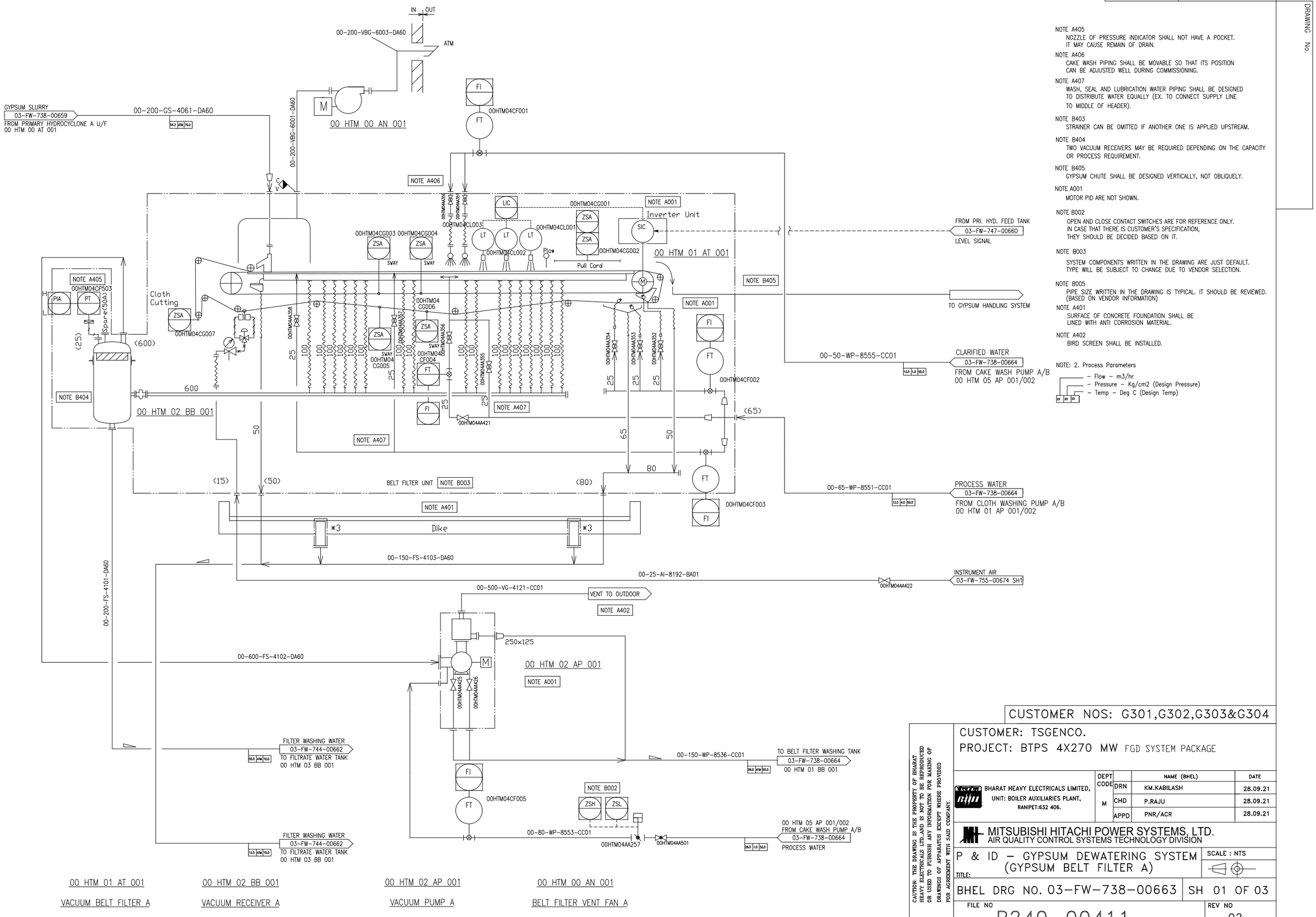
MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – SYMBOL MARK (2/2) | SCALE : NTS

BHEL DRG NO. 03–FW–000–00675 | SH 02 of 02

FILE NO B240 – 00002 | REV NO 00

0 1 2 3 4 5 6 7 8 9 10



NOTE A405
NOZZLE OF PRESSURE INDICATOR SHALL NOT HAVE A POCKET. IT MAY CAUSE REMAIN OF DRAIN.

NOTE A406
CAKE WASH PIPING SHALL BE MOVABLE SO THAT ITS POSITION CAN BE ADJUSTED WELL DURING COMMISSIONING.

NOTE A407
WASH, SEAL AND LUBRICATION WATER PIPING SHALL BE DESIGNED TO DISTRIBUTE WATER EQUALLY (EX. TO CONNECT SUPPLY LINE TO MIDDLE OF HEADER).

NOTE B403
STRAINER CAN BE OMITTED IF ANOTHER ONE IS APPLIED UPSTREAM.

NOTE B404
TWO VACUUM RECEIVERS MAY BE REQUIRED DEPENDING ON THE CAPACITY OR PROCESS REQUIREMENT.

NOTE B405
GYPSUM CHUTE SHALL BE DESIGNED VERTICALLY, NOT OBLIQUELY.

NOTE A001
MOTOR PID ARE NOT SHOWN.

NOTE B002
OPEN AND CLOSE CONTACT SWITCHES ARE FOR REFERENCE ONLY. IN CASE THAT THERE IS CUSTOMER'S SPECIFICATION, THEY SHOULD BE DECIDED BASED ON IT.

NOTE B003
SYSTEM COMPONENTS WRITTEN IN THE DRAWING ARE JUST DEFAULT. TYPE WILL BE SUBJECT TO CHANGE DUE TO VENDOR SELECTION.

NOTE B005
PIPE SIZE WRITTEN IN THE DRAWING IS TYPICAL. IT SHOULD BE REVIEWED. (BASED ON VENDOR INFORMATION)

NOTE A401
SURFACE OF CONCRETE FOUNDATION SHALL BE LINED WITH ANTI CORROSION MATERIAL.

NOTE A402
BIRD SCREEN SHALL BE INSTALLED.

NOTE: 2. Process Parameters
- Flow – m3/hr
- Pressure – Kg/cm2 (Design Pressure)
- Temp – Deg C (Design Temp)

THIRD ANGLE | No. REQ'D | A3 | DRAWING No.

CUSTOMER NOS: G301,G302,G303&G304

CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

BHARAT HEAVY ELECTRICALS LIMITED, UNIT: BOILER AUXILIARIES PLANT, RANIPET:632 406.	DEPT CODE		NAME (BHEL)	DATE
	M	DRN	KM.KABILASH	28.09.21
		CHD	P.RAJU	28.09.21
		APPD	PNR/ACR	28.09.21

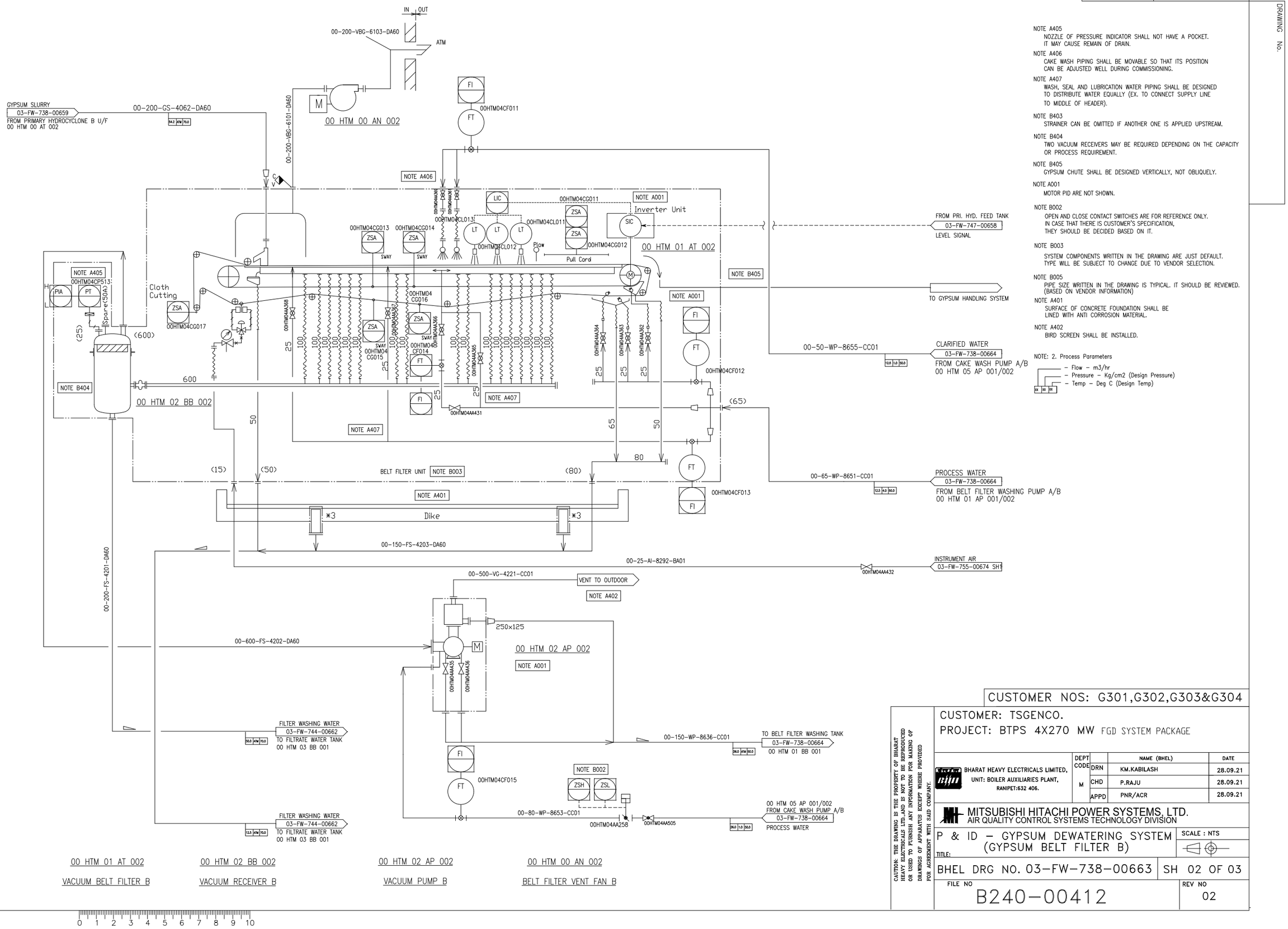
MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – GYPSUM DEWATERING SYSTEM (GYPSUM BELT FILTER A) | SCALE : NTS

BHEL DRG NO. 03–FW–738–00663 | SH 01 OF 03

FILE NO B240–00411 | REV NO 02

CAUTION: THE DRAWING IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LTD.AND IS NOT TO BE REPRODUCED OR USED TO FURNISH ANY INFORMATION FOR MAKING OF DRAWINGS OF APPARATUS EXCEPT WHERE PROVIDED FOR AGREEMENT WITH SAID COMPANY.



THIRD ANGLE | No. REQ'D | A3

DRAWING No.

NOTE A405
NOZZLE OF PRESSURE INDICATOR SHALL NOT HAVE A POCKET. IT MAY CAUSE REMAIN OF DRAIN.

NOTE A406
CAKE WASH PIPING SHALL BE MOVABLE SO THAT ITS POSITION CAN BE ADJUSTED WELL DURING COMMISSIONING.

NOTE A407
WASH, SEAL AND LUBRICATION WATER PIPING SHALL BE DESIGNED TO DISTRIBUTE WATER EQUALLY (EX. TO CONNECT SUPPLY LINE TO MIDDLE OF HEADER).

NOTE B403
STRAINER CAN BE OMITTED IF ANOTHER ONE IS APPLIED UPSTREAM.

NOTE B404
TWO VACUUM RECEIVERS MAY BE REQUIRED DEPENDING ON THE CAPACITY OR PROCESS REQUIREMENT.

NOTE B405
GYPSUM CHUTE SHALL BE DESIGNED VERTICALLY, NOT OBLIQUELY.

NOTE A001
MOTOR PID ARE NOT SHOWN.

NOTE B002
OPEN AND CLOSE CONTACT SWITCHES ARE FOR REFERENCE ONLY. IN CASE THAT THERE IS CUSTOMER'S SPECIFICATION, THEY SHOULD BE DECIDED BASED ON IT.

NOTE B003
SYSTEM COMPONENTS WRITTEN IN THE DRAWING ARE JUST DEFAULT. TYPE WILL BE SUBJECT TO CHANGE DUE TO VENDOR SELECTION.

NOTE B005
PIPE SIZE WRITTEN IN THE DRAWING IS TYPICAL. IT SHOULD BE REVIEWED. (BASED ON VENDOR INFORMATION)

NOTE A401
SURFACE OF CONCRETE FOUNDATION SHALL BE LINED WITH ANTI CORROSION MATERIAL.

NOTE A402
BIRD SCREEN SHALL BE INSTALLED.

NOTE: 2. Process Parameters
- Flow – m3/hr
- Pressure – Kg/cm2 (Design Pressure)
- Temp – Deg C (Design Temp)

CUSTOMER NOS: G301,G302,G303&G304

CUSTOMER: TSGENCO.

PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

	DEPT CODE	NAME (BHEL)	DATE
BHARAT HEAVY ELECTRICALS LIMITED, UNIT: BOILER AUXILIARIES PLANT, RANIPET:632 406.	M	DRN KM.KABILASH	28.09.21
		CHD P.RAJU	28.09.21
		APPD PNR/ACR	28.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – GYPSUM DEWATERING SYSTEM (GYPSUM BELT FILTER B)

SCALE : NTS

BHEL DRG NO. 03–FW–738–00663 | SH 02 OF 03

FILE NO B240–00412 | REV NO 02

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WRITE UP ON VACUUM BELT FILTER & ACCESSORIES

Purpose: This write up describes the equipment associated with Primary Hydrocyclone, Secondary hydrocyclone & Vacuum Belt filters and defines the associated control system.

Equipment List:

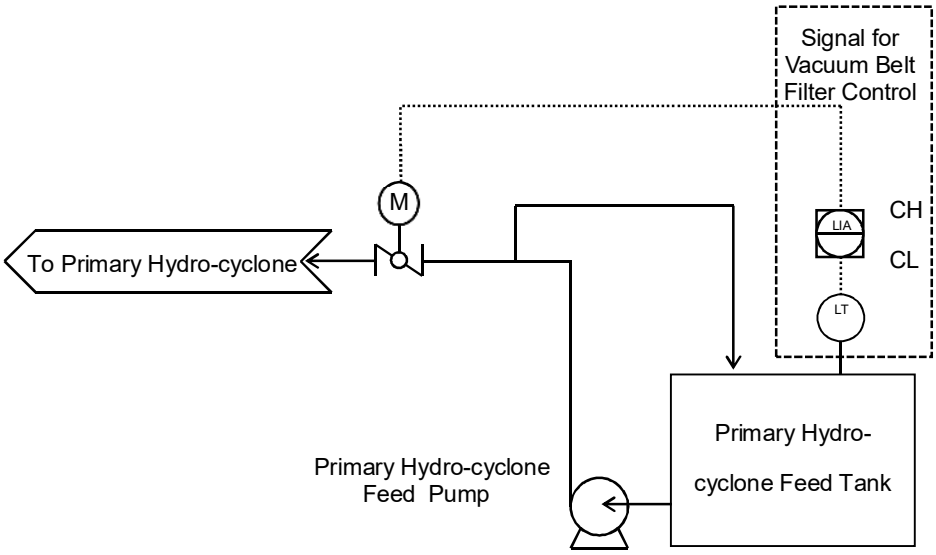
S. No.	Description	Item No.	Qty
1.	Vacuum Belt filter	00 HTM 01 AT 001/002	1W+1S
2.	Vacuum Receiver	00 HTM 02 BB 001/002	1W+1S
3.	Vacuum Pump	00 HTM 02 AP 001/002	1W+1S
4.	Belt Filter washing Pump	00 HTM 01 AP 001/002	1W+1S
5.	Belt Filter washing tank	00 HTM 01 BB 001	1

Operation & Control Write Up:

Primary Hydrocyclone:

Gypsum slurry from Absorber is fed to primary hydro cyclone feed tank by Gypsum Bleed Pumps. From Primary Hydro cyclone feed tank slurry is fed to primary hydro cyclone by feed pumps for first stage of dewatering. Hydro cyclone separates feed gypsum slurry into high concentration underflow and low concentration overflow. Primary hydro cyclone underflow is sent to vacuum belt filter for second stage of dewatering. Slurry Primary hydro cyclone overflow is sent to secondary hydro cyclone feed tank.

Primary Hydro Cyclone Feed Tank Level Control

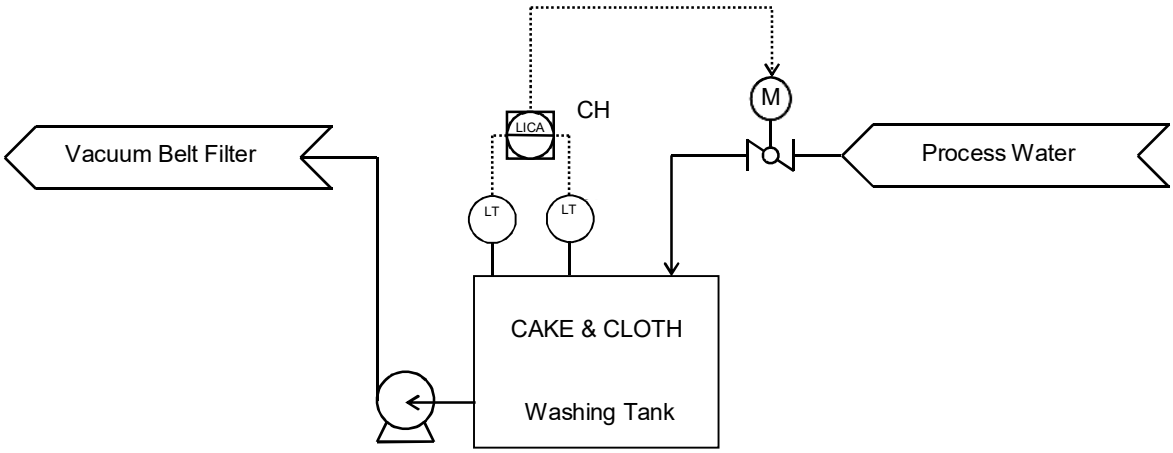


Vacuum Belt Filters:

The underflow from primary hydro cyclone is fed to vacuum belt filter for final stage of dewatering gypsum slurry to produce gypsum cake of required quality. The filtrate from each belt filter, cake washing & cloth washing is taken to a Vacuum receiver with the aid of Vacuum Pump.

Belt Filter Washing Tank:

Cake wash pumps will feed the water for gypsum cake washing and for Vacuum Pump Sealing. Cloth wash pump will feed the water for cloth washing. Cake and cloth wash tank level is to keep operated in the suitable range level, Tank level is controlled by the quantity of clarified water supply to the tank by batch operation.



Instrument List (Sheet 1)

SL.No	KKS Code	Description	Qty
1.	00HTM04CL001/003	Level Transmitter	3 Nos
2.	00HTM04CF001/005	Rotameter (Flow meter)	5 Nos
3.	00HTM04CP503	Pressure Transmitter	1 No

Instrument List (Sheet 2)

SL.No	KKS Code	Description	Qty
1.	00HTM04CL011/012	Level Transmitter	3 Nos
2.	00HTM04CF011/015	Rotameter (Flow meter)	5 Nos
3.	00HTM04CP513	Pressure Transmitter	1 No

THIRD ANGLE PROJECTION	No. REQ'D	A3

DRAWING No.

DRAIN AND OVERFLOW
03-FW-738-00664
FROM BELT FILTER WASHING TANK
00 HTM 01 BB 001

DRAIN AND OVERFLOW
03-FW-744-00662
FROM FILTRATE WATER TANK
00 HTM 03 BB 001

SUCTION AND PUMP DRAIN
03-FW-744-00662
FROM FILTRATE WATER TANK PUMP A/B
00 HTM 03 AP 001/002

DRAIN AND OVERFLOW
03-FW-747-00660
FROM SECONDARY HYDROCYCLONE FEED TANK
00 HTM 04 BB 001

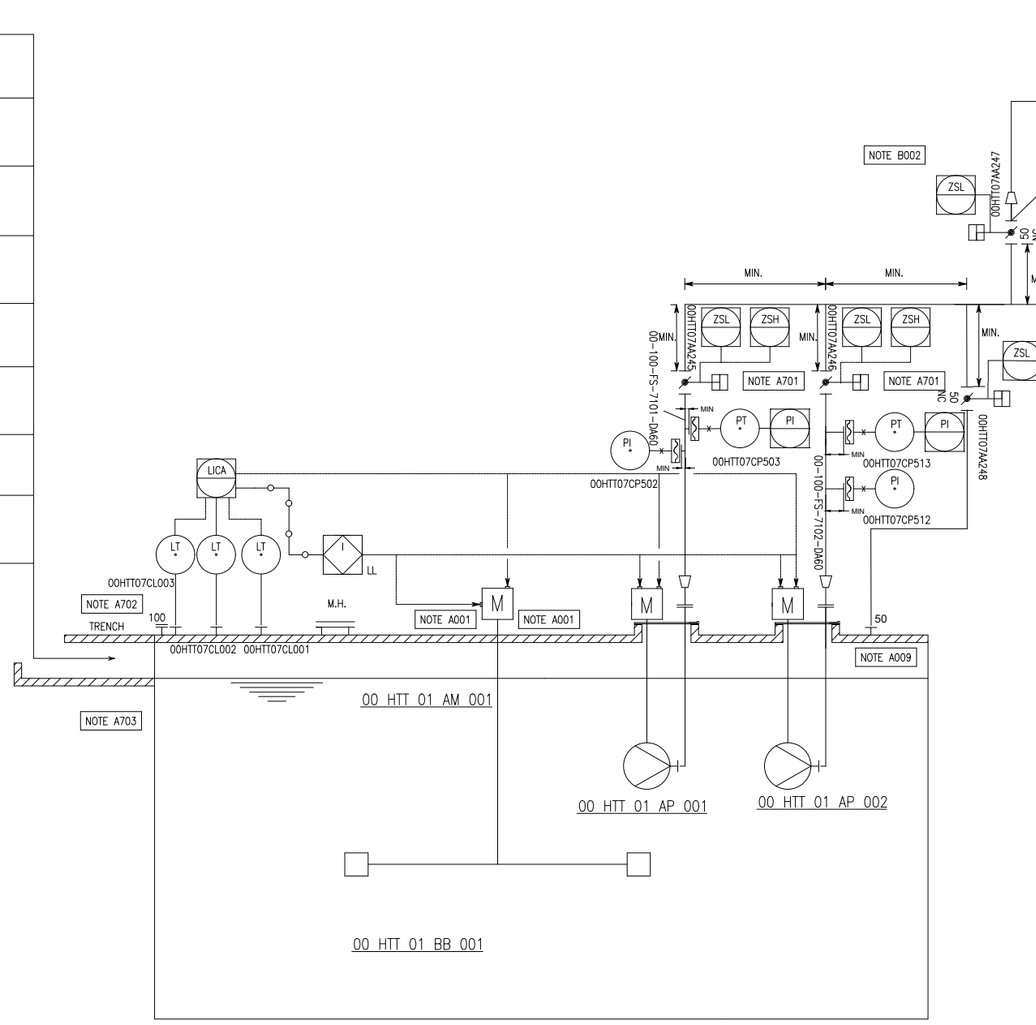
SUCTION AND PUMP DRAIN
03-FW-747-00660
FROM SECONDARY HYDROCYCLONE FEED TANK PUMP A/B
00 HTM 04 AP 001/002

DRAIN AND OVERFLOW
03-FW-745-00665
FROM WASTE WATER STORAGE TANK
00 HTM 05 BB 001

SUCTION AND PUMP DRAIN
03-FW-745-00665
FROM WASTE WATER PUMP A/B
00 HTM 05 AP 001/002

DRAIN AND OVERFLOW
03-FW-747-00658
FROM PRIMARY HYDROCYCLONE FEED TANK A
00 HTM 00 BB 001

SUCTION AND PUMP DRAIN
03-FW-747-00658
FROM PRIMARY HYDROCYCLONE FEED TANK PUMP A/B
00 HTM 00 AP 001/002



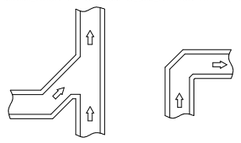
NOTE: 2. Process Parameters
- Flow – m3/hr
- Pressure – Kg/cm2 (Design Pressure)
- Temp – Deg C (Design Temp)

NOTE A001
MOTOR PID ARE NOT SHOWN.

NOTE A701
THE DISTANCE BETWEEN THE PUMP DISCHARGE NOZZLE AND THE DISCHARGE VALVE SHALL BE THE MINIMUM, BUT A SPLIT FLANGE SHALL BE PROVIDED BETWEEN THESE TWO SO THAT THE PUMP CAN BE REMOVED FROM THE PIT WITHOUT INTERFERENCE FOR MAINTENANCE.

NOTE A702
AT THE OPENING OF TRENCH, SCREEN SHALL BE PROVIDED TO PREVENT INGRESS OF DEBRIS.

NOTE A703
CORNER OF TRENCH SHALL BE AS SHOWN BELOW FOR MINIMIZATION OF GYPSUM SEDIMENTATION AT THE CORNER.



NOTE B002
OPEN AND CLOSE CONTACT SWITCHES ARE FOR REFERENCE ONLY. IN CASE THAT THERE IS CUSTOMER'S SPECIFICATION, THEY SHOULD BE DECIDED BASED ON IT.

00 HTT 01 AM 001
GYPSUM AREA DRAIN SUMP AGITATOR

00 HTT 01 BB 001
GYPSUM AREA DRAIN SUMP

00 HTT 01 AP 001/002
GYPSUM AREA DRAIN SUMP PUMP A/B

CUSTOMER NOS: G301,G302,G303&G304

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CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

	DEPT CODE		NAME (BHEL)	DATE
BHARAT HEAVY ELECTRICALS LIMITED, UNIT: BOILER AUXILIARIES PLANT, RANIPET:632 406.	M	DRN	KM.KABILASH	30.09.21
		CHD	P.RAJU	30.09.21
		APPD	PNR/ACR	30.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – GYPSUM AREA DRAIN SUMP
SCALE : NTS

BHEL DRG NO. 03-FW-738-00663 SH 03 OF 03

FILE NO B240-00720
REV NO 02

0 1 2 3 4 5 6 7 8 9 10

Write Up on Gypsum area drain sump & Pumps

Purpose: This write up describes the equipment associated with Gypsum area sump system and defines the associated control system.

Equipment List:

S. No.	Description	Item No.	Qty
1	Gypsum area Drain Sump Agitator	00 HTT 01 AM 001	1 No
2	Gypsum area Drain Sump Pump	00 HTT 01 AP 001/002	2 Nos(1W+1S)
3	Gypsum area Drain Sump	00 HTT 01 BB 001	1 No

The Gypsum area drain sump pump is located inside Gypsum dewatering system area.

Operation Write Up:

Purpose of drain sump

(a) In the Normal Operation: Gypsum Area Drain sump receives the drain from Primary Hydro cyclone, Filtrate Water pump, Waste Water Hydro cyclone Feed Tank pump and Waste Water pump when these equipment are stopped. The received drain in the sump is returned to Filtrate Water Tank by Gypsum Area Drain Sump Pump.
(b) In the maintenance: Gypsum Area Drain sump receives the drain from Filtrate water tanks, Waste water hydro cyclone feed tanks, waste water tanks, belt filter washing tanks temporarily. The received drain in the sump is transferred only to Filtrate Water Tank by Gypsum Area Drain Sump Pump.

Design Basis of Drain Sump

The size of the sump is 4.0mD x 4.0mW x 4.0mH as standard of MHPS based on the frequency of pump operation and the limitation of sump area space*. (*It is necessary for the space of Sump pump, Sump agitator and pipes to install on the sump area.)
The sump operation levels are decided on reasons as follows;

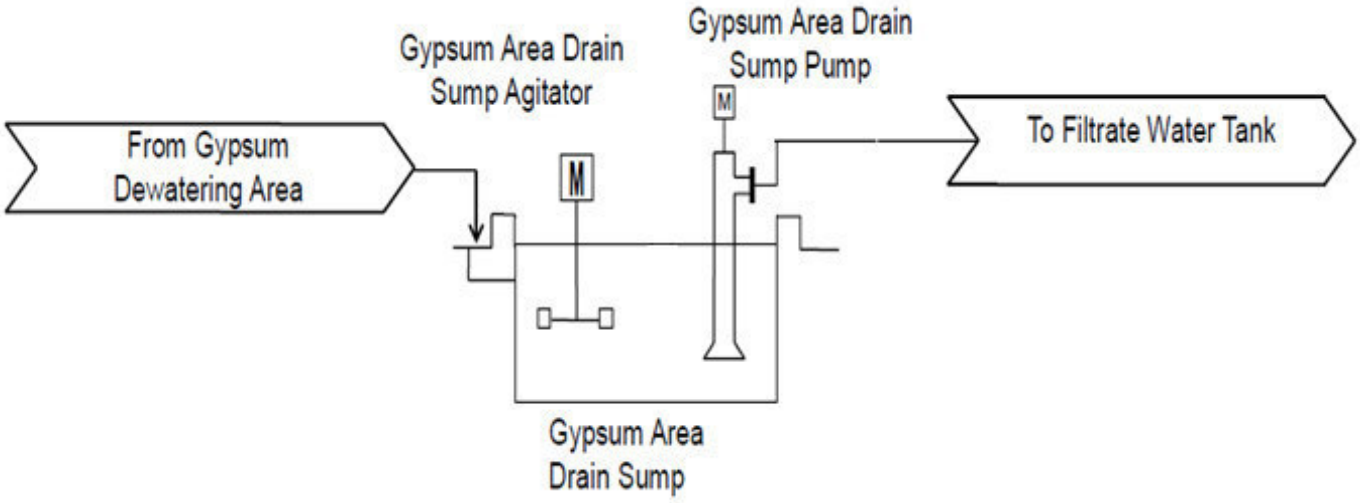
HH level : Overflow level

H, L level: The level at which alarm operates.

CH, CL level: The level at which pump operates and stops.

LL level : The level at which pump stops for pump protection.

The tank drain under the LL level is transferred to another tank via the drain sump.



Gypsum area sump along with agitator and Pump

Instrument List (Sheet 3)

SL.No	KKS Code	Description	Qty
1.	00HTT07CL001/003	Level Transmitter	3 Nos
2.	00HTT07CP502 & 00HTT07CP512	Pressure Indicator	2 Nos
3.	00HTT07CP503/506 & 00HTT07CP513	Pressure Transmitter	5 No

Table 3.3 Set Point List

Pressure

No.	KKS Tag no.	Service	Range	Unit	Set Point	Value	Action	Basis	Remark
1	PIA 10/40HTA01CP001/003	BUF Inlet Pressure		kPa	HH	6.5		Mechanical design pressure of FGD inlet duct: +6.47 kpa	
					H	1.0	H ANN	Normal pressure + 1.0 kPa	
					L	−1.0	L ANN	Normal pressure − 1.0 kPa	
					LL	−1.5	INT : FGD Bypass Demper Open LL ANN	Mechanical design pressure of FGD inlet duct: − 1.47 kpa	
					△H	Later	H ANN	PT measuring range x 0.05 (5%)	
2	PIA 10/40HTA01CP007	Absorber Inlet Pressure		kPa	H	4.7	H ANN	Normal pressure + 1.0 kPa	
					L	3.7	L ANN	Normal pressure − 1.0 kPa	
3	PDIA 10/40HTE02CP001	Mist Eliminator Differential Pressure		kPa	H	(*1)	H ANN	(Design pressure of ME +0.10kPa(Dirty)) x 1.1^2	
4	PIA 10/40HTY08CP002	Instrumentation Air Pressure		MPa	H	0.8	H ANN	Design Pressure	
					L	(*1)	L ANN	Minimum pressure of solenoid valve +0.5 MPa	

※1 : Will be provided later based on the vendor information.

Table 3.3 Set Point List

Temperature

No.	Tag no.	Service	Range	Unit	Set Point	Value	Action	Basis	Remark
1	TIA 10/40HTA01CT001/003	FGD Inlet Temperature		deg.C	HH	300	Interlock	Maximum temperature in AH mechanical trip condition	Emergency Spray valve open
					H	290	H ANN	Maximum temperature in AH mechanical trip condition – 10 deg.C	
					△H	(*1)	H ANN	TE measuring range × 0.05 (5%)	prevention for meter deflection
2	TIA 10/40HTA01CT005/007	FGD Outlet Temperature		deg.C	HH	70	Interlock	Heat-resistant value of Absorber internal material	Emergency Spray valve open
					H	65	H ANN	Heat-resistant value of Absorber internal material – 5 deg.C	
					△H	(*1)	H ANN	TE measuring range × 0.05 (5%)	prevention for meter deflection

※1 : Will be provided later based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	LICA 10/40HTD02CL001/003	Absorber Level		m	HH	7.0	Overflow	Normal Level + 1.0 m	
					H	6.3	H ANN	CH Level + 0.2 m	
					CH2	6.3	Start Permission for 1st Absorber Circulation Pump	The value that does not drop to L level after startng pump.	
					CH	6.1	Absorber make-up water supply stop	Normal Level + 0.1 m	
					N	6.0		Design Level (Normal Level)	
					CL	5.9	Absorber make-up water supply start	Normal Level - 0.1 m	
					L	5.7	L ANN	CL Level - 0.2 m	
					LL1	4.2(*1)	INT : Absorber Recirculation Pump Stop LL1 ANN		Pump Protection
					LL2	3.2(*1)	INT : Absorber Agitator Stop LL2 ANN	(Agitator installation Level :1.6m) + (Impeller dia.:1.6m)	Agitator Protection
					LL3	1.5(*1)	INT : Absorber Bleed Pump Stop LL3 ANN		Pump Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
2	LICA 00HTM04CL007/009	Belt Filter Washing Tank Level		m	HH	3	Over flow	Top level - 0.5m	
					H	2.8	H ANN	HH Level - 0.2 m	
					CH	2.6	Make-up water supply stop	H Level - 0.2 m	
					CL	1.4	Make-up water supply start	L Level + 0.2 m	
					L	1.2	L ANN	LL Level + 0.2 m.	
					LL	1.0(*1)	INT : Pump Stop LL ANN	(Suction pipe center)+2.5 x (Suction pipe Dia.)	Pump Protection
					△H	0.2	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
3	LICA 00HTM04CL011/013	Filtrate Water Tank Level		m	HH	5.1	Over flow	Top level - 0.5m	
					H	4.9	H ANN	HH Level - 0.2 m	
					CH	4.7	Absorber Return Valve Open	H Level - 0.2 m	
					CL	1.6	Absorber Return Valve Close	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
4	LICA 00HTM04CL001/003	Primary Hydrocyclone Feed Tank Level		m	HH	6.5	Over flow	Top level - 0.5m	
					H	6.3	H ANN	HH Level - 0.2 m	
					CH	6.1	Hydro-cyclone Feed start	H Level - 0.2 m	
					CL	1.6	Hydro-cyclone Feed Stop	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump Protection Agitator Protection
					△H	0.6	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
4	LICA 00HTM04CL003/005	Secondary Waste Water Hydrocyclone Feed Tank Level		m	HH	5.5	Over flow	Top level - 0.5m	
					H	5.3	H ANN	HH Level - 0.2 m	
					CH	5.1	Hydro-cyclone Feed start	H Level - 0.2 m	
					CL	1.5	Hydro-cyclone Feed Stop	L Level + 0.2 m	
					L	1.3	L ANN	LL Level + 0.2 m.	
					LL	1.1(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
5	LICA	Waste Water Storage Tank		m	HH	6.5	Over flow	Top level - 0.5m	

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
	00HTM04CL013/015	Level			H	6.3	H ANN	HH Level - 0.2 m	
					CH1	6.1	Filtrate Water Tank Feed Start	H Level - 0.2 m	
					CL1	5.6	Filtrate Water Tank Feed Stop	CH1 Level - 0.5 m	
					CH2	2.1	Waste Water Treatment Feed Start	CL2 Level + 0.5 m	
					CL2	1.6	Waste Water Treatment Feed Stop	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
7	LICA	Mill Circuit Tank Level		m	HH	Later(*1)	HH ANN	To be finalize by BHEL based on vedor information.	Silo & Bag Filter Protection
	00HTK05CL001/003				H	Later(*1)	H ANN	To be finalize by BHEL based on vedor information.	
	00HTK05CL004/006				L	Later(*1)	L ANN	To be finalize by BHEL based on vedor information.	
					LL	Later(*1)	LL ANN	To be finalize by BHEL based on vedor information.	
8	LICA	Limestone Slurry Storage Tank		m	HH	11.5	Over flow	Top level - 0.8m	
	00HTK05CL021/023	Level			H	11.3	H ANN	HH Level - 0.2 m	
					CH	10.8	Wet Limestone Grinding Mill stop	H Level - 0.5 m	
					CL	4.4	Wet Limestone Grinding Mill start		
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
9	LIC	Absorber Area Drain Sump		m	HH	3.5	Over flow	Top level - 0.5m	
	10/40HTT07CL001/003	Level			H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN		Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
10	LIA 00HTT07CL001/003	Aixiliary Absorbent Tank Level		m	HH	10.1	Over flow	Top level - 0.8m	
					H	9.9	H ANN	HH Level - 0.2 m	
					L	4.4	L ANN	LL1 Level + 0.2 m	
					LL1	3.4(*1)	INT : Agitator Stop LL1 ANN		
					LL2	2.0*1)	INT : Pump Stop LL2 ANN		Pump Protection
11	LICA 00HTT07CL001/003	Gypsum Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump protection Agitator Protection
12	LICA 00HTT07CL004/006	Limestone Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
13	LICA	Process Water Tank Level		m	HH	4.9	Over flow	Top level - 0.5m	
	00HTQ08CL001/003				H	4.7	H ANN	HH Level - 0.2 m	
	00HTQ08CL004/006				CH	4.5	Make-up water supply stop	H Level - 0.2 m	
		`			CL	4.0	Make-up water supply start	CH Level - 0.5 m	
					L	1.5	L ANN	LL Level + 0.2 m.	
					LL	1.3(*1)	INT : Pump Stop LL ANN		Pump Protection
					△H	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
14	LICA	Emergency Water Tank Level		m	HH	3	Over flow	Top level - 0.5m	
	10/40HTQ08CL021/023				H	2.8	H ANN	HH Level - 0.2 m	
					CH	2.6	Make-up water supply stop	H Level - 0.2 m	
					CL	2.4	Make-up water supply start	CH Level - 0.2 m	
					L	0.5	L ANN	Bottom + 0.5 m	

※This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL shall add set point for unit equipment and finalize the list according to the vender information.

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Others

No.	KKS Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	AICA	Absorber pH		–	H	6.5	H ANN	Normal pH + α	
	10/40HTD02CQ001/003				N	Later	Set point for pH control	Commissioning adjustment value	
					L	Later	L ANN, Set point for minimum pH	Commissioning adjustment value	
2	DICA	Absorber Density		wt.%	H	35	H ANN	Normal Density + 5 wt.%	Pump & Belt Filter Protection
	10/40HTM01CD001/003				CH	32	Absorber Slurry Bleed Start	Normal Density + 2 wt.%	
					N	30	Set point for Density Control	Design Density	
					CL	28	Absorber Slurry Bleed Stop	Normal Density – 2 wt.%	
					L	25	L ANN	Normal Density – 5 wt.%	
3	AICA	FGD Outlet SO2		mg/Nm^3	H	100	H ANN	Design FGD Outlet SO2 concentration	
	10/40HTA01CQ005				N	Later	Set point for SO2 control	Commissioning adjustment	

※This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL will add set point for unit equipment and finalize the list according to the vender information.

04	30.11.21	Replied to customer comments	KMK	PR	PNR
03	23.10.21	Revised the document as per TSGENCO comments	KMK	PR	RSB
02	18.03.20	Revised the document as per the comments	KMK	PR	RSB
01	29.01.20	Revised the document as per the comments	KMK	PR	SKD
00	12.11.19	Fresh Issue	KMK	PR	SKD
REV	DATE	DESCRIPTION /NOTE	PRD	CHD	APD

REVISIONS

TITLE:

P&ID_BELT FILTER WASHING TANK & PUMP(A)

OWNER/PROJECT: **TELANGANA STATE POWER GENERATION CORPORATION LTD**

BHADRADRI (4X270 MW) THERMAL POWER STATION–
FGD SYSTEM PACKAGE

CONSULTANT:

DESEIN PRIVATE LIMITED.
NEW DELHI

EPC CONTRACTOR:

BHARAT HEAVY ELECTRICALS LTD.
BOILER AUXILIARIES PLANT,RANIPET

COLLABORATOR

MITSUBISHI HITACHI POWER SYSTEMS, LTD
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

	BHEL	Date	
PREPARED BY	KABILASH	30.11.21	STATUS : *FOR APPROVAL*
CHECKED BY	RAJU P	30.11.21	BHEL CUST NO : G301,G302,G303 &G304
APPROVED BY	P.NAVEEN	30.11.21	BHEL DOC NO : 03-FW-738-00664
			REV NO :04

THIRD ANGLE PROJECTION | No. REQ'D | A3 | DRAWING No.

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
M	ACTUATED BY MOTOR
IM	ACTUATED BY MOTOR (INCHING)
	AIR CONTROL VALVE
S	SOLENOID ACTUATOR
	SELF REGURATING VALVE
	SELF REGURATING VALVE

TRENCH SYMBOLS

SYMBOLS	NAME
A	TO ABSORBER AREA DRAIN SUMP
D	TO GYPSUM AREA DRAIN SUMP
L	TO LIMESTONE AREA DRAIN SUMP

SYMBOLS FOR PIPING PARTS & INSTRUMENT PARTS

SYMBOLS	NAME
T	STEAM TRAP
AT	AIR TRAP
	Y-STRAINER
	T-STRAINER
TS	TEMPORARY STRAINER
	REDUCER
	EXPANSION JOINT
	DUCT EXPANSION JOINT
	FLEXIBLE HOSE
	SPOOL PIECE
	VENT
	HOSE CONNECTION
	BLIND FLANGE
	REDUCING FLANGE
	CAP (BW)
	CAP (SCR)
	TRENCH
SG	SIGHT GLASS
	SILENCER
	ORIFICE
	DIAPHRAGM
M	MAGNETIC FLOW METER
	VORTEX FLOW METER
	PH METER
	FILTER
M.H. M.H. M.H. I.H.	MANHOLE
	INSPECTION HOLE
	PITOT TUBE
	SAMPLING POT
S	SAMPLING NOZZLE
RO	RESTRICTION ORIFICE
FI	ROTOMETER TYPE FLOW METER

SYMBOLS FOR VALVE OPERATION

SYMBOLS	NAME
FO	FAILURE OPEN (THE VALVE OPENS WHEN AIR OR ELECTRICITY FOR ACTUATOR FAILS.)
FC	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 CLIENT AND CONTRACTOR
CONTRACTOR | XXX	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
AA	ANTIFOAM AGENT	WCS	COOLING WATER SUPPLY
AC	COMPRESSED AIR	WCR	COOLING WATER RETURN
AF	FLUIDIZER AIR	WC	Ca(OH)2
AI	INSTRUMENT AIR	WP	PROCESS WATER
AO	OXIDATION AIR	WR	RAW WATER
AS	SEAL AIR	WW	WASTE WATER
DD	DUCT DRAIN	VG	VACUUM PUMP VENT
FS	FILTRATE SLURRY	VBG	BELT FILTER VENT GAS
GS	GYPSUM SLURRY	LD	LIMESTONE DEDUSTING
LS	LIMESTONE SLURRY	LOL	LUBE OIL (LOW PRESSURE)
FG	FLUE GAS	LOH	LUBE OIL (HIGH PRESSURE)

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 / GI PIPING	AI, LOL
BA02	Gr.304 STAINLESS STEEL / GI 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
DA60	FRP PIPING (PIPE DIA UPTO 400 NB)	GS,FS,WW,DD
DA40	FRP PIPING (PIPE DIA UPTO 400 NB)	LS, WP, WC

UNIT CODE

SYMBOLS	UNIT IDENTIFICATION
90	COMMON
10	UNIT-1 FGD SYSTEM AND AUXILIARIES
20	UNIT-2 FGD SYSTEM AND AUXILIARIES
30	UNIT-3 FGD SYSTEM AND AUXILIARIES
40	UNIT-4 FGD SYSTEM AND AUXILIARIES
50	UNIT-5 FGD SYSTEM AND AUXILIARIES

EXPRESSION OF PIPING LINE

10 - 200 - GS - 2 00 1 - AA60 - HF

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

CUSTOMER NOS: G301,G302,G303&G304

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CUSTOMER: TSGENCO.

PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

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

DEPT CODE		NAME (BHEL)	DATE
M	DRN	KM.KABILASH	24.09.21
	CHD	P.RAJU	24.09.21
	APPD	PNR/ACR	24.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – SYMBOL MARK (1/2)

SCALE : NTS

BHEL DRG NO. 03-FW-000-00675 | SH 01 of 02

FILE NO: B240 – 00001 | REV NO: 00

THIRD ANGLE PROJECTION | No. REQ'D | A3 | DRAWING No.

INSTRUMENT ABBREVIATION

	FIRST–LETTER		SUCCEEDING–LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		BLANK	BLANK	BLANK
C	BLANK			CONTROL	
D	BLANK	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	BLANK		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	BLANK	MOMENTARY			MIDDLE, INTERMEDIATE
N	BLANK		BLANK	BLANK	BLANK
O	BLANK		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT(TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

INSTRUMENT SYMBOLS

SYMBOLS	NAME
	FIELD MOUNTED
	FOR CONTROL ROOM
	FOR LOCAL CONTROL PANEL
	FOR DCS
I	INTERLOCK LOGIC

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 SWITH
FLXXWA–SL	SINGLE SOLENOID WITH LIMIT SWITCH

MACHINARY SYMBOLS

SYMBOLS	NAME
	PUMP
	FAN / BLOWER
	AGITATOR (FLAT BLADE)
	AGITATOR (PROPELLOR)
	ROTARY VALVE
	CRUSHER
	BELT FEEDER
	BELT FILTER
	BALL MILL
	CYCLONE
	MIST ELIMINATOR

EQUIPMENT SYMBOLS

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

DRIVER SYMBOLS

SYMBOLS	NAME
A	AIR MOTOR
M	ELECTRIC MOTOR

OTHER SYMBOLS

SYMBOLS	NAME
	INSERT PIPE / LANCE
	CHUTE
	TRUCK

CUSTOMER NOS: G301,G302,G303&G304
CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

CUSTOMER NOS: G301,G302,G303&G304

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CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

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

DEPT CODE		NAME (BHEL)	DATE
M	DRN	KM.KABILASH	24.09.21
	CHD	P.RAJU	24.09.21
	APPD	PNR/ACR	24.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – SYMBOL MARK (2/2) | SCALE : NTS

BHEL DRG NO. 03–FW–000–00675 | SH 02 of 02

FILE NO B240 – 00002 | REV NO 00

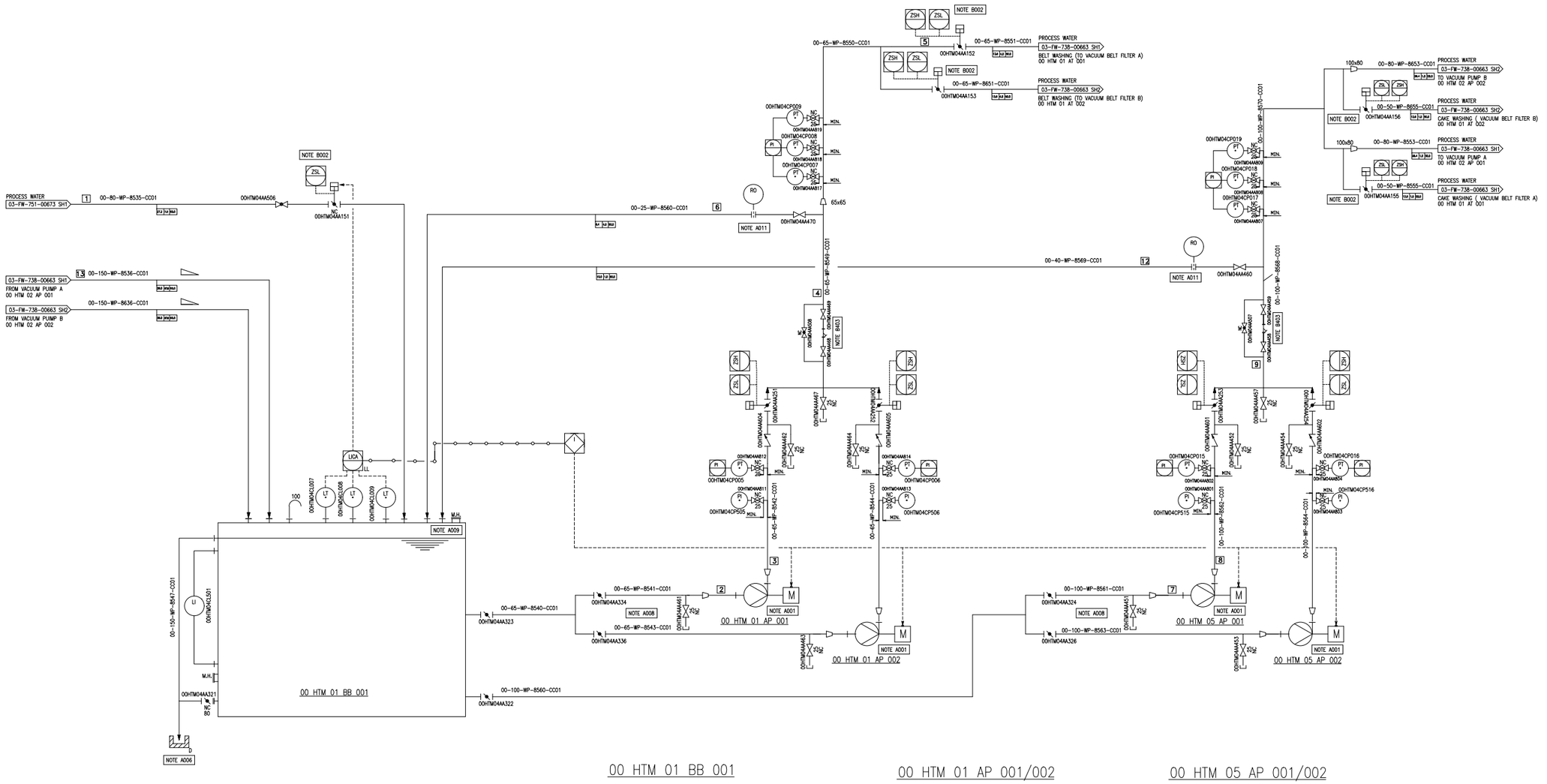
0 1 2 3 4 5 6 7 8 9 10

THIRD ANGLE PROJECTION

No. REQ'D

A3

DRAWING No.



00 HTM 01 BB 001

BELT FILTER WASHING TANK

00 HTM 01 AP 001/002

BELT FILTER WASHING PUMP A/B

00 HTM 05 AP 001/002

CAKE WASH PUMP A/B

NOTE: 2. Process Parameters
– Flow – m3/hr
– Pressure – Kg/cm2 (Design Pressure)
– Temp – Deg C (Design Temp)

NOTE A001
MOTOR PID ARE NOT SHOWN.

NOTE A006
DISCHARGE OF DRAIN AND OVERFLOW LINE SHALL HAVE 45 DEG INCLINATION TOWARD FLOW DIRECTION OF TRENCH FOR SMOOTH FLOW.

NOTE A008
TEMPORARY STRAINER SHALL BE INSTALLED AT THE PUMP SUCTION FOR THE TERMS OF PRE-COMMISSIONING.

NOTE A009
THERE SHOULD BE CERTAIN DISTANCE BETWEEN NOZZLES FOR INFLUENT LINE AND PUMP SUCTION NOZZLE AS LONG AS THERE IS NO INSERT PIPE.

NOTE A011
RO SHALL BE INSTALLED IN VERTICAL LINE.

NOTE B002
OPEN AND CLOSE CONTACT SWITCHES ARE FOR REFERENCE ONLY. IN CASE THAT THERE IS CUSTOMER'S SPECIFICATION, THEY SHOULD BE DECIDED BASED ON IT.

NOTE B403
STRAINER SHALL BE ELIMINATED IF ANY INSTALLED UPSTREAM

NOTE
PIPE SIZE MENTIONED IN THIS P&ID IS TYPICAL. TO BE REVISED BASED ON VENDORS INFORMATION.

CUSTOMER NOS: G301,G302,G303&G304

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CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

	DEPT CODE	NAME (BHEL)	DATE
BHARAT HEAVY ELECTRICALS LIMITED, UNIT: BOILER AUXILIARIES PLANT, RANIPET:632 406.	M	DRN KM.KABILASH	27.09.21
		CHD P.RAJU	27.09.21
		APPD PNR/ACR	27.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – CAKE AND CLOTH WASHING PUMPS & TANKS

SCALE : NTS

BHEL DRG NO. 03-FW-738-00328 SH 01 OF 01

FILE NO B240-00421

REV NO 03

WRITE UP ON CLOTH & CAKE WASHING TANK AND PUMPS

Purpose:

This write up describes the equipment associated with Belt Filters Washing Tank and defines the associated control system.

Equipment List:

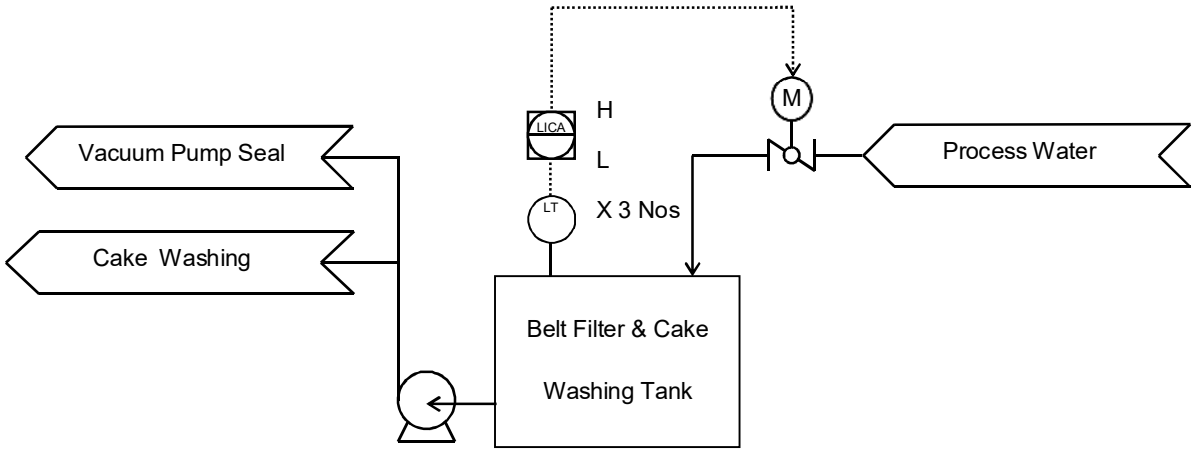
S. No.	Description	Item No.	Qty
1.	Cloth washing Pump	00 HTM 01 AP 001/002	1W+1S
2.	Cake washing Pump	00 HTM 05 AP 001/002	1W+1S
3.	Cloth washing tank	00 HTM 01 BB 001	1

Operation & Control Write Up:

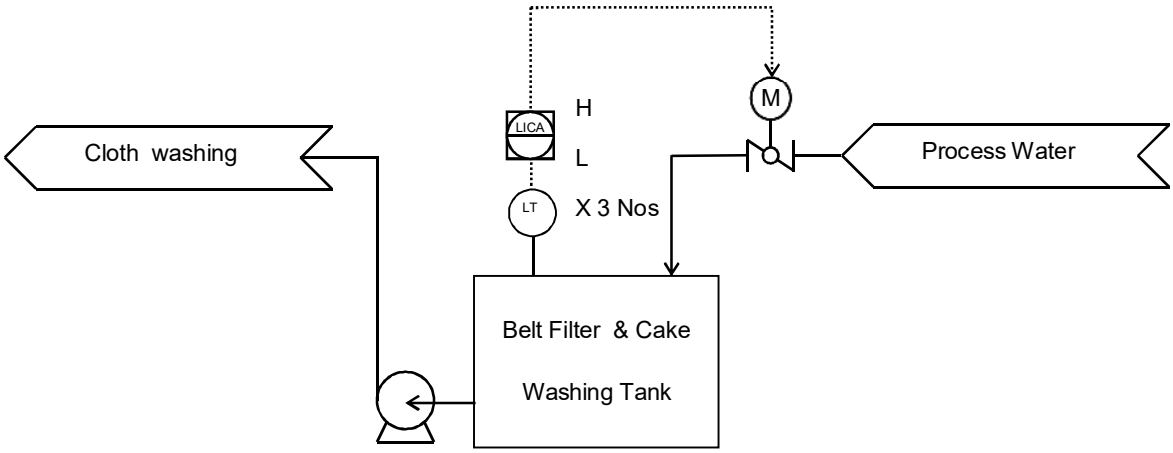
Cloth & Cake Washing Tank:

Cloth wash pumps will feed the water for Vacuum belt filter Cloth washing. Cake washing pumps will feed the water for Gypsum Cake washing and for Vacuum Pump Sealing.

Cloth & cake washing tank level is controlled to keep operated in the suitable range level. Based on the tank level feed line valve operates to allow the water to flow in to the tank. The tank level is controlled by the quantity of process water supply to Cloth & cake washing tank by batch operation.



Cake Washing Pump arrangement



Cloth Washing Pump arrangement

Cake and cloth wash pumps capacities provided in P&ID are tentative, actual pump capacity will be finalized by Vacuum belt filter supplier based on the vendor design philosophy.

Instrument List

Sl.No	KKS code	Description	Qty
1.	00HTM04CL007/009	Level Transmitter	03 Nos
2.	00HTM04CP505/506 & 00HTM04CP515/516	Pressure Indicator	04 Nos
3.	00HTM04CP005/009 & 00HTM04CP015/019	Pressure transmitter	10 Nos
4.	00HTM04CL501	Level Gauge(mechanical)	01 No

Table 3.3 Set Point List

Pressure

No.	KKS Tag no.	Service	Range	Unit	Set Point	Value	Action	Basis	Remark
1	PIA 10/40HTA01CP001/003	BUF Inlet Pressure		kPa	HH	6.5		Mechanical design pressure of FGD inlet duct: +6.47 kpa	
					H	1.0	H ANN	Normal pressure + 1.0 kPa	
					L	−1.0	L ANN	Normal pressure − 1.0 kPa	
					LL	−1.5	INT : FGD Bypass Demper Open LL ANN	Mechanical design pressure of FGD inlet duct: − 1.47 kpa	
					△H	Later	H ANN	PT measuring range x 0.05 (5%)	
2	PIA 10/40HTA01CP007	Absorber Inlet Pressure		kPa	H	4.7	H ANN	Normal pressure + 1.0 kPa	
					L	3.7	L ANN	Normal pressure − 1.0 kPa	
3	PDIA 10/40HTE02CP001	Mist Eliminator Differential Pressure		kPa	H	(*1)	H ANN	(Design pressure of ME +0.10kPa(Dirty)) x 1.1^2	
4	PIA 10/40HTY08CP002	Instrumentation Air Pressure		MPa	H	0.8	H ANN	Design Pressure	
					L	(*1)	L ANN	Minimum pressure of solenoid valve +0.5 MPa	

※1 : Will be provided later based on the vendor information.

Table 3.3 Set Point List

Temperature

No.	Tag no.	Service	Range	Unit	Set Point	Value	Action	Basis	Remark
1	TIA 10/40HTA01CT001/003	FGD Inlet Temperature		deg.C	HH	300	Interlock	Maximum temperature in AH mechanical trip condition	Emergency Spray valve open
					H	290	H ANN	Maximum temperature in AH mechanical trip condition – 10 deg.C	
					△H	(*1)	H ANN	TE measuring range × 0.05 (5%)	prevention for meter deflection
2	TIA 10/40HTA01CT005/007	FGD Outlet Temperature		deg.C	HH	70	Interlock	Heat-resistant value of Absorber internal material	Emergency Spray valve open
					H	65	H ANN	Heat-resistant value of Absorber internal material – 5 deg.C	
					△H	(*1)	H ANN	TE measuring range × 0.05 (5%)	prevention for meter deflection

※1 : Will be provided later based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	LICA 10/40HTD02CL001/003	Absorber Level		m	HH	7.0	Overflow	Normal Level + 1.0 m	
					H	6.3	H ANN	CH Level + 0.2 m	
					CH2	6.3	Start Permission for 1st Absorber Circulation Pump	The value that does not drop to L level after startng pump.	
					CH	6.1	Absorber make-up water supply stop	Normal Level + 0.1 m	
					N	6.0		Design Level (Normal Level)	
					CL	5.9	Absorber make-up water supply start	Normal Level - 0.1 m	
					L	5.7	L ANN	CL Level - 0.2 m	
					LL1	4.2(*1)	INT : Absorber Recirculation Pump Stop LL1 ANN		Pump Protection
					LL2	3.2(*1)	INT : Absorber Agitator Stop LL2 ANN	(Agitator installation Level :1.6m) + (Impeller dia.:1.6m)	Agitator Protection
					LL3	1.5(*1)	INT : Absorber Bleed Pump Stop LL3 ANN		Pump Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
2	LICA 00HTM04CL007/009	Belt Filter Washing Tank Level		m	HH	3	Over flow	Top level - 0.5m	
					H	2.8	H ANN	HH Level - 0.2 m	
					CH	2.6	Make-up water supply stop	H Level - 0.2 m	
					CL	1.4	Make-up water supply start	L Level + 0.2 m	
					L	1.2	L ANN	LL Level + 0.2 m.	
					LL	1.0(*1)	INT : Pump Stop LL ANN	(Suction pipe center)+2.5 x (Suction pipe Dia.)	Pump Protection
					△H	0.2	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
3	LICA 00HTM04CL011/013	Filtrate Water Tank Level		m	HH	5.1	Over flow	Top level - 0.5m	
					H	4.9	H ANN	HH Level - 0.2 m	
					CH	4.7	Absorber Return Valve Open	H Level - 0.2 m	
					CL	1.6	Absorber Return Valve Close	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
4	LICA 00HTM04CL001/003	Primary Hydrocyclone Feed Tank Level		m	HH	6.5	Over flow	Top level - 0.5m	
					H	6.3	H ANN	HH Level - 0.2 m	
					CH	6.1	Hydro-cyclone Feed start	H Level - 0.2 m	
					CL	1.6	Hydro-cyclone Feed Stop	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump Protection Agitator Protection
					△H	0.6	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
4	LICA 00HTM04CL003/005	Secondary Waste Water Hydrocyclone Feed Tank Level		m	HH	5.5	Over flow	Top level - 0.5m	
					H	5.3	H ANN	HH Level - 0.2 m	
					CH	5.1	Hydro-cyclone Feed start	H Level - 0.2 m	
					CL	1.5	Hydro-cyclone Feed Stop	L Level + 0.2 m	
					L	1.3	L ANN	LL Level + 0.2 m.	
					LL	1.1(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
5	LICA	Waste Water Storage Tank		m	HH	6.5	Over flow	Top level - 0.5m	

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
	00HTM04CL013/015	Level			H	6.3	H ANN	HH Level - 0.2 m	
					CH1	6.1	Filtrate Water Tank Feed Start	H Level - 0.2 m	
					CL1	5.6	Filtrate Water Tank Feed Stop	CH1 Level - 0.5 m	
					CH2	2.1	Waste Water Treatment Feed Start	CL2 Level + 0.5 m	
					CL2	1.6	Waste Water Treatment Feed Stop	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
7	LICA	Mill Circuit Tank Level		m	HH	Later(*1)	HH ANN	To be finalize by BHEL based on vedor information.	Silo & Bag Filter Protection
	00HTK05CL001/003				H	Later(*1)	H ANN	To be finalize by BHEL based on vedor information.	
	00HTK05CL004/006				L	Later(*1)	L ANN	To be finalize by BHEL based on vedor information.	
					LL	Later(*1)	LL ANN	To be finalize by BHEL based on vedor information.	
8	LICA	Limestone Slurry Storage Tank		m	HH	11.5	Over flow	Top level - 0.8m	
	00HTK05CL021/023	Level			H	11.3	H ANN	HH Level - 0.2 m	
					CH	10.8	Wet Limestone Grinding Mill stop	H Level - 0.5 m	
					CL	4.4	Wet Limestone Grinding Mill start		
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
9	LIC	Absorber Area Drain Sump		m	HH	3.5	Over flow	Top level - 0.5m	
	10/40HTT07CL001/003	Level			H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN		Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
10	LIA 00HTT07CL001/003	Aixiliary Absorbent Tank Level		m	HH	10.1	Over flow	Top level - 0.8m	
					H	9.9	H ANN	HH Level - 0.2 m	
					L	4.4	L ANN	LL1 Level + 0.2 m	
					LL1	3.4(*1)	INT : Agitator Stop LL1 ANN		
					LL2	2.0*1)	INT : Pump Stop LL2 ANN		Pump Protection
11	LICA 00HTT07CL001/003	Gypsum Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump protection Agitator Protection
12	LICA 00HTT07CL004/006	Limestone Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
13	LICA	Process Water Tank Level		m	HH	4.9	Over flow	Top level - 0.5m	
	00HTQ08CL001/003				H	4.7	H ANN	HH Level - 0.2 m	
	00HTQ08CL004/006				CH	4.5	Make-up water supply stop	H Level - 0.2 m	
		`			CL	4.0	Make-up water supply start	CH Level - 0.5 m	
					L	1.5	L ANN	LL Level + 0.2 m.	
					LL	1.3(*1)	INT : Pump Stop LL ANN		Pump Protection
					△H	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
14	LICA	Emergency Water Tank Level		m	HH	3	Over flow	Top level - 0.5m	
	10/40HTQ08CL021/023				H	2.8	H ANN	HH Level - 0.2 m	
					CH	2.6	Make-up water supply stop	H Level - 0.2 m	
					CL	2.4	Make-up water supply start	CH Level - 0.2 m	
					L	0.5	L ANN	Bottom + 0.5 m	

※This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL shall add set point for unit equipment and finalize the list according to the vender information.

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Others

No.	KKS Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	AICA	Absorber pH		–	H	6.5	H ANN	Normal pH + α	
	10/40HTD02CQ001/003				N	Later	Set point for pH control	Commissioning adjustment value	
					L	Later	L ANN, Set point for minimum pH	Commissioning adjustment value	
2	DICA	Absorber Density		wt.%	H	35	H ANN	Normal Density + 5 wt.%	Pump & Belt Filter Protection
	10/40HTM01CD001/003				CH	32	Absorber Slurry Bleed Start	Normal Density + 2 wt.%	
					N	30	Set point for Density Control	Design Density	
					CL	28	Absorber Slurry Bleed Stop	Normal Density – 2 wt.%	
					L	25	L ANN	Normal Density – 5 wt.%	
3	AICA	FGD Outlet SO2		mg/Nm^3	H	100	H ANN	Design FGD Outlet SO2 concentration	
	10/40HTA01CQ005				N	Later	Set point for SO2 control	Commissioning adjustment	

※This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL will add set point for unit equipment and finalize the list according to the vender information.

05	29.11.21	Replied to customer comments	KMK	PR	SKD
04	20.10.21	Revised as per KTPS design philosophy	KMK	PR	SKD
03	20.11.19	Revised the document as per the comments	KMK	PR	SKD
02	04.11.19	Revised the document by including the reply sheet	KMK	PR	SKD
01	22.10.19	Replied to the comments given by TSGENCO/DESEIN	KMK	PR	SKD
00	18.09.19	Fresh Issue	KMK	PR	SKD
REV	DATE	DESCRIPTION /NOTE	PRD	CHD	APD

REVISIONS

TITLE:

P&ID_PRIMARY HYDROCYCLONE FEED TANK AND PUMPS

OWNER/PROJECT: **TELANGANA STATE POWER GENERATION CORPORATION LTD**

BHADRADRI (4X270 MW) THERMAL POWER STATION–
FGD SYSTEM PACKAGE

CONSULTANT:

DESEIN PRIVATE LIMITED.
NEW DELHI

EPC CONTRACTOR:

BHARAT HEAVY ELECTRICALS LTD.
BOILER AUXILIARIES PLANT,RANIPET

COLLABORATOR

MITSUBISHI HITACHI POWER SYSTEMS, LTD
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

	BHEL	Date	
PREPARED BY	Kabilash	29.11.21	STATUS : *FOR APPROVAL*
CHECKED BY	Raju P	29.11.21	BHEL CUST NO : G301,G302,G303 & G304
APPROVED BY	SK Dash	29.11.21	BHEL DOC NO : 03- FW-747-00658
			REV NO :05

THIRD ANGLE PROJECTION | No. REQ'D | A3 | DRAWING No.

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
M	ACTUATED BY MOTOR
IM	ACTUATED BY MOTOR (INCHING)
	AIR CONTROL VALVE
S	SOLENOID ACTUATOR
	SELF REGURATING VALVE
	SELF REGURATING VALVE

TRENCH SYMBOLS

SYMBOLS	NAME
A	TO ABSORBER AREA DRAIN SUMP
D	TO GYPSUM AREA DRAIN SUMP
L	TO LIMESTONE AREA DRAIN SUMP

SYMBOLS FOR PIPING PARTS & INSTRUMENT PARTS

SYMBOLS	NAME
T	STEAM TRAP
AT	AIR TRAP
	Y-STRAINER
	T-STRAINER
TS	TEMPORARY STRAINER
	REDUCER
	EXPANSION JOINT
	DUCT EXPANSION JOINT
	FLEXIBLE HOSE
	SPOOL PIECE
	VENT
	HOSE CONNECTION
	BLIND FLANGE
	REDUCING FLANGE
	CAP (BW)
	CAP (SCR)
	TRENCH
SG	SIGHT GLASS
	SILENCER
	ORIFICE
	DIAPHRAGM
M	MAGNETIC FLOW METER
	VORTEX FLOW METER
	PH METER
	FILTER
M.H. M.H. M.H. I.H.	MANHOLE
	INSPECTION HOLE
	PITOT TUBE
	SAMPLING POT
S	SAMPLING NOZZLE
RO	RESTRICTION ORIFICE
FI	ROTOMETER TYPE FLOW METER

SYMBOLS FOR VALVE OPERATION

SYMBOLS	NAME
FO	FAILURE OPEN (THE VALVE OPENS WHEN AIR OR ELECTRICITY FOR ACTUATOR FAILS.)
FC	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 CLIENT AND CONTRACTOR
CONTRACTOR | XXX	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
AA	ANTIFOAM AGENT	WCS	COOLING WATER SUPPLY
AC	COMPRESSED AIR	WCR	COOLING WATER RETURN
AF	FLUIDIZER AIR	WC	Ca(OH)2
AI	INSTRUMENT AIR	WP	PROCESS WATER
AO	OXIDATION AIR	WR	RAW WATER
AS	SEAL AIR	WW	WASTE WATER
DD	DUCT DRAIN	VG	VACUUM PUMP VENT
FS	FILTRATE SLURRY	VBG	BELT FILTER VENT GAS
GS	GYPSUM SLURRY	LD	LIMESTONE DEDUSTING
LS	LIMESTONE SLURRY	LOL	LUBE OIL (LOW PRESSURE)
FG	FLUE GAS	LOH	LUBE OIL (HIGH PRESSURE)

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 / GI PIPING	AI, LOL
BA02	Gr.304 STAINLESS STEEL / GI 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
DA60	FRP PIPING (PIPE DIA UPTO 400 NB)	GS,FS,WW,DD
DA40	FRP PIPING (PIPE DIA UPTO 400 NB)	LS, WP, WC

UNIT CODE

SYMBOLS	UNIT IDENTIFICATION
90	COMMON
10	UNIT-1 FGD SYSTEM AND AUXILIARIES
20	UNIT-2 FGD SYSTEM AND AUXILIARIES
30	UNIT-3 FGD SYSTEM AND AUXILIARIES
40	UNIT-4 FGD SYSTEM AND AUXILIARIES
50	UNIT-5 FGD SYSTEM AND AUXILIARIES

EXPRESSION OF PIPING LINE

10 - 200 - GS - 2 00 1 - AA60 - HF

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

CUSTOMER NOS: G301,G302,G303&G304

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CUSTOMER: TSGENCO.

PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

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

DEPT CODE		NAME (BHEL)	DATE
M	DRN	KM.KABILASH	24.09.21
	CHD	P.RAJU	24.09.21
	APPD	PNR/ACR	24.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – SYMBOL MARK (1/2)

SCALE : NTS

BHEL DRG NO. 03-FW-000-00675 | SH 01 of 02

FILE NO: B240 – 00001 | REV NO: 00

THIRD ANGLE PROJECTION | No. REQ'D | A3 | DRAWING No.

INSTRUMENT ABBREVIATION

	FIRST–LETTER		SUCCEEDING–LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		BLANK	BLANK	BLANK
C	BLANK			CONTROL	
D	BLANK	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	BLANK		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	BLANK	MOMENTARY			MIDDLE, INTERMEDIATE
N	BLANK		BLANK	BLANK	BLANK
O	BLANK		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT(TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

INSTRUMENT SYMBOLS

SYMBOLS	NAME
	FIELD MOUNTED
	FOR CONTROL ROOM
	FOR LOCAL CONTROL PANEL
	FOR DCS
I	INTERLOCK LOGIC

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 SWITH
FLXXWA–SL	SINGLE SOLENOID WITH LIMIT SWITCH

MACHINARY SYMBOLS

SYMBOLS	NAME
	PUMP
	FAN / BLOWER
	AGITATOR (FLAT BLADE)
	AGITATOR (PROPELLOR)
	ROTARY VALVE
	CRUSHER
	BELT FEEDER
	BELT FILTER
	BALL MILL
	CYCLONE
	MIST ELIMINATOR

EQUIPMENT SYMBOLS

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

DRIVER SYMBOLS

SYMBOLS	NAME
A	AIR MOTOR
M	ELECTRIC MOTOR

OTHER SYMBOLS

SYMBOLS	NAME
	INSERT PIPE / LANCE
	CHUTE
	TRUCK

CUSTOMER NOS: G301,G302,G303&G304
CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

CUSTOMER NOS: G301,G302,G303&G304

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CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

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

DEPT CODE		NAME (BHEL)	DATE
M	DRN	KM.KABILASH	24.09.21
	CHD	P.RAJU	24.09.21
	APPD	PNR/ACR	24.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – SYMBOL MARK (2/2) | SCALE : NTS

BHEL DRG NO. 03–FW–000–00675 | SH 02 of 02

FILE NO B240 – 00002 | REV NO 00

0 1 2 3 4 5 6 7 8 9 10

THIRD ANGLE PROJECTION

No. REQ'D

A3

DRAWING No.

FROM GYPSUM BLEED PUMP A/B (UNIT-1)
03-FW-701-00654 SH1
10 HTM 00 AP 001/002

FROM GYPSUM BLEED PUMP A/B (UNIT-2)
03-FW-701-00654 SH2
20 HTM 00 AP 001/002

FROM GYPSUM BLEED PUMP A/B (UNIT-3)
03-FW-701-00654 SH3
30 HTM 00 AP 001/002

FROM GYPSUM BLEED PUMP A/B (UNIT-4)
03-FW-701-00654 SH4
40 HTM 00 AP 001/002

10-80-GS-4021-DA60
20-80-GS-4021-DA60
30-80-GS-4021-DA60
40-80-GS-4021-DA60

00HTM04CF010 FT
00-150-GS-4601-DA60
00HTM04AA245
00HTM04AA251
00HTM04AA253
00-150-GS-4502-DA60
00-150-GS-4512-DA60

BF STOP SIGNAL
03-FW-738-00663 SH1
VACUUM BELT FILTER- A

BF STOP SIGNAL
03-FW-738-00663 SH2
VACUUM BELT FILTER- B

03-FW-738-00663 SH1
TO PRIMARY HYDROCYCLONE A
00 HTM 00 AT 001

03-FW-738-00663 SH2
TO PRIMARY HYDROCYCLONE B
00 HTM 00 AT 002

00HTM04CP022 PT
00HTM04CP021 PT
00HTM04CP020 PT
00HTM04AA242
00-250-GS-4501-DA60
00HTM04AA252
00HTM04AA254

00HTM04AA233
00HTM04AA227
00HTM04AA228
00HTM04AA234
00HTM04AA239
00HTM04CP017 PT PI
00HTM04CP015 PI
00-250-GS-4402-DA60
00-250-GS-4412-DA60
00HTM04CP018 PT PI
00HTM04CP016 PI

00HTM04CT001 FT
PROCESS WATER
03-FW-751-00673 SH1
00-25-WP-8510-CC01

LIC
LIA
LL1
LL2
LL3
00HTM04CL001
00HTM04CL002
00HTM04CL003
00HTM04CL110 LI
M.H.
80

NOTE A009
00 HTM 00 AM 001

00-350-GS-4431-AA60

M.H.
00 HTM 00 BB 001

00HTM04AA316
NC 125
NOTE A006
NOTE A004

00 HTM 00 AP 001
NOTE A008
EX-4130
EX-4110
NOTE A230
NOTE A001
00-25-WP-8691-CC01

00HTM04AA221
00HTM04AA222
00-250-GS-4401-DA60
00-250-GS-4411-DA60
NOTE A004

00HTM04AA224
00HTM04AA225
00-250-GS-4421-DA60
00-25-WP-8600-CC01

00 HTM 00 AP 002
EX-4120
EX-4140
NOTE A008
NOTE A230
NOTE A001
00-25-WP-8693-CC01
00-25-WP-8692-CC01

NOTE A006
NOTE A011
NOTE A014
NOTE B002

NOTE A001
MOTOR PID ARE NOT SHOWN.

NOTE A004
TO PREVENT NONFUNCTIONING OF SLURRY TANK PUMP SUCTION VALVE DUE TO SOLID SEDIMENTATION, THE SHAFT OF BUTTERFLY VALVE SHOULD BE INSTALLED HOLIZONTALLY AND UPPER HALF OF THE DISC SHOULD BE TURN INTO TANK INSIDE. SUCTION VALVES SHALL BE MOUNTED ON NOZZLE DIRECTLY AS LONG AS ACTUATOR DOES NOT COLLIDE WITH TANK CASING.

NOTE A006
DISCHARGE OF DRAIN AND OVERFLOW LINE SHALL HAVE 45 DEG INCLINATION TOWARD FLOW DIRECTION OF TRENCH FOR SMOOTH FLOW.

NOTE A008
TEMPORARY STRAINER SHALL BE INSTALLED AT THE PUMP SUCTION FOR THE TERMS OF PRE-COMMISSIONING.

NOTE A009
THERE SHOULD BE CERTAIN DISTANCE BETWEEN NOZZLES FOR INFLUENT LINE AND PUMP SUCTION NOZZLE AS LONG AS THERE IS NO INSERT PIPE.

NOTE A011
RO SHALL BE INSTALLED IN VERTICAL LINE.

NOTE A014
THE DRAIN NOZZLE SHALL BE EMBEDDED IN THE TANK BASE. AND IT SHALL BE DIRRECTED TO TRENCH SO THAT SLURRY IN THE TANK CAN BE DRAINED OUT COMPLETELY.

NOTE B002
OPEN AND CLOSE CONTACT SWITCHES ARE FOR REFERENCE ONLY. IN CASE THAT THERE IS CUSTOMER'S SPECIFICATION, THEY SHOULD BE DECIDED BASED ON IT.

NOTE A230
THIS WATER LINE IS FOR MECHANICAL SEAL QUENCHING. WATER DRAIN SHALL BE DISCHARGED TO TRENCH THROUGH PUMP DRAIN PAN AND PIPING.

VENDOR : BHEL

NOTE: 2. Process Parameters
- Flow - m3/hr
- Pressure - Kg/cm2 (Design Pressure)
- Temp - Deg C (Design Temp)

00 HTM 00 BB 001
PRIMARY HYDROCYCLONE FEED TANK A

00 HTM 00 AM 001
PRIMARY HYDROCYCLONE FEED TANK AGITATOR A

00 HTM 00 AP 001/002
PRIMARY HYDROCYCLONE FEED TANK PUMP A/B

CUSTOMER NOS: G301,G302,G303&G304

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CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

	DEPT CODE		NAME (BHEL)	DATE
BHARAT HEAVY ELECTRICALS LIMITED, UNIT: BOILER AUXILIARIES PLANT, RANIPET:632 406.	M	DRN	KM.KABILASH	27.09.21
		CHD	P.RAJU	27.09.21
		APPD	PNR/ACR	27.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID - GYPSUM DEWATERING SYSTEM PRIMARY HYDROCYCLONE FEED TANK

SCALE : NTS

BHEL DRG NO. 03-FW-747-00658 SH 01 OF 01

FILE NO B240-00400

REV NO 04

0 1 2 3 4 5 6 7 8 9 10

WRITEUP ON PRIMARY HYDROCYCLONE FEED TANK AND PUMPS

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

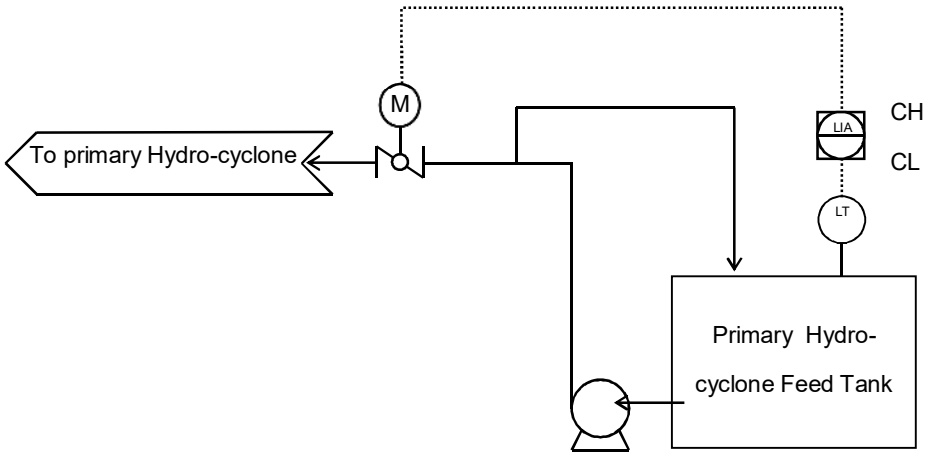
Equipment List:

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

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 32 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 form 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

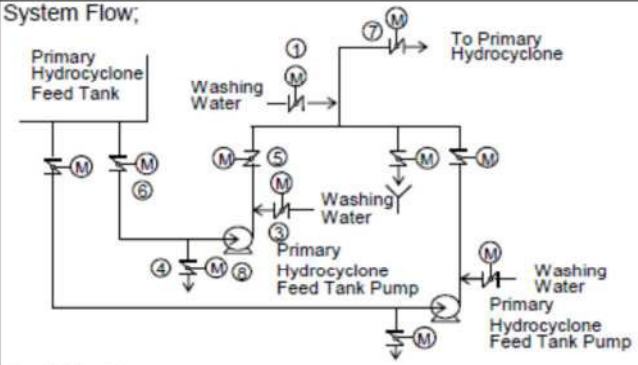
T5 = 180sec

T6 = 180sec

These timing will be optimized during commissioning.

Item	Service	
00 HTM 00 AP 001/002	Primary Hydrocyclone Feed Tank Pump A/B Sub Function Group	Stand-by Auto Mode (Back-up start)

System Flow;



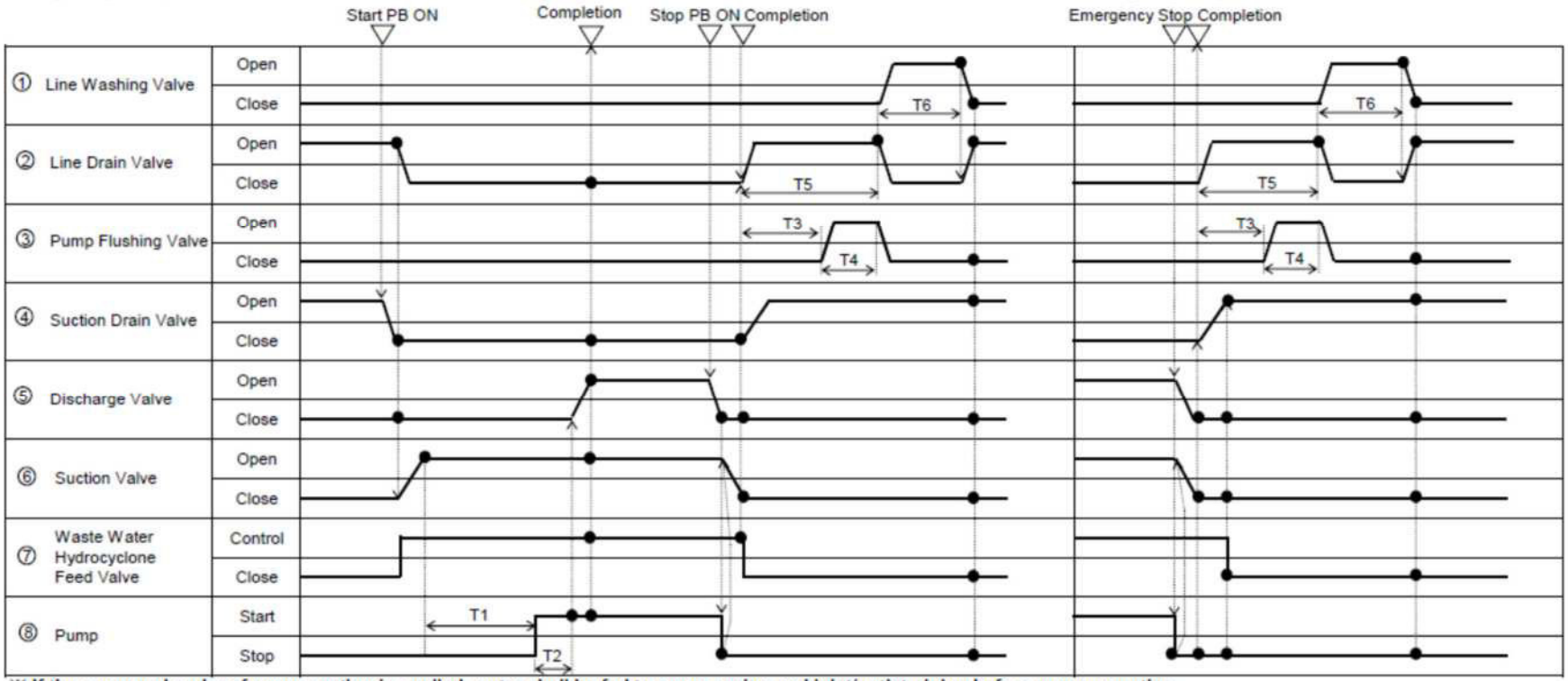
Start Permission;
- Primary Hydrocyclone Feed Tank Level : Not LL

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;



※ If the common header of pump suction is applied, water shall be fed to pump casing and inlet/outlet piping before pump operation.

Instruments List

Sl.No	KKS Code	Description of instrument	Quantity
01	00HTM04CF001	Rotameter (flow meter)	01 No
02	00HTM04CP017/21	Pressure Transmitter	05 Nos
03	00HTM04CP015/016	Pressure Indicator	02 Nos
04	00HTM04CL001/003	Level Transmitter	03 Nos
05	00HTM04CL110	Level Indicator	01 No

Table 3.3 Set Point List

Pressure

No.	KKS Tag no.	Service	Range	Unit	Set Point	Value	Action	Basis	Remark
1	PIA 10/40HTA01CP001/003	BUF Inlet Pressure		kPa	HH	6.5		Mechanical design pressure of FGD inlet duct: +6.47 kpa	
					H	1.0	H ANN	Normal pressure + 1.0 kPa	
					L	−1.0	L ANN	Normal pressure − 1.0 kPa	
					LL	−1.5	INT : FGD Bypass Demper Open LL ANN	Mechanical design pressure of FGD inlet duct: − 1.47 kpa	
					△H	Later	H ANN	PT measuring range x 0.05 (5%)	
2	PIA 10/40HTA01CP007	Absorber Inlet Pressure		kPa	H	4.7	H ANN	Normal pressure + 1.0 kPa	
					L	3.7	L ANN	Normal pressure − 1.0 kPa	
3	PDIA 10/40HTE02CP001	Mist Eliminator Differential Pressure		kPa	H	(*1)	H ANN	(Design pressure of ME +0.10kPa(Dirty)) x 1.1^2	
4	PIA 10/40HTY08CP002	Instrumentation Air Pressure		MPa	H	0.8	H ANN	Design Pressure	
					L	(*1)	L ANN	Minimum pressure of solenoid valve +0.5 MPa	

※1 : Will be provided later based on the vendor information.

Table 3.3 Set Point List

Temperature

No.	Tag no.	Service	Range	Unit	Set Point	Value	Action	Basis	Remark
1	TIA 10/40HTA01CT001/003	FGD Inlet Temperature		deg.C	HH	300	Interlock	Maximum temperature in AH mechanical trip condition	Emergency Spray valve open
					H	290	H ANN	Maximum temperature in AH mechanical trip condition – 10 deg.C	
					△H	(*1)	H ANN	TE measuring range × 0.05 (5%)	prevention for meter deflection
2	TIA 10/40HTA01CT005/007	FGD Outlet Temperature		deg.C	HH	70	Interlock	Heat-resistant value of Absorber internal material	Emergency Spray valve open
					H	65	H ANN	Heat-resistant value of Absorber internal material – 5 deg.C	
					△H	(*1)	H ANN	TE measuring range × 0.05 (5%)	prevention for meter deflection

※1 : Will be provided later based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	LICA 10/40HTD02CL001/003	Absorber Level		m	HH	7.0	Overflow	Normal Level + 1.0 m	
					H	6.3	H ANN	CH Level + 0.2 m	
					CH2	6.3	Start Permission for 1st Absorber Circulation Pump	The value that does not drop to L level after startng pump.	
					CH	6.1	Absorber make-up water supply stop	Normal Level + 0.1 m	
					N	6.0		Design Level (Normal Level)	
					CL	5.9	Absorber make-up water supply start	Normal Level - 0.1 m	
					L	5.7	L ANN	CL Level - 0.2 m	
					LL1	4.2(*1)	INT : Absorber Recirculation Pump Stop LL1 ANN		Pump Protection
					LL2	3.2(*1)	INT : Absorber Agitator Stop LL2 ANN	(Agitator installation Level :1.6m) + (Impeller dia.:1.6m)	Agitator Protection
					LL3	1.5(*1)	INT : Absorber Bleed Pump Stop LL3 ANN		Pump Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
2	LICA 00HTM04CL007/009	Belt Filter Washing Tank Level		m	HH	3	Over flow	Top level - 0.5m	
					H	2.8	H ANN	HH Level - 0.2 m	
					CH	2.6	Make-up water supply stop	H Level - 0.2 m	
					CL	1.4	Make-up water supply start	L Level + 0.2 m	
					L	1.2	L ANN	LL Level + 0.2 m.	
					LL	1.0(*1)	INT : Pump Stop LL ANN	(Suction pipe center)+2.5 x (Suction pipe Dia.)	Pump Protection
					△H	0.2	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
3	LICA 00HTM04CL011/013	Filtrate Water Tank Level		m	HH	5.1	Over flow	Top level - 0.5m	
					H	4.9	H ANN	HH Level - 0.2 m	
					CH	4.7	Absorber Return Valve Open	H Level - 0.2 m	
					CL	1.6	Absorber Return Valve Close	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
4	LICA 00HTM04CL001/003	Primary Hydrocyclone Feed Tank Level		m	HH	6.5	Over flow	Top level - 0.5m	
					H	6.3	H ANN	HH Level - 0.2 m	
					CH	6.1	Hydro-cyclone Feed start	H Level - 0.2 m	
					CL	1.6	Hydro-cyclone Feed Stop	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump Protection Agitator Protection
					△H	0.6	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
4	LICA 00HTM04CL003/005	Secondary Waste Water Hydrocyclone Feed Tank Level		m	HH	5.5	Over flow	Top level - 0.5m	
					H	5.3	H ANN	HH Level - 0.2 m	
					CH	5.1	Hydro-cyclone Feed start	H Level - 0.2 m	
					CL	1.5	Hydro-cyclone Feed Stop	L Level + 0.2 m	
					L	1.3	L ANN	LL Level + 0.2 m.	
					LL	1.1(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
5	LICA	Waste Water Storage Tank		m	HH	6.5	Over flow	Top level - 0.5m	

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
	00HTM04CL013/015	Level			H	6.3	H ANN	HH Level - 0.2 m	
					CH1	6.1	Filtrate Water Tank Feed Start	H Level - 0.2 m	
					CL1	5.6	Filtrate Water Tank Feed Stop	CH1 Level - 0.5 m	
					CH2	2.1	Waste Water Treatment Feed Start	CL2 Level + 0.5 m	
					CL2	1.6	Waste Water Treatment Feed Stop	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
7	LICA	Mill Circuit Tank Level		m	HH	Later(*1)	HH ANN	To be finalize by BHEL based on vedor information.	Silo & Bag Filter Protection
	00HTK05CL001/003				H	Later(*1)	H ANN	To be finalize by BHEL based on vedor information.	
	00HTK05CL004/006				L	Later(*1)	L ANN	To be finalize by BHEL based on vedor information.	
					LL	Later(*1)	LL ANN	To be finalize by BHEL based on vedor information.	
8	LICA	Limestone Slurry Storage Tank		m	HH	11.5	Over flow	Top level - 0.8m	
	00HTK05CL021/023	Level			H	11.3	H ANN	HH Level - 0.2 m	
					CH	10.8	Wet Limestone Grinding Mill stop	H Level - 0.5 m	
					CL	4.4	Wet Limestone Grinding Mill start		
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
9	LIC	Absorber Area Drain Sump		m	HH	3.5	Over flow	Top level - 0.5m	
	10/40HTT07CL001/003	Level			H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN		Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
10	LIA 00HTT07CL001/003	Aixiliary Absorbent Tank Level		m	HH	10.1	Over flow	Top level - 0.8m	
					H	9.9	H ANN	HH Level - 0.2 m	
					L	4.4	L ANN	LL1 Level + 0.2 m	
					LL1	3.4(*1)	INT : Agitator Stop LL1 ANN		
					LL2	2.0*1)	INT : Pump Stop LL2 ANN		Pump Protection
11	LICA 00HTT07CL001/003	Gypsum Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump protection Agitator Protection
12	LICA 00HTT07CL004/006	Limestone Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
13	LICA	Process Water Tank Level		m	HH	4.9	Over flow	Top level - 0.5m	
	00HTQ08CL001/003				H	4.7	H ANN	HH Level - 0.2 m	
	00HTQ08CL004/006				CH	4.5	Make-up water supply stop	H Level - 0.2 m	
		`			CL	4.0	Make-up water supply start	CH Level - 0.5 m	
					L	1.5	L ANN	LL Level + 0.2 m.	
					LL	1.3(*1)	INT : Pump Stop LL ANN		Pump Protection
					△H	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
14	LICA	Emergency Water Tank Level		m	HH	3	Over flow	Top level - 0.5m	
	10/40HTQ08CL021/023				H	2.8	H ANN	HH Level - 0.2 m	
					CH	2.6	Make-up water supply stop	H Level - 0.2 m	
					CL	2.4	Make-up water supply start	CH Level - 0.2 m	
					L	0.5	L ANN	Bottom + 0.5 m	

※This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL shall add set point for unit equipment and finalize the list according to the vender information.

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Others

No.	KKS Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	AICA	Absorber pH		–	H	6.5	H ANN	Normal pH + α	
	10/40HTD02CQ001/003				N	Later	Set point for pH control	Commissioning adjustment value	
					L	Later	L ANN, Set point for minimum pH	Commissioning adjustment value	
2	DICA	Absorber Density		wt.%	H	35	H ANN	Normal Density + 5 wt.%	Pump & Belt Filter Protection
	10/40HTM01CD001/003				CH	32	Absorber Slurry Bleed Start	Normal Density + 2 wt.%	
					N	30	Set point for Density Control	Design Density	
					CL	28	Absorber Slurry Bleed Stop	Normal Density – 2 wt.%	
					L	25	L ANN	Normal Density – 5 wt.%	
3	AICA	FGD Outlet SO2		mg/Nm^3	H	100	H ANN	Design FGD Outlet SO2 concentration	
	10/40HTA01CQ005				N	Later	Set point for SO2 control	Commissioning adjustment	

※This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL will add set point for unit equipment and finalize the list according to the vender information.

04	05.02.22	Revised as per customer comments	KMK	PR	PRN
04	29.11.21	Replied to customer comments	KMK	PR	PRN
03	20.10.21	Revised the document as per KTPS FGD	KMK	PR	PRN
02	15.10.19	Revised the document as per the comments	KMK	PR	VK
01	04.10.19	Revised the document as per the comments	KMK	PR	VK
00	17.09.19	Fresh Issue	KMK	PR	VK
REV	DATE	DESCRIPTION /NOTE	PRD	CHD	APD

REVISIONS

TITLE:

P&ID_PRIMARY HYDROCYCLONE SYSTEM

OWNER/PROJECT: **TELANGANA STATE POWER GENERATION CORPORATION LTD**

BHADRADRI (4X270 MW) THERMAL POWER STATION–
FGD SYSTEM PACKAGE

CONSULTANT:

DESEIN PRIVATE LIMITED.
NEW DELHI

EPC CONTRACTOR:

BHARAT HEAVY ELECTRICALS LTD.
BOILER AUXILIARIES PLANT,RANIPET

COLLABORATOR

MITSUBISHI HITACHI POWER SYSTEMS, LTD
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

	BHEL	Date	
PREPARED BY	Kabilash	05.02.22	STATUS : *FOR APPROVAL*
CHECKED BY	Raju P	05.02.22	BHEL CUST NO : G301,G302,G303 & G304
APPROVED BY	P.Naveen	05.02.22	BHEL DOC NO : 03- FW-738-00659
			REV NO : 05

THIRD ANGLE PROJECTION | No. REQ'D | A3 | DRAWING No.

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
M	ACTUATED BY MOTOR
IM	ACTUATED BY MOTOR (INCHING)
	AIR CONTROL VALVE
S	SOLENOID ACTUATOR
	SELF REGURATING VALVE
	SELF REGURATING VALVE

TRENCH SYMBOLS

SYMBOLS	NAME
A	TO ABSORBER AREA DRAIN SUMP
D	TO GYPSUM AREA DRAIN SUMP
L	TO LIMESTONE AREA DRAIN SUMP

SYMBOLS FOR PIPING PARTS & INSTRUMENT PARTS

SYMBOLS	NAME
T	STEAM TRAP
AT	AIR TRAP
	Y-STRAINER
	T-STRAINER
TS	TEMPORARY STRAINER
	REDUCER
	EXPANSION JOINT
	DUCT EXPANSION JOINT
	FLEXIBLE HOSE
	SPOOL PIECE
	VENT
	HOSE CONNECTION
	BLIND FLANGE
	REDUCING FLANGE
	CAP (BW)
	CAP (SCR)
	TRENCH
SG	SIGHT GLASS
	SILENCER
	ORIFICE
	DIAPHRAGM
M	MAGNETIC FLOW METER
	VORTEX FLOW METER
	PH METER
	FILTER
M.H. M.H. M.H. I.H.	MANHOLE
	INSPECTION HOLE
	PITOT TUBE
	SAMPLING POT
S	SAMPLING NOZZLE
RO	RESTRICTION ORIFICE
FI	ROTOMETER TYPE FLOW METER

SYMBOLS FOR VALVE OPERATION

SYMBOLS	NAME
FO	FAILURE OPEN (THE VALVE OPENS WHEN AIR OR ELECTRICITY FOR ACTUATOR FAILS.)
FC	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 CLIENT AND CONTRACTOR
CONTRACTOR | XXX	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
AA	ANTIFOAM AGENT	WCS	COOLING WATER SUPPLY
AC	COMPRESSED AIR	WCR	COOLING WATER RETURN
AF	FLUIDIZER AIR	WC	Ca(OH)2
AI	INSTRUMENT AIR	WP	PROCESS WATER
AO	OXIDATION AIR	WR	RAW WATER
AS	SEAL AIR	WW	WASTE WATER
DD	DUCT DRAIN	VG	VACUUM PUMP VENT
FS	FILTRATE SLURRY	VBG	BELT FILTER VENT GAS
GS	GYPSUM SLURRY	LD	LIMESTONE DEDUSTING
LS	LIMESTONE SLURRY	LOL	LUBE OIL (LOW PRESSURE)
FG	FLUE GAS	LOH	LUBE OIL (HIGH PRESSURE)

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 / GI PIPING	AI, LOL
BA02	Gr.304 STAINLESS STEEL / GI 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
DA60	FRP PIPING (PIPE DIA UPTO 400 NB)	GS,FS,WW,DD
DA40	FRP PIPING (PIPE DIA UPTO 400 NB)	LS, WP, WC

UNIT CODE

SYMBOLS	UNIT IDENTIFICATION
90	COMMON
10	UNIT-1 FGD SYSTEM AND AUXILIARIES
20	UNIT-2 FGD SYSTEM AND AUXILIARIES
30	UNIT-3 FGD SYSTEM AND AUXILIARIES
40	UNIT-4 FGD SYSTEM AND AUXILIARIES
50	UNIT-5 FGD SYSTEM AND AUXILIARIES

EXPRESSION OF PIPING LINE

10 - 200 - GS - 2 00 1 - AA60 - HF

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

CUSTOMER NOS: G301,G302,G303&G304

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CUSTOMER: TSGENCO.

PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

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

DEPT CODE		NAME (BHEL)	DATE
M	DRN	KM.KABILASH	24.09.21
	CHD	P.RAJU	24.09.21
	APPD	PNR/ACR	24.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – SYMBOL MARK (1/2)

SCALE : NTS

BHEL DRG NO. 03-FW-000-00675 | SH 01 of 02

FILE NO: B240 – 00001 | REV NO: 00

THIRD ANGLE PROJECTION | No. REQ'D | A3 | DRAWING No.

INSTRUMENT ABBREVIATION

	FIRST–LETTER		SUCCEEDING–LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		BLANK	BLANK	BLANK
C	BLANK			CONTROL	
D	BLANK	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	BLANK		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	BLANK	MOMENTARY			MIDDLE, INTERMEDIATE
N	BLANK		BLANK	BLANK	BLANK
O	BLANK		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT(TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

INSTRUMENT SYMBOLS

SYMBOLS	NAME
	FIELD MOUNTED
	FOR CONTROL ROOM
	FOR LOCAL CONTROL PANEL
	FOR DCS
I	INTERLOCK LOGIC

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 SWITH
FLXXWA–SL	SINGLE SOLENOID WITH LIMIT SWITCH

MACHINARY SYMBOLS

SYMBOLS	NAME
	PUMP
	FAN / BLOWER
	AGITATOR (FLAT BLADE)
	AGITATOR (PROPELLOR)
	ROTARY VALVE
	CRUSHER
	BELT FEEDER
	BELT FILTER
	BALL MILL
	CYCLONE
	MIST ELIMINATOR

EQUIPMENT SYMBOLS

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

DRIVER SYMBOLS

SYMBOLS	NAME
A	AIR MOTOR
M	ELECTRIC MOTOR

OTHER SYMBOLS

SYMBOLS	NAME
	INSERT PIPE / LANCE
	CHUTE
	TRUCK

CUSTOMER NOS: G301,G302,G303&G304
CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

CUSTOMER NOS: G301,G302,G303&G304

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CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

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

DEPT CODE		NAME (BHEL)	DATE
M	DRN	KM.KABILASH	24.09.21
	CHD	P.RAJU	24.09.21
	APPD	PNR/ACR	24.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – SYMBOL MARK (2/2) | SCALE : NTS

BHEL DRG NO. 03–FW–000–00675 | SH 02 of 02

FILE NO B240 – 00002 | REV NO 00

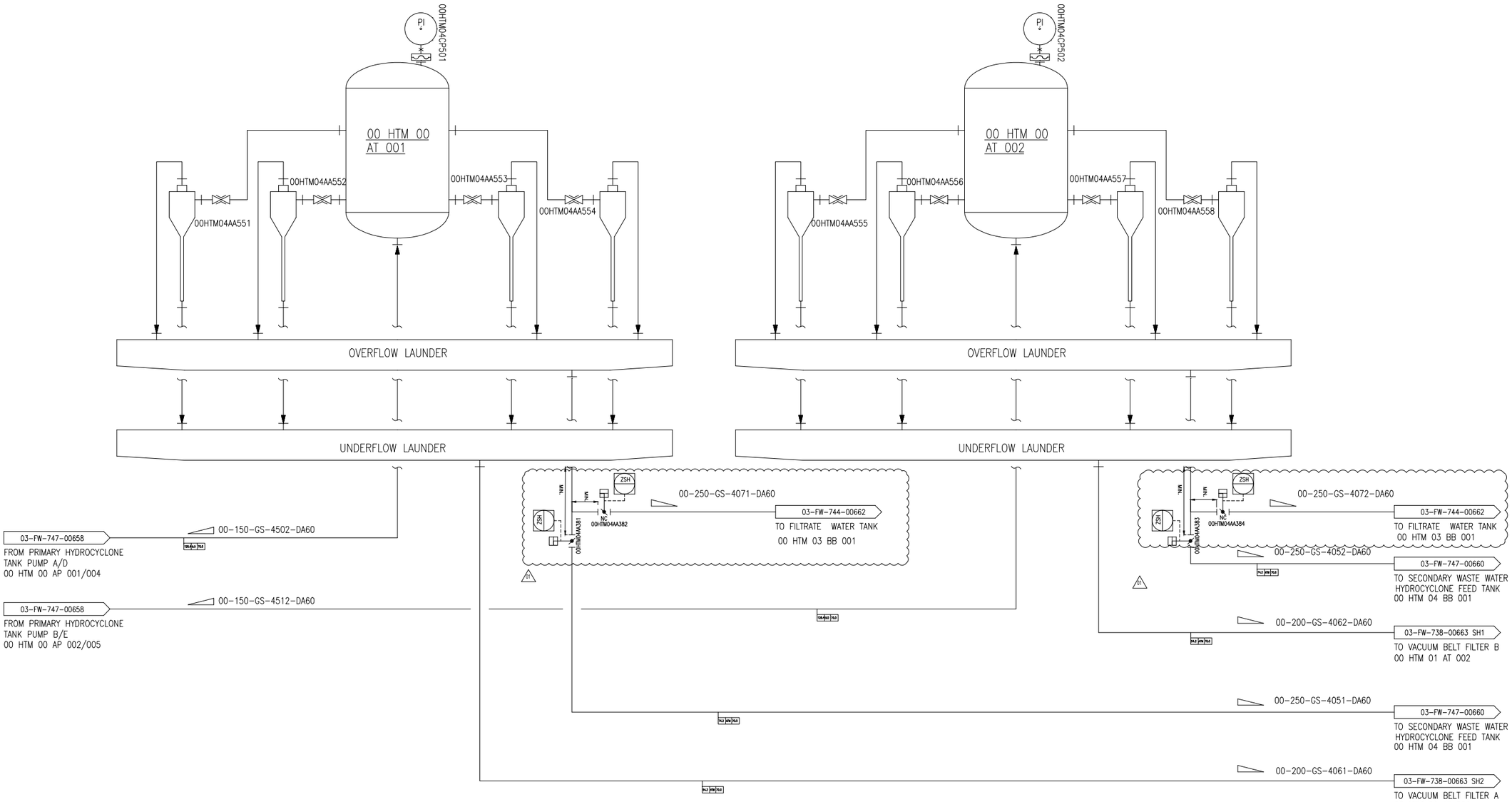
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THIRD ANGLE PROJECTION

No. REQ'D

A3

DRAWING No.



00 HTM 00 AT 001/002

PRIMARY HYDROCYCLONE A/B

NOTE: 2. Process Parameters
- Flow – m3/hr
- Pressure – Kg/cm2 (Design Pressure)
- Temp – Deg C (Design Temp)

NOTE: NUMBER OF VALVES & HYDROCYCLONES SHALL BE FINALIZED AFTER VENDOR'S INFORMATION

CUSTOMER NOS: G301,G302,G303&G304

CUSTOMER: TSGENCO.

PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

	DEPT CODE		NAME (BHEL)	DATE
BHARAT HEAVY ELECTRICALS LIMITED, UNIT: BOILER AUXILIARIES PLANT, RANIPET-632 406.	M	DRN	KM.KABILASH	27.09.21
		CHD	P.RAJU	27.09.21
		APPD	PNR/ACR	27.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID - GYPSUM DEWATERING SYSTEM PRIMARY HYDROCYCLONE

SCALE : NTS

BHEL DRG NO. 03-FW-738-00659 SH 01 OF 01

FILE NO B240-00402

REV NO 01

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Write Up on Primary Hydro Cyclone System

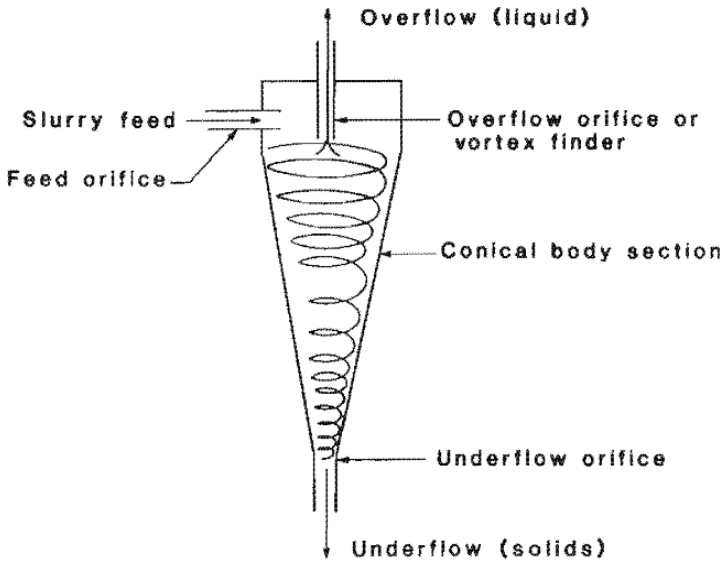
Purpose: This write up describes the Primary hydro cyclone system and defines the associated control system.

Equipment List:

S. No.	Description	Item No.	Qty
1.	Primary hydro cyclone feed tank	00 HTM 00 BB 001	1
2.	Primary hydro cyclone feed tank Pumps	00 HTM 00 AP 001/002	1W + 1S
3.	Primary Hydro Cyclone	00 HTM 00 AT 001/002	1W + 1S

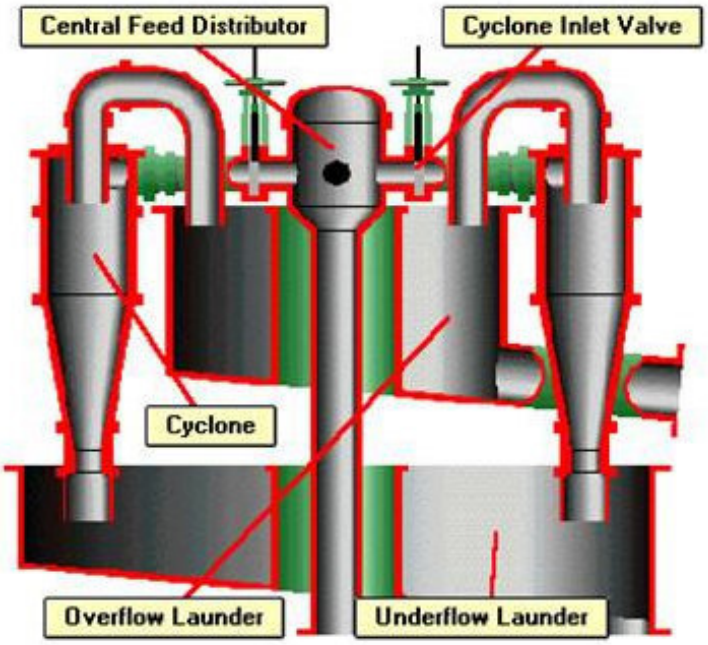
Operation Write Up:

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.



Cross section of hydrocyclone

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



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

Sl.No	Item Description	MOC (Material of Construction)
1.	Hydro cyclones	Polyurethane or urethane material
2.	Feed, Overflow & Underflow launder	CS + Rubber Lining(12mm)
3.	Distribution Chamber	CS + Rubber Lining(12mm)
4.	Piping	Carbon steel with Rubber lining or FRP.
5.	Valves (Pinch Valves)	Cast Iron + Neopren Rubber

Instruments List

Sl.No	KKS Code	Description of instrument	Quantity
01	00HTM04CP501/502	Pressure Indicator	02 Nos

Table 3.3 Set Point List

Pressure

No.	KKS Tag no.	Service	Range	Unit	Set Point	Value	Action	Basis	Remark
1	PIA 10/40HTA01CP001/003	BUF Inlet Pressure		kPa	HH	6.5		Mechanical design pressure of FGD inlet duct: +6.47 kpa	
					H	1.0	H ANN	Normal pressure + 1.0 kPa	
					L	−1.0	L ANN	Normal pressure − 1.0 kPa	
					LL	−1.5	INT : FGD Bypass Demper Open LL ANN	Mechanical design pressure of FGD inlet duct: − 1.47 kpa	
					△H	Later	H ANN	PT measuring range x 0.05 (5%)	
2	PIA 10/40HTA01CP007	Absorber Inlet Pressure		kPa	H	4.7	H ANN	Normal pressure + 1.0 kPa	
					L	3.7	L ANN	Normal pressure − 1.0 kPa	
3	PDIA 10/40HTE02CP001	Mist Eliminator Differential Pressure		kPa	H	(*1)	H ANN	(Design pressure of ME +0.10kPa(Dirty)) x 1.1^2	
4	PIA 10/40HTY08CP002	Instrumentation Air Pressure		MPa	H	0.8	H ANN	Design Pressure	
					L	(*1)	L ANN	Minimum pressure of solenoid valve +0.5 MPa	

※1 : Will be provided later based on the vendor information.

Table 3.3 Set Point List

Temperature

No.	Tag no.	Service	Range	Unit	Set Point	Value	Action	Basis	Remark
1	TIA 10/40HTA01CT001/003	FGD Inlet Temperature		deg.C	HH	300	Interlock	Maximum temperature in AH mechanical trip condition	Emergency Spray valve open
					H	290	H ANN	Maximum temperature in AH mechanical trip condition – 10 deg.C	
					△H	(*1)	H ANN	TE measuring range × 0.05 (5%)	prevention for meter deflection
2	TIA 10/40HTA01CT005/007	FGD Outlet Temperature		deg.C	HH	70	Interlock	Heat-resistant value of Absorber internal material	Emergency Spray valve open
					H	65	H ANN	Heat-resistant value of Absorber internal material – 5 deg.C	
					△H	(*1)	H ANN	TE measuring range × 0.05 (5%)	prevention for meter deflection

※1 : Will be provided later based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	LICA 10/40HTD02CL001/003	Absorber Level		m	HH	7.0	Overflow	Normal Level + 1.0 m	
					H	6.3	H ANN	CH Level + 0.2 m	
					CH2	6.3	Start Permission for 1st Absorber Circulation Pump	The value that does not drop to L level after startng pump.	
					CH	6.1	Absorber make-up water supply stop	Normal Level + 0.1 m	
					N	6.0		Design Level (Normal Level)	
					CL	5.9	Absorber make-up water supply start	Normal Level - 0.1 m	
					L	5.7	L ANN	CL Level - 0.2 m	
					LL1	4.2(*1)	INT : Absorber Recirculation Pump Stop LL1 ANN		Pump Protection
					LL2	3.2(*1)	INT : Absorber Agitator Stop LL2 ANN	(Agitator installation Level :1.6m) + (Impeller dia.:1.6m)	Agitator Protection
					LL3	1.5(*1)	INT : Absorber Bleed Pump Stop LL3 ANN		Pump Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
2	LICA 00HTM04CL007/009	Belt Filter Washing Tank Level		m	HH	3	Over flow	Top level - 0.5m	
					H	2.8	H ANN	HH Level - 0.2 m	
					CH	2.6	Make-up water supply stop	H Level - 0.2 m	
					CL	1.4	Make-up water supply start	L Level + 0.2 m	
					L	1.2	L ANN	LL Level + 0.2 m.	
					LL	1.0(*1)	INT : Pump Stop LL ANN	(Suction pipe center)+2.5 x (Suction pipe Dia.)	Pump Protection
					△H	0.2	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
3	LICA 00HTM04CL011/013	Filtrate Water Tank Level		m	HH	5.1	Over flow	Top level - 0.5m	
					H	4.9	H ANN	HH Level - 0.2 m	
					CH	4.7	Absorber Return Valve Open	H Level - 0.2 m	
					CL	1.6	Absorber Return Valve Close	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
4	LICA 00HTM04CL001/003	Primary Hydrocyclone Feed Tank Level		m	HH	6.5	Over flow	Top level - 0.5m	
					H	6.3	H ANN	HH Level - 0.2 m	
					CH	6.1	Hydro-cyclone Feed start	H Level - 0.2 m	
					CL	1.6	Hydro-cyclone Feed Stop	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump Protection Agitator Protection
					△H	0.6	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
4	LICA 00HTM04CL003/005	Secondary Waste Water Hydrocyclone Feed Tank Level		m	HH	5.5	Over flow	Top level - 0.5m	
					H	5.3	H ANN	HH Level - 0.2 m	
					CH	5.1	Hydro-cyclone Feed start	H Level - 0.2 m	
					CL	1.5	Hydro-cyclone Feed Stop	L Level + 0.2 m	
					L	1.3	L ANN	LL Level + 0.2 m.	
					LL	1.1(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
5	LICA	Waste Water Storage Tank		m	HH	6.5	Over flow	Top level - 0.5m	

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
	00HTM04CL013/015	Level			H	6.3	H ANN	HH Level - 0.2 m	
					CH1	6.1	Filtrate Water Tank Feed Start	H Level - 0.2 m	
					CL1	5.6	Filtrate Water Tank Feed Stop	CH1 Level - 0.5 m	
					CH2	2.1	Waste Water Treatment Feed Start	CL2 Level + 0.5 m	
					CL2	1.6	Waste Water Treatment Feed Stop	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
7	LICA	Mill Circuit Tank Level		m	HH	Later(*1)	HH ANN	To be finalize by BHEL based on vedor information.	Silo & Bag Filter Protection
	00HTK05CL001/003				H	Later(*1)	H ANN	To be finalize by BHEL based on vedor information.	
	00HTK05CL004/006				L	Later(*1)	L ANN	To be finalize by BHEL based on vedor information.	
					LL	Later(*1)	LL ANN	To be finalize by BHEL based on vedor information.	
8	LICA	Limestone Slurry Storage Tank		m	HH	11.5	Over flow	Top level - 0.8m	
	00HTK05CL021/023	Level			H	11.3	H ANN	HH Level - 0.2 m	
					CH	10.8	Wet Limestone Grinding Mill stop	H Level - 0.5 m	
					CL	4.4	Wet Limestone Grinding Mill start		
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
9	LIC	Absorber Area Drain Sump		m	HH	3.5	Over flow	Top level - 0.5m	
	10/40HTT07CL001/003	Level			H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN		Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
10	LIA 00HTT07CL001/003	Aixiliary Absorbent Tank Level		m	HH	10.1	Over flow	Top level - 0.8m	
					H	9.9	H ANN	HH Level - 0.2 m	
					L	4.4	L ANN	LL1 Level + 0.2 m	
					LL1	3.4(*1)	INT : Agitator Stop LL1 ANN		
					LL2	2.0*1)	INT : Pump Stop LL2 ANN		Pump Protection
11	LICA 00HTT07CL001/003	Gypsum Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump protection Agitator Protection
12	LICA 00HTT07CL004/006	Limestone Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
13	LICA	Process Water Tank Level		m	HH	4.9	Over flow	Top level - 0.5m	
	00HTQ08CL001/003				H	4.7	H ANN	HH Level - 0.2 m	
	00HTQ08CL004/006				CH	4.5	Make-up water supply stop	H Level - 0.2 m	
		`			CL	4.0	Make-up water supply start	CH Level - 0.5 m	
					L	1.5	L ANN	LL Level + 0.2 m.	
					LL	1.3(*1)	INT : Pump Stop LL ANN		Pump Protection
					△H	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
14	LICA	Emergency Water Tank Level		m	HH	3	Over flow	Top level - 0.5m	
	10/40HTQ08CL021/023				H	2.8	H ANN	HH Level - 0.2 m	
					CH	2.6	Make-up water supply stop	H Level - 0.2 m	
					CL	2.4	Make-up water supply start	CH Level - 0.2 m	
					L	0.5	L ANN	Bottom + 0.5 m	

※This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL shall add set point for unit equipment and finalize the list according to the vender information.

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Others

No.	KKS Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	AICA	Absorber pH		–	H	6.5	H ANN	Normal pH + α	
	10/40HTD02CQ001/003				N	Later	Set point for pH control	Commissioning adjustment value	
					L	Later	L ANN, Set point for minimum pH	Commissioning adjustment value	
2	DICA	Absorber Density		wt.%	H	35	H ANN	Normal Density + 5 wt.%	Pump & Belt Filter Protection
	10/40HTM01CD001/003				CH	32	Absorber Slurry Bleed Start	Normal Density + 2 wt.%	
					N	30	Set point for Density Control	Design Density	
					CL	28	Absorber Slurry Bleed Stop	Normal Density – 2 wt.%	
					L	25	L ANN	Normal Density – 5 wt.%	
3	AICA	FGD Outlet SO2		mg/Nm^3	H	100	H ANN	Design FGD Outlet SO2 concentration	
	10/40HTA01CQ005				N	Later	Set point for SO2 control	Commissioning adjustment	

※This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL will add set point for unit equipment and finalize the list according to the vender information.

05	29.11.21	Replied to the customer comments	KMK	PR	SKD
04	20.10.21	Revised the document as per KTPS FGD project	KMK	PR	SKD
03	20.11.19	Revised the document as per the comments	KMK	PR	SKD
02	04.11.19	Revised the document by including the reply sheet	KMK	PR	SKD
01	22.10.19	Revised the document as per the comments	KMK	PR	SKD
00	19.09.19	Fresh Issue	KMK	PR	SKD
REV	DATE	DESCRIPTION /NOTE	PRD	CHD	APD

REVISIONS

TITLE:

P&ID_SECONDARYHYDROCYCLONE FEED TANK AND PUMPS

OWNER/PROJECT: **TELANGANA STATE POWER GENERATION CORPORATION LTD**

BHADRADRI (4X270 MW) THERMAL POWER STATION–
FGD SYSTEM PACKAGE

CONSULTANT:

DESEIN PRIVATE LIMITED.
NEW DELHI

EPC CONTRACTOR:

BHARAT HEAVY ELECTRICALS LTD.
BOILER AUXILIARIES PLANT,RANIPET

COLLABORATOR

MITSUBISHI HITACHI POWER SYSTEMS, LTD
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

	BHEL	Date	
PREPARED BY	Kabilash	29.11.21	STATUS : *FOR APPROVAL*
CHECKED BY	Raju P	29.11.21	BHEL CUST NO : G301,G302,G303 & G304
APPROVED BY	SK Dash	29.11.21	BHEL DOC NO : 03- FW-747-00660
			REV NO :05

THIRD ANGLE PROJECTION | No. REQ'D | A3 | DRAWING No.

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
M	ACTUATED BY MOTOR
IM	ACTUATED BY MOTOR (INCHING)
	AIR CONTROL VALVE
S	SOLENOID ACTUATOR
	SELF REGURATING VALVE
	SELF REGURATING VALVE

TRENCH SYMBOLS

SYMBOLS	NAME
A	TO ABSORBER AREA DRAIN SUMP
D	TO GYPSUM AREA DRAIN SUMP
L	TO LIMESTONE AREA DRAIN SUMP

SYMBOLS FOR PIPING PARTS & INSTRUMENT PARTS

SYMBOLS	NAME
T	STEAM TRAP
AT	AIR TRAP
	Y-STRAINER
	T-STRAINER
TS	TEMPORARY STRAINER
	REDUCER
	EXPANSION JOINT
	DUCT EXPANSION JOINT
	FLEXIBLE HOSE
	SPOOL PIECE
	VENT
	HOSE CONNECTION
	BLIND FLANGE
	REDUCING FLANGE
	CAP (BW)
	CAP (SCR)
	TRENCH
SG	SIGHT GLASS
	SILENCER
	ORIFICE
	DIAPHRAGM
M	MAGNETIC FLOW METER
	VORTEX FLOW METER
	PH METER
	FILTER
M.H. M.H. M.H. I.H.	MANHOLE
	INSPECTION HOLE
	PITOT TUBE
	SAMPLING POT
S	SAMPLING NOZZLE
RO	RESTRICTION ORIFICE
FI	ROTOMETER TYPE FLOW METER

SYMBOLS FOR VALVE OPERATION

SYMBOLS	NAME
FO	FAILURE OPEN (THE VALVE OPENS WHEN AIR OR ELECTRICITY FOR ACTUATOR FAILS.)
FC	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 CLIENT AND CONTRACTOR
CONTRACTOR | XXX	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
AA	ANTIFOAM AGENT	WCS	COOLING WATER SUPPLY
AC	COMPRESSED AIR	WCR	COOLING WATER RETURN
AF	FLUIDIZER AIR	WC	Ca(OH)2
AI	INSTRUMENT AIR	WP	PROCESS WATER
AO	OXIDATION AIR	WR	RAW WATER
AS	SEAL AIR	WW	WASTE WATER
DD	DUCT DRAIN	VG	VACUUM PUMP VENT
FS	FILTRATE SLURRY	VBG	BELT FILTER VENT GAS
GS	GYPSUM SLURRY	LD	LIMESTONE DEDUSTING
LS	LIMESTONE SLURRY	LOL	LUBE OIL (LOW PRESSURE)
FG	FLUE GAS	LOH	LUBE OIL (HIGH PRESSURE)

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 / GI PIPING	AI, LOL
BA02	Gr.304 STAINLESS STEEL / GI 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
DA60	FRP PIPING (PIPE DIA UPTO 400 NB)	GS,FS,WW,DD
DA40	FRP PIPING (PIPE DIA UPTO 400 NB)	LS, WP, WC

UNIT CODE

SYMBOLS	UNIT IDENTIFICATION
90	COMMON
10	UNIT-1 FGD SYSTEM AND AUXILIARIES
20	UNIT-2 FGD SYSTEM AND AUXILIARIES
30	UNIT-3 FGD SYSTEM AND AUXILIARIES
40	UNIT-4 FGD SYSTEM AND AUXILIARIES
50	UNIT-5 FGD SYSTEM AND AUXILIARIES

EXPRESSION OF PIPING LINE

10 - 200 - GS - 2 00 1 - AA60 - HF

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

CUSTOMER NOS: G301,G302,G303&G304

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CUSTOMER: TSGENCO.

PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

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

DEPT CODE		NAME (BHEL)	DATE
M	DRN	KM.KABILASH	24.09.21
	CHD	P.RAJU	24.09.21
	APPD	PNR/ACR	24.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – SYMBOL MARK (1/2)

SCALE : NTS

BHEL DRG NO. 03-FW-000-00675 | SH 01 of 02

FILE NO: B240 – 00001 | REV NO: 00

THIRD ANGLE PROJECTION | No. REQ'D | A3 | DRAWING No.

INSTRUMENT ABBREVIATION

	FIRST–LETTER		SUCCEEDING–LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		BLANK	BLANK	BLANK
C	BLANK			CONTROL	
D	BLANK	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	BLANK		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	BLANK	MOMENTARY			MIDDLE, INTERMEDIATE
N	BLANK		BLANK	BLANK	BLANK
O	BLANK		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT(TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

INSTRUMENT SYMBOLS

SYMBOLS	NAME
	FIELD MOUNTED
	FOR CONTROL ROOM
	FOR LOCAL CONTROL PANEL
	FOR DCS
I	INTERLOCK LOGIC

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 SWITH
FLXXWA–SL	SINGLE SOLENOID WITH LIMIT SWITCH

MACHINARY SYMBOLS

SYMBOLS	NAME
	PUMP
	FAN / BLOWER
	AGITATOR (FLAT BLADE)
	AGITATOR (PROPELLOR)
	ROTARY VALVE
	CRUSHER
	BELT FEEDER
	BELT FILTER
	BALL MILL
	CYCLONE
	MIST ELIMINATOR

EQUIPMENT SYMBOLS

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

DRIVER SYMBOLS

SYMBOLS	NAME
A	AIR MOTOR
M	ELECTRIC MOTOR

OTHER SYMBOLS

SYMBOLS	NAME
	INSERT PIPE / LANCE
	CHUTE
	TRUCK

CUSTOMER NOS: G301,G302,G303&G304
CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

CUSTOMER NOS: G301,G302,G303&G304

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CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

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

DEPT CODE		NAME (BHEL)	DATE
M	DRN	KM.KABILASH	24.09.21
	CHD	P.RAJU	24.09.21
	APPD	PNR/ACR	24.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

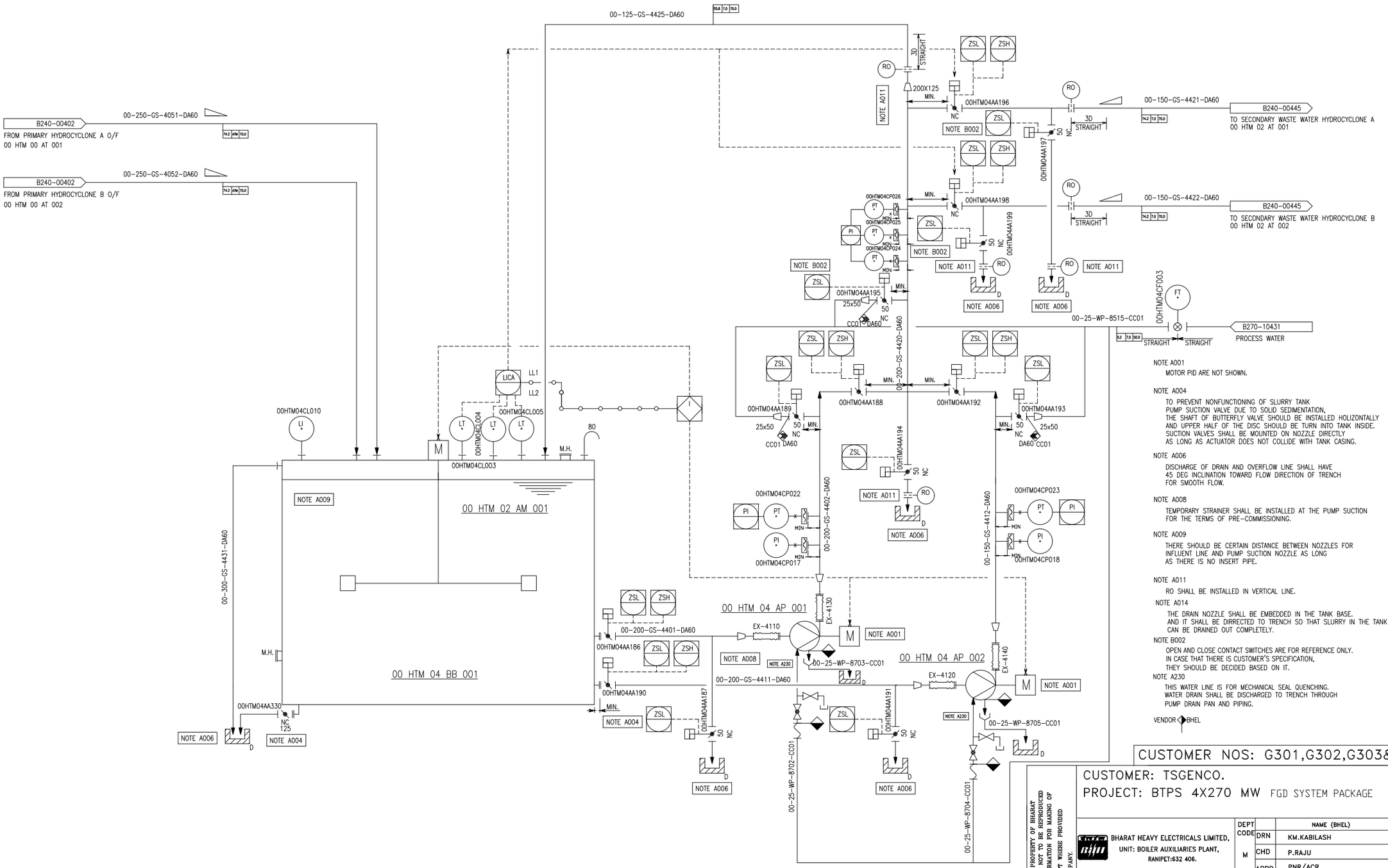
TITLE: P & ID – SYMBOL MARK (2/2) | SCALE : NTS

BHEL DRG NO. 03–FW–000–00675 | SH 02 of 02

FILE NO B240 – 00002 | REV NO 00

0 1 2 3 4 5 6 7 8 9 10

THIRD ANGLE PROJECTION | No. REQ'D | A3 | DRAWING No.



NOTE A001
MOTOR PID ARE NOT SHOWN.

NOTE A004
TO PREVENT NONFUNCTIONING OF SLURRY TANK PUMP SUCTION VALVE DUE TO SOLID SEDIMENTATION, THE SHAFT OF BUTTERFLY VALVE SHOULD BE INSTALLED HOLIZONTALLY AND UPPER HALF OF THE DISC SHOULD BE TURN INTO TANK INSIDE. SUCTION VALVES SHALL BE MOUNTED ON NOZZLE DIRECTLY AS LONG AS ACTUATOR DOES NOT COLLIDE WITH TANK CASING.

NOTE A006
DISCHARGE OF DRAIN AND OVERFLOW LINE SHALL HAVE 45 DEG INCLINATION TOWARD FLOW DIRECTION OF TRENCH FOR SMOOTH FLOW.

NOTE A008
TEMPORARY STRAINER SHALL BE INSTALLED AT THE PUMP SUCTION FOR THE TERMS OF PRE-COMMISSIONING.

NOTE A009
THERE SHOULD BE CERTAIN DISTANCE BETWEEN NOZZLES FOR INFLUENT LINE AND PUMP SUCTION NOZZLE AS LONG AS THERE IS NO INSERT PIPE.

NOTE A011
RO SHALL BE INSTALLED IN VERTICAL LINE.

NOTE A014
THE DRAIN NOZZLE SHALL BE EMBEDDED IN THE TANK BASE. AND IT SHALL BE DIRRECTED TO TRENCH SO THAT SLURRY IN THE TANK CAN BE DRAINED OUT COMPLETELY.

NOTE B002
OPEN AND CLOSE CONTACT SWITCHES ARE FOR REFERENCE ONLY. IN CASE THAT THERE IS CUSTOMER'S SPECIFICATION, THEY SHOULD BE DECIDED BASED ON IT.

NOTE A230
THIS WATER LINE IS FOR MECHANICAL SEAL QUENCHING. WATER DRAIN SHALL BE DISCHARGED TO TRENCH THROUGH PUMP DRAIN PAN AND PIPING.

VENDOR ◇ BHEL

NOTE: 2. Process Parameters
- Flow – m3/hr
- Pressure – Kg/cm2 (Design Pressure)
- Temp – Deg C (Design Temp)

xx xx xx

00 HTM 04 BB 001
SECONDARY WASTE WATER HYDROCYCLONE FEED TANK

00 HTM 02 AM 001
SECONDARY WASTE WATER HYDROCYCLONE FEED TANK AGITATOR

00 HTM 04 AP 001/002
SECONDARY WASTE WATER HYDROCYCLONE FEED TANK PUMP A/B

CUSTOMER NOS: G301,G302,G303&G304

CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

	DEPT CODE		NAME (BHEL)	DATE
BHARAT HEAVY ELECTRICALS LIMITED, UNIT: BOILER AUXILIARIES PLANT, RANIPET:632 406.	M	DRN	KM.KABILASH	28.09.21
		CHD	P.RAJU	28.09.21
		APPD	PNR/ACR	28.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – GYPSUM DEWATERING SYSTEM SECONDRAY HYDROCYCLONE FEED TANK

SCALE : NTS

BHEL DRG NO. 03-FW-747-00660 | SH 01 OF 01

FILE NO B240-00441 | REV NO 04

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0 1 2 3 4 5 6 7 8 9 10

WRITEUP ON SECONDARY HYDROCYCLONE FEED TANK AND PUMPS

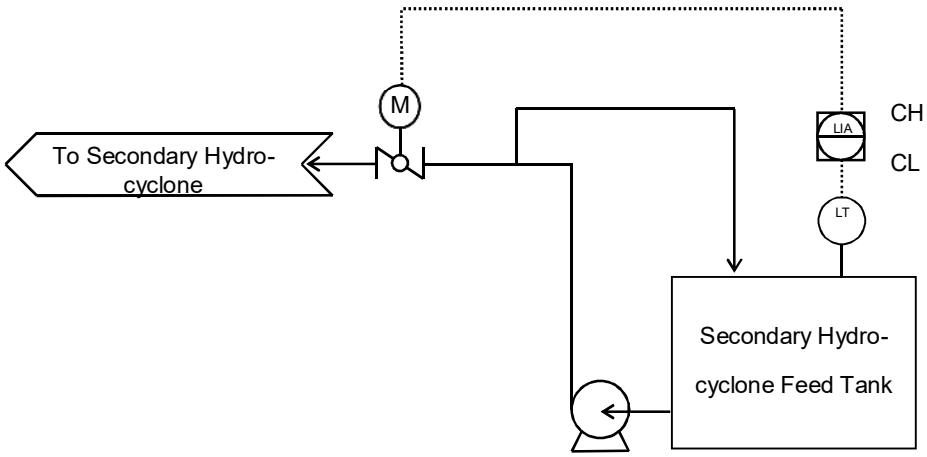
Purpose: This write up describes the Secondary Hydrocyclone feed tanks and pumps and associated control system.

Equipment List:

S. No.	Description	Item No.	Qty
1.	Secondary hydro cyclone feed tank	00 HTM 04 BB 001	1
2.	Secondary hydro cyclone feed tank Pump	00 HTM 04 AP 001/002	1W + 1S
3.	Secondary Hydro Cyclone	00 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. 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 control valve is opened to secondary hydro cyclone. When the level reaches CL, the motorized valve closed. Meanwhile re circulation is carried out form 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 = 10sec

T2 = 0.2sec

T3 = 60sec

T4 = 60sec

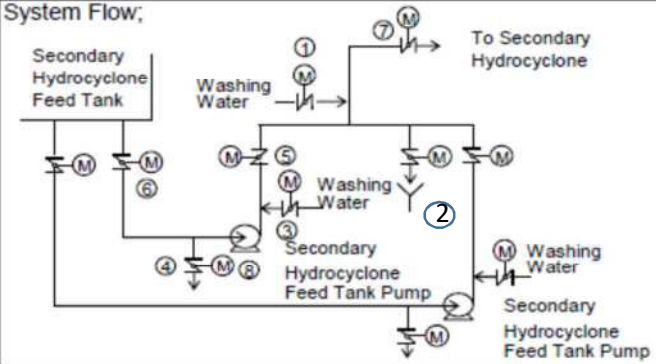
T5 = 180sec

T6 = 180sec

These timing will be optimized during commissioning of FGD.

Item	Service	
00 HTM 04 AP 001/002	Secondary Hydrocyclone Feed Tank Pump A/B Sub Function Group	Stand-by Auto Mode (Back-up start)

System Flow;



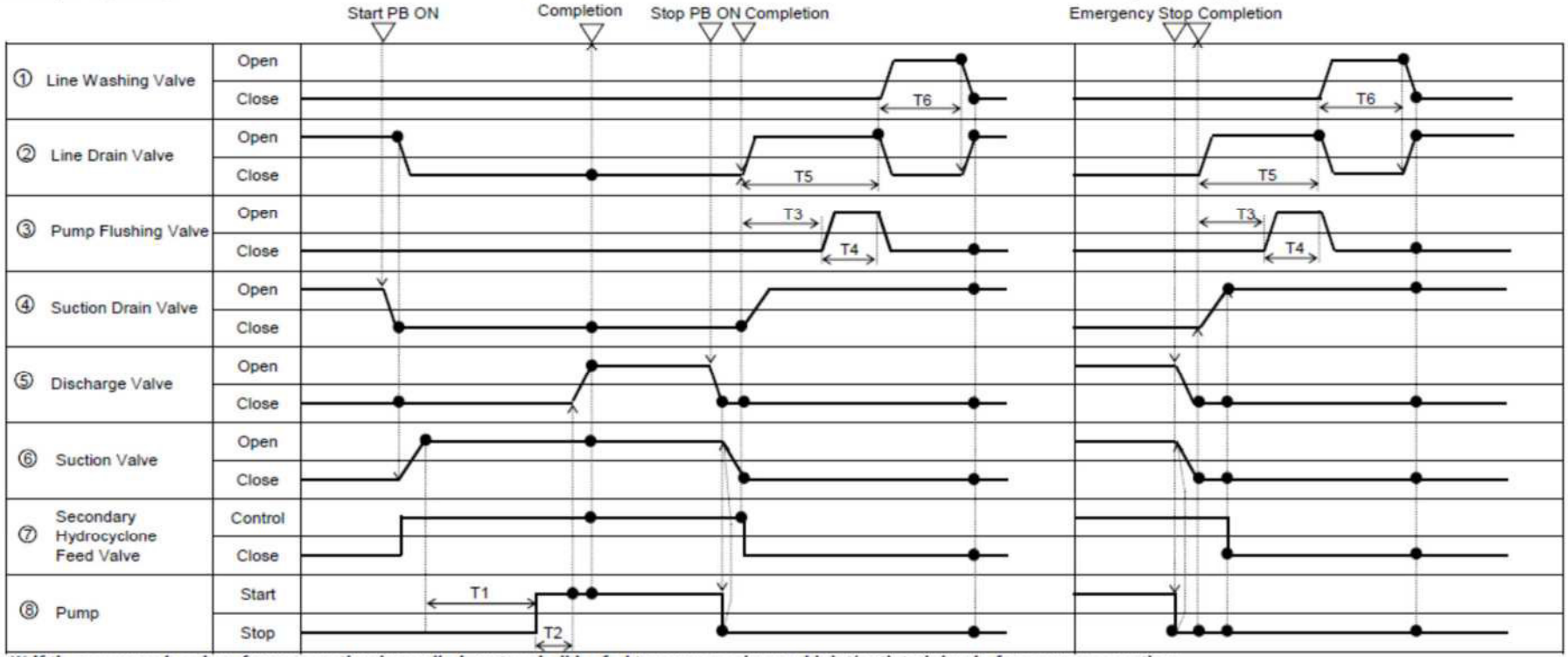
Start Permission;
- Secondary Hydrocyclone Feed Tank Level : Not LL

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.

Instruments List

Sl.No	KKS Code	Description of instrument	Quantity
01	00HTM04CF003	Rotameter (flow meter)	01 No
02	00HTM04CP022/026	Pressure Transmitter	05 Nos
03	00HTM04CP017/018	Pressure Indicator	02 Nos
04	00HTM04CL003/005	Level Transmitter	03 Nos
05	00HTM04CL010	Level Indicator	01 No

Table 3.3 Set Point List

Pressure

No.	KKS Tag no.	Service	Range	Unit	Set Point	Value	Action	Basis	Remark
1	PIA 10/40HTA01CP001/003	BUF Inlet Pressure		kPa	HH	6.5		Mechanical design pressure of FGD inlet duct: +6.47 kpa	
					H	1.0	H ANN	Normal pressure + 1.0 kPa	
					L	−1.0	L ANN	Normal pressure − 1.0 kPa	
					LL	−1.5	INT : FGD Bypass Demper Open LL ANN	Mechanical design pressure of FGD inlet duct: − 1.47 kpa	
					△H	Later	H ANN	PT measuring range x 0.05 (5%)	
2	PIA 10/40HTA01CP007	Absorber Inlet Pressure		kPa	H	4.7	H ANN	Normal pressure + 1.0 kPa	
					L	3.7	L ANN	Normal pressure − 1.0 kPa	
3	PDIA 10/40HTE02CP001	Mist Eliminator Differential Pressure		kPa	H	(*1)	H ANN	(Design pressure of ME +0.10kPa(Dirty)) x 1.1^2	
4	PIA 10/40HTY08CP002	Instrumentation Air Pressure		MPa	H	0.8	H ANN	Design Pressure	
					L	(*1)	L ANN	Minimum pressure of solenoid valve +0.5 MPa	

※1 : Will be provided later based on the vendor information.

Table 3.3 Set Point List

Temperature

No.	Tag no.	Service	Range	Unit	Set Point	Value	Action	Basis	Remark
1	TIA 10/40HTA01CT001/003	FGD Inlet Temperature		deg.C	HH	300	Interlock	Maximum temperature in AH mechanical trip condition	Emergency Spray valve open
					H	290	H ANN	Maximum temperature in AH mechanical trip condition – 10 deg.C	
					△H	(*1)	H ANN	TE measuring range × 0.05 (5%)	prevention for meter deflection
2	TIA 10/40HTA01CT005/007	FGD Outlet Temperature		deg.C	HH	70	Interlock	Heat-resistant value of Absorber internal material	Emergency Spray valve open
					H	65	H ANN	Heat-resistant value of Absorber internal material – 5 deg.C	
					△H	(*1)	H ANN	TE measuring range × 0.05 (5%)	prevention for meter deflection

※1 : Will be provided later based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	LICA 10/40HTD02CL001/003	Absorber Level		m	HH	7.0	Overflow	Normal Level + 1.0 m	
					H	6.3	H ANN	CH Level + 0.2 m	
					CH2	6.3	Start Permission for 1st Absorber Circulation Pump	The value that does not drop to L level after startng pump.	
					CH	6.1	Absorber make-up water supply stop	Normal Level + 0.1 m	
					N	6.0		Design Level (Normal Level)	
					CL	5.9	Absorber make-up water supply start	Normal Level - 0.1 m	
					L	5.7	L ANN	CL Level - 0.2 m	
					LL1	4.2(*1)	INT : Absorber Recirculation Pump Stop LL1 ANN		Pump Protection
					LL2	3.2(*1)	INT : Absorber Agitator Stop LL2 ANN	(Agitator installation Level :1.6m) + (Impeller dia.:1.6m)	Agitator Protection
					LL3	1.5(*1)	INT : Absorber Bleed Pump Stop LL3 ANN		Pump Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
2	LICA 00HTM04CL007/009	Belt Filter Washing Tank Level		m	HH	3	Over flow	Top level - 0.5m	
					H	2.8	H ANN	HH Level - 0.2 m	
					CH	2.6	Make-up water supply stop	H Level - 0.2 m	
					CL	1.4	Make-up water supply start	L Level + 0.2 m	
					L	1.2	L ANN	LL Level + 0.2 m.	
					LL	1.0(*1)	INT : Pump Stop LL ANN	(Suction pipe center)+2.5 x (Suction pipe Dia.)	Pump Protection
					△H	0.2	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
3	LICA 00HTM04CL011/013	Filtrate Water Tank Level		m	HH	5.1	Over flow	Top level - 0.5m	
					H	4.9	H ANN	HH Level - 0.2 m	
					CH	4.7	Absorber Return Valve Open	H Level - 0.2 m	
					CL	1.6	Absorber Return Valve Close	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
4	LICA 00HTM04CL001/003	Primary Hydrocyclone Feed Tank Level		m	HH	6.5	Over flow	Top level - 0.5m	
					H	6.3	H ANN	HH Level - 0.2 m	
					CH	6.1	Hydro-cyclone Feed start	H Level - 0.2 m	
					CL	1.6	Hydro-cyclone Feed Stop	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump Protection Agitator Protection
					△H	0.6	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
4	LICA 00HTM04CL003/005	Secondary Waste Water Hydrocyclone Feed Tank Level		m	HH	5.5	Over flow	Top level - 0.5m	
					H	5.3	H ANN	HH Level - 0.2 m	
					CH	5.1	Hydro-cyclone Feed start	H Level - 0.2 m	
					CL	1.5	Hydro-cyclone Feed Stop	L Level + 0.2 m	
					L	1.3	L ANN	LL Level + 0.2 m.	
					LL	1.1(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
5	LICA	Waste Water Storage Tank		m	HH	6.5	Over flow	Top level - 0.5m	

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
	00HTM04CL013/015	Level			H	6.3	H ANN	HH Level - 0.2 m	
					CH1	6.1	Filtrate Water Tank Feed Start	H Level - 0.2 m	
					CL1	5.6	Filtrate Water Tank Feed Stop	CH1 Level - 0.5 m	
					CH2	2.1	Waste Water Treatment Feed Start	CL2 Level + 0.5 m	
					CL2	1.6	Waste Water Treatment Feed Stop	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
7	LICA	Mill Circuit Tank Level		m	HH	Later(*1)	HH ANN	To be finalize by BHEL based on vedor information.	Silo & Bag Filter Protection
	00HTK05CL001/003				H	Later(*1)	H ANN	To be finalize by BHEL based on vedor information.	
	00HTK05CL004/006				L	Later(*1)	L ANN	To be finalize by BHEL based on vedor information.	
					LL	Later(*1)	LL ANN	To be finalize by BHEL based on vedor information.	
8	LICA	Limestone Slurry Storage Tank		m	HH	11.5	Over flow	Top level - 0.8m	
	00HTK05CL021/023	Level			H	11.3	H ANN	HH Level - 0.2 m	
					CH	10.8	Wet Limestone Grinding Mill stop	H Level - 0.5 m	
					CL	4.4	Wet Limestone Grinding Mill start		
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
9	LIC	Absorber Area Drain Sump		m	HH	3.5	Over flow	Top level - 0.5m	
	10/40HTT07CL001/003	Level			H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN		Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
10	LIA 00HTT07CL001/003	Aixiliary Absorbent Tank Level		m	HH	10.1	Over flow	Top level - 0.8m	
					H	9.9	H ANN	HH Level - 0.2 m	
					L	4.4	L ANN	LL1 Level + 0.2 m	
					LL1	3.4(*1)	INT : Agitator Stop LL1 ANN		
					LL2	2.0*1)	INT : Pump Stop LL2 ANN		Pump Protection
11	LICA 00HTT07CL001/003	Gypsum Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump protection Agitator Protection
12	LICA 00HTT07CL004/006	Limestone Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
13	LICA	Process Water Tank Level		m	HH	4.9	Over flow	Top level - 0.5m	
	00HTQ08CL001/003				H	4.7	H ANN	HH Level - 0.2 m	
	00HTQ08CL004/006				CH	4.5	Make-up water supply stop	H Level - 0.2 m	
		`			CL	4.0	Make-up water supply start	CH Level - 0.5 m	
					L	1.5	L ANN	LL Level + 0.2 m.	
					LL	1.3(*1)	INT : Pump Stop LL ANN		Pump Protection
					△H	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
14	LICA	Emergency Water Tank Level		m	HH	3	Over flow	Top level - 0.5m	
	10/40HTQ08CL021/023				H	2.8	H ANN	HH Level - 0.2 m	
					CH	2.6	Make-up water supply stop	H Level - 0.2 m	
					CL	2.4	Make-up water supply start	CH Level - 0.2 m	
					L	0.5	L ANN	Bottom + 0.5 m	

※This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL shall add set point for unit equipment and finalize the list according to the vender information.

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Others

No.	KKS Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	AICA	Absorber pH		–	H	6.5	H ANN	Normal pH + α	
	10/40HTD02CQ001/003				N	Later	Set point for pH control	Commissioning adjustment value	
					L	Later	L ANN, Set point for minimum pH	Commissioning adjustment value	
2	DICA	Absorber Density		wt.%	H	35	H ANN	Normal Density + 5 wt.%	Pump & Belt Filter Protection
	10/40HTM01CD001/003				CH	32	Absorber Slurry Bleed Start	Normal Density + 2 wt.%	
					N	30	Set point for Density Control	Design Density	
					CL	28	Absorber Slurry Bleed Stop	Normal Density – 2 wt.%	
					L	25	L ANN	Normal Density – 5 wt.%	
3	AICA	FGD Outlet SO2		mg/Nm^3	H	100	H ANN	Design FGD Outlet SO2 concentration	
	10/40HTA01CQ005				N	Later	Set point for SO2 control	Commissioning adjustment	

※This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL will add set point for unit equipment and finalize the list according to the vender information.

04	29.11.21	Replied to the customer comments	KMK	PR	SKD
03	20.10.21	Document resubmitted in line with KTPS FGD project	KMK	PR	SKD
02	04.11.19	Document resubmitted by including the reply sheet	KMK	PR	SKD
01	22.10.19	Revised the document as per the comments	KMK	PR	SKD
00	19.09.19	Fresh Issue	KMK	PR	SKD
REV	DATE	DESCRIPTION /NOTE	PRD	CHD	APD

REVISIONS

TITLE:

P&ID_SECONDARYHYDROCYCLONE SYSTEM

OWNER/PROJECT: **TELANGANA STATE POWER GENERATION CORPORATION LTD**

BHADRADRI (4X270 MW) THERMAL POWER STATION–
FGD SYSTEM PACKAGE

CONSULTANT:

DESEIN PRIVATE LIMITED.
NEW DELHI

EPC CONTRACTOR:

BHARAT HEAVY ELECTRICALS LTD.
BOILER AUXILIARIES PLANT,RANIPET

COLLABORATOR

MITSUBISHI HITACHI POWER SYSTEMS, LTD
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

	BHEL	Date	
PREPARED BY	Kabilash	29.11.21	STATUS : *FOR APPROVAL*
CHECKED BY	Raju P	29.11.21	BHEL CUST NO : G301,G302,G303 & G304
APPROVED BY	SK Dash	29.11.21	BHEL DOC NO : 03- FW-738-00661
			REV NO :04

THIRD ANGLE PROJECTION | No. REQ'D | A3 | DRAWING No.

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
M	ACTUATED BY MOTOR
IM	ACTUATED BY MOTOR (INCHING)
	AIR CONTROL VALVE
S	SOLENOID ACTUATOR
	SELF REGURATING VALVE
	SELF REGURATING VALVE

TRENCH SYMBOLS

SYMBOLS	NAME
A	TO ABSORBER AREA DRAIN SUMP
D	TO GYPSUM AREA DRAIN SUMP
L	TO LIMESTONE AREA DRAIN SUMP

SYMBOLS FOR PIPING PARTS & INSTRUMENT PARTS

SYMBOLS	NAME
T	STEAM TRAP
AT	AIR TRAP
	Y-STRAINER
	T-STRAINER
TS	TEMPORARY STRAINER
	REDUCER
	EXPANSION JOINT
	DUCT EXPANSION JOINT
	FLEXIBLE HOSE
	SPOOL PIECE
	VENT
	HOSE CONNECTION
	BLIND FLANGE
	REDUCING FLANGE
	CAP (BW)
	CAP (SCR)
	TRENCH
SG	SIGHT GLASS
	SILENCER
	ORIFICE
	DIAPHRAGM
M	MAGNETIC FLOW METER
	VORTEX FLOW METER
	PH METER
	FILTER
M.H. M.H. M.H. I.H.	MANHOLE
	INSPECTION HOLE
	PITOT TUBE
	SAMPLING POT
S	SAMPLING NOZZLE
RO	RESTRICTION ORIFICE
FI	ROTOMETER TYPE FLOW METER

SYMBOLS FOR VALVE OPERATION

SYMBOLS	NAME
FO	FAILURE OPEN (THE VALVE OPENS WHEN AIR OR ELECTRICITY FOR ACTUATOR FAILS.)
FC	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 CLIENT AND CONTRACTOR
CONTRACTOR | XXX	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
AA	ANTIFOAM AGENT	WCS	COOLING WATER SUPPLY
AC	COMPRESSED AIR	WCR	COOLING WATER RETURN
AF	FLUIDIZER AIR	WC	Ca(OH)2
AI	INSTRUMENT AIR	WP	PROCESS WATER
AO	OXIDATION AIR	WR	RAW WATER
AS	SEAL AIR	WW	WASTE WATER
DD	DUCT DRAIN	VG	VACUUM PUMP VENT
FS	FILTRATE SLURRY	VBG	BELT FILTER VENT GAS
GS	GYPSUM SLURRY	LD	LIMESTONE DEDUSTING
LS	LIMESTONE SLURRY	LOL	LUBE OIL (LOW PRESSURE)
FG	FLUE GAS	LOH	LUBE OIL (HIGH PRESSURE)

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 / GI PIPING	AI, LOL
BA02	Gr.304 STAINLESS STEEL / GI 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
DA60	FRP PIPING (PIPE DIA UPTO 400 NB)	GS,FS,WW,DD
DA40	FRP PIPING (PIPE DIA UPTO 400 NB)	LS, WP, WC

UNIT CODE

SYMBOLS	UNIT IDENTIFICATION
90	COMMON
10	UNIT-1 FGD SYSTEM AND AUXILIARIES
20	UNIT-2 FGD SYSTEM AND AUXILIARIES
30	UNIT-3 FGD SYSTEM AND AUXILIARIES
40	UNIT-4 FGD SYSTEM AND AUXILIARIES
50	UNIT-5 FGD SYSTEM AND AUXILIARIES

EXPRESSION OF PIPING LINE

10 - 200 - GS - 2 00 1 - AA60 - HF

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

CUSTOMER NOS: G301,G302,G303&G304

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CUSTOMER: TSGENCO.

PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

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

DEPT CODE		NAME (BHEL)	DATE
M	DRN	KM.KABILASH	24.09.21
	CHD	P.RAJU	24.09.21
	APPD	PNR/ACR	24.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – SYMBOL MARK (1/2)

SCALE : NTS

BHEL DRG NO. 03-FW-000-00675 | SH 01 of 02

FILE NO: B240 – 00001 | REV NO: 00

THIRD ANGLE PROJECTION | No. REQ'D | A3 | DRAWING No.

INSTRUMENT ABBREVIATION

	FIRST–LETTER		SUCCEEDING–LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		BLANK	BLANK	BLANK
C	BLANK			CONTROL	
D	BLANK	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	BLANK		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	BLANK	MOMENTARY			MIDDLE, INTERMEDIATE
N	BLANK		BLANK	BLANK	BLANK
O	BLANK		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT(TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

INSTRUMENT SYMBOLS

SYMBOLS	NAME
	FIELD MOUNTED
	FOR CONTROL ROOM
	FOR LOCAL CONTROL PANEL
	FOR DCS
I	INTERLOCK LOGIC

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 SWITH
FLXXWA–SL	SINGLE SOLENOID WITH LIMIT SWITCH

MACHINARY SYMBOLS

SYMBOLS	NAME
	PUMP
	FAN / BLOWER
	AGITATOR (FLAT BLADE)
	AGITATOR (PROPELLOR)
	ROTARY VALVE
	CRUSHER
	BELT FEEDER
	BELT FILTER
	BALL MILL
	CYCLONE
	MIST ELIMINATOR

EQUIPMENT SYMBOLS

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

DRIVER SYMBOLS

SYMBOLS	NAME
A	AIR MOTOR
M	ELECTRIC MOTOR

OTHER SYMBOLS

SYMBOLS	NAME
	INSERT PIPE / LANCE
	CHUTE
	TRUCK

CUSTOMER NOS: G301,G302,G303&G304
CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

CUSTOMER NOS: G301,G302,G303&G304

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CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

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

DEPT CODE		NAME (BHEL)	DATE
M	DRN	KM.KABILASH	24.09.21
	CHD	P.RAJU	24.09.21
	APPD	PNR/ACR	24.09.21

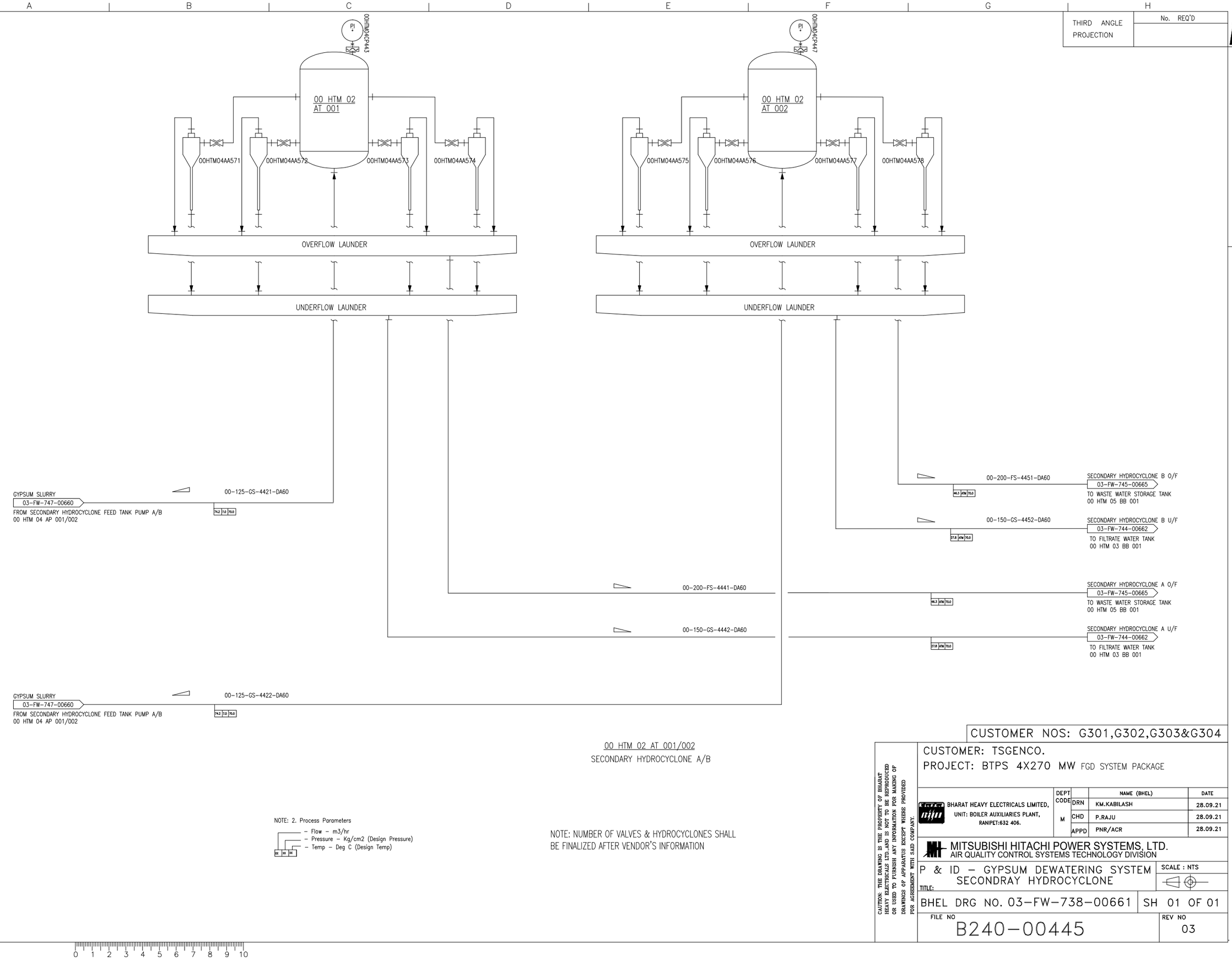
MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – SYMBOL MARK (2/2) | SCALE : NTS

BHEL DRG NO. 03–FW–000–00675 | SH 02 of 02

FILE NO B240 – 00002 | REV NO 00

0 1 2 3 4 5 6 7 8 9 10



00 HTM 02 AT 001/002
SECONDARY HYDROCYCLONE A/B

NOTE: NUMBER OF VALVES & HYDROCYCLONES SHALL BE FINALIZED AFTER VENDOR'S INFORMATION

THIRD ANGLE PROJECTION | No. REQ'D | A3 | DRAWING No.

CUSTOMER NOS: G301,G302,G303&G304

CUSTOMER: TSGENCO.

PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

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

DEPT CODE		NAME (BHEL)	DATE
M	DRN	KM.KABILASH	28.09.21
	CHD	P.RAJU	28.09.21
	APPD	PNR/ACR	28.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – GYPSUM DEWATERING SYSTEM SECONDRAY HYDROCYCLONE

SCALE : NTS

BHEL DRG NO. 03-FW-738-00661 | SH 01 OF 01

FILE NO B240-00445 | REV NO 03

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WRITE UP ON SECONDARY HYDRO CYCLONE

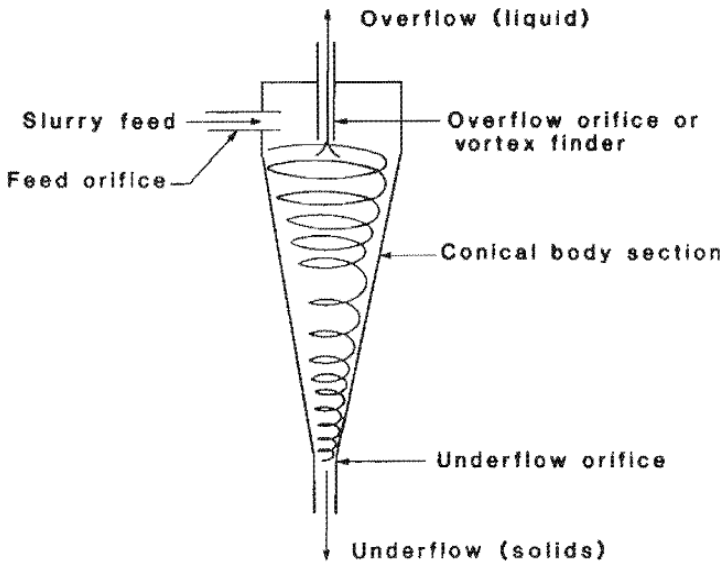
Purpose: This write up describes the Secondary hydro cyclone,

Equipment List:

S. No.	Description	Item No.	Qty
1.	Secondary hydro cyclone	00 HTM 02 AT 001/002	1W + 1S

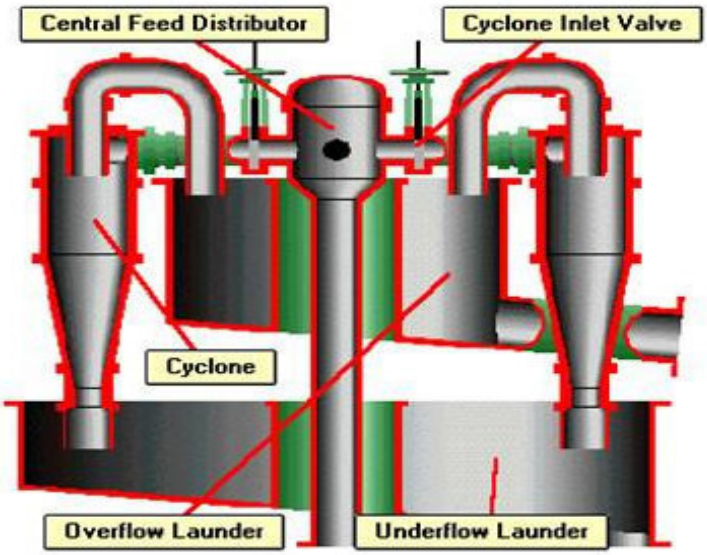
Operation Write Up:

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.



Cross section of hydrocyclone

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.

Instruments List

Sl.No	KKS Code	Description of instrument	Quantity
01	00HTM04CP443 & 00HTM04CP447	Pressure Indicator	02 Nos

Table 3.3 Set Point List

Pressure

No.	KKS Tag no.	Service	Range	Unit	Set Point	Value	Action	Basis	Remark
1	PIA 10/40HTA01CP001/003	BUF Inlet Pressure		kPa	HH	6.5		Mechanical design pressure of FGD inlet duct: +6.47 kpa	
					H	1.0	H ANN	Normal pressure + 1.0 kPa	
					L	−1.0	L ANN	Normal pressure − 1.0 kPa	
					LL	−1.5	INT : FGD Bypass Demper Open LL ANN	Mechanical design pressure of FGD inlet duct: − 1.47 kpa	
					△H	Later	H ANN	PT measuring range x 0.05 (5%)	
2	PIA 10/40HTA01CP007	Absorber Inlet Pressure		kPa	H	4.7	H ANN	Normal pressure + 1.0 kPa	
					L	3.7	L ANN	Normal pressure − 1.0 kPa	
3	PDIA 10/40HTE02CP001	Mist Eliminator Differential Pressure		kPa	H	(*1)	H ANN	(Design pressure of ME +0.10kPa(Dirty)) x 1.1^2	
4	PIA 10/40HTY08CP002	Instrumentation Air Pressure		MPa	H	0.8	H ANN	Design Pressure	
					L	(*1)	L ANN	Minimum pressure of solenoid valve +0.5 MPa	

※1 : Will be provided later based on the vendor information.

Table 3.3 Set Point List

Temperature

No.	Tag no.	Service	Range	Unit	Set Point	Value	Action	Basis	Remark
1	TIA 10/40HTA01CT001/003	FGD Inlet Temperature		deg.C	HH	300	Interlock	Maximum temperature in AH mechanical trip condition	Emergency Spray valve open
					H	290	H ANN	Maximum temperature in AH mechanical trip condition – 10 deg.C	
					△H	(*1)	H ANN	TE measuring range × 0.05 (5%)	prevention for meter deflection
2	TIA 10/40HTA01CT005/007	FGD Outlet Temperature		deg.C	HH	70	Interlock	Heat-resistant value of Absorber internal material	Emergency Spray valve open
					H	65	H ANN	Heat-resistant value of Absorber internal material – 5 deg.C	
					△H	(*1)	H ANN	TE measuring range × 0.05 (5%)	prevention for meter deflection

※1 : Will be provided later based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	LICA 10/40HTD02CL001/003	Absorber Level		m	HH	7.0	Overflow	Normal Level + 1.0 m	
					H	6.3	H ANN	CH Level + 0.2 m	
					CH2	6.3	Start Permission for 1st Absorber Circulation Pump	The value that does not drop to L level after startng pump.	
					CH	6.1	Absorber make-up water supply stop	Normal Level + 0.1 m	
					N	6.0		Design Level (Normal Level)	
					CL	5.9	Absorber make-up water supply start	Normal Level - 0.1 m	
					L	5.7	L ANN	CL Level - 0.2 m	
					LL1	4.2(*1)	INT : Absorber Recirculation Pump Stop LL1 ANN		Pump Protection
					LL2	3.2(*1)	INT : Absorber Agitator Stop LL2 ANN	(Agitator installation Level :1.6m) + (Impeller dia.:1.6m)	Agitator Protection
					LL3	1.5(*1)	INT : Absorber Bleed Pump Stop LL3 ANN		Pump Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
2	LICA 00HTM04CL007/009	Belt Filter Washing Tank Level		m	HH	3	Over flow	Top level - 0.5m	
					H	2.8	H ANN	HH Level - 0.2 m	
					CH	2.6	Make-up water supply stop	H Level - 0.2 m	
					CL	1.4	Make-up water supply start	L Level + 0.2 m	
					L	1.2	L ANN	LL Level + 0.2 m.	
					LL	1.0(*1)	INT : Pump Stop LL ANN	(Suction pipe center)+2.5 x (Suction pipe Dia.)	Pump Protection
					△H	0.2	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
3	LICA 00HTM04CL011/013	Filtrate Water Tank Level		m	HH	5.1	Over flow	Top level - 0.5m	
					H	4.9	H ANN	HH Level - 0.2 m	
					CH	4.7	Absorber Return Valve Open	H Level - 0.2 m	
					CL	1.6	Absorber Return Valve Close	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
4	LICA 00HTM04CL001/003	Primary Hydrocyclone Feed Tank Level		m	HH	6.5	Over flow	Top level - 0.5m	
					H	6.3	H ANN	HH Level - 0.2 m	
					CH	6.1	Hydro-cyclone Feed start	H Level - 0.2 m	
					CL	1.6	Hydro-cyclone Feed Stop	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump Protection Agitator Protection
					△H	0.6	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
4	LICA 00HTM04CL003/005	Secondary Waste Water Hydrocyclone Feed Tank Level		m	HH	5.5	Over flow	Top level - 0.5m	
					H	5.3	H ANN	HH Level - 0.2 m	
					CH	5.1	Hydro-cyclone Feed start	H Level - 0.2 m	
					CL	1.5	Hydro-cyclone Feed Stop	L Level + 0.2 m	
					L	1.3	L ANN	LL Level + 0.2 m.	
					LL	1.1(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
5	LICA	Waste Water Storage Tank		m	HH	6.5	Over flow	Top level - 0.5m	

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
	00HTM04CL013/015	Level			H	6.3	H ANN	HH Level - 0.2 m	
					CH1	6.1	Filtrate Water Tank Feed Start	H Level - 0.2 m	
					CL1	5.6	Filtrate Water Tank Feed Stop	CH1 Level - 0.5 m	
					CH2	2.1	Waste Water Treatment Feed Start	CL2 Level + 0.5 m	
					CL2	1.6	Waste Water Treatment Feed Stop	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
7	LICA	Mill Circuit Tank Level		m	HH	Later(*1)	HH ANN	To be finalize by BHEL based on vedor information.	Silo & Bag Filter Protection
	00HTK05CL001/003				H	Later(*1)	H ANN	To be finalize by BHEL based on vedor information.	
	00HTK05CL004/006				L	Later(*1)	L ANN	To be finalize by BHEL based on vedor information.	
					LL	Later(*1)	LL ANN	To be finalize by BHEL based on vedor information.	
8	LICA	Limestone Slurry Storage Tank		m	HH	11.5	Over flow	Top level - 0.8m	
	00HTK05CL021/023	Level			H	11.3	H ANN	HH Level - 0.2 m	
					CH	10.8	Wet Limestone Grinding Mill stop	H Level - 0.5 m	
					CL	4.4	Wet Limestone Grinding Mill start		
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
9	LIC	Absorber Area Drain Sump		m	HH	3.5	Over flow	Top level - 0.5m	
	10/40HTT07CL001/003	Level			H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN		Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
10	LIA 00HTT07CL001/003	Aixiliary Absorbent Tank Level		m	HH	10.1	Over flow	Top level - 0.8m	
					H	9.9	H ANN	HH Level - 0.2 m	
					L	4.4	L ANN	LL1 Level + 0.2 m	
					LL1	3.4(*1)	INT : Agitator Stop LL1 ANN		
					LL2	2.0*1)	INT : Pump Stop LL2 ANN		Pump Protection
11	LICA 00HTT07CL001/003	Gypsum Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump protection Agitator Protection
12	LICA 00HTT07CL004/006	Limestone Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
13	LICA	Process Water Tank Level		m	HH	4.9	Over flow	Top level - 0.5m	
	00HTQ08CL001/003				H	4.7	H ANN	HH Level - 0.2 m	
	00HTQ08CL004/006				CH	4.5	Make-up water supply stop	H Level - 0.2 m	
		`			CL	4.0	Make-up water supply start	CH Level - 0.5 m	
					L	1.5	L ANN	LL Level + 0.2 m.	
					LL	1.3(*1)	INT : Pump Stop LL ANN		Pump Protection
					△H	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
14	LICA	Emergency Water Tank Level		m	HH	3	Over flow	Top level - 0.5m	
	10/40HTQ08CL021/023				H	2.8	H ANN	HH Level - 0.2 m	
					CH	2.6	Make-up water supply stop	H Level - 0.2 m	
					CL	2.4	Make-up water supply start	CH Level - 0.2 m	
					L	0.5	L ANN	Bottom + 0.5 m	

※This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL shall add set point for unit equipment and finalize the list according to the vender information.

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Others

No.	KKS Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	AICA	Absorber pH		–	H	6.5	H ANN	Normal pH + α	
	10/40HTD02CQ001/003				N	Later	Set point for pH control	Commissioning adjustment value	
					L	Later	L ANN, Set point for minimum pH	Commissioning adjustment value	
2	DICA	Absorber Density		wt.%	H	35	H ANN	Normal Density + 5 wt.%	Pump & Belt Filter Protection
	10/40HTM01CD001/003				CH	32	Absorber Slurry Bleed Start	Normal Density + 2 wt.%	
					N	30	Set point for Density Control	Design Density	
					CL	28	Absorber Slurry Bleed Stop	Normal Density – 2 wt.%	
					L	25	L ANN	Normal Density – 5 wt.%	
3	AICA	FGD Outlet SO2		mg/Nm^3	H	100	H ANN	Design FGD Outlet SO2 concentration	
	10/40HTA01CQ005				N	Later	Set point for SO2 control	Commissioning adjustment	

※This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL will add set point for unit equipment and finalize the list according to the vender information.

05	01.03.22	Revised the document as per the comments	KMK	PR	PNR
04	05.02.22	Replied to customer comments	KMK	PR	PNR
03	23.10.21	Revised the document as per the comments	KMK	PR	PNR
02	19.03.20	Replied to customer comments	KMK	PR	RSB
01	27.01.20	Replied to customer comments	KMK	PR	VK
00	12.11.19	Fresh Issue	KMK	PR	VK
REV	DATE	DESCRIPTION /NOTE	PRD	CHD	APD

REVISIONS

TITLE:

P&ID_WASTE WATER TANK & PUMP

OWNER/PROJECT: **TELANGANA STATE POWER GENERATION CORPORATION LTD**

BHADRADRI (4X270 MW) THERMAL POWER STATION– FGD SYSTEM PACKAGE

CONSULTANT:

DESEIN PRIVATE LIMITED.
NEW DELHI

EPC CONTRACTOR:

BHARAT HEAVY ELECTRICALS LTD.
BOILER AUXILIARIES PLANT,RANIPET

COLLABORATOR

MITSUBISHI HITACHI POWER SYSTEMS, LTD
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

	BHEL	Date	
PREPARED BY	Kabilash	01.03.22	STATUS : *FOR APPROVAL*
CHECKED BY	Raju Puram	01.03.22	BHEL CUST NO : G301, G302,G303 &G304
APPROVED BY	P.Naveen	01.03.22	BHEL DOC NO: 03-FW-745-00665
			REV NO :05

THIRD ANGLE PROJECTION | No. REQ'D | A3 | DRAWING No.

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
M	ACTUATED BY MOTOR
IM	ACTUATED BY MOTOR (INCHING)
	AIR CONTROL VALVE
S	SOLENOID ACTUATOR
	SELF REGURATING VALVE
	SELF REGURATING VALVE

TRENCH SYMBOLS

SYMBOLS	NAME
A	TO ABSORBER AREA DRAIN SUMP
D	TO GYPSUM AREA DRAIN SUMP
L	TO LIMESTONE AREA DRAIN SUMP

SYMBOLS FOR PIPING PARTS & INSTRUMENT PARTS

SYMBOLS	NAME
T	STEAM TRAP
AT	AIR TRAP
	Y-STRAINER
	T-STRAINER
TS	TEMPORARY STRAINER
	REDUCER
	EXPANSION JOINT
	DUCT EXPANSION JOINT
	FLEXIBLE HOSE
	SPOOL PIECE
	VENT
	HOSE CONNECTION
	BLIND FLANGE
	REDUCING FLANGE
	CAP (BW)
	CAP (SCR)
	TRENCH
SG	SIGHT GLASS
	SILENCER
	ORIFICE
	DIAPHRAGM
M	MAGNETIC FLOW METER
	VORTEX FLOW METER
	PH METER
	FILTER
M.H. M.H. M.H. I.H.	MANHOLE
	INSPECTION HOLE
	PITOT TUBE
	SAMPLING POT
S	SAMPLING NOZZLE
RO	RESTRICTION ORIFICE
FI	ROTOMETER TYPE FLOW METER

SYMBOLS FOR VALVE OPERATION

SYMBOLS	NAME
FO	FAILURE OPEN (THE VALVE OPENS WHEN AIR OR ELECTRICITY FOR ACTUATOR FAILS.)
FC	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 CLIENT AND CONTRACTOR
CONTRACTOR | XXX	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
AA	ANTIFOAM AGENT	WCS	COOLING WATER SUPPLY
AC	COMPRESSED AIR	WCR	COOLING WATER RETURN
AF	FLUIDIZER AIR	WC	Ca(OH)2
AI	INSTRUMENT AIR	WP	PROCESS WATER
AO	OXIDATION AIR	WR	RAW WATER
AS	SEAL AIR	WW	WASTE WATER
DD	DUCT DRAIN	VG	VACUUM PUMP VENT
FS	FILTRATE SLURRY	VBG	BELT FILTER VENT GAS
GS	GYPSUM SLURRY	LD	LIMESTONE DEDUSTING
LS	LIMESTONE SLURRY	LOL	LUBE OIL (LOW PRESSURE)
FG	FLUE GAS	LOH	LUBE OIL (HIGH PRESSURE)

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 / GI PIPING	AI, LOL
BA02	Gr.304 STAINLESS STEEL / GI 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
DA60	FRP PIPING (PIPE DIA UPTO 400 NB)	GS,FS,WW,DD
DA40	FRP PIPING (PIPE DIA UPTO 400 NB)	LS, WP, WC

UNIT CODE

SYMBOLS	UNIT IDENTIFICATION
90	COMMON
10	UNIT-1 FGD SYSTEM AND AUXILIARIES
20	UNIT-2 FGD SYSTEM AND AUXILIARIES
30	UNIT-3 FGD SYSTEM AND AUXILIARIES
40	UNIT-4 FGD SYSTEM AND AUXILIARIES
50	UNIT-5 FGD SYSTEM AND AUXILIARIES

EXPRESSION OF PIPING LINE

10 - 200 - GS - 2 00 1 - AA60 - HF

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

CUSTOMER NOS: G301,G302,G303&G304

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CUSTOMER: TSGENCO.

PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

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

DEPT CODE		NAME (BHEL)	DATE
M	DRN	KM.KABILASH	24.09.21
	CHD	P.RAJU	24.09.21
	APPD	PNR/ACR	24.09.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – SYMBOL MARK (1/2)

SCALE : NTS

BHEL DRG NO. 03-FW-000-00675 | SH 01 of 02

FILE NO: B240 – 00001 | REV NO: 00

THIRD ANGLE PROJECTION | No. REQ'D | A3 | DRAWING No.

INSTRUMENT ABBREVIATION

	FIRST–LETTER		SUCCEEDING–LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		BLANK	BLANK	BLANK
C	BLANK			CONTROL	
D	BLANK	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	BLANK		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	BLANK	MOMENTARY			MIDDLE, INTERMEDIATE
N	BLANK		BLANK	BLANK	BLANK
O	BLANK		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT(TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

INSTRUMENT SYMBOLS

SYMBOLS	NAME
	FIELD MOUNTED
	FOR CONTROL ROOM
	FOR LOCAL CONTROL PANEL
	FOR DCS
I	INTERLOCK LOGIC

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 SWITH
FLXXWA–SL	SINGLE SOLENOID WITH LIMIT SWITCH

MACHINARY SYMBOLS

SYMBOLS	NAME
	PUMP
	FAN / BLOWER
	AGITATOR (FLAT BLADE)
	AGITATOR (PROPELLOR)
	ROTARY VALVE
	CRUSHER
	BELT FEEDER
	BELT FILTER
	BALL MILL
	CYCLONE
	MIST ELIMINATOR

EQUIPMENT SYMBOLS

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

DRIVER SYMBOLS

SYMBOLS	NAME
A	AIR MOTOR
M	ELECTRIC MOTOR

OTHER SYMBOLS

SYMBOLS	NAME
	INSERT PIPE / LANCE
	CHUTE
	TRUCK

CUSTOMER NOS: G301,G302,G303&G304
CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

CUSTOMER NOS: G301,G302,G303&G304

CAUTION: THE DRAWING IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LTD.AND IS NOT TO BE REPRODUCED OR USED TO FURNISH ANY INFORMATION FOR MAKING OF DRAWINGS OF APPARATUS EXCEPT WHERE PROVIDED FOR AGREEMENT WITH SAID COMPANY.

CUSTOMER: TSGENCO.
PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

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

DEPT CODE		NAME (BHEL)	DATE
M	DRN	KM.KABILASH	24.09.21
	CHD	P.RAJU	24.09.21
	APPD	PNR/ACR	24.09.21

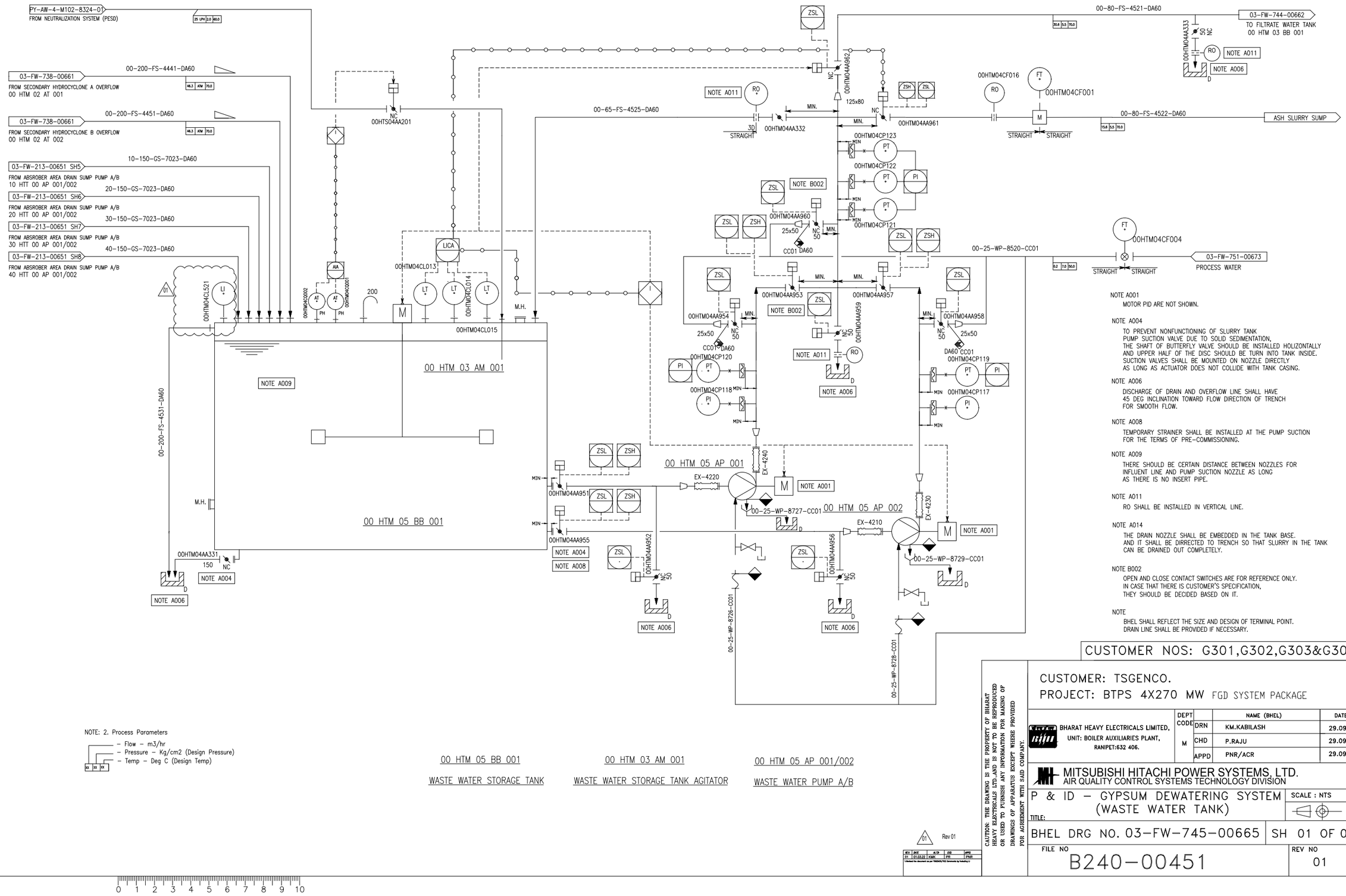
MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – SYMBOL MARK (2/2) | SCALE : NTS

BHEL DRG NO. 03–FW–000–00675 | SH 02 of 02

FILE NO B240 – 00002 | REV NO 00

0 1 2 3 4 5 6 7 8 9 10



THIRD ANGLE PROJECTION

No. REQ'D

A3

DRAWING No.

NOTE A001
MOTOR PID ARE NOT SHOWN.

NOTE A004
TO PREVENT NONFUNCTIONING OF SLURRY TANK PUMP SUCTION VALVE DUE TO SOLID SEDIMENTATION, THE SHAFT OF BUTTERFLY VALVE SHOULD BE INSTALLED HOLIZONTALLY AND UPPER HALF OF THE DISC SHOULD BE TURN INTO TANK INSIDE. SUCTION VALVES SHALL BE MOUNTED ON NOZZLE DIRECTLY AS LONG AS ACTUATOR DOES NOT COLLIDE WITH TANK CASING.

NOTE A006
DISCHARGE OF DRAIN AND OVERFLOW LINE SHALL HAVE 45 DEG INCLINATION TOWARD FLOW DIRECTION OF TRENCH FOR SMOOTH FLOW.

NOTE A008
TEMPORARY STRAINER SHALL BE INSTALLED AT THE PUMP SUCTION FOR THE TERMS OF PRE-COMMISSIONING.

NOTE A009
THERE SHOULD BE CERTAIN DISTANCE BETWEEN NOZZLES FOR INFLUENT LINE AND PUMP SUCTION NOZZLE AS LONG AS THERE IS NO INSERT PIPE.

NOTE A011
RO SHALL BE INSTALLED IN VERTICAL LINE.

NOTE A014
THE DRAIN NOZZLE SHALL BE EMBEDDED IN THE TANK BASE. AND IT SHALL BE DIRRECTED TO TRENCH SO THAT SLURRY IN THE TANK CAN BE DRAINED OUT COMPLETELY.

NOTE B002
OPEN AND CLOSE CONTACT SWITCHES ARE FOR REFERENCE ONLY. IN CASE THAT THERE IS CUSTOMER'S SPECIFICATION, THEY SHOULD BE DECIDED BASED ON IT.

NOTE
BHEL SHALL REFLECT THE SIZE AND DESIGN OF TERMINAL POINT. DRAIN LINE SHALL BE PROVIDED IF NECESSARY.

CUSTOMER NOS: G301,G302,G303&G304

CUSTOMER: TSGENCO.

PROJECT: BTPS 4X270 MW FGD SYSTEM PACKAGE

DEPT CODE		NAME (BHEL)	DATE
M	DRN	KM.KABILASH	29.09.21
	CHD	P.RAJU	29.09.21
	APPD	PNR/ACR	29.09.21

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

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: P & ID – GYPSUM DEWATERING SYSTEM (WASTE WATER TANK)

SCALE : NTS

BHEL DRG NO. 03-FW-745-00665 SH 01 OF 01

FILE NO B240-00451

REV NO 01

REV	INIT	A/D	CD	APPD
01	07.03.22	KMK	PR	PNR

1.Marked the document as per TR0045/TQC Comments by Industry-U

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WRITE UP ON WASTE WATER TANK & PUMPS

Purpose:

This write up describes the waste water discharge system and defines the associated control system.

Equipment List:

S. No.	Description	Item No.	Qty
1.	Waste Water Tank	00 HTM 05 BB 001	1
2.	Waste Water Tank pump	00 HTM 05 AP 001/002	1W+1S
3.	Waste Water Tank Agitator	00 HTM 03 AM 001	1

Operation Write Up:

Waste Water hydro cyclone overflow is collected in waste water tank. A part of fluid in waste water tank is sent to FGD Waste water treatment plant and the remaining fluid is sent to Filtrate water tank.

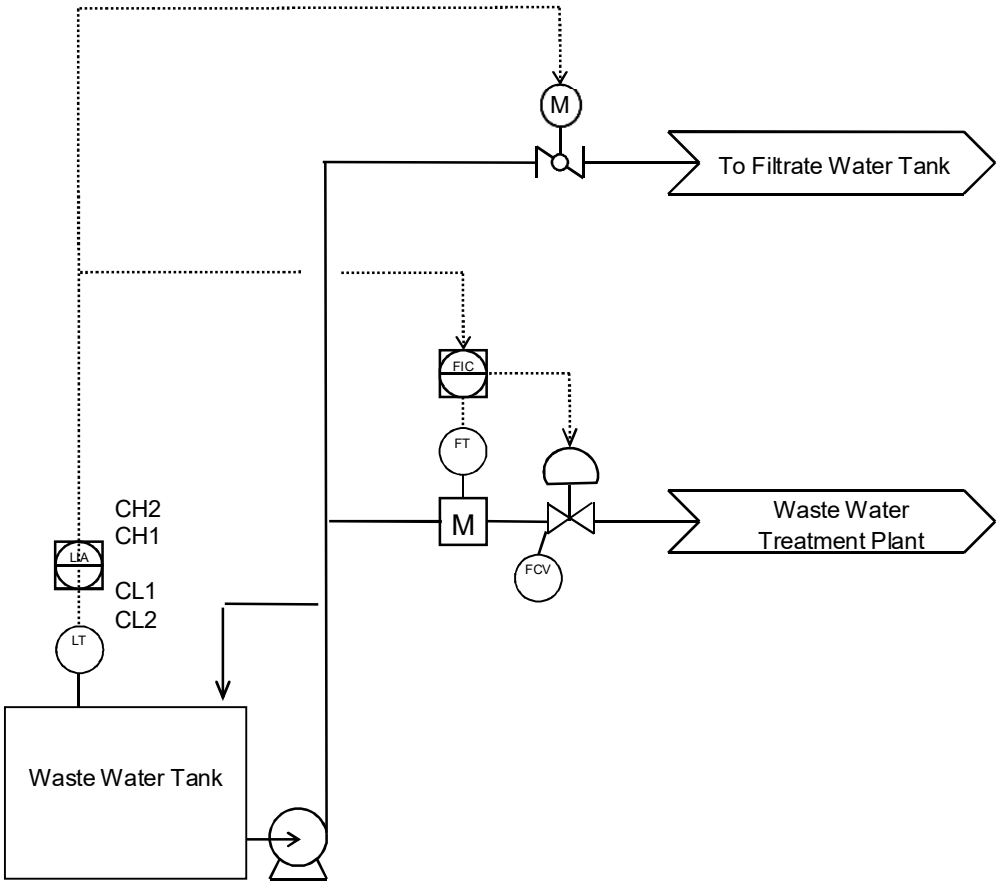
1.1 Waste Water Tank Level Control

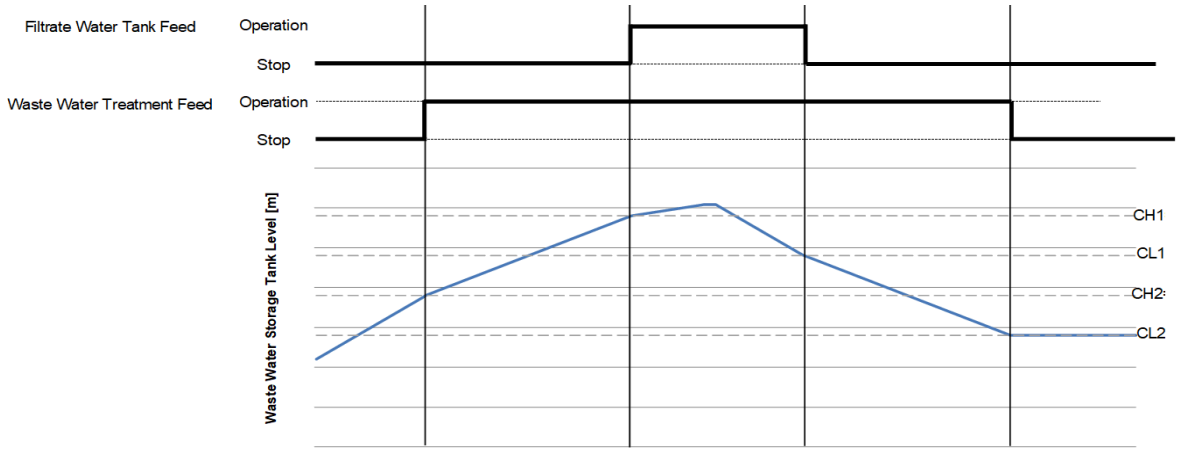
Waste water tank level is controlled to keep the level in suitable range. If the tank level becomes CL1, the waste water flow to the filtrate water tank is stopped by closing the On/Off valve automatically. When the tank level is increased until CH1, waste water flow to filtrate water tank starts again.

1.2 Waste Water Flow Rate Control

Waste water flow rate is controlled to keep the constant flow rate by observing the flow rate with flow meter. If the tank level becomes to CL2, waste water flow to the waste water terminal point is stopped by closing the control valve automatically. When the tank level is increased to CH2, waste water flow to waste water terminal point starts again.

Waste Water Tank Level Control





Valve opening sequence

Instruments List

Sl.No	KKS Code	Description of instrument	Quantity
01	00HTM04CF002	Rotameter (flow meter)	01 No
02	00HTM04CP119/123	Pressure Transmitter	05 Nos
03	00HTM04CP117/118	Pressure Indicator	02 Nos
04	00HTM04CL013/015	Level Transmitter	03 Nos
05	00HTM04CL521	Level Indicator	01 No
06	00HTM04CQ001/002	pH analyzer	02 No
07	00HTM04CF001	Magnetic Flow meter	01 No

Table 3.3 Set Point List

Pressure

No.	KKS Tag no.	Service	Range	Unit	Set Point	Value	Action	Basis	Remark
1	PIA 10/40HTA01CP001/003	BUF Inlet Pressure		kPa	HH	6.5		Mechanical design pressure of FGD inlet duct: +6.47 kpa	
					H	1.0	H ANN	Normal pressure + 1.0 kPa	
					L	−1.0	L ANN	Normal pressure − 1.0 kPa	
					LL	−1.5	INT : FGD Bypass Demper Open LL ANN	Mechanical design pressure of FGD inlet duct: − 1.47 kpa	
					△H	Later	H ANN	PT measuring range x 0.05 (5%)	
2	PIA 10/40HTA01CP007	Absorber Inlet Pressure		kPa	H	4.7	H ANN	Normal pressure + 1.0 kPa	
					L	3.7	L ANN	Normal pressure − 1.0 kPa	
3	PDIA 10/40HTE02CP001	Mist Eliminator Differential Pressure		kPa	H	(*1)	H ANN	(Design pressure of ME +0.10kPa(Dirty)) x 1.1^2	
4	PIA 10/40HTY08CP002	Instrumentation Air Pressure		MPa	H	0.8	H ANN	Design Pressure	
					L	(*1)	L ANN	Minimum pressure of solenoid valve +0.5 MPa	

※1 : Will be provided later based on the vendor information.

Table 3.3 Set Point List

Temperature

No.	Tag no.	Service	Range	Unit	Set Point	Value	Action	Basis	Remark
1	TIA 10/40HTA01CT001/003	FGD Inlet Temperature		deg.C	HH	300	Interlock	Maximum temperature in AH mechanical trip condition	Emergency Spray valve open
					H	290	H ANN	Maximum temperature in AH mechanical trip condition – 10 deg.C	
					△H	(*1)	H ANN	TE measuring range × 0.05 (5%)	prevention for meter deflection
2	TIA 10/40HTA01CT005/007	FGD Outlet Temperature		deg.C	HH	70	Interlock	Heat-resistant value of Absorber internal material	Emergency Spray valve open
					H	65	H ANN	Heat-resistant value of Absorber internal material – 5 deg.C	
					△H	(*1)	H ANN	TE measuring range × 0.05 (5%)	prevention for meter deflection

※1 : Will be provided later based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	LICA 10/40HTD02CL001/003	Absorber Level		m	HH	7.0	Overflow	Normal Level + 1.0 m	
					H	6.3	H ANN	CH Level + 0.2 m	
					CH2	6.3	Start Permission for 1st Absorber Circulation Pump	The value that does not drop to L level after startng pump.	
					CH	6.1	Absorber make-up water supply stop	Normal Level + 0.1 m	
					N	6.0		Design Level (Normal Level)	
					CL	5.9	Absorber make-up water supply start	Normal Level - 0.1 m	
					L	5.7	L ANN	CL Level - 0.2 m	
					LL1	4.2(*1)	INT : Absorber Recirculation Pump Stop LL1 ANN		Pump Protection
					LL2	3.2(*1)	INT : Absorber Agitator Stop LL2 ANN	(Agitator installation Level :1.6m) + (Impeller dia.:1.6m)	Agitator Protection
					LL3	1.5(*1)	INT : Absorber Bleed Pump Stop LL3 ANN		Pump Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
2	LICA 00HTM04CL007/009	Belt Filter Washing Tank Level		m	HH	3	Over flow	Top level - 0.5m	
					H	2.8	H ANN	HH Level - 0.2 m	
					CH	2.6	Make-up water supply stop	H Level - 0.2 m	
					CL	1.4	Make-up water supply start	L Level + 0.2 m	
					L	1.2	L ANN	LL Level + 0.2 m.	
					LL	1.0(*1)	INT : Pump Stop LL ANN	(Suction pipe center)+2.5 x (Suction pipe Dia.)	Pump Protection
					△H	0.2	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
3	LICA 00HTM04CL011/013	Filtrate Water Tank Level		m	HH	5.1	Over flow	Top level - 0.5m	
					H	4.9	H ANN	HH Level - 0.2 m	
					CH	4.7	Absorber Return Valve Open	H Level - 0.2 m	
					CL	1.6	Absorber Return Valve Close	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
4	LICA 00HTM04CL001/003	Primary Hydrocyclone Feed Tank Level		m	HH	6.5	Over flow	Top level - 0.5m	
					H	6.3	H ANN	HH Level - 0.2 m	
					CH	6.1	Hydro-cyclone Feed start	H Level - 0.2 m	
					CL	1.6	Hydro-cyclone Feed Stop	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump Protection Agitator Protection
					△H	0.6	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
4	LICA 00HTM04CL003/005	Secondary Waste Water Hydrocyclone Feed Tank Level		m	HH	5.5	Over flow	Top level - 0.5m	
					H	5.3	H ANN	HH Level - 0.2 m	
					CH	5.1	Hydro-cyclone Feed start	H Level - 0.2 m	
					CL	1.5	Hydro-cyclone Feed Stop	L Level + 0.2 m	
					L	1.3	L ANN	LL Level + 0.2 m.	
					LL	1.1(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
5	LICA	Waste Water Storage Tank		m	HH	6.5	Over flow	Top level - 0.5m	

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
	00HTM04CL013/015	Level			H	6.3	H ANN	HH Level - 0.2 m	
					CH1	6.1	Filtrate Water Tank Feed Start	H Level - 0.2 m	
					CL1	5.6	Filtrate Water Tank Feed Stop	CH1 Level - 0.5 m	
					CH2	2.1	Waste Water Treatment Feed Start	CL2 Level + 0.5 m	
					CL2	1.6	Waste Water Treatment Feed Stop	L Level + 0.2 m	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					△H	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
7	LICA 00HTK05CL001/003 00HTK05CL004/006	Mill Circuit Tank Level		m	HH	Later(*1)	HH ANN	To be finalize by BHEL based on vedor information.	Silo & Bag Filter Protection
					H	Later(*1)	H ANN	To be finalize by BHEL based on vedor information.	
					L	Later(*1)	L ANN	To be finalize by BHEL based on vedor information.	
					LL	Later(*1)	LL ANN	To be finalize by BHEL based on vedor information.	
8	LICA 00HTK05CL021/023	Limestone Slurry Storage Tank Level		m	HH	11.5	Over flow	Top level - 0.8m	
					H	11.3	H ANN	HH Level - 0.2 m	
					CH	10.8	Wet Limestone Grinding Mill stop	H Level - 0.5 m	
					CL	4.4	Wet Limestone Grinding Mill start		
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
9	LIC 10/40HTT07CL001/003	Absorber Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN		Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
10	LIA 00HTT07CL001/003	Aixiliary Absorbent Tank Level		m	HH	10.1	Over flow	Top level - 0.8m	
					H	9.9	H ANN	HH Level - 0.2 m	
					L	4.4	L ANN	LL1 Level + 0.2 m	
					LL1	3.4(*1)	INT : Agitator Stop LL1 ANN		
					LL2	2.0*1)	INT : Pump Stop LL2 ANN		Pump Protection
11	LICA 00HTT07CL001/003	Gypsum Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump protection Agitator Protection
12	LICA 00HTT07CL004/006	Limestone Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN	Impeller dia. / 3 + 0.4m	Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
13	LICA 00HTQ08CL001/003 00HTQ08CL004/006	Process Water Tank Level `		m	HH	4.9	Over flow	Top level - 0.5m	
					H	4.7	H ANN	HH Level - 0.2 m	
					CH	4.5	Make-up water supply stop	H Level - 0.2 m	
					CL	4.0	Make-up water supply start	CH Level - 0.5 m	
					L	1.5	L ANN	LL Level + 0.2 m.	
					LL	1.3(*1)	INT : Pump Stop LL ANN		Pump Protection
					△H	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
14	LICA 10/40HTQ08CL021/023	Emergency Water Tank Level		m	HH	3	Over flow	Top level - 0.5m	
					H	2.8	H ANN	HH Level - 0.2 m	
					CH	2.6	Make-up water supply stop	H Level - 0.2 m	
					CL	2.4	Make-up water supply start	CH Level - 0.2 m	
					L	0.5	L ANN	Bottom + 0.5 m	

※This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL shall add set point for unit equipment and finalize the list according to the vender information.

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Others

No.	KKS Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	AICA	Absorber pH		–	H	6.5	H ANN	Normal pH + α	
	10/40HTD02CQ001/003				N	Later	Set point for pH control	Commissioning adjustment value	
					L	Later	L ANN, Set point for minimum pH	Commissioning adjustment value	
2	DICA	Absorber Density		wt.%	H	35	H ANN	Normal Density + 5 wt.%	Pump & Belt Filter Protection
	10/40HTM01CD001/003				CH	32	Absorber Slurry Bleed Start	Normal Density + 2 wt.%	
					N	30	Set point for Density Control	Design Density	
					CL	28	Absorber Slurry Bleed Stop	Normal Density – 2 wt.%	
					L	25	L ANN	Normal Density – 5 wt.%	
3	AICA	FGD Outlet SO2		mg/Nm^3	H	100	H ANN	Design FGD Outlet SO2 concentration	
	10/40HTA01CQ005				N	Later	Set point for SO2 control	Commissioning adjustment	

※This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL will add set point for unit equipment and finalize the list according to the vender information.

REPLY SHEET

Document title: Reply to comments of TSGENCO/ DESEIN on _ P&ID_WASTE WATER TANK & PUMP.

BHEL Drg No: 03-FW-745-00665, Rev 01.

S.NO	TSGENCO/DESEIN COMMENTS	BHEL REPLY
1	PT Shall be provided for remote indication and soft switch for initiating standby pump operation in case of low pressure on running pump.	As per MHPS standard practice, Pressure transmitters are not required for these lines, as there is no interlock envisaged based on the line pressure. As per MHPS standard design practice, Stand by pump start signal will be initiated from main DCS based on electrical failure of running pump. So, no soft switch is envisaged.
	Please note that electrical failure may not be the only reason for low pressure. Mechanical failures also can cause low pressure. How such failures can be detected and addressed. Please clarify.	Please refer Attached MHPS Dwg. No. – B240-00200. In this project also as per MHPS standard design practice Pressure Transmitter has been not provided on discharge side of Pumps. Hence, It is requested to TSGENCO/DESEIN to adopt & accept the same practice

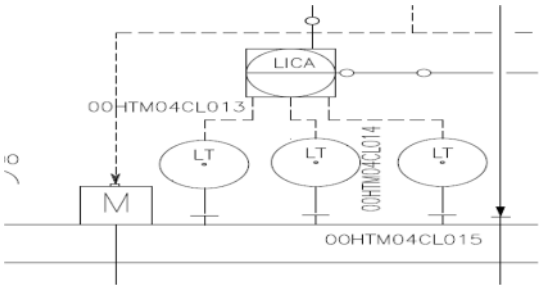
Document title: Reply to comments of TSGENCO/ DESEIN on _ P&ID_WASTE WATER TANK & PUMP.

BHEL Drg No: 03-FW-745-00665, Rev 02.

Sl.No	TSGENCO/DCPL Comments	BHEL reply
1.	Three number of LT shall be indicated, as it is used for protection.	BHEL agreed to provide Three LTs in each tank.
2.	One LI shall be indicated on each tank.	Two LTs will be provided which will have in built local indication also. Mechanical level gauge cannot be provided for slurry tanks.
3.	On each pump discharge one PG shall be indicated.	BHEL agreed to provide three PTs in the common discharge line and one PI & one PT will be provided in each individual pump discharges.
4.	There is confusion in dwg numbers referred, BHEL is requested to follow /indicate one dwg reference (either B240-… FORMAT or 03-FW-…).	03-FW-XXX-XXX is followed.
5.	PH analyzer is used for interlock, hence 3 numbers of PH analyzers shall be indicated.	Two PH analyzer will be provided since it is used in interlock.
6.	Lime solution tank, LT shall be used instead of LS. THE NUMBER OF It SHALL BE AS PER REDUNDECY .i.e 2 numbers of LT shall be indicated.	Two LTs will be provided instead of LS.
7.	FT shall be indicated on each line to ash slurry sump -1/2/3.	FT is provided in line going to ash slurry sump.

Document title: Reply to comments of TSGENCO/ DESEIN on _ P&ID_WASTE WATER TANK & PUMP.

BHEL Drg No: 03-FW-745-00665, Rev 03

Sl.No	TSGENCO/DCPL Comments	BHEL reply
1.	**General comments** 1. Moisture traps shall be provided for instrument and conveying air lines. 2. KKS tag numbers shall be provided for all instruments, valves and equipment etc., in P&IDs. 3. Instrument schedule shall be provided along with KKS tag, description, set pints, instrument type, range, and alarm/interlock for all P&IDs as attachment. 4. All SOVs shall be placed in pneumatic junction box only, air supply through SS manifolds only. 5. All instruments shall follow redundant philosophy instruments used for protection/CLCS-triple, permissive / interlock - dual and monitoring/alarm single.	1. Noted. 2. KKS tag numbers are provided for all the instruments valves and equipments, same details are already shown in P&IDs 3. A separate MDL: Instruments List is provided to submit the details of instruments schedule along with KKS tag, description, instrument type, range. Interlocks and set points are already included in the document. 4. Noted. 5. Complied.
2.	Level gauges shall be provided for waste water tank.	3 Nos of Level gauges are already considered and same are already shown in P&ID. 

Document title: Reply to comments of TSGENCO/ DESEIN on _ P&ID_WASTE WATER TANK & PUMP.

BHEL Drg No: 03-FW-745-00665, Rev 04

1.	Level gauges/Level indicator shall be provided for waste water tank.	Revised the document by providing level indicator.

Annexure-VIII-Seaworthy packing Specification

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

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

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.

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.

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

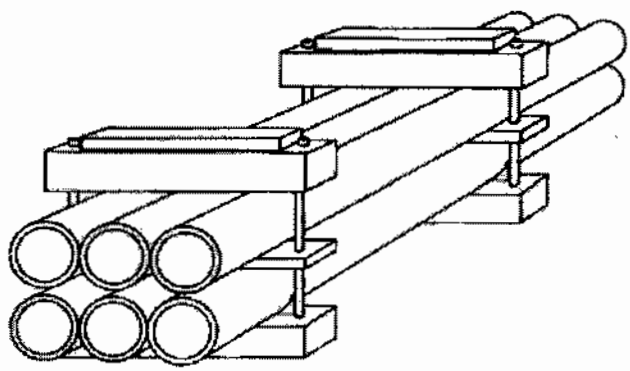
Structural Steel, reinforcing rods, bars, etc., should be packed in bundles of uniform length. Refer to articles 8.1.2, for strapping requirements. Bundle weight not normally to exceed 2,000 kg. Fabricated structures and structural steelwork, etc, should be bundled and packed using wooden beams and long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

8.2 Bundling – Packing Category I

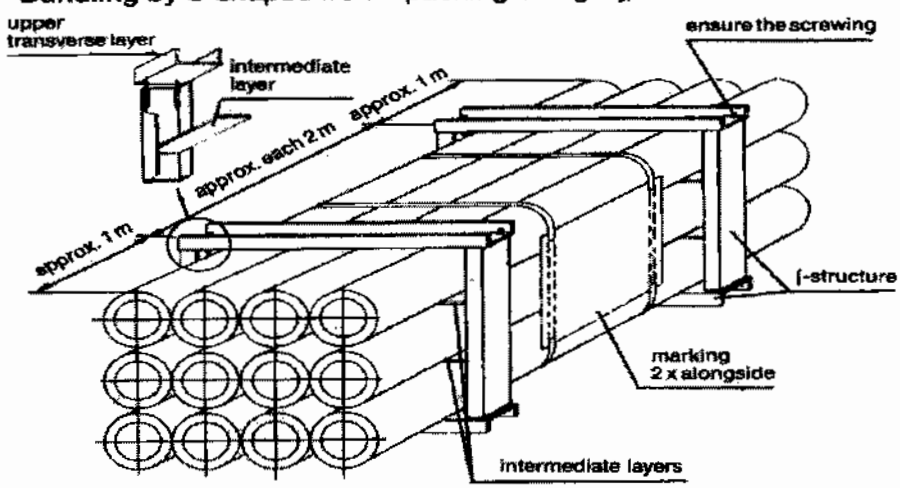
8.2.1 Type of Equipment

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

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)

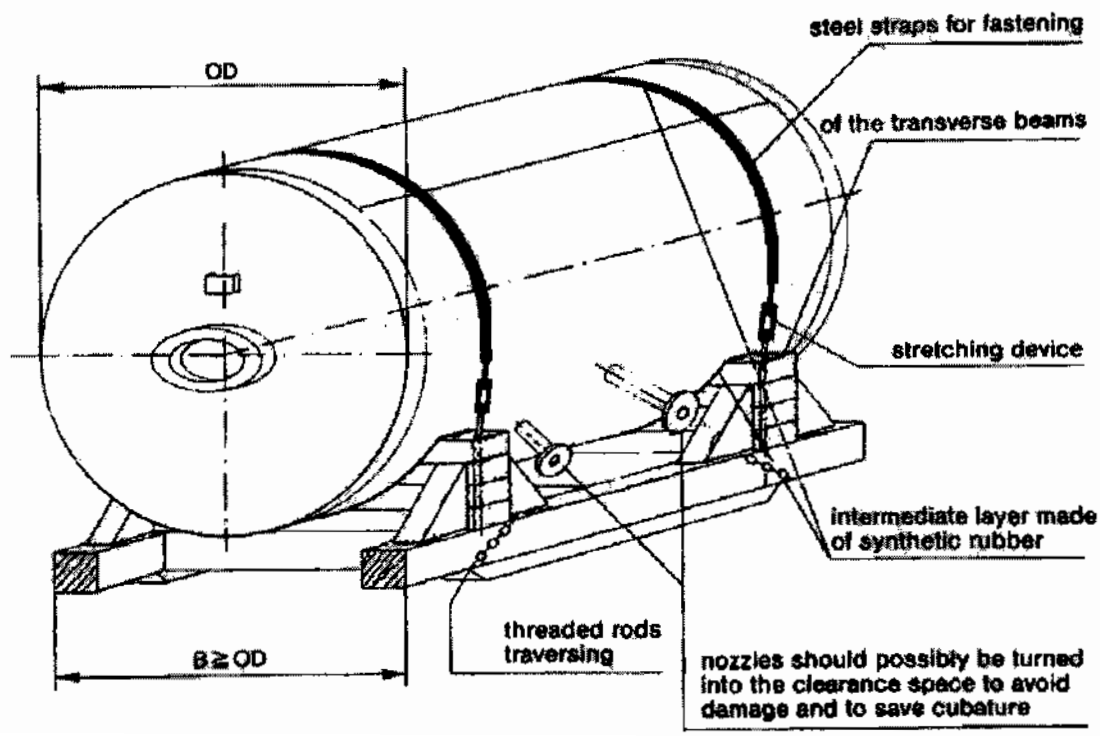
8.3.1 Type of Equipment

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



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

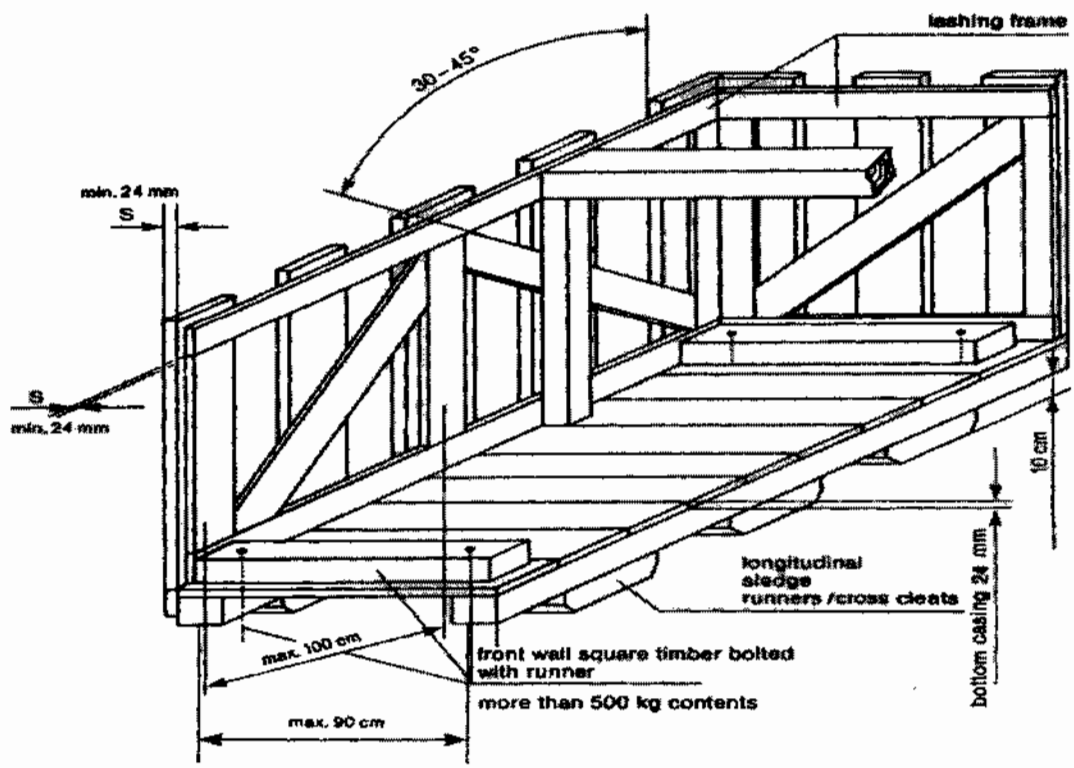
Fabricated equipment, which cannot be transported on cradles; frame-works, prefabricated piping and fittings, mechanical and electrical assemblies. *This type of packing is recommended where many parts of the equipment/component/assembly are not protruding out.*

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



8.4.2 Cases with Lining – Packing Category IV

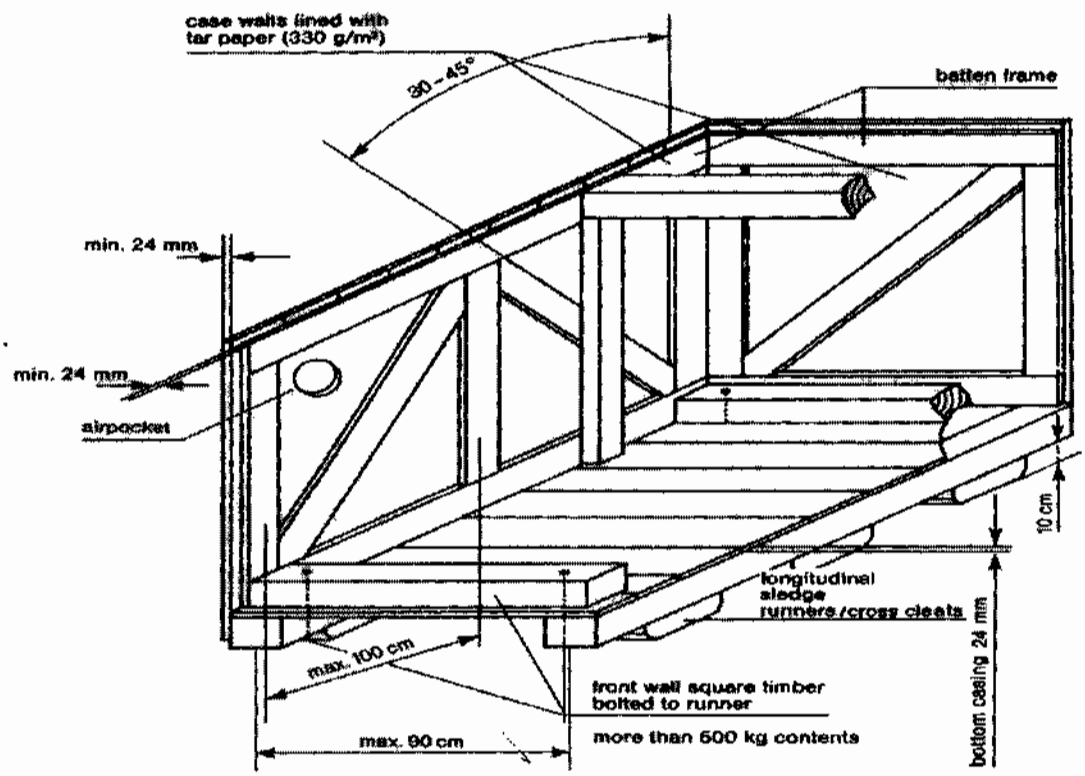
8.4.2.1 Type of Equipment

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

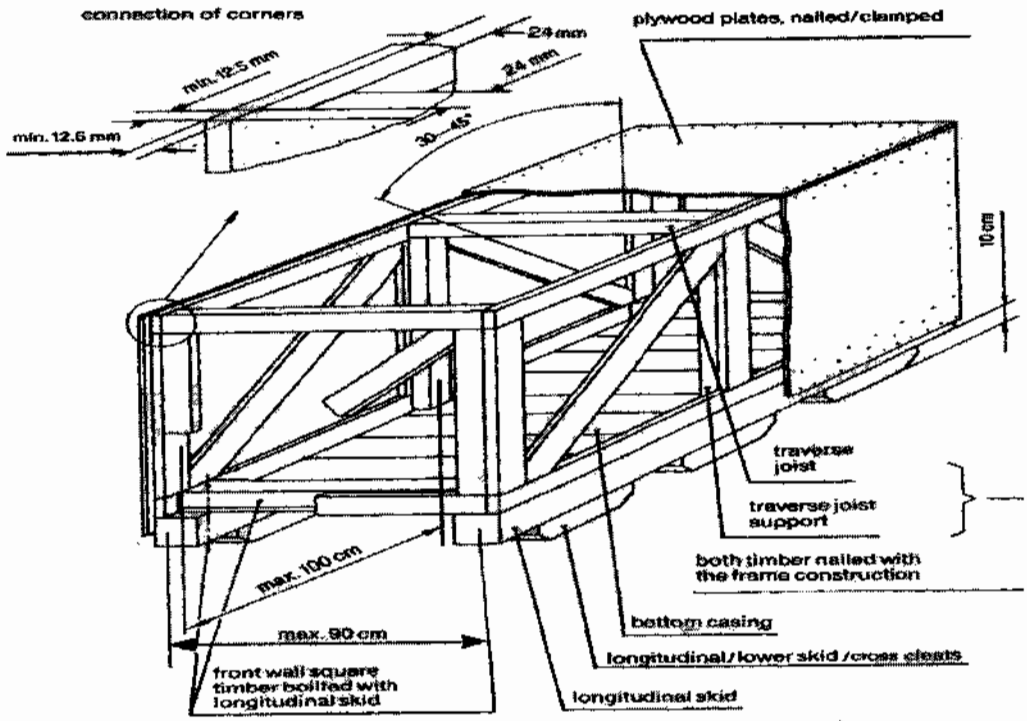
The same type of construction as article 8.4.1.2, but with all sides completely boarded without space between the boards. Sides to be provided with waterproof lining; fabric-reinforced waterproof tar paper or polyethylene-foils resistant to ultraviolet rays can be used. Polyethylene-foil shall be fixed 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



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

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

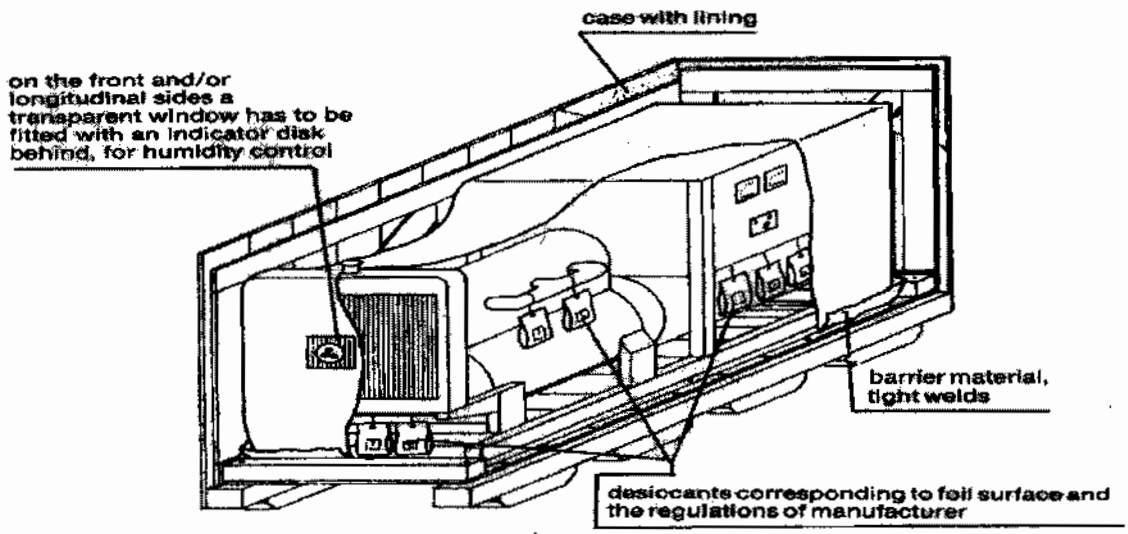
8.4.5.2 Type of Construction

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).

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.

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 <u>Detailed specification for Wooden Crates/Boxes/Cases and other packing materials</u>

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, crakes, 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

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

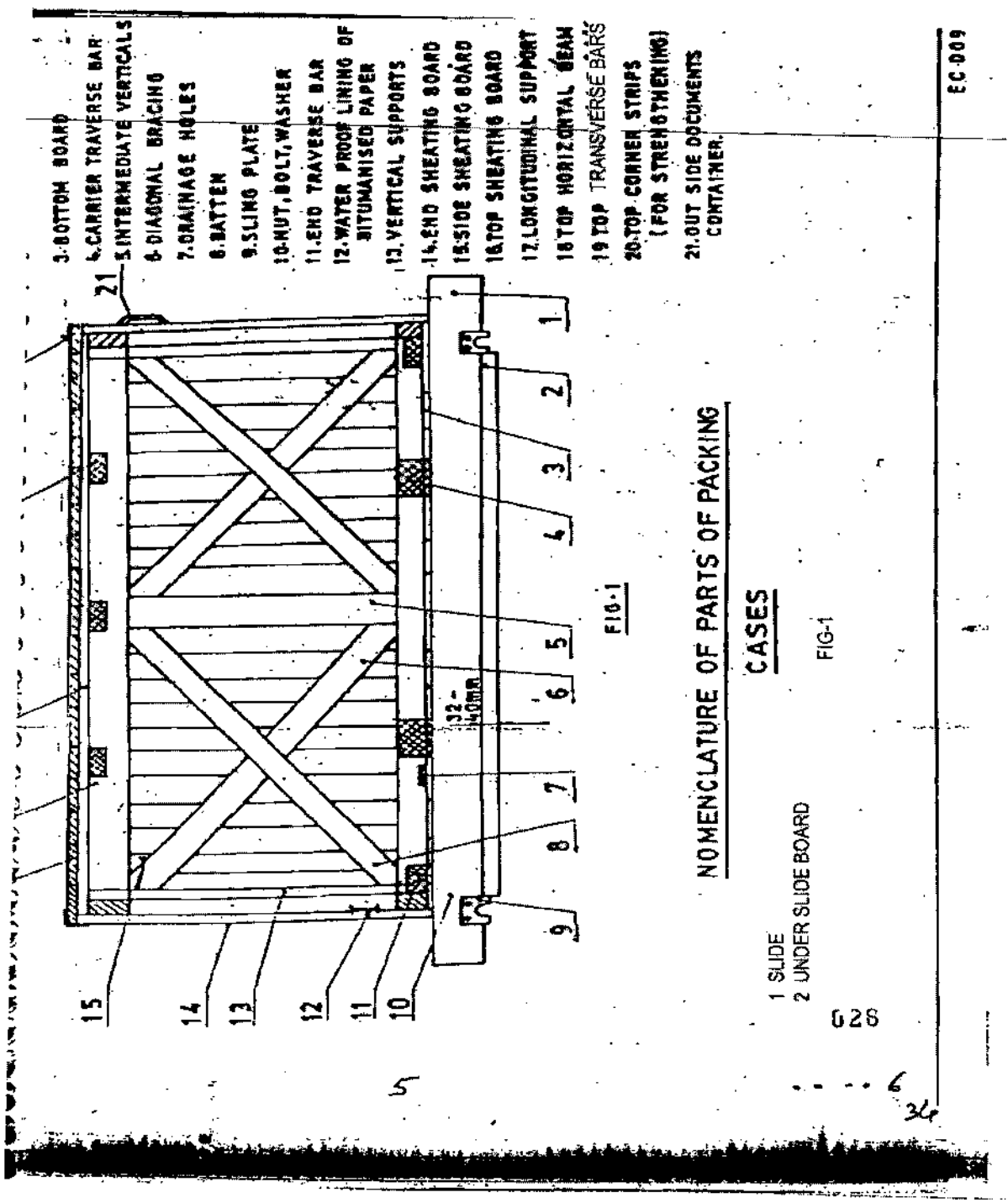
shall be filled with rubberized coir with distance between consecutive supports less than 500 mm (ref fig15). For other equipment suitable support from sides of the casing shall be provided.

- 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.


3.BOTTOM BOARD
4.CARRIER TRAVERSE BAR
5.INTERMEDIATE VERTICALS
6.DIAGONAL BRACING
7.DRAINAGE HOLES
8.BATTEN
9.SLING PLATE
10.NUT,BOLT,WASHER
11.END TRAVERSE BAR
12.WATER PROOF LINING OF BITUMANISED PAPER
13.VERTICAL SUPPORTS
14.END SHEATING BOARD
15.SIDE SHEATING BOARD
16.TOP SHEATING BOARD
17.LONGITUDINAL SUPPORT
18.TOP HORIZONTAL BEAM
19.TOP TRANSVERSE BARS
20.TOP CORNER STRIPS (FOR STRENGTHENING)
21.OUT SIDE DOCUMENTS CONTAINER.
EC-009
NOMENCLATURE OF PARTS OF PACKING
CASES
FIG-1
1 SLIDE
2 UNDER SLIDE BOARD
FIG-1
G26

BOTTOM FRAME ARRANGEMENTS

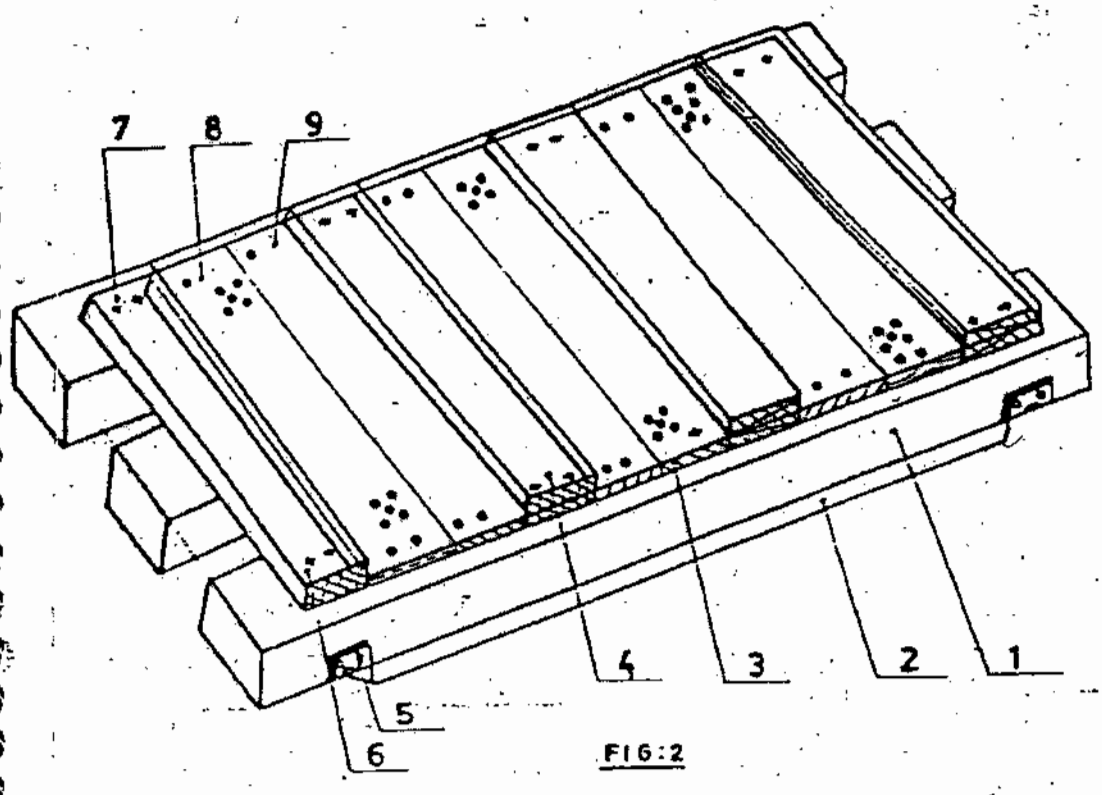


FIG:2

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 1
Cross section of end traverse bar; 100 X 100 mm (minimum)

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

027

TOP FRAME ARRANGEMENT

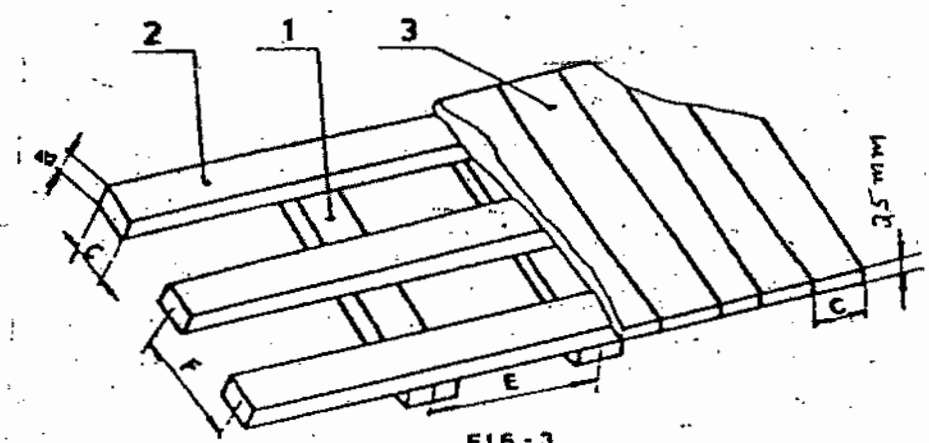
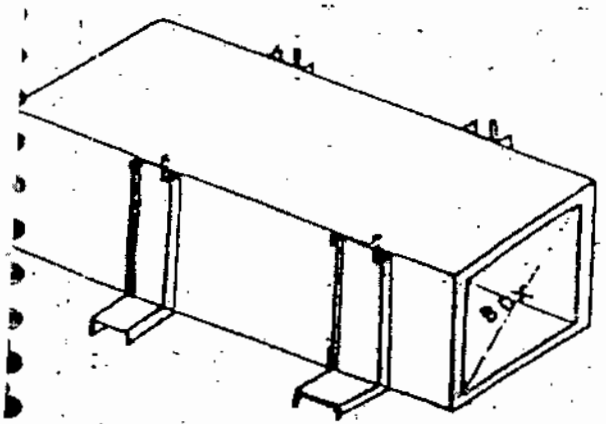


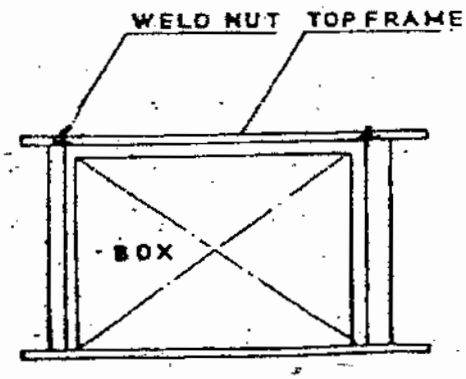
FIG-3

F : 700 to 1000 mm
E : 500 to 900 mm
: 30×100 mm.

1 – Traverse Bars
2 – Horizontal Beams
3 – Top Board

ARRANGEMENT OF C-CLAMPS AROUND CASES





ARRANGEMENT OF DIAGONAL BRACING AND HORIZONTAL SUPPORT

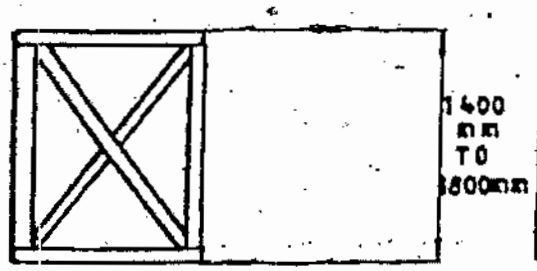


FIG:6

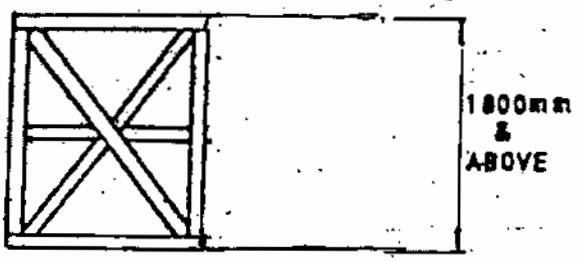


FIG:8

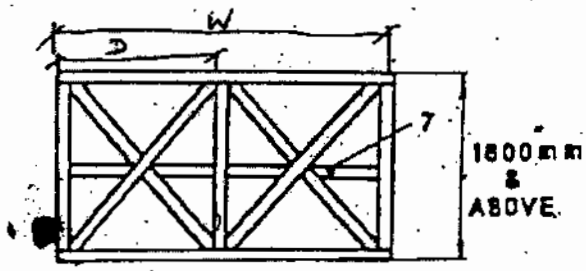


FIG:9

7- Middle Horizontal support

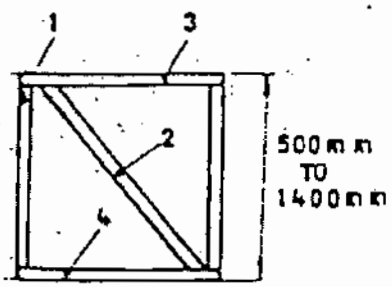


FIG:5

1- Vertical support

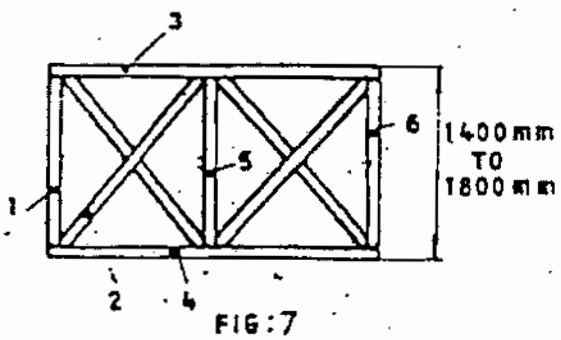
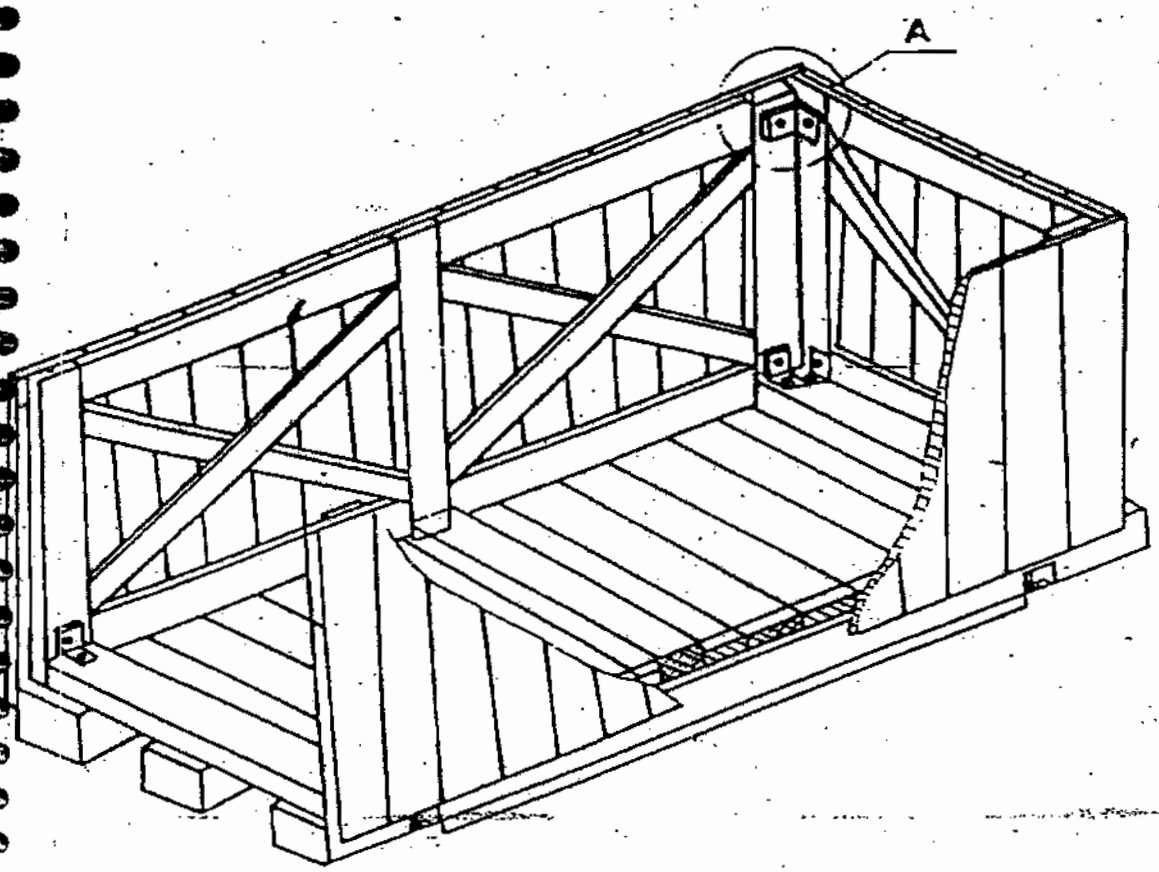
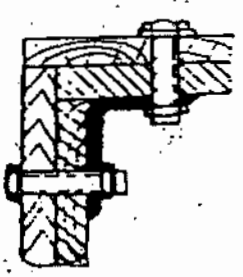


FIG:7

1, 5, 6 - Vertical support

ARRANGEMENT OF PACKING CASE





DETAIL-A

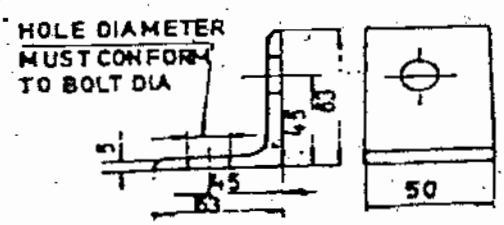


FIG:10

ARRANGEMENT OF SLING PLATE ON CASES

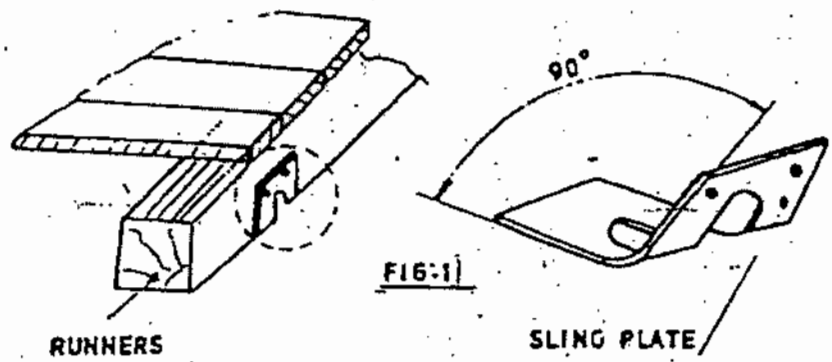


FIG:1

TABLE-1

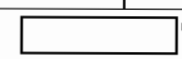
LOADS	LENGTHS OF SLIDES						
	600	800	1000	1200	1300	1500	2000
	Cross section b x c						
500	50 X 100	50 X 100	50 X 100	50 X 100	75 X 100	75 X 100	100 X 100
800	50 X 100	50 X 100	75 X 100	75 X 100	75 X 100	75 X 100	100 X 100
1000	75 X 100	75 X 100	75 X 100	100 X 100	100 X 100	100 X 110	100 X 150
1500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

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 X 100	30 X 100	30 X 100	30 X 130	30 X 130	30 X 130	30 X 130
	1201 to 1600	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130
	1601 to 2000	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130
	2001 to 3000	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130	40 X 150
	3001 to 4000	40 X 150	40 X 150	40 X 150	40 X 150	40 X 150	40 X 150	40 X 150

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.

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.

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

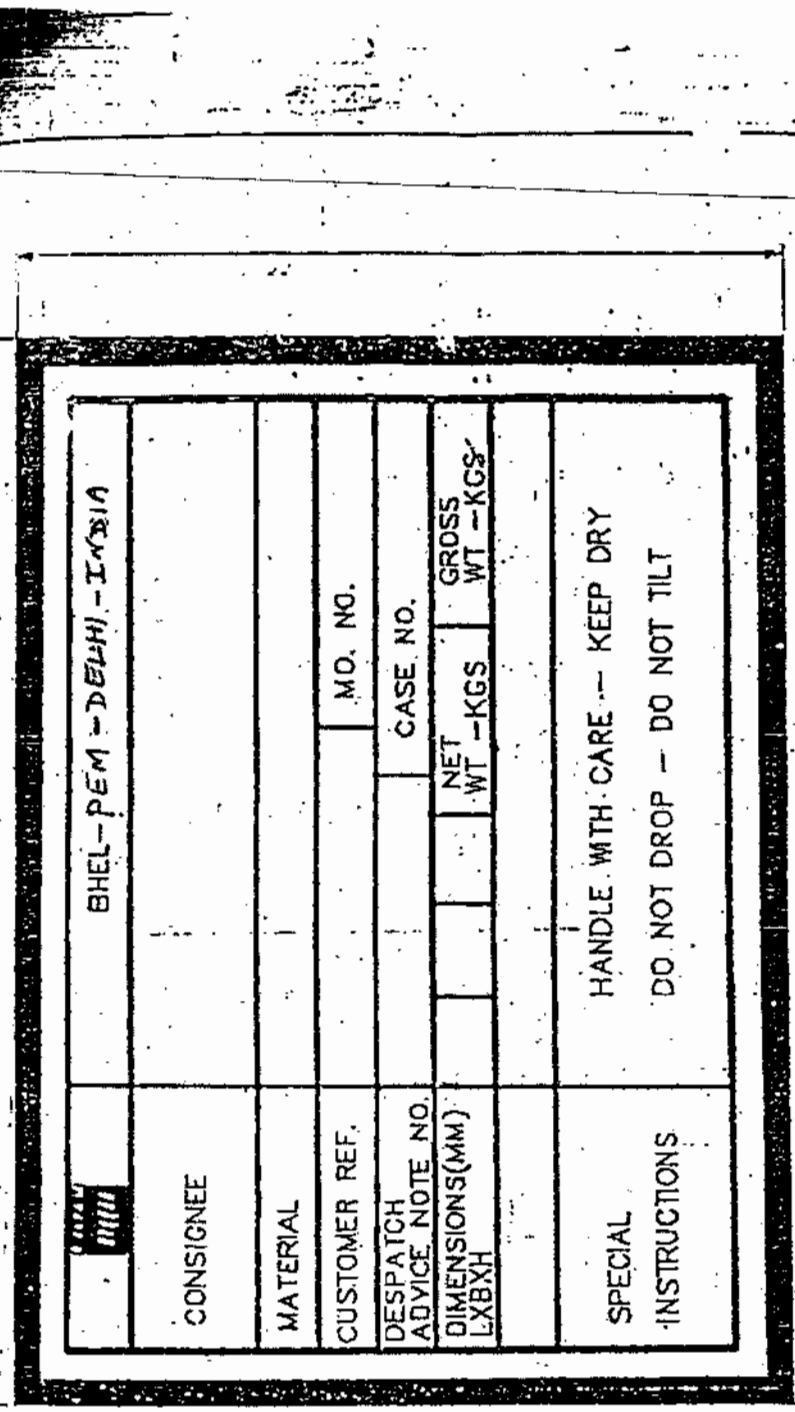
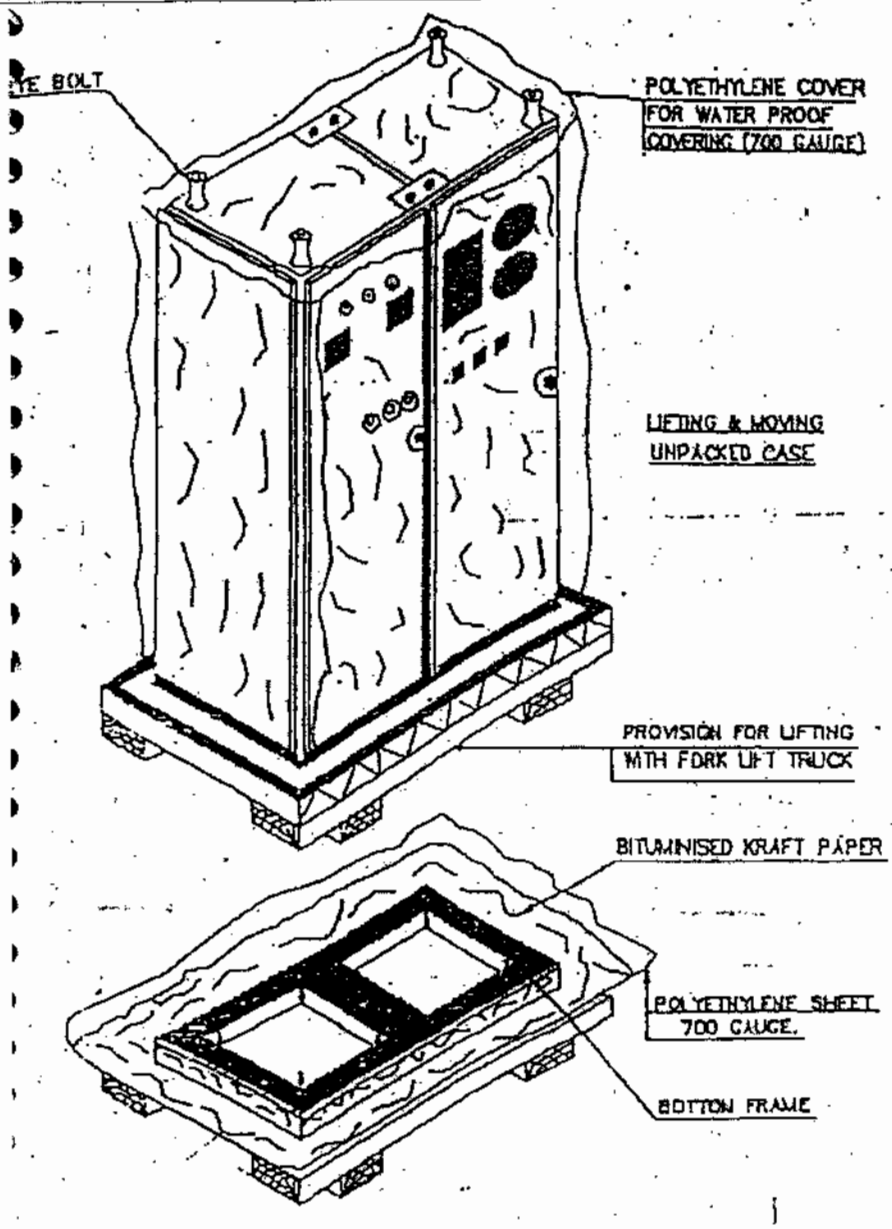


FIG-13: MARKING PLATE


YE BOLT
POLYETHYLENE COVER FOR WATER PROOF COVERING (700 GAUGE)
LIFTING & MOVING UNPACKED CASE
PROVISION FOR LIFTING WITH FORK LIFT TRUCK
BITUMINISED KRAFT PAPER
POLYETHYLENE SHEET 700 GAUGE.
BOTTOM FRAME

FIGURE–14

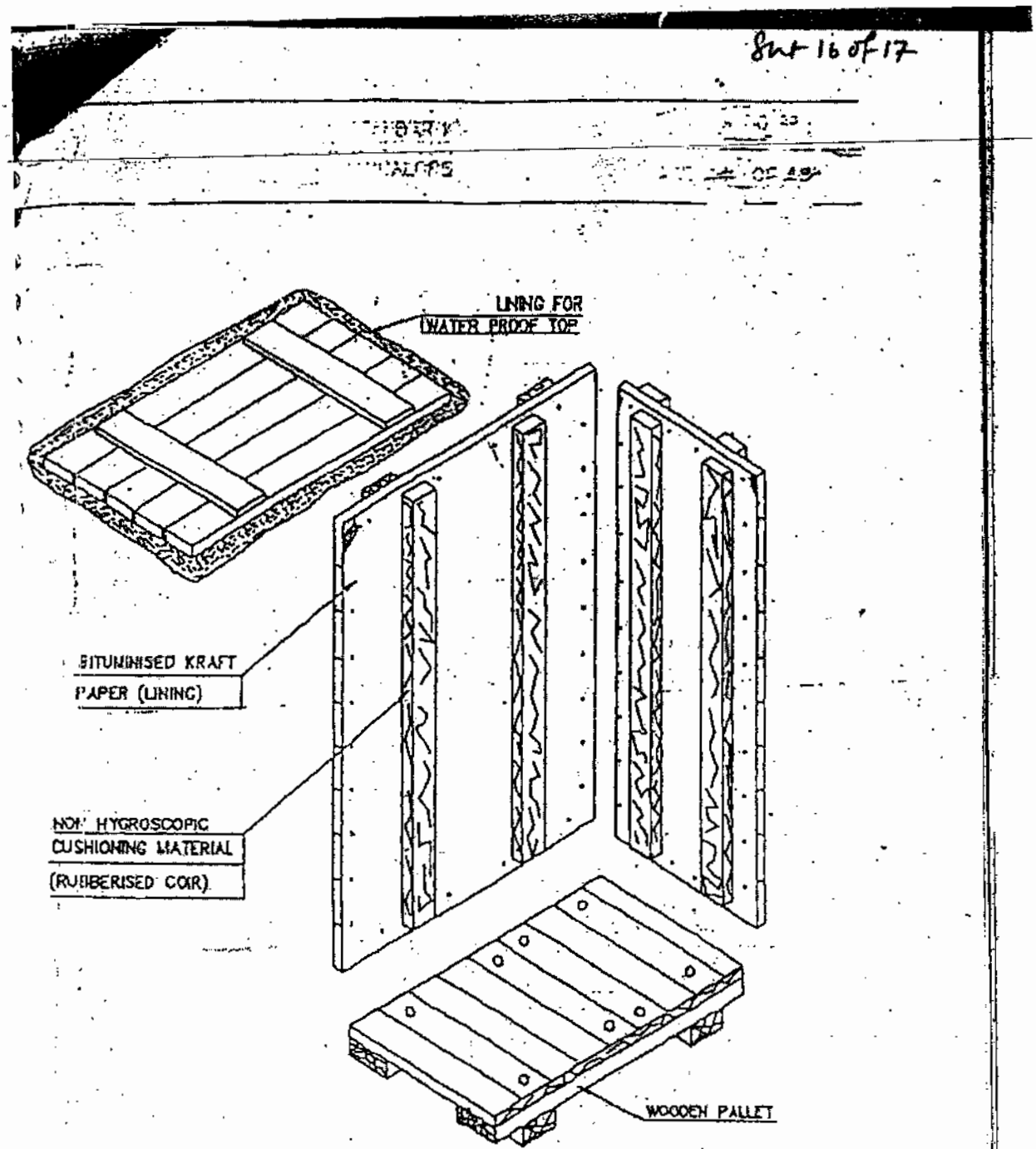

LINING FOR
WATER PROOF TOP
BITUMINISED KRAFT
PAPER (LINING)
NON HYGROSCOPIC
CUSHIONING MATERIAL
(RUBBERISED COIR)
WOODEN PALLET

FIGURE-15

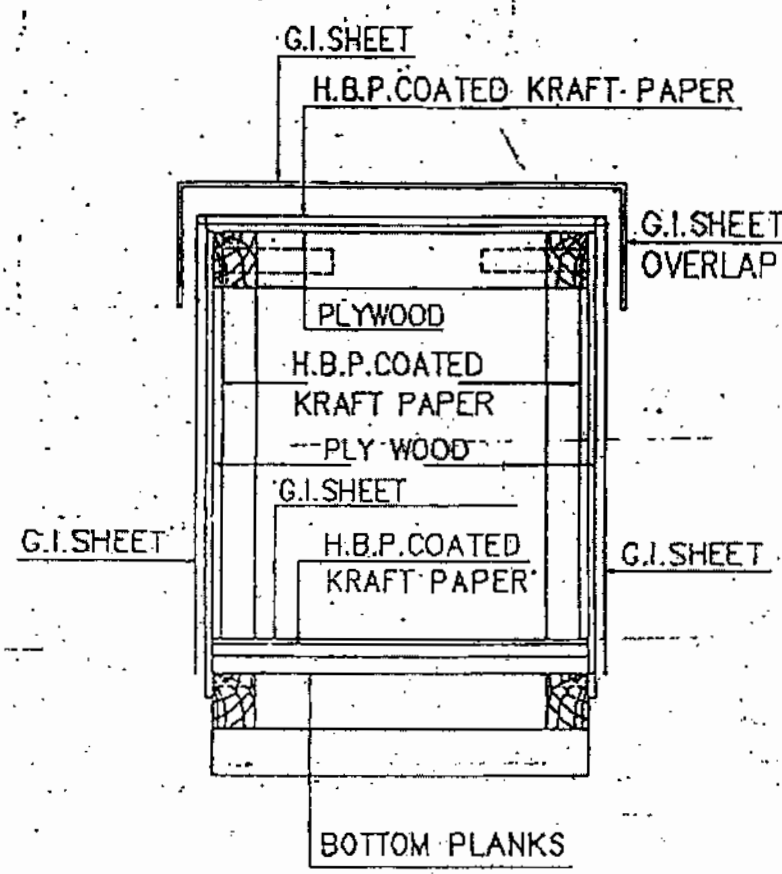


FIG-16 : CLOSED PACKING CASE WITH G.I.SHEET SHOWING LAYERS OF PACKING MATERIALS.

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

a) Project Name
b) Purchase Order No.
c) Sl. No. of package
d) Size of mattress (Thickness x Length x Width)
e) Density
f) Wire netting material and size
g) 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

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. 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

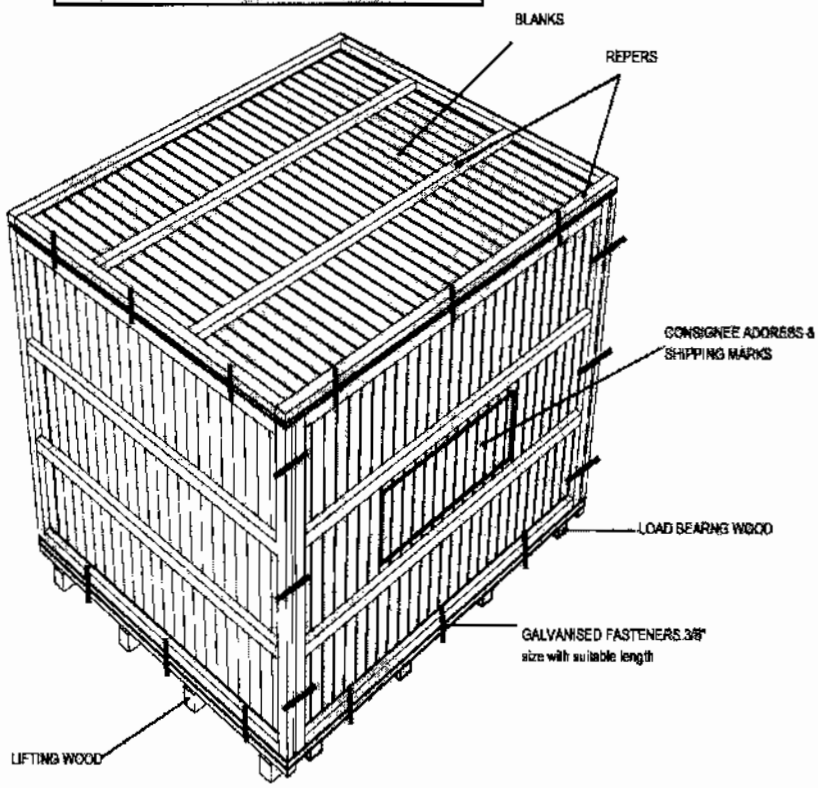
This procedure is applicable for the shipment of Onload Tube Cleaning System and accessories by sea.

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.

- 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.

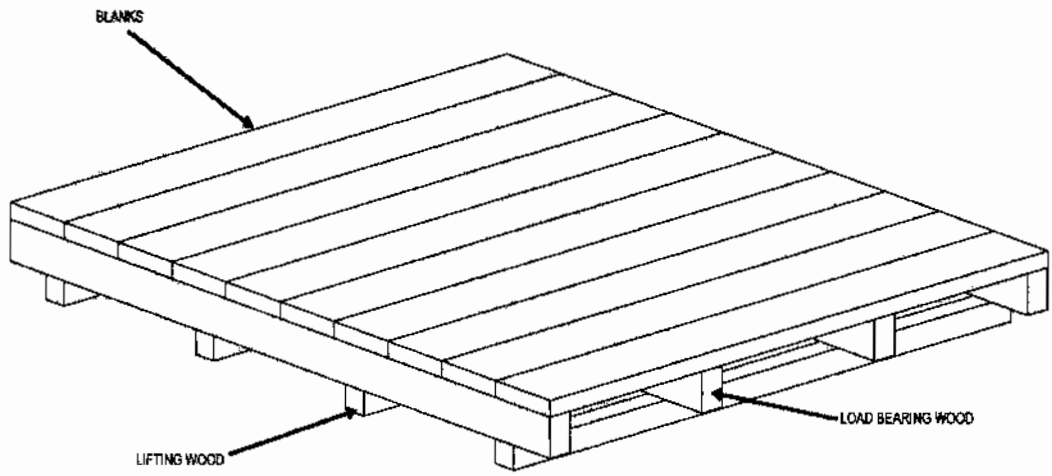
MODEL: FASTNERS TYPE (BASE, SIDE &TOP ATTACHED WITH BOLT, NUT & WASHER)



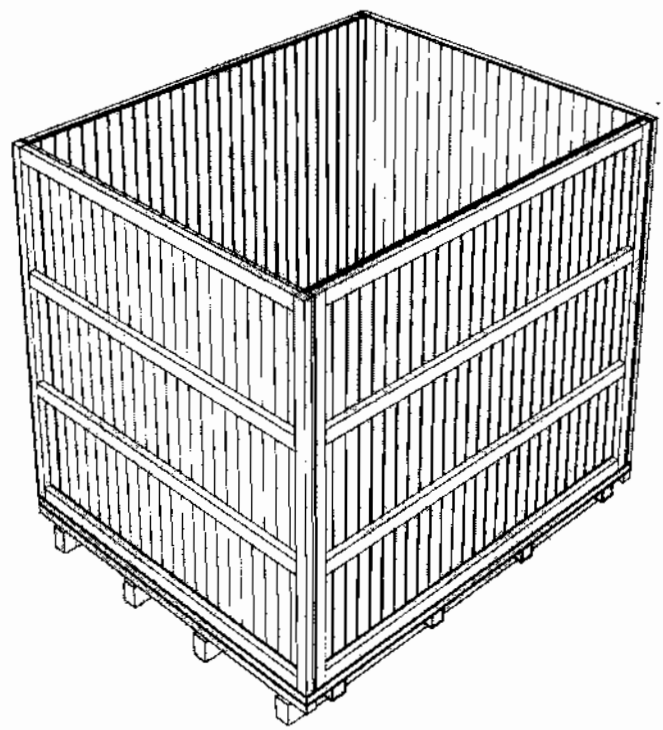
This Type of case to be used for following items:

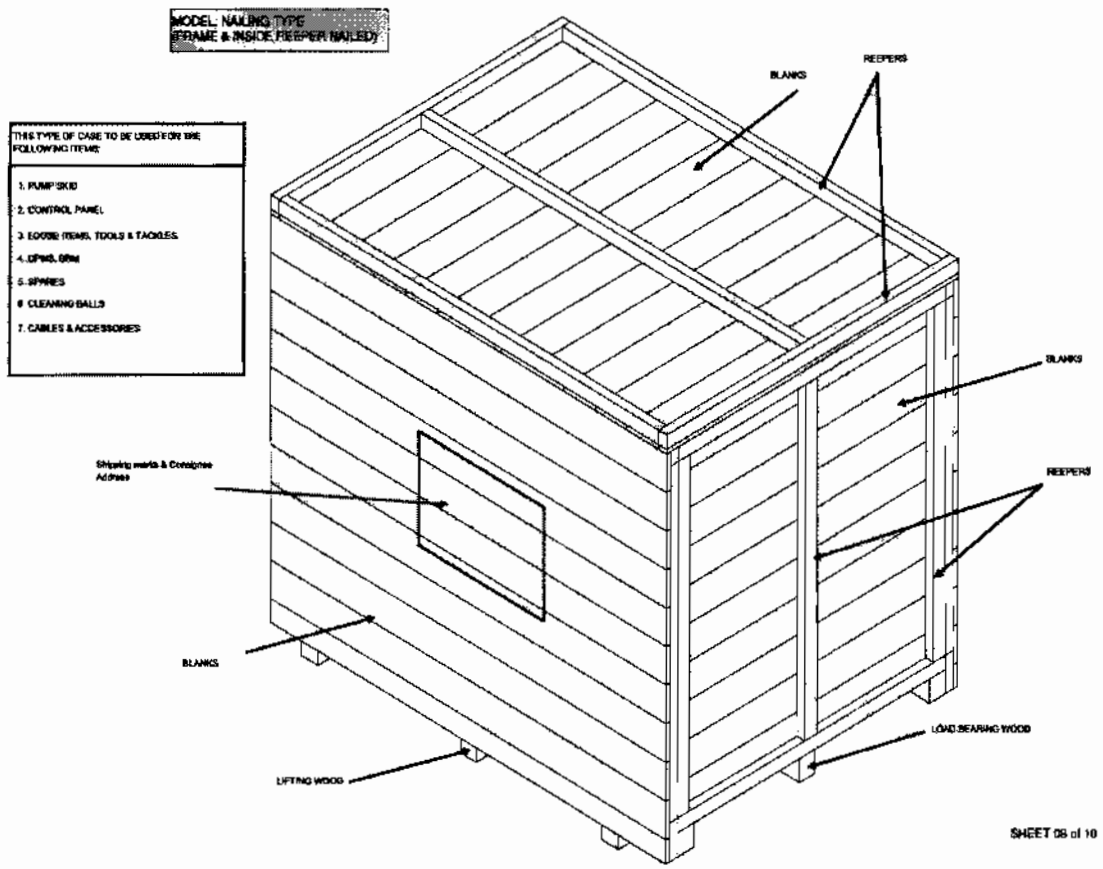
1. BALL SEPERATOR
2. BALL COLECTOR SKID

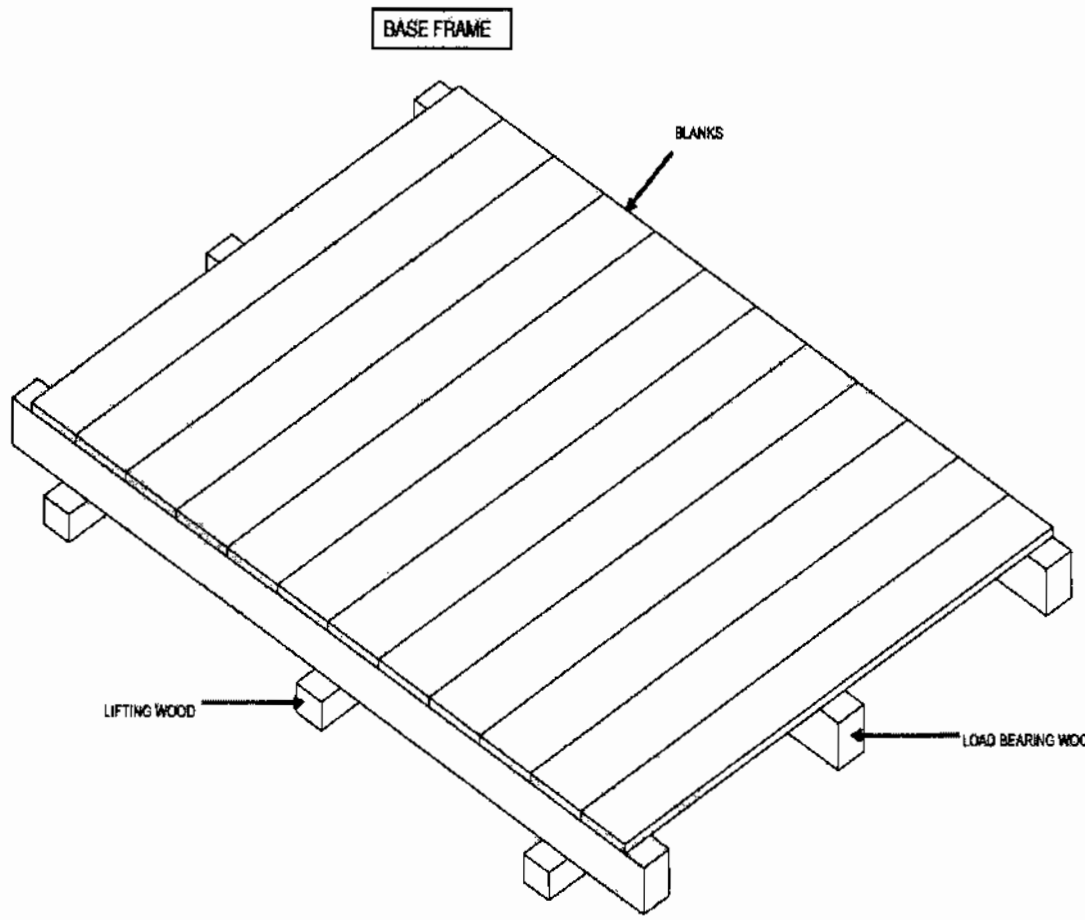
BASE FRAME



MODEL: FASTNERS TYPE - WITHOUT TOP

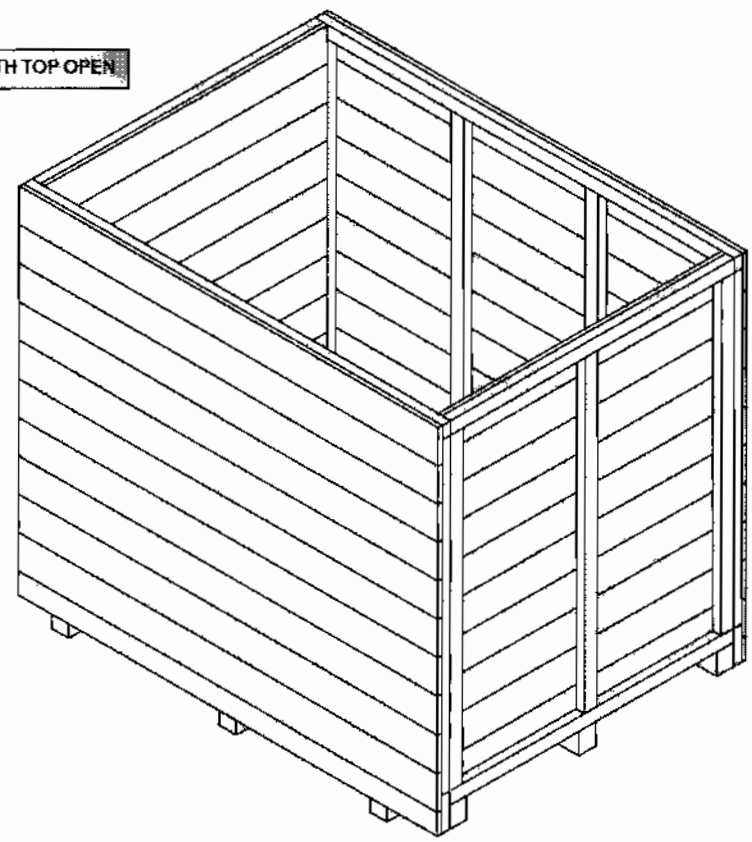



MODEL: NAILING TYPE
(FRAME & INSIDE KEEPER NAILED)
THIS TYPE OF CASE TO BE USED FOR THE FOLLOWING ITEMS:
1. PUMP SKID
2. CONTROL PANEL
3. LOOSE ITEMS, TOOLS & TACKLES
4. SPARES
5. CLEANING BALLS
6. CABLES & ACCESSORIES
BLANKS
KEEPERS
BLANKS
KEEPERS
Shipping marks & Consignee Address
BLANKS
LOAD BEARING WOOD
LIFTING WOOD
SHEET 08 of 10



SHEET 09 of 10

NAILING TYPE MODEL WITH TOP OPEN



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.

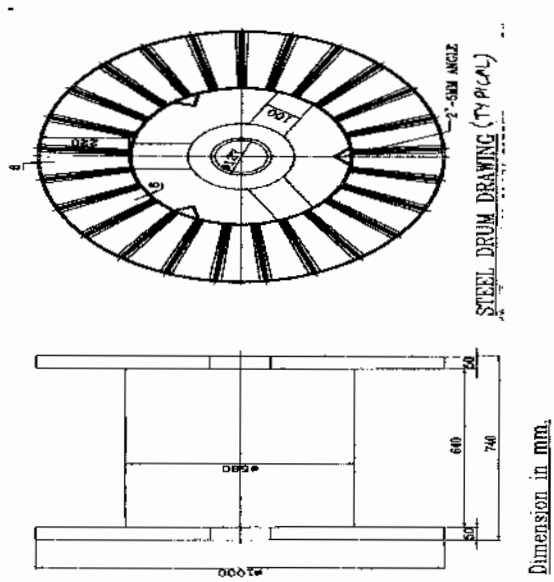
11.0 PACKING OF ELECTRICAL ITEMS

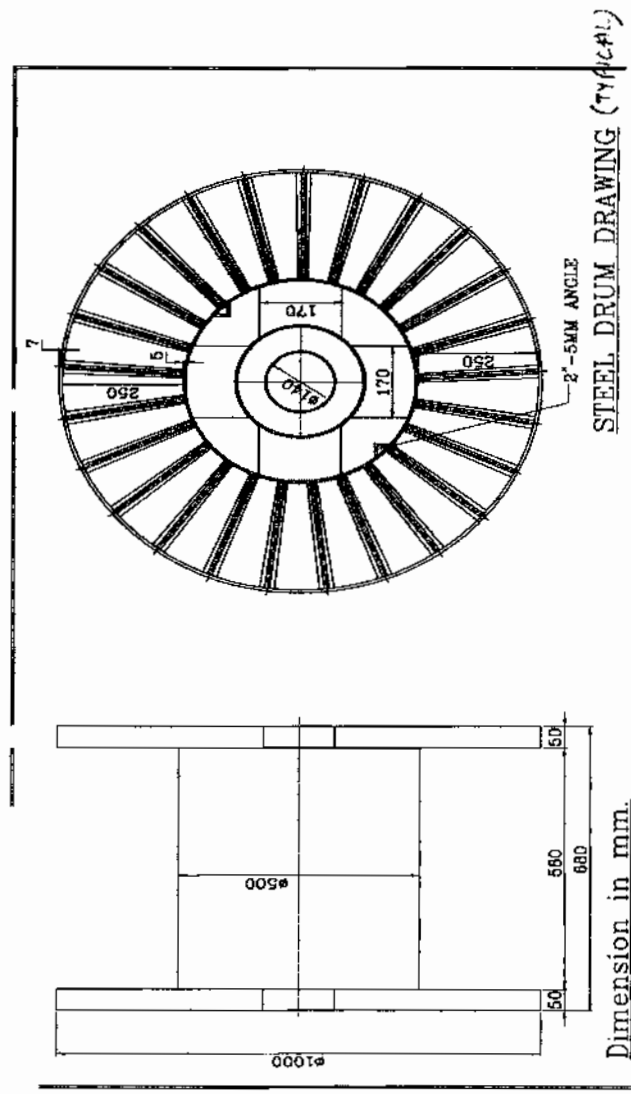
11.1 CABLES

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).


STEEL DRUM DRAWING (TYPICAL)
Dimension in mm.



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.

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

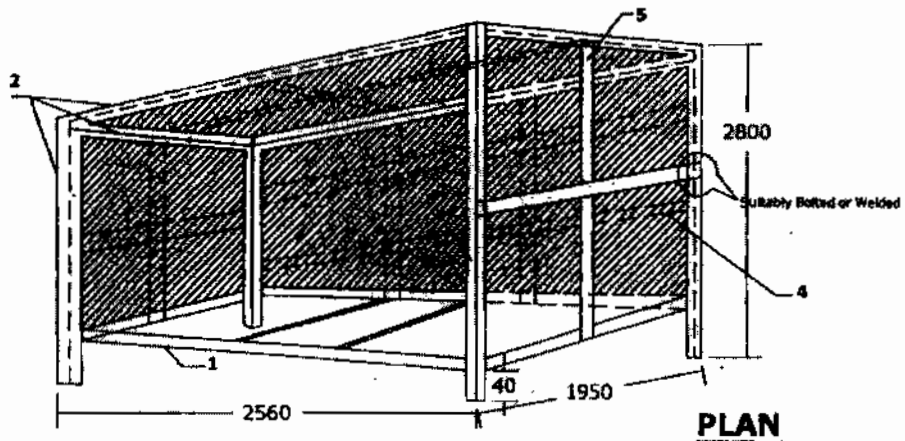
8) One copy of packing slip wrapped in polythylene bag covered with suitable aluminium .packing slip holder to be nailed on the external surface of the box. One more copy 9f the packing Slip wrapped in polythylene bag to be kept inside the box at the prominent place.

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.

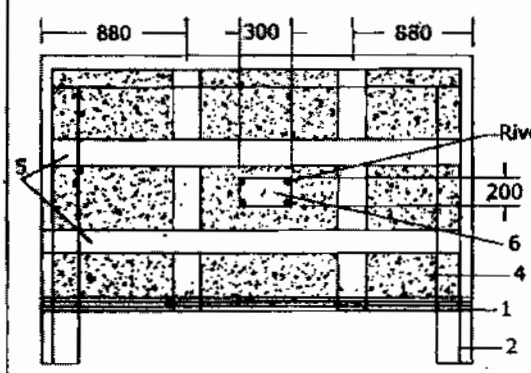
10) Each item as mentioned in BOQ shall be packed & supplied as a set comprising of required numbers of associated fasteners & hardware etc

	TITLE	SPECIFICATION NO. PE-TS-888-100-A001
	TECHNICAL SPECIFICATION FOR SEAWORTHY PACKING FOR EXPORT JOBS	VOLUME II B
		SECTION D
		REV. NO. 0 DATE 10/08/2010
		SHEET 43 OF 52

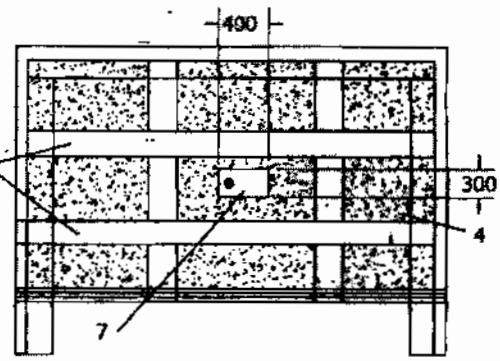
STEEL PACKING (TYPICAL DETAILS)



PLAN



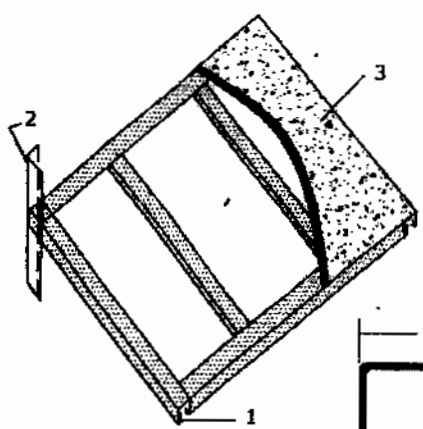
FRONT SIDE OF BOX



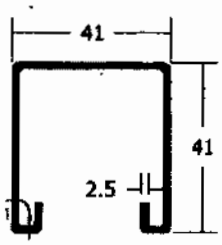
BACK SIDE OF BOX

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 Alluminium Plate for Marking.
7. Hinged Inspection Window.



BOTTOM FRAME ARRANGEMENT



DETAILS OF "C" CHANNEL

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,

a) Construction of packing case for LIGHTING DIATRIBUTION 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.
b) Each Panel/Transformer shall be individually covered with double polythene sheet of thickness 175 microns minimum.
c) 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 .

d) 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.
e) Silica get packed in cotton bags shall be placed at different positions inside the packing.
f) 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 COMMIOSSIONING SPARES, RECOMMENDED SPARES , ERECTION MATERIAL AND CONSUMBALES

a) Construction of packing case for THE ABOVE MATERIAL shall be as per FIGURE 1to11.
b) Items placed inside the case shall be covered with double polythene sheet of thickness 175 microns minimum.
c) 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.
d) 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:

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.

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

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.

PACKING PROCEDURE FOR CONDUIT PIPE

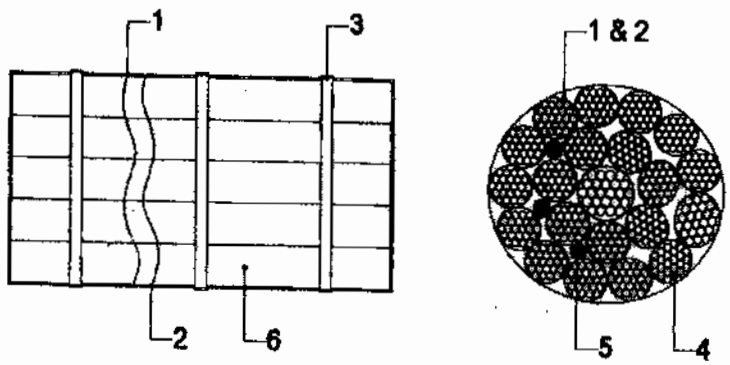


FIGURE "A"

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.

PACKING PROCEDURE FOR STRUCTURAL STEEL

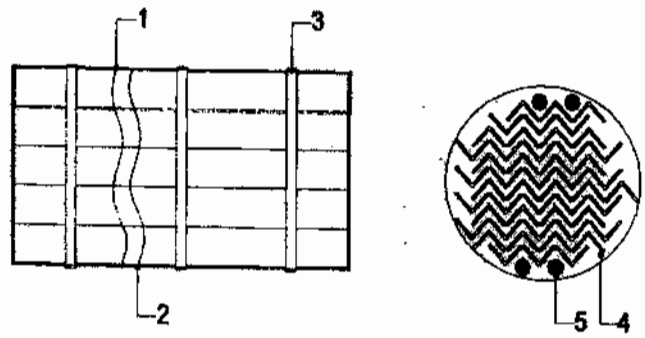


FIGURE "B"

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

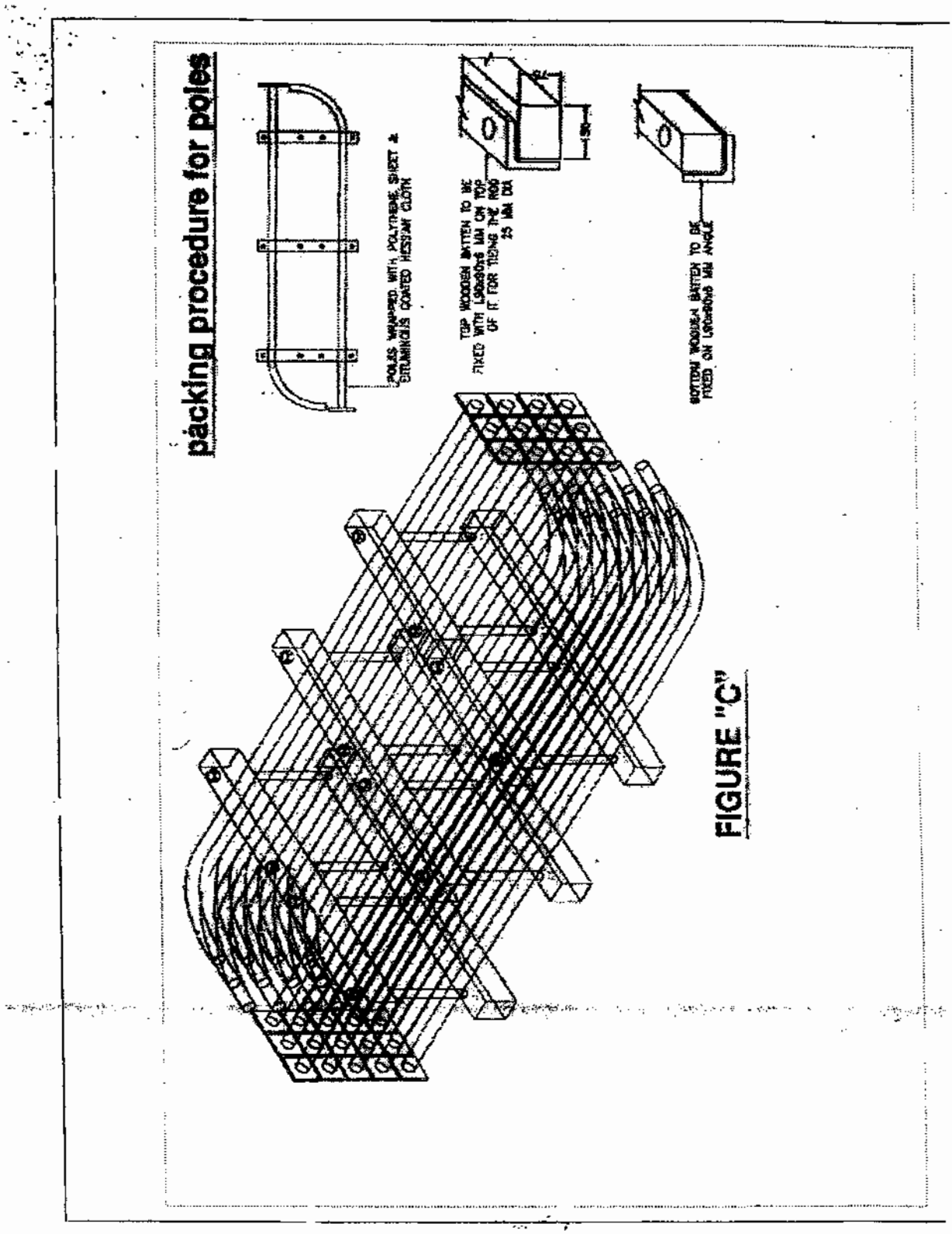

packing procedure for poles
POLES WRAPPED WITH POLYTHENE SHEET & STRUMMIGIS COATED HESSIAN CLOTH
TOP WOODEN BATTEN TO BE FIXED WITH LOCKSPIKE MM ON TOP OF IT FOR TYING THE ROD 25 MM DIA
BOTTOM WOODEN BATTEN TO BE FIXED ON LOCKSPIKE MM ANGLE

FIGURE "C"

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 $\geq$ 0.175mm) 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

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:

- 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

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.

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					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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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**
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			PAGE NO:	**Page 2 of 6**

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					M	C/N					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

Rakesh Kumar Madhu,(SEr/QA)

REVIEWD & APPROVED BY

K C Gandhi Parimalam,(DGM/QA)

	MANUFACTURER'S NAME AND ADDRESS	STANDARD QUALITY PLAN		
Ranipet	**M/S BHEL: BAP: RANIPET 632 406 TAMIL NADU**	**ITEM: VACCUM BELT FILTER SYSTEM: FGD**	**QP NO**	**FGS:725**
			REV. NO:	**00**
			DATE:	**12.02.2019**
			PAGE NO:	**Page 3 of 6**

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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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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**
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			PAGE NO:	**Page 4 of 6**

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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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PREPARED BY	REVIEWD & APPROVED BY
Rakesh Kumar Madhu,(SEr/QA)	**K C Gandhi Parimalam,(DGM/QA)**

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			PAGE NO:	**Page 5 of 6**

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					M	C/N					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	

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	REVIEWD & APPROVED BY
Rakesh Kumar Madhu,(SEr/QA)	**K C Gandhi Parimalam,(DGM/QA)**

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 6 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.		** 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	

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.
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PREPARED BY

Rakesh Kumar Madhu,(SEr/QA)

REVIEWD & APPROVED BY

K C Gandhi Parimalam,(DGM/QA)

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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.

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GUIDELINES TO VENDORS FOR PREPARATION OF QUALITY ASSURANCE PLAN

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.

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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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 code1.

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.

VENDOR'S NAME & ADDRESS:	**MANUFACTURING QUALITY PLAN**	QP. NO.:
	CUSTOMER: PROJECT: PRODUCT:	BHEL P.O.NO.: P.O.DATE: BHEL SPEC: REV:	REV NO: DATE: PAGE 1 OF 1

SL NO	COMPONENTS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY			REMARKS
									D	P	W	V	
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 VENDOR'S SIGNATURE & STAMP	APPROVED BY BHEL QA SIGNATURE & STAMP	APPROVED BY CUSTOMER'S SIGNATURE & STAMP

PROJECT ENGINEERING & SYSTEMS DIVISION
RC PURAM, HYDERABAD.
QUALITY & BUSINESS EXELLENCE

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:**

TELANGANA STATE POWER GENERATION CORPORATION LIMITED

KOTHAGUDEM, ANDHRA PRADESH, INDIA

1x800 MW KOTHAGUDEM THERMAL POWER STATION

STAGE-VII, UNIT#12

EPC BID DOCUMENT

DOCUMENT NO. e-PCT/TS/K/02/2014-15

VOLUME-V
TECHNICAL SPECIFICATIONS
ELECTRICAL EQUIPMENT & ACCESSORIES

OCTOBER 2014

DEVELOPMENT CONSULTANTS PRIVATE LIMITED
CONSULTING ENGINEERS
24B PARK STREET, KOLKATA – 700 016, INDIA

TELANGANA STATE POWER GENERATION CORPORATION LIMITED

KOTHAGUDEM, ANDHRA PRADESH, INDIA

1x800 MW KOTHAGUDEM THERMAL POWER STATION STAGE-VII, UNIT#12

OVERALL CONTENT

VOLUME-I (Part-A)	**:**	**CONDITIONS OF CONTRACT AND BID PROPOSAL SHEETS (PRICE)**
VOLUME-I (Part-B)	**:**	**PRE QUALIFICATION REQUIREMENTS**
VOLUME-I (Part-C)	**:**	**DEED OF JOINT UNDERTAKINGS (DJUs)**
VOLUME-II	**:**	**TECHNICAL SPECIFICATION - LEAD SPECIFICATION, BTG & POWER CYCLE PIPING**
VOLUME-III	**:**	**TECHNICAL SPECIFICATION – BOP (MECHANICAL)**
VOLUME-IV	**:**	**TECHNICAL SPECIFICATION - COAL HANDLING, ASH HANDLING AND MILL REJECT SYSTEM**
VOLUME-V	**:**	**TECHNICAL SPECIFICATION - ELECTRICAL**
VOLUME-VI	**:**	**TECHNICAL SPECIFICATION - CONTROL & INSTRUMENTATION**
VOLUME-VII	**:**	**TECHNICAL SPECIFICATION - CIVIL, STRUCTURAL & ARCHITECTURAL WORK, INCLUDING NDCT**
VOLUME-VIII	**:**	**TENDER DRAWINGS**
VOLUME-IX	**:**	**BID PROPOSAL SHEETS (TECHNICAL)**
VOLUME-X	**:**	**PERFORMANCE GUARANTEES AND PROCEDURE FOR CONDUCTING PG TESTS**

VOLUME : V-A

TECHNICAL SPECIFICATIONS
FOR
ELECTRICAL EQUIPMENT AND ACCESSORIES

CONTENTS

VOLUME V-A : TECHNICAL SPECIFICATIONS FOR ELECTRICAL EQUIPMENT & ACCESSORIES

SECTIONS		DESCRIPTION
SECTION-I	:	GENERAL ELECTRICAL SPECIFICATION
SECTION-II	:	A.C. & D.C. MOTORS
SECTION-III	:	ELECTRIC MOTOR ACTUATORS
SECTION-IV	:	GENERATOR BUS DUCT
SECTION-V	:	HT SWITCHGEARS
SECTION-VI	:	3.3 kV & 11 kV SEGREGATED PHASE BUS DUCT
SECTION-VII	:	415V PMCC/MCC, 415V ACDB AND 220V DCDB
SECTION-VIII	:	LOCAL CONTROL BOARDS/PANELS, LOCAL ISOLATING SWITCH UNITS AND LOCAL PUSH BUTTON STATIONS
SECTION-IX	:	GENERATOR TRANSFORMER
SECTION-X	:	UNIT TRANSFORMER
SECTION-XI	:	STANDBY TRANSFORMER
SECTION-XII	:	VARIABLE FREQUENCY DRIVES
SECTION-XIII	:	NON-SEGREGATED PHASE BUS DUCT
SECTION-XIV	:	GENERATOR CIRCUIT BREAKER
SECTION-XV	:	400KV SWITCHYARD

VOLUME : V-A

SECTION-I

GENERAL ELECTRICAL SPECIFICATION

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	**GENERAL REQUIREMENT**
1.01.00	General
1.02.00	Codes & Standards
1.03.00	Environmental Conditions
1.04.00	Auxiliary Voltages
1.05.00	Equipment Protection
1.06.00	Type & Rating of Equipment
1.07.00	Control Philosophy
1.08.00	Scheme for Auxiliary Power Distribution
1.09.00	Islanding Scheme
1.10.00	Power Evacuation
1.11.00	Insulation Level
1.12.00	Neutral Grounding
1.13.00	Motor Voltage
1.14.00	Tropical Protection
1.15.00	Enclosure Protection
1.16.00	Painting for Electrical Equipment
1.17.00	Redundancy
1.18.00	Quality Assurance
1.19.00	Drawings/ Documents for Approval
2.00.00	**SCOPE OF SUPPLY & WORK**
2.01.00	General
2.02.00	Generator & Auxiliary System
2.03.00	Generator Busduct & MV Busduct
2.04.00	Generator Circuit Breaker
2.05.00	Transformers
2.06.00	Switchgears
2.07.00	DC System
2.08.00	Motors
2.09.00	Electrical Actuators
2.10.00	Variable Frequency Drives
2.11.00	Cabling
2.12.00	Cables
2.13.00	Grounding & Lightning Protection
2.14.00	Station Lighting
2.15.00	DG Set
2.16.00	EHV Switchyard
2.17.00	Energy Management System
2.18.00	Erection & Testing Equipment
2.19.00	Construction Power
2.20.00	Type Test

2.21.00 Mandatory Spares
2.22.00 Scope of Design Work

3.00.00 LAYOUT CRITERIA
3.01.00 Transformer Yard
3.02.00 Criteria of Oil Pit for Transformer
3.03.00 Layout Requirement for BOP Auxiliary Buildings
3.04.00 Equipment Layout
3.05.00 Interplant Cable Routing

4.00.00 SIZING CRITERIA
4.01.00 Generator
4.02.00 Generator Transformer
4.03.00 Unit & Standby Transformers
4.04.00 Auxiliary and LT Transformers
4.05.00 Bus ducts and Cables
4.06.00 DC System
4.07.00 DG Set
4.08.00 UPS System
4.09.00 Electrical Laboratory Equipment

5.00.00 PROVEN-MAKE CRITERIA
5.01.00 Isolated Phase Busduct
5.02.00 Power Transformers
5.03.00 Auxiliary Oil Filled /Dry type Transformers
5.04.00 11 kV & 3.3kV Switchgears
5.05.00 LT Switchgear
5.06.00 Numerical Relays & Networking
5.07.00 HT Motor
5.08.00 LT Control Cables
5.09.00 LT Power Cables
5.10.00 HT Cables
5.11.00 DG Sets
5.12.00 DC Batteries
5.13.00 Battery Charger
5.14.00 Generator Circuit Breaker
5.15.00 400kV Switchyard Equipment (AIS)
5.16.00 Substation Automation System & Protective Relays

ATTACHMENTS

ANNEXURE – A TECHNICAL PARAMETERS OF ELECTRICAL SYSTEM

VOLUME : V-A
SECTION-I
GENERAL ELECTRICAL SPECIFICATION

1.00.00 GENERAL REQUIREMENT

1.01.00 General

1.01.01 Contractor shall provide fully compatible electrical system, equipments, accessories and services for the entire station/plant in his scope as well as those specifically required by the Owner.

1.01.02 All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and International Codes & Standards, in particular the Indian Statutory Regulations.

1.01.03 Drawings and annexure appended to this specification shall form part of this specification and supplement the requirements specified herein. This specification shall be read and construed in conjunction with the drawings and annexure to determine the scope of work and terminal points.

1.01.04 It is not the intent to specify completely herein all details of the system or equipment. Nevertheless, the system/equipment shall be complete and operative in all aspects and shall conform to highest standard of engineering, design and workmanship.

1.01.05 Any system, material or accessory which may not have been specifically mentioned but which is necessary or usual for satisfactory and trouble-free operation and maintenance of the equipment shall be furnished without any commercial implication to the Owner.

1.01.06 In case of a conflict between this Section (GENERAL ELECTRICAL SPECIFICATION) and the other Sections of Volume V-A & Volume V-B, the stipulation under this Section shall prevail, unless the Owner advises otherwise on a specific issue at the Bidding stage.

1.01.07 Proposal Data Sheets

The Proposal Data Sheets annexed to this specification shall be filled in without any ambiguity by typing in appropriate place on each page. These pages must be properly signed by authorized representative of the Bidder as verification of the data and submitted along with the bid to form part of the Bidder's formal proposal.

1.01.08 Guaranteed Performance

The performance figures quoted in Technical Particular Sheets shall be guaranteed within the tolerance permitted by relevant standards. In case of failure of the equipment to meet the guarantee, the equipment may be liable for rejection at any stage.

1.01.09 Deviation

Should the Bidder wish to deviate from this specification in any way, he shall draw specific attention to such deviation. All such deviations shall be clearly mentioned on the Deviation sheet enclosed, with reference to the respective clause of the specification. Unless such deviations are recorded in the Deviation sheets and submitted with the offer, it shall be taken for granted that the offer is made in conformity with this specification in all respects.

1.01.10 Drawing Approval

Before starting manufacture of any equipment, the contractor shall have to take approval of relevant drawings and data from Engineer in writing. Any manufacture done prior to the approval of drawings/data shall be rectified in accordance with the approved drawings/data by the Contractor at his own cost and the equipment shall be supplied within the stipulated period.

1.01.11 Site Condition

For the purpose of equipment design, reference ambient temperature shall be taken as 50°C. Other site conditions shall be as indicated in the Lead Specification.

1.01.12 The Contractor shall furnish calculations of maximum loading and fault levels under the most onerous conditions for the various equipment/systems as defined elsewhere in the specification to prove adequacy of their parameters. In case any equipment or system is found to be inadequate, it shall be changed/ modified without any additional financial liability to the Owner.

1.01.13 Transformer voltage ratios, taps, impedances and tolerances thereon, shall be so optimized so that the auxiliary system voltages under various grid and loading conditions are always within permissible limits and equipment are not subjected to unacceptable voltages during operation and starting of large motors such as MDBFP etc. The vector groups of the transformers shall be so selected that all the buses of particular voltage level have same vector throughout the plant.

1.01.14 Responsibility of coordination with electrical agencies /TAC/Pollution control board/Electrical Inspectorate and obtaining all necessary clearances shall be of the contractor.

1.01.15 Special Tools & Tackles

A set of special tools & tackle which are necessary or convenient for erection, commissioning, maintenance and overhauling of the equipment shall be supplied.

The tools shall be shipped in separate containers, clearly marked with the name of the equipment for which they are intended.

1.01.16 Spares

(a) 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.

(b) The Bidder shall quote and supply mandatory spare parts as per list attached in Vol. IIA, Sec.8. The final quantity shall be decided during placement of order.

(c) Each list shall be complete with specification, make, identification number, unit rate, quantity etc.

1.02.00 **Codes & Standards**

1.02.01 Equipment

Requirement of conformance with Codes and Standards is described in individual Sections.

1. 02.02 Installation

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 the Tariff Advisory Committee (TAC). 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.

1. 02.03 Nothing in this enquiry specification shall be construed to relieve the Contractor of his responsibility to abide by the Standards or Codes.

1.03.00 **Environmental Conditions**

1.03.01 The equipment will be installed in hot humid and tropical atmosphere highly polluted with coal dust and fly ash.

1.03.02 Sensitive relay and other electrical and electronic devices shall be located in controlled environment such as control room, electronic equipment room etc. as applicable.

1.03.03 For equipment installed outdoor and exposed to direct sun rays, the effect of solar heat shall be considered in determining the design ambient temperature.

1.04.00 **Auxiliary Voltages**

1.04.01 Auxiliary AC voltage supply arrangement shall have 11 kV, 3.3 kV and 415V systems. It shall be designed to limit voltage variations as given below under worst operating condition:

a) HT & LT AC System - ± 10%
b) 220V DC - -15% to +10%

1.04.02 Following auxiliary voltages will be envisaged for LT auxiliary power, control and instrumentation.

a) 240 V ± 10%, 1 Ph, 50 Hz +3% to -5%

b) 220 V DC +10% to (-) 15%, two wire, ungrounded

c) 240 V, 1 Ph, 50 Hz, UPS System

d) 24 V / 48 V DC, as required

1.04.03 Nominal voltage of main DC system shall be 220V. DC batteries shall be designed for continuous float operation with trickle charging, hence all the associated components like batteries, battery chargers, DC motors, relays, contactors, timers etc shall be suitable for continuous operation at the maximum continuous battery float voltage including suitable temperature correction factors.

In addition, the bidder may propose 48V or 24V systems as per requirements of control and instrumentation of his equipment and design.

1.05.00 **Equipment Protection**

1.05.01 The Contractor shall design the plant with the primary objective to mitigate the damage of the plant and equipment during fault or system disturbances.

1.05.02 Automatic trip functions will be initiated for isolation of fault, which could cause immediate and severe damage.

1.05.03 Every effort shall be made to avoid unnecessary trip. There will be annunciation to alert the operator to take corrective action in time.

1.05.04 At least two protective devices, preferably operating in parallel on different principles, will be utilized in protecting major equipment, where possible.

1.05.05 Major protections envisaged for various equipment are listed under relevant sections of this specification.

1.06.00 **Type & Rating of Equipment**

1.06.01 Number of types and sizes of standard products like motors, switchgear and control gear components etc. shall be kept to a minimum so that the requirement of spares is reduced.

1.06.02 Equipment shall be rated for the load and duty cycle of the intended service Circuit breakers and fuses shall be rated to withstand and interrupt the maximum fault current at the point of application in the circuit.

1.07.00 **Control Philosophy for plant Electrical System**

1.07.01 In line with the present-day practice centralised control of the electrical system/equipment has been envisaged for the plant. Control of electrical system of main plant and EHV breakers of generator bay shall be provided from DDCMIS with soft HMI. The details of the same are specified in relevant sections of Control and Instrumentation.

1.07.02 Generator will be controlled from Central Control Room in the Power House. However, bus selection for generator shall be done from Switchyard Control Room by operation of associated disconnecting switches.

1.07.03 400kV side of Standby Transformer feeder, when fed from 400kV switchyard, shall be controlled from Switchyard Control Room. OLTC control for such Standby Transformer shall also be done from Switchyard Control Panel.

1.07.04 Control & metering of Generator, GT, UT, ST etc. will be from Central Operating Console as well as from ECP. The protection of above shall be effected through redundant (2x100%) numerical protection relays. Separate set of CTs & PTs shall be used for implementation of such redundancy. Protection of GT, ST, UT shall be achieved through discrete numerical relay protection. Two (2) groups of different make numerical protection relays shall be adopted for Generator protection relays.

1.07.05 The control, indication, metering and monitoring of the electrical auxiliary power distribution system comprising of 11 kV & 3.3 kV circuit breakers (except those for motor feeders), 11/3.6kV Auxiliary transformers, LT transformers, 415 V switchgear breakers for incomers and bus couplers, DG system, etc. shall be achieved from operator's consoles through DDCMIS/PLC and ECP (as applicable). For details relevant section of C & I shall be referred.

1.07.06 All equipment/components, viz., transducers, etc. required to interface with plant DDCMIS/PLC system shall be provided in switchgear/control panels. The minimum protection required for different equipment and system are indicated in other Sections.

1.07.07 STOP pushbutton shall be provided in the local control panel for motors and this STOP annunciation signal shall be provided to the DDCMIS by hardware connection.

1.07.08 Control panels for service systems like Ash, C.W. pumps, ash dyke etc. shall be located in the respective control room. In addition, some local panels shall be provided near respective system/equipment such as boiler feed pump, hydrogen seal oil system, electrostatic precipitator, PMCC, ash dyke PMCC etc.

1.07.09 In case of internal faults in the generator transformer both turbine and generator will automatically trip. For faults external to the generator and transformer, the generator transformer breaker will open and the turbine, generator shall operate on house load.

1.07.10 Suitable unit interlock and protection scheme shall be developed to ensure safety of equipment and stable operation of the unit within permissible limits. Apart from this, the Generator Transformer, the Unit Transformer and the Standby Transformer have to be provided with necessary safety interlock.

1.07.11 In case of tripping of the unit, Fast bus change over scheme is proposed to change supply of the Boiler and the Turbine Auxiliaries from Unit to Standby system automatically and thereby avoiding trip out of the Boiler and providing uninterrupted supply to vital Turbine auxiliaries. Under this `Fast bus change over' scheme the Boiler shall be operating with 60% HP-LP Bypass even if there is trip out of Turbine & Generator.

1.07.12 Suitable operational logic shall be developed to operate and control the unit from Central Control Room along with its sub-group and sub-loop control. House load operation of this Unit has been contemplated.

1.08.00 **Scheme For Auxiliary Power Distribution**

1.08.01 Owner has chosen 'Generator Circuit Breaker Scheme' for the project as indicated in the Electrical Single Line Diagram enclosed with the specification documents.

1.08.02 Auxiliary Power Distribution scheme shown in the attached Electrical Single Line Diagram is for the Bidder's guidance. The Bidder shall develop his own scheme maintaining the reliability and redundancy criteria. It shall be subject to the Owner's acceptance.

1.08.03 In order to ensure safe shut down of the plant under emergency condition and to provide backup in case of total power failure, one (1) Diesel Generating set shall be provided.

1.08.04 Overall system shall be such that failure of any unit auxiliary like transformer, DC battery, Battery charger and DG set shall not reduce the plant's generating capability or affect the safe shut down requirements of the unit.

1.08.05 Wherever plant auxiliary supply is extended outside the plant boundary, suitable isolation through transformer shall be done.

1.09.00 **Islanding Scheme**

The unit shall be designed to operate in islanding mode of operation by tripping all the lines and the unit shall run with the available plant load under such condition. Necessary control philosophy shall be submitted by the Bidder.

1.10.00 **Power Evacuation**

The generated power will be stepped up to 400kV and evacuated through 400KV transmission lines. For new unit at KTPS (Kothagudem), power evacuation will be through 3 nos. new 400kV lines.

1.11.00 **Insulation Level**

The insulation level for the transformer windings and bushings shall be as under :

	Winding		Bushing	
Highest System Voltage	Rated Power Freq. withstand Voltage (kVrms)	Rated lightning Impulse withstand Voltage (kVp)	Rated Power freq. withstand voltage (kV rms)	Rated lighting Impulse withstand Voltage (kVp)
0.433 kV	3		3	
3.6 kV	10	40	10	40
7.2 kV	20	60	20	60
12 kV	28	75	28	75
17.5 kV	38	95	38	95
24kV	50	125	50	125
36kV	70	170	70	170
72.5 kV	140	325	140	325
145kV	275/*	650	275	650
245kV	395*	950/1050**	460	1050
420kV	630/*	1425/1570**	630	1425

* In case of non-uniformly insulated (refer IEC 60076-3, Table D.2)

**Chopped Wave BIL

1.12.00 **Neutral Grounding**

1.12.01 Neutral earthing equipment shall be designed duly taking into account the maximum permissible operating voltage of the generator, voltage rise on load throw off (subsequent to detection of earth fault) field suppression time, ferro resonance, etc. The generator shall be grounded through distribution transformer with secondary loading resistor, limiting the earth fault current to about 5-10 A and to restrict the over voltages caused due to capacitive currents. The neutral earthing equipment shall be rated to carry this current for at least 5 minutes considering the generator terminal voltage under maximum field forcing conditions.

1.12.02 11 kV/3.3kV system earthing shall be low resistance earthed type to limit earth fault current to 300A. The resistor shall be rated to carry this current at least for 10 seconds.

400kV system is solidly grounded.

Neutrals of Generator Transformers (on 400kV side) and all LT Transformers (415V) shall be solidly earthed through bolted links.

220V DC system shall be kept ungrounded.

Diesel generator shall also be kept ungrounded (earthing through PT).

1.13.00 **Motor Voltage**

The voltage level for motors shall be as follows:

a)	Up to 0.2 kW	-	240V AC / 415V AC
b)	Above 0.2 kW and up to less than 175 kW	-	3 ph, 415V AC
c)	175 kW and up to less than 1500 kW	-	3 ph, 3.3KV AC
d)	1500 kW & above	-	11 kV

415V or 3.3 kV may be adopted by the bidder for the drives in the range of 175-210 kW.

3.3 kV AC supply for CHP conveyor motors of rating above 160 kW is to be used.

The voltage rating of the drives indicated above is for basic guideline. Minor variations can be accepted on case to case basis based on techno-economic considerations of the various sub-systems.

Voltage rating for special purpose motors viz, VFD and screw compressors, shall be as per manufacturer's standard. All the motors ratings on Stacker/ Reclaimer shall be 415V AC supply only.

1.14.00 **Tropical Protection**

1.14.01 All electrical equipment, accessories and wiring shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion.

1.14.02 Fine mesh screen of corrosion resistant material shall be furnished on all ventilating openings to prevent entry of insects.

1.15.00 **Enclosure Protection**

1.15.01 Degree of protection of enclosures as per IS:13947 shall be as follows:

	Item	Degree of Protection
1	11kV & 3.3kV Switchgears	IP4X
2	415V MCC / DBs / Fuse Board	IP52 for indoor and IP65 for outdoor
3a	Motor	IP55
3b	Motor Actuator	IP65
4a	Control and Relay Panel in AC area	IP3X
4b	Control and Relay Panel in normal area	IP42
5a	Pushbutton Station/Kiosk/Panel - Indoor	IP55
5b	-Do - Outdoor	IP65
6	Indoor Junction boxes for cables / wires	IP55
7	Outdoor lighting fixtures	IPW55
8	Battery Charger Panel	IP42

1.15.02 In fire hazardous areas like gas/ liquid fuel storage/ handling areas, lighting fixtures, switchgears shall be of tested and certified flame proof design.

1.16.00 **Painting For Electrical Equipment**

Unless explicitly stated in relevant chapters of the specification, the painting of all electrical equipment shall be as follows:

Epoxy based with suitable additives. The thickness of finish coat shall be minimum 80 microns (minimum total DFT shall be 100 microns). However in case electrostatic process of painting is offered for any electrical equipment, minimum paint thickness of 80 microns shall be acceptable for finish coat. Paint shade shall be as per technical specification.

Paint shade of finish coat shall be as per Section-X of Volume – IIA: Lead Specification.

1.17.00 **Redundancy**

The Contractor shall develop the system configuration based on the concept that failure of any one auxiliary transformer or supply feeder will not affect full load operation or start up/shut down of the unit.

1.18.00 **Quality Assurance**

1.18.01 The Contractor shall follow his standard procedures for quality assurance and control. A copy of the said standard procedures shall be submitted to the Owner / Purchaser for his reference. However, Owner / Purchaser reserves the right to review the same and give his observations, if any, for compliance.

1.18.02 The procedures shall be in such a form as to clearly delineate the manufacturing sequence, inspection points, tests and test procedures, acceptable ranges / values, reference drawings etc.

1.18.03 The Owner / Purchaser shall inform the Contractor as to which of the inspection points and tests shall be witnessed. As a minimum, inspection and testing of the finished equipment shall be made prior to shipment, unless specifically waived by the Owner / Purchaser. The contractor shall give at least fifteen (15) days advance notice regarding readiness of the equipment.

1.18.04 Manufacturing and quality control procedures shall be available for audit to the Owner / Purchaser and/or its representative at the place of manufacture.

1.18.05 The Owner / Purchaser reserves the right to inspect the equipment at the point of manufacture and witness factory and other such tests as may be necessary to ensure conformance to the specification.

1.18.06 The Owner / Purchaser reserves the right to inspect the Contractor's facilities prior to award of contract.

1.18.07 The Owner / Purchaser reserves the right to witness any or all of the tests stipulated in the relevant standards and this specification.

1.18.08 The Owner / Purchaser may conduct surveillance of the Contractor's facilities for compliance to his standard procedures of Quality Assurance and Quality Control while work on the specified equipment is in progress.

1.19.00 **Drawings / documents for Approval**

1.19.01 The Contractor shall submit his Master Deliverable Schedule considering the priority of the listed documents with respect to the project execution schedule to enable the Owner's Consultants (DCPL) to plan manpower deployment. The documents in the Schedule should be marked in two categories viz. (a) 'For Approval' (A) and (b) 'For Reference' (R).

1.19.02 The Contractor shall assign the basic engineering documents in 'For Approval' category and obtain approval of those documents prior to submittal of corresponding detail engineering documents. For the Bidder's guidance - such documents shall include, but not limited to the following:

a) Master Deliverable List – Electrical with schedule of submission
b) Electrical key single line diagram for the entire plant indicating rating of equipment
c) Electrical system study (load flow, short circuit, motor starting) with software output.
d) Diagram of Generator, GT, UT & ST with Metering & Protection
e) Design Memorandum & Sizing Calculation for–
    i. Generator and Excitation System
    ii. GCB
    iii. Generator Busduct
    iv. GT, UT, ST and other auxiliary transformers
    v. MV busduct
    vi. DC System
    vii. DG Set
    vii. UPS
    viii. HT & LT Switchgears
    ix. HT & LT Cables
f) General Technical Particulars (GTP) of all electrical equipment
g) Logic diagram for Generator, GT, UT, ST.- Protection & Annunciation
h) Logic diagram for HT & LT Switchgears – Incomer, Tie, Bus-coupler, Feeders, Drives
i) Test protocol for all electrical equipment
j) Integrated unit protection scheme
k) Relay setting calculation for Generator, Transformer, 11kV/3.3kV/0.415kV system relay panels
l) CT and VT calculations for Generator circuit
m) Electrical single line diagram for auxiliary power distribution system
n) Design Memorandum - Grounding system
o) Design Memorandum – Lightning protection system
p) Design Memorandum – Cable raceway system
q) Design Memorandum – Station lighting system
r) Design Memorandum – Chimney & Cooling Tower electrical
s) Cable numbering scheme
t) Drive control & measurement philosophy and Plant Control Philosophy
u) Layout for -
    i. Transformer Yard
    ii. 400kV Switchyard
    iii. HT & LT Switchgear Rooms
    iv. Electrical Control Rooms
    v. Battery & Battery Charger Rooms
    vi. Inter-plant Cable Raceway

vii. Area Lighting
viii. Station Grounding Mat

u) All drawings/data relevant to the equipment like QAP, Guaranteed Technical Particulars, General Arrangement Drawing, Bill of Material, Foundation Plan, Single Line Diagram, Control Schematic, Wiring Diagram, Sizing calculations, etc. shall be furnished for approval of Owner/Owner's Consultant.

1.19.03 The Owner's Consultants may review a document assigned in 'For Reference' category as they deem necessary and furnish comments for compliance by the Contractor.

2.00.00 SCOPE OF SUPPLY & WORK

2.01.00 General

2.01.01 The scope of work related to electrical system is an intrinsic part of the total EPC Contract.

The Bidder's scope shall include design, engineering, manufacture, type testing, inspection & shop testing at supplier's works, packing, forwarding to site including customs clearance/ port clearance (if required), receipt and unloading, in-plant transportation, handling and storage (preservation & conservation of equipment) at site, erection including associated civil and structural works, testing and commissioning of the Electrical equipment/ system and works indicated in subsequent sections of Volumes – V-A, V-B & IIC (Generator) for one (1) unit and balance of plant (BOP) as indicated in this chapter. The scope includes all interface/ interconnections with the electrical systems under this contract as required for main plant, balance of plant, switchyard and other systems mentioned elsewhere. Electrical scope shall be as described briefly in the following clauses but not limited to it.

2.01.02 Scope of work shall also cover the design, manufacture, assembly, testing at manufacturer's works/laboratory, supply, delivery, properly packed for transport to site, storing at site of mandatory spares, 3 years O & M spares as detailed hereinafter in subsequent sections of Volumes- V-A, V-B & IIC as required for efficient and trouble free operation.

2.02.00 Generator and Auxiliary System

2.02.01 Generator complete in all respects including stator, rotor, bearings, couplings, terminal pads with palms and all its associated supervisory and instrumentation system.

2.02.02 Complete hydrogen cooling, carbon dioxide and nitrogen gas systems as applicable including the necessary piping and pipe supports, valves, measuring system along with the control panel and gas cylinders.

2.02.03 Complete seal oil system including the necessary tanks, pumps, motors, coolers, strainers, piping and pipe supports, valves, measuring system along with control panel.

2.02.04 Complete water cooling system where applicable including the necessary tanks, pumps, motors, heat exchangers, strainers, piping and pipe supports, valves, measuring system along with control panel.

2.02.05 Complete excitation system (brushless or static type) with main exciter, excitation transformer, thyristors, pilot exciter, rectifiers and filters, field flashing and field forcing

equipment, rotating diodes etc. as applicable along with the DAVR, de-excitation equipment, cables/bus duct and all necessary control, annunciation and monitoring equipment mounted on suitable panels.

2.03.00 **Generator Busduct and MV Busduct**

(a) Generator Busduct and Auxiliary equipment –Three phase busduct will run from generator terminals upto generator circuit breaker and from generator circuit breaker to generator transformer with intermediate tap-off connection to Unit/Standby Transformers and V.T. & S.P. cubicles. Delta run of busduct shall be achieved prior to connection with 1-phase GTs. Neutral side busduct run will terminate at the Neutral Grounding Transformer (NGT) cubicle. CTs shall be provided both phase & neutral sides of busduct.

(b) Medium Voltage Busduct

The standard equipment ratings have been specified in the relevant Sections.

2.04.00 **Generator Circuit Breaker**

A set of Generator Circuit Breaker alongwith one spare pole complete with all associated equipment, isolator on GT side and earth switches on both sides.

2.05.00 **Transformers**

S.No.	Equipment Name	Rating / Parameters/Quantity
1.	Power Transformers	
a)	Generator Transformers	330 MVA(minimum), 1-ph, as per SLD & system requirement
b)	Standby/Startup Transformers	as per SLD & system requirement
c)	Unit Transformers	as per SLD & system requirement
2.	Auxiliary Oil filled Transformers	as per SLD & system requirement
3.	Indoor Transformers (Cast Resin Dry type)	as per SLD & system requirement
4.	High voltage transformer-rectifier sets for ESP	as per system requirement
5.	NGR	as per system requirement
6.	Spare Oil for Transformer/ Reactor	10% of total oil for all Transformers

2.06.00 **Switchgear**

2.06.01 **11kV and 3.3kV Switchgear**

The scope shall include 11kV & 3.3kV Switchgear boards as required for power distribution to plant auxiliaries. Typical key single line diagram for auxiliary power supply is enclosed. The design and sizing criteria of the Switchboards shall be as described later in this Section.

All the Switchboards (each section) shall have two (2) nos. transformer feeder and two (2) nos. motor feeder of highest rating as spares.

SPBD tie connection among the 11kV unit and standby switchboards shall be provided in order to augment redundancy,

Owner would prefer supply of MV Switchgear from a single manufacturer.

2.06.02 **LV Switchgears and LV Busducts**

The scope of work includes the following for feeding all the LV Loads of the power plant as required. A typical key single line diagram for Aux Power Supply Drawing is enclosed. The design and sizing criteria of the Switchboards shall be as described in subsequent clauses. The major LT Switchgear shall include the following:

- 415 Volt Switchgears
- 415 Volt Motor Control Centers
- 415 Volt AC Distribution Boards
- 220 V DC /48 V DC Distribution Boards
- 415 Volt AC Fuse Boards
- 220 Volt DC Fuse Boards
- Local Motor Starters, Local Control Panels, Local Push Button Stations, Telescopic Trolley/ Welding / Lighting Transformers
- LV Bus ducts

The scope includes the following features:

(a) All switchgear, Motor Control Centers (MCCs) & AC/DC distribution boards, etc. shall have at least 20% or minimum two (whichever is higher) fully equipped switch-fuse modules of each rating as spares, uniformly distributed over different vertical sections.

(b) All switchgears, MCCs, AC/DC boards, etc., shall have at least twenty (20%) per cent of starter modules/MCCB module or at least one module (whichever is higher) of each physical size as spares, equipped for the rating of the largest auxiliary fed from that size of module.

(c) L.V. switchgear shall have duplicate supply source through two incoming line breakers and one bus section breaker, with provision of slow 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.

(d) LT PCC/PMCC for ESP shall have upstream dry / oil type LT Transformers, connected by non-segregated phase bus duct. These transformers shall be fed from 11kV unit switchgears. There shall be one MCC/ACP for each pass of ESP.

(e) Combined Local Starter Panels (CLSP) for group of Ventilation fans (up to and including 5.5 kW motors).

Owner would prefer supply of LT Switchgears and LT Bus ducts from maximum two different manufacturers.

2.06.03 **Numerical Relay Networking**

The Contractor's scope of work shall include the following for all the 11kV, 3.3kV and LV Switchgears for the 800MW unit. The communication architecture and design criteria have been explained elsewhere in the specification.

The Contractor's scope of work shall include the supply, delivery, installation, testing and commissioning of the following:

a) Communicable Numerical Relays (both MV and LV Switchgears) conforming to IEC 61850 protocol.

b) Data Concentrators with redundant Servers (not more than 100 relays shall be connected to one such Data Concentrators); 50 Nos of additional relays (Owner's requirement) shall be considered while designing Data Concentrators

c) LAN Network along with 61850 Ethernet Switches for both MV & LV Switchgears

d) HMI station (with Operator Work Station, Engineering Workstations and printers)

e) Fiber Optical cable & HDPE Conduit (length as required), Terminal equipment such as LIU, etc. (quantity as required), GPS (Two Nos) and Laptops (at least 10 Nos)

f) Any other equipment required to the intended specification

g) Suitable gateway to interface DDCMIS and Numerical relay network (at Data concentrator level)

The typical configuration of such a proposed system is enclosed. The numerical relay network shall include relays on all MV & LV switchgears being supplied under this package. Data concentrators shall be distributed functionally and geographically and shall be interconnected through Fibre Optic cables. Required number of FO ports for interface to DDCMIS with Fibre Optic cables shall be made available on all Data concentrators. Provision for connection and arrangement for termination of Fibre Optic cables from DDCMIS at Data concentrator end shall be made.

2.07.00 **DC System**

2.07.01 Lead acid plante type batteries and battery chargers, with the battery taking over and catering to all the loads connected to the D.C. system, including emergency loads for main plant, switchyard and all other areas in the scope of the contractor, as per system requirement.

2.07.02 Following DC systems shall be supplied to cater to various DC loads in the plant:

a) Two nos. 220V batteries with each battery having Float & Float cum Boost chargers, each rated for 100% capacity for the main plant loads and one 100% capacity Standby Boost charger.

b) 220V battery with Float & Float cum Boost chargers each rated for 100% capacity to meet CHP requirement.

c) 220V battery with Float & Float cum Boost chargers each rated for 100% capacity to meet loads of other far-away auxiliary systems like AWRS, make-up water, ash silo (if any) etc.

d) Two nos. 220V batteries, each battery having Float & Float cum Boost chargers, each rated for 100% capacity for 400kV Switchyard.

e) Two nos. 24V batteries, each battery having Float & Float cum Boost chargers, each rated for 100% capacity for plant DCS system.

2.07.03 Design / sizing criteria shall be as described in subsequent clauses of this Section.

2.07.04 DC System shall be supplied from a single manufacturer.

2.08.00 **Motors**

Motors along with couplings and coupling guards for all rotating auxiliaries covered under this package.

2.09.00 **Electrical Actuators**

Electric actuators with integral starters along with associated accessories etc shall be supplied on as required basis for Valves / Dampers to meet the functional and the other specification requirement

2.10.00 **Variable Frequency Drives**

Variable Frequency Drive (VFD) shall be supplied for ID Fan and any other drive as specified elsewhere or if required by practice. VFD shall be microprocessor based digital controlled with necessary motor protection etc. To minimize the harmonic affects on source side necessary Auxiliary Isolation Transformers shall be provided wherever VFD's are used.

Variable Voltage Variable Frequency (VVFD) Drives shall be considered for controlling Stacker- Reclaimer machine and other equipments as required for Coal Handling Plant.

2.11.00 **Cabling**

2.11.01 Cabling work, but not limited to the following shall be in the scope of the contractor for the complete plant, building, equipment and switchyard system etc. including interplant areas.

(a) Laying of HT power, LT power and control cables.

(b) Cable trestles, cable trays and fittings, along with support system.

(c) Cable glands and lugs.

(d) Straight-through jointing kits for HT XLPE power cable, LT power and control cables.

(e) Cable termination kits for HT XLPE power cables.

(f) Trefoil cable clamps.

(g) Junction boxes.

(h) Galvanized steel pipes/ HDPE/ Hume pipes/ PVC pipes

(i) Miscellaneous items like M.S. sections etc. as required

(j) Fire proof cable penetration sealing system for cable galleries, cable exits etc.

2.11.02 3.3kV power supply to Stacker/ Reclaimer through land mounted junction box, flexible trailing cable with cable reeling drum, transformer mounted on the mobile equipment.

2.11.03 In addition to other drawings, Contractor shall also prepare complete equipment layout drawings, lighting layout drawings including cable tray layout, routing, Power and control cable schedules etc.

2.11.04 Power and Control cable interconnection charts shall also be prepared by bidder and submitted for review.

2.12.00 **Cables**

2.12.01 **HT Power Cables**

HT power cables required to feed the transformer feeders, motor feeders and inter-stage connection with feeders shall be a indicated in typical key single line diagrams for Aux Power Supply, along with necessary termination, lugs and/ glands.

2.12.02 **LT Power and Control Cables**

LT Power and Control cables as required for the complete plant, building, equipment and switchyard system etc.

2.12.03 **Fire Survival Cables**

Fire Survival Cables, suitable for a minimum temperature of 750 deg. C for 3 hours, for both power & control, shall be provided for the following –

i. DC emergency lube oil pump

ii. DC hydrogen seal pump

iii. Turbine lube oil pump/barring gear

iv. DC emergency lighting for main building and service building

v. DC cables for battery to charger & DC distribution boards

vi. Jacking oil pump

vii. Emergency turbine trip in control room

viii. Boiler Turbine : Generator inter trip which include the interconnection between -

- Boiler master fuel trip and turbine trip relays
- Generator trip relays & turbine trip relays
- Generator trip relays & generator breaker
- Generator trip relays & field breaker
- Generator trip relays & unit auxiliary transformer breaker
- Incomer cables for DG board, emergency board, DC lighting board etc.

2.13.00 **Grounding & Lightning Protection**

2.13.01 Scope of grounding system for the power station complex includes in principle:

a) System grounding to facilitate ground fault relaying and to reduce the magnitude of transient over voltage

b) Equipment grounding to provide protection to personnel from potential caused by ground fault currents and lightning discharges.

c) Electronic Equipment grounding for multiple purpose of signal return, safety, EMI control, and antenna function

2.13.02 System grounding involves grounding of the neutrals of generators, transformers, DG sets etc. as discussed in Clause No. 1.12.00.

2.13.03 Scope also includes stable ground grid for grounding of equipment and structures and for maintaining the step and touch potentials within safe limits. An earth mat buried at a suitable depth of 1.0m below the ground will be laid in and around the power station including transformer yard and switchyard. All metallic parts of equipment, supposed to be kept at earth potential, will be connected to the grounding mat. Buildings, structures, transmission towers, plant railroad tracks, the perimeter fencing will also be connected to the grounding mat. The grounding mat will be interconnected with each other with in the plant area. Switchyard earth mat and main plant earth mat shall be connected at minimum two (2) places with test links.

2.13.04 Grounding of equipment body is to be adopted to provide protection to personnel from potential caused by ground fault currents and lightning discharges. Electrical equipment shall be earthed at two points.

2.13.05 Electronic grounding will be a separate earthing system consisting of a number of deep driven earthing rods interconnected with insulated cables and insulated risers are to be installed. This system will be totally isolated from the power equipment earthing mesh risers described above and will be located underground vertically below the electronic equipment room.

2.13.06 Lightning protection system will be installed for protection of the buildings/ structures and equipment against lightning discharge. This will be achieved by providing lightning masts on stacks, cooling towers, power house building, towers in switchyard, flood light towers etc. and connecting these with ground grid.

2.14.00 **Station Lighting**

Station lighting system for the complete plant, buildings and equipment, Lighting fixture complete with lamps & accessories, Lighting Panels, Receptacles, Switch boxes. Conduits, Lighting Wires, Ceiling fans with regulators, Lighting poles, Lighting masts, Earth wires and rods, Junction boxes, Battery operated automatic self contained lighting fixture, Maintenance ladders shall be in the scope of contract.

2.15.00 **DG Set**

2.15.01 One (1) no. Diesel Generator set alongwith acoustic enclosure of stationary type suitable for outdoor installation to be provided. DG sets shall normally be started from plant DDCMIS located in central control room with provision of manual control from D.G. control room.

2.15.02 DG set rating shall be finalized by the EPC contractor for this 800 MW Power plant to serve as emergency power for safe shut down in case of total grid failure, taking into account the following 415 V essential auxiliaries/services :

1	Barring gear	7	BFP Lub Oil Pump
2	AC Emergency Lub Oil Pump	8	Flame Scanner Cooling Air Fan
3	AC Jacking Oil pump	9	Emergency Light & Lift
4	I.D. Fan Lub Oil Pump	10	Station Battery Charger (220V DC & 24V DC)
5	F.D. Fan Lub Oil Pump	11	UPS
6	A.C. Seal Oil Pump	12	Valve & Damper DBs, Soot blower MCC

2.15.03 Separate DG building shall be provided to accommodate DG sets, AMF panels, Auxiliary MCC, Battery & Battery charger, PCC, Protection & Metering panel, Fuel Oil day tank etc.

2.16.00 **EHV Switchyard**

2.16.01 Scope of work is for the supply, erection, testing and commissioning of 400kV air insulated switchyard as shown in the Single Line Diagram. The switchyard shall be complete with a self-contained switchyard control building.

2.16.02 Scope of work shall comprise but not limited to, the design, engineering, manufacture, testing and inspection at manufacturer's works, packing, supply, transportation, transit

insurance, delivery to site, unloading, storage and equipment erection including associated civil and structural works.

2.16.03 400kV switchyard shall have two main bus. Synchronizing of Generator Transformer & protection scheme shall be developed by bidder accordingly. 400kV switchyard shall generally employ one and half breaker switching scheme as indicated in the enclosed Single Line Diagram.

2.16.04 400kV circuits that are required to be created in the switchyard are shown in the enclosed Single Line Diagram.

2.16.05 Equipment and materials broadly in scope of supply and erection:

a) 420 kV SF6 Circuit Breakers

b) 420 kV Disconnecting switch with and without earth switches

c) 420 kV Current Transformers (CTs)

d) 420 kV Capacitive Voltage Transformers (CVTs) / Electromagnetic Voltage Transformer (EMVT)

e) 360 kV Lightning Arresters (LAs)

f) Tubular Bus bars, Twin moose ACSR conductors

g) Tension Insulator & Suspension Insulator string assembly sets

h) Conductor Spacers, Clamps & connectors, sag compensators

i) Bus Post and Disc insulators

j) ACSR Conductors & shielding wires

k) Bay marshalling boxes / AC kiosks

l) Junction box for CT and CVT

m) OLTE & associated equipment (as applicable)

n) Switchyard relay, control and metering panels. The protection system shall be coordinated with the overall protection system of the Plant.

o) Complete Substation Automation System (SAS) consisting of Bay Control Unit, data acquisition system, monitors, printers, fibre optic cable with terminal and interface along with necessary operating and application software.

2.16.06 Scope shall include but not limited to complete switchyard gantry structures, support, platform and miscellaneous structures, switchyard fencing, trenches and complete civil works considering the following:

a) Galvanized steel structures for CB, DS, CT, CVT, EMVT, LA, etc.
b) Galvanized steel gantry structures for main buses.

2.16.07 Scope shall also include the following:

a) Flood Light towers in new and extension areas of 400 kV switchyard.

b) Complete earthing grid (inclusive of supply of MS rod and GI flat) for earthing of all switchyard equipment.

c) Complete direct stroke Lightning Protection using Lightning Mast and/or shield wire and its connection to earth mat.

d) Armored Power and control cables, cabling (including interpole and interpanel), cable support angles, cable trays and accessories as necessary for cable erection such as glands, lugs, clamps for cables, ferrules, cable ties, hume pipe etc. Cable route markers for buried cable trench are also included in the scope.

e) Switchyard Control room (also see clause no. 2.16.01)

f) Substation Automation System (SAS based on IEC 61850 protocol) for control and protection of all 400kV bays

g) AC and Ventilation for control room building

h) ABT based energy metering system for all 400kV feeders.

i) Time synchronization equipment for switchyard and GRP.

j) Islanding scheme for entire 400 KV switchyard bays

k) Protection panels for Generator, GT, UT (GRP) to be located in corresponding CER and to be networked as per the SAS Architecture Drawing. One number generator DR with both slow and fast scan feature to located in GRP

l) All interconnecting facilities between substation automation system and Generating plant control system (Main Plant DDCMIS)

m) All third party interfaces with RLDC and OS Control room as per tender drawing for SAS Architecture

n) Interface between Protection Panels and OLTE system

o) AC & DC power supply system for entire EHV system Bay equipments

2.16.08 Equipment like breaker, Isolators, earth switch, CT, CVT, LA, insulators etc. shall have similar current/voltage rating irrespective of bay capacity to minimize spares and inventory.

2.16.09 All protections of 400kV system as per relevant tender SLDs shall be provided. Protection system shall be provided with Numerical relays compliant with IEC 61850 protocol.

2.16.10 Equipment and materials to be supplied by the Contractor shall form a complete 400kV switchyard. It is in the interest of the Contractor to acquaint himself with the site conditions and scope before submission of offer.

2.16.11 List of items mentioned under the scope is not exhaustive. Any item/items which are not specifically mentioned herein but are required to make the switchyard complete in all respects for its safe, efficient, reliable and trouble free operation shall also be deemed to be included and the same shall be supplied and erected by the Contractor.

2.17.00 **Energy Management System**

2.17.01 The scope includes Energy Management System (EMS) for accounting of the electricity to various segments of electrical system.

2.17.02 EMS will measure, record and display Apparent Power, Phase wise voltage, kW & kVA (reactive) at peak kVA, Power Down Time, Average Power Factor, Line Currents etc. Data collected from various meters will be displayed through various MMI pages of the EDMS system in Control Room.

2.17.03 The location of these meters will be as under following the Central Electricity Authority Regulation guideline:

- At a point after the generator stator terminals and before the tap-off to the UTs.
- On each incoming feeder (excluding tie feeders) of HT buses.
- On LV side of each incoming transformer feeder of LV buses.
- On each incoming feeder of emergency MCC buses from DG PCC and
- On all HT motor feeders.

2.17.04 EMS will generate Power Generation/Consumption and PLF Reports (Shift wise, Daily, Weekly, Monthly & Yearly basis), Single Line Diagram, Breaker on/off status and Load Flow and Reactive Power Flow Report as the minimum.

2.17.05 The system shall be complete with all necessary equipment and accessories like meters as per clause no 2.17.02, Communication Servers, Data Viewers / Operator Console with Printer, RS 485 to TCP/IP Converter, TCP/IP to FO Converter with FO Outputs, Light Interface Unit , Fibre Optics & HDPE Cables, TCP/IP Switches, CAT 5 HUB Cable, Twisted RS 485 Cable etc.

2.18.00 **Erection & Testing Equipment**

2.18.01 It shall be Contractor's responsibility to arrange all the erection and testing equipment as required at the erection stage and thereafter at the pre-commissioning and commissioning stages.

2.18.02 The Contractor's/his sub-contractors' testing equipment to be used at the pre-commissioning and commissioning stages must have valid calibration certificates available for the Owner's examination on demand.

2.18.03 The scope also includes electrical testing/laboratory instruments required by the Owner for his use after plant handover. Details of such electrical testing/laboratory instruments are given in separate Section of this Specification.

2.19.00 **Construction Power**

Owner will arrange power source free of cost at 11 kV level at one point. Street lighting and distribution system to be done by EPC contractor. High mast lighting and adequate lighting from safety point of view is to be provided in the construction area by the EPC contractor.

2.20.00 **Tests**

2.20.01 Various routine, type and acceptance tests shall be carried out on each equipment as listed in the individual sections.

All the tests shall be carried out in the presence of the Owner's representative unless

the witnessing of tests is waived beforehand by the Owner.

The contractor shall give minimum 15 days advance notice of the date when the tests would be carried out.

2.20.02 The contractor shall obtain the Owner's approval for the type test procedure before conducting the type test. The procedure shall specify the test set up, instrument to be used, acceptance norms, interval of recording etc. for the type test to be carried out.

In case the contractor has conducted any of the specified type tests on similar equipment within the last five (5) years as on the date of bid opening, he may submit type test report during detail engineering for waive of conducting such test. This clause shall be applicable to only those type tests which are so indicated in the individual sections. For these tests, only reports are to be submitted.

In case the contractor is not able to submit report of the type test(s) conducted within last five (5) years from the date of bid opening or in the case of type test(s) reports are not found to be meeting to specification requirement, the contractor shall conduct all such test(s) under this contract at no additional cost to the Owner either at third party facility or in presence of Owner's representative and submit the reports for approval.

2.20.03 For short circuit test, proto-type of similar design and of same capacity with documentary evidence shall be submitted for customer approval.

2.20.03 For newly designed equipment, type test shall be conducted at CPRI or Government approved laboratory at the Contractor's cost.

2.20.04 Certified reports of all the tests carried out at the works shall be furnished in six (6) sets to the Owner for approval.

2.20.05 The equipment shall be dispatched from works only after receipt of Owner's written approval of the test reports and MDCC.

2.21.00 **Mandatory Spares**

Contractors scope shall include Mandatory Spares of all equipments as mentioned in the relevant portion of Technical Specification and under Vol. IIA, Sec.-8.

2.22.00 **Scope of Design Work**

2.21.01 Complete basic design engineering and detail design engineering for the plant is in the scope of the EPC Contractor.

2.21.02 Contractor's output of basic design engineering work need to be submitted for review and approval of the Owner/Owner's Engineer. Accordingly, the Contractor's documents containing outputs of the basic design engineering work that need to be submitted 'FOR APPROVAL' are listed in Clause No.1.19.02.

2.21.03 Detailed design engineering shall be in conformity with and based on the approved basic engineering documents only. The Contractor shall submit detail engineering output in the form of drawings, data, curves & manuals in two categories: 'For Reference' and 'For Approval'. Those are listed in individual Sections of Volume V-A and Volume V-B.

3.00.00 **LAYOUT CRITERIA**

3.01.00 **Transformer Yard**

3.01.01 Generator Transformers, Unit Transformers, Unit Auxiliary Transformers and Standby Transformers, Station Auxiliary Transformers will be installed in transformer yard. Spare Generator Transformer shall be placed in transformer yard at a suitable location.

3.01.02 Aux. power transformers for BOP systems will be installed in respective areas of CHP, AHP etc. Only LT dry type (AN cooled) transformers shall be located inside a building.

3.01.04 One or if required two main rail track parallel to power house building shall be provided. It will be interconnected with the rail track in unloading bay. From main track, several branch tracks will be laid up to individual transformer location.

3.01.03 Layout shall allow removal of any transformer on rail track without affecting other transformers, equipment and structure.

3.01.05 Jacking pads will be provided at each right-angled connection of rail track right up to unloading bay.

3.01.06 GT & UT centre lines shall match with the centre line of generator isolated phase busduct. Reasonable space shall be kept in between the transformers and the Power House wall on 'A' row, for convenient and easy handling.

3.01.07 Baffle wall in between single phase GT unit, GT & UTs and between UATs & SATs shall be provided as per applicable codes.

Fire Wall in between other Aux. Power Transformer located in CHP, AHP and Water system areas shall be provided as per applicable codes like TAC recommendations.

Recommendations of TAC shall be followed regarding fire rating of Powerhouse walls/Pump House wall (as applicable) adjacent to transformers depending on the distance of the transformers.

3.01.08 Symmetry shall be maintained for transformer layouts to achieve more or less identical arrangement for each unit, in case of a multiple-unit station.

3.01.09 Equipment layout and cable routing as prepared by the successful bidder shall be subject to revisions upon review by the Owner's Engineer to achieve a neat layout, adequate working space all around, better aesthetics, or to meet statutory regulation and codes. Required changes shall be done by the successful bidder without any commercial implication.

3.01.11 Routing of 11kV and 3.3kV segregated phase busducts, both indoor and outdoor, will be so designed as to cause no interference with any other equipment, cable trays, pipe racks, etc.

3.01.12 Each transformer yard shall be fenced with gate for controlled movement of personnel as well as for removal of transformer without dismantling busduct or cable boxes.

3.02.00 **Criteria of Oil Pit for Transformer**

An oil soak pit under the transformer and a common oil pit (unitized) outside the transformer yard / building at a distance ≥ 2.5 m from the fencing shall be provided for transformer containing ≥ 2000 litre of oil.

3.02.01 Oil Pit under Transformer and its Cooler Bank

a) Gravel filled open oil pit will be provided under each transformer and its cooler bank. 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 60 mm.

b) Each pit will be connected to the drain line of at least 150mm diameter stoneware pipe with a minimum slope of 1:96 leading to common oil pit. Level of the pit under the transformer shall be such that there will not be permanent accumulation of oil/water.

3.02.02 Common Oil Pit

A common oil pit (unitized) shall be provided for GT, ST, UTs, UATs and SAT in transformer yard. For other HT aux. power transformers a common oil pit (unitized) shall be provided in transformer yard near respective pump house. All the oil pits shall be connected to the drain line of waste water treatment system.

a) Volume of the oil pit upto bottom level of the oil pit shall be calculated based on : (a) Oil quantity of the largest transformer, (b) Quantity of the water for sprinkler system based on 10.2lit/min/sq.meter of the largest transformer surface area (Ref: TAC manual for water spray system) and 10 minutes operation of spray water system (ref : NFPA 850),.and (c) Quantity of rainwater collected from all associated pits (assumed 5-7% of total oil quantity of associated transformers)

b) The common oil pit will be closed type of water-proof concrete construction.

c) Pit will be provided with two (2) sump pumps. Discharge rate of each pump shall be at least equal to the discharge rate of high velocity water spray system provided for fire-fighting of the transformer. The sump-pump shall have automatic operation by float switch with manual over-riding facility.

d) The sump-pump outlet will be connected to oil-water separator.

f) Transformer fire/drainage of oil will be considered for only one transformer at a time.

3.03.00 **Layout Requirement for BOP Auxiliary Buildings**

3.03.01 CHP Electrical cum Control buildings shall be preferably two (2) storied building. The ground floor shall be used as cable vault room. The first floor (minimum floor level at 3.5metre above cable vault finished floor level) shall accommodate electrical/ communication/monitoring equipment. It shall also accommodate CHP fire fighting panel and HVAC equipment as applicable with associated equipment.

3.03.02 Wagon tippler control room for each wagon tippler shall be located near track. Control room wall facing the track shall be provided with glass panes to have a full view of the coal unloading operation.

3.03.03 Separate Control rooms will be provided at C.W. pump house, ESP control building, Vacuum pump building, Fly ash conveying compressor building, Ash slurry and Ash Water pump house complex, Fuel oil pump house , DM plant building (as required), etc. Control rooms will be generally provided at the same floor level of switchgear room with access between the two.

3.03.04 For areas where Switchgear/MCC /Control Rooms are located at upper floor without any cable spreader room below, adequate height shall be provided for rooms below to accommodate overhead cable racks inside room.

3.03.05 Separate rooms shall be provided for batteries with lay down space for one identical battery set. Battery charger and D.C. distribution board will be located in different room.

3.03.06 Two covered stairs shall be provided on opposite sides of all multistoried building.

3.04.00 **Equipment Layout**

3.04.01 Flexibility shall be kept for handling of equipment without obstruction both during erection and maintenance. Adequate handling facilities, space, door/ rolling shutter of adequate width and height shall be provided for the purpose.

3.04.02 Generator circuit breaker (GCB) shall be located inside the Power House building. If the layout demands locating the GCB at an elevated level, an all-around working platform of adequate size at that level with a permanent staircase shall be provided.

3.04.03 **Layout Requirement for Switchgear Rooms**

a) The following clearances shall be maintained for Switchboards:

		HT Switchboard	LV Switchboard
a)	Front Clearance		
	For one Row of Swgr	2.0m (Min)	1.5m (Min)
	For two Rows of Swgr facing each other	2.5m (Min)	2.0m
b)	Back Clearance		
	For single front	1.5m(Min.)	1.0m (Min.) (c)*
	For double front	NA	1.5m (Min.)
c)	Side Clearance	Min. 800mm plus width of one panel	

b) HT Switchboard clearances shall be followed wherever both LT & HT switch boards are in the same room.

c) * Minimum clearance of 1500 mm shall be provided on rear of panel for single front boards where rear door width is less than 1500 mm and where cable trench/trays below is not obstructed by column foundation/columns.

d) Where the specified front clearance is not adequate for movement of any electrical equipment like dry type L.T. transformers, the same shall be increased to suit transformer dimensions.

3.04.04 Generally all electrical room shall be provided with 2 doors in addition to the shutters provided for handling transformer, switchgear, panels etc.

3.04.05 Air-conditioned rooms shall be provided with double door.

3.04.06 All busduct shall enter the PCC/PMCC from either top or from side.

3.04.07 Clearance of 1500 mm in between adjacent panels in a row or from the side wall/door shall be so decided that handling of shipping section of any board is not obstructed.

3.04.08 Cable spreader room floors shall have all openings properly ridged to prevent water drainage into the room below. In addition proper facilities shall be provided at cable spreader floor to drain the water in case of operation of sprinkler system.

3.05.00 **Interplant Cable Routing**

3.05.01 Interplant cable routing will be on overhead cable trays on pipe cum cable trestle or on cable trestle except where approved by purchaser/consultant. In exceptional case, small stretch of outdoor run of interplant cable routing may be taken through cable trench only with the Owner's prior approval.

3.05.02 Only in specific areas where number of cables are too small compared to the route length, cables may be directly buried underground with prior approval by Owner.

3.05.03 Space for accommodating additional trays, which may come in future, shall be provided in the cable route. The Contractor shall provide such trays without any extra cost implication to purchaser.

3.05.04 Cable trestles shall have a minimum 600mm clear walk way all along its routes and shall have maintenance platforms as required.

3.05.05 Cable in CHP area shall be generally routed through the conveyor gallery / tunnel, TP / Buildings by separate supporting structures, Pipe cum cable bridge. The cables shall be laid in vertical trays.

3.05.06 The bottom of the steel supporting structure shall be generally at 2.5 m above the grade level except for road crossing and rail crossing where the same shall be 8.0 m and 9.0m respectively above finished grade level.

3.05.07 Routing of cables shall be designed taking care of the following:

(a) Separate trays shall be provided for H.T., L.T., control and instrumentation and FS cables.

(b) LT mutlicore power cables shall be laid touching each other in single layer & touching formation.

(c) LT single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil centre lines.

(d) Control and instrumentation cables shall be laid in maximum of two layers formation.

(e) Single core HT power cables shall be laid on trefoil formation with a distance of four times the diameter of cable between trefoil centre lines.

(f) Multi core HT power cables shall be laid in single layer & touching formation.

(g) Normally cable trays shall be designed with 70% fill-in criteria and conduit 40% fill-in criteria.

(h) Separate cable tray shall be provided for Fire Survival cables.

4.00.00 **SIZING CRITERIA FOR ELECTRICAL EQUIPMENT**

4.01.00 **Generator**

4.01.01 Generator and its excitation system shall have a capability at least matching the declared maximum continuous rated output of the associated steam turbine for the design maximum secondary cooling water temperature (ECW temperature) at/with:

(a) all power factors between 0.85 lagging and 0.95 leading

(b) +3% to -5% frequency variation,

(c) terminal voltage variation of +/- 5% and

(d) combined voltage & frequency variation of 5%.

4.01.02 It shall be ensured that when the Generator is working at this capability and design maximum secondary cooling water temperature (ECW temperature), no part of the Generator shall attain a temperature in excess of the temperature limits specified for Thermal Class 130 (B) insulation as per IEC-60034.

4.01.03 Also the generator and its excitation system shall be capable of continuous stable operation without any excessive temperature rise at the peak output of the associated steam turbine under VWO & HP heater out condition, etc. as available for design maximum secondary cooling water temperature (ECW temperature) at /with

(a) all power factors between 0.85 lagging and 0.95 leading

(b) +3% to -5% frequency variation,

(c) terminal voltage variation of +/- 5% and

(d) combined voltage & frequency variation of 5%.

Temperature of different parts may exceed those permissible for Thermal Class 130 (B) insulation under such operating conditions, but shall be lower than those permissible for Thermal Class 155 (F) insulation as per IEC-60034.

4.01.04 Capacity with one gas cooler out

Generator shall be capable of delivering at least two-third of the rated and maximum continuous MVA with ten (10) percent of tubes in each cooler plugged without exceeding the temperature limits of thermal class 130 (B) and thermal class 155 (F) respectively.

4.02.00 **Generator Transformer**

4.02.01 Rating of the Generator Transformer shall be suitable for continuous stable operation of unit at the rated nominal output at all power factors between 0.85 lagging and 0.95 leading. The minimum rating of the each single phase GT shall be 330 MVA (1-Phase).

4.02.02 Further the Generator transformer shall be rated for evacuation of peak net output (peak output of the generator under VWO/ HP heater out condition etc. less 50% of unit auxiliary power consumption i.e. one of the unit board fed from Standby Transformer) as indicated above at Clause 4.01.03, at all power factors between 0.85 lagging and 0.95 leading, continuously.

4.03.00 **Unit & Standby Transformers**

4.03.01 **Unit Transformer**

a. Unit transformers would be sized to meet the loads corresponding to auxiliaries required to meet the peak load requirements of the unit.

b. Each unit transformer shall be sized for the following:

The loads of a set of unit auxiliaries (including MDBFP) corresponding to 60% BMCR operation plus

The connected station load plus

Owner's load of *6.3MVA* for other purposes like colony etc. (if specified elsewhere), plus

Loads due to outage of largest rated outgoing transformer feeder on other bus, plus

10% margin on the aforesaid mentioned sum

Multiplied by no load voltage correction factor as defined later

c. The minimum ONAF rating of each Unit Transformer shall be 50MVA.

4.03.02 **Stand by Transformer**

a. The Stand by transformer shall be sized to cater outage of one fully loaded Unit Transformer under the condition specified above plus any other loads connected on each winding/station bus. A margin of 10 % and no load voltage correction factor as defined later shall be considered.

b. The minimum ONAF rating of each Stand-by Transformer shall be 100MVA.

4.03.03 Rating of each Unit Transformer shall be so chosen as to limit transient voltage dip on DOL starting of the largest rated 11kV motor (may be the BFP motor), to less than 20% while also limiting the maximum MV Switchgear fault level to 50kA(rms).

4.03.04 No Load Voltage Correction Factor (= Transformer No Load voltage/ rated bus Voltage) shall be used for sizing of all transformers i.e.
Transformer size = the calculated size X no load voltage correction factor (11.5/11, 3.6/3.3, 0.433/0.415).

4.03.05 All the transformers shall be sized based on the maximum load expected to be fed by the transformers. All auxiliary transformers except Unit and Standby Transformers shall be sized so as to have 20% margin at design ambient conditions after considering final load requirements at peak conditions.

4.03.06 The successful bidder shall determine voltage regulation and short circuit levels through system study considering various conditions of operations, to ensure that these are within permissible value.

4.04.00 **Auxiliary and LT Transformers**

Adequate number of auxiliary transformers shall be provided to meet the demand on 3.3kV and 415V systems under most onerous conditions, with the criteria that each 3.3kV / 415V switchgear / MCC / DB shall be fed by 2x100% transformers / feeders, and these shall be rated to carry the maximum load expected to be imposed.

CHP auxiliary transformers shall be sized to meet the demand on simultaneous operation of both the streams.

4.05.00 **Bus ducts and Cables**

4.05.01 The short circuit rating of the generator main busduct will correspond to higher of the fault current contributions from generator or transformer side while the tap-off busducts will be designed for sum of the fault contributions from generator and GT side.

4.05.02 HT and LT power cables shall be selected on the basis of current carrying capacity, short circuit rating and permissible maximum voltage drop at equipment terminals during normal operation and starting conditions. Voltage drop of the cable during motor starting condition shall be limited to 15% and during full load running condition shall be limited to 3 % of the rated voltage. Other outgoing feeder /transformer feeder shall be limited to 3%.

4.05.03 Cables and bus ducts feeding switchboards from transformers shall be sized based on transformer rating and considering the maximum negative voltage variations envisage in the specifications. All derating factors applicable shall be taken into consideration.

4.05.04 Cables and bus ducts feeding transformers shall be sized based on current ratings of transformer at the minimum voltage tap of the transformer. All derating factors applicable shall be taken into consideration.

4.05.05 All other cables/bus-ducts shall be sized based on the load demand under most onerous conditions.

4.05.06 Cables shall be derated for the site ambient and ground temperatures, grouping and soil resistivity and cable laying configuration.

4.05.07 Cables, for circuit breaker controlled feeders, shall withstand the short circuit current for the fault clearing time. 0.16 sec. for outgoing feeder, 0.5 sec. for tie breaker and 1.0 sec. for Incomer.

4.05.08 For the fuse/MCCB/Circuit breaker protected circuits, the cable size shall depend upon full load current subject to voltage drop limited to 3% during running of all feeders and 15% during starting for motor feeders. In addition, transformer regulation shall also be considered for loads fed from 415V PMCC. In case of other out going feeder voltage drop shall be limited to 3%. For welding receptacle, 3% running drop shall only be considered.

4.05.09 For loads fed from local panels, the total running voltage drop in cable from 415V PMCC to local panel and from local panel to individual motor shall be limited to 3% at full load motor current while the same during starting shall be limited to 15%.

4.05.10 Current rating of motor feeder/cables should be at least 125% of full load current.

4.05.11 For Flap Gate, Rack & Pinion Gate, Electrical Hoist - 3% running drop and 10% starting drop shall be considered with reference to 415 V bus voltage.

4.05.12 Minimum size of control cables shall be 2.5 sq. mm copper and for power cable shall be 6.0 sq.mm aluminium.

4.06.00 **DC System**

4.06.01 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.

4.06.02 Sizing of all batteries except those for the Switchyard shall be done based on different types of continuous and intermittent loads including motor starting for the complete emergency duration specified as per the system requirement. All intermittent loads shall be considered with minimum 1 minute duration. The no. of cells, end cell voltage shall be considered based on the minimum and maximum voltage window and cable drop etc as per system requirement. Minimum electrolyte temperature for battery sizing purpose shall be considered as 5ºC lower than the annual mean lowest ambient temperature of the site.

4.06.03 Total DC load shall include load for Owner's facilities also, as identified elsewhere in the Specification.

4.06.04 DC scheme shall ensure that each critical load is fed from two different bus sections. DCDBs shall provide adequate number of feeders on each section.

4.06.05 Each of the batteries shall be sized to supply total DC load of that area at an acceptable voltage for at least ten (10) hours under complete blackout condition. The minimum size of battery for BTG area shall be 1500AH for lead acid Planté type.

4.06.06 CHP battery shall be sized to supply DC lighting for at least one hour under complete blackout condition.

4.06.07 Sizing of Switchyard battery shall take into account the emergency lighting in Switchyard control room for a period of 1 hour. In addition to this all continuous DC loads of relay & control panels/OLTE panels and interlocking coils of isolators/earth switches shall be considered including requirement of line bays (where applicable), for a duration of 3 hours. Battery should be sized considering the worst of the following conditions:

(i) Simultaneous operation of the maximum number of breakers & associated equipments in case of bus fault in the switchyard.

(ii) Operation of Breaker failure relay (LBB relay)

4.06.08 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.

4.06.09 Boost/Float-cum-boost charger shall be sized to restore the fully discharged battery to full charge condition in ten (10) hour for lead-acid battery with 25% margin over maximum charging rate or to operate as a float charger with duty requirement, whichever is greater.

4.07.00 **DG Set**

4.07.01 DG set shall be able to meet safe shut down of the plant under emergency condition and in case of total power failure. It shall be sized to meet 100% of essential load requirements of the generating unit including starting of the largest motor (DOL) with other loads connected without exceeding the permissible starting voltage drop. Some of the vital station auxiliaries/systems like battery chargers of switchyard, auxiliary

supplies of instrument/plant air compressors, emergency air conditioning and ventilation system loads shall also be fed from DG set supply.

4.07.02 Minimum size of DG shall be 1500kVA.

4.08.00 **UPS System**

UPS System provides a regulated and uninterrupted single phase A.C. power, within specified tolerances, to critical station loads during normal and emergency operation. Capacity of inverter output shall be computed by the contractor considering the above requirement. 25% spare margin shall be kept on the total of above requirement. UPS shall be 415V AC, 3 phase input and 240V AC, 1 phase output.

The UPS system shall have 2x100% parallel redundant chargers and inverters, 2x100% PLANTE type battery bank, bypass line transformers and voltage stabiliser, static switch, manual bypass switch, 2x100% AC/DC distribution boards, other necessary protective devices and accessories.

4.09.00 **Electrical Laboratory Equipment**

Electrical laboratory equipment shall be supplied for testing various electrical equipment/devices during operation and maintenance of plant.

5.00.00 **PROVEN-MAKE CRITERIA FOR ELECTRICAL EQUIPMENT**

5.00.01 To read "Bidder/Contractor" in place of "Sub-vendor" in the following clauses in case the Bidder himself is the OEM.

5.01.00 **Isolated Phase Busduct**

5.01.01 Sub-vendor should have designed, manufactured, type tested, supplied, erected and commissioned Isolated Phase Bus duct for a turbo-generator of at least 500MW, which is in successful operation for a period of not less than two (2) years as on date of Techno-Commercial bid opening.

And

5.01.02 Sub-vendor should have firm Purchase Order for manufacture and supply of Isolated Phase Bus duct for a turbo-generator set of at least 660MW as on date of Techno-Commercial bid opening.

5.02.00 **Power Transformers**

5.02.01 Sub-vendor should have designed, manufactured, installed / supervised installation and commissioned/supervised commissioning of at least two (2) nos. (one each at two different project sites) of 400 kV or above class Generator Transformers of at least (a) 200 MVA capacity per single phase unit or (b) 330MVA capacity three phase transformer as a single unit, which should be in successful operation for at least two(2) years as on date of Techno-Commercial bid opening.

Or

5.02.02 Sub-vendor who have designed, manufactured, installed/supervised installation and commissioned/supervised commissioning of at least two (2) no. 220 kV or above class transformer which are in successful operation for two (2) years as on date of Techno-Commercial bid opening and have established manufacturing facilities for 400 kV class transformers based on technological support of its associate or collaborator, can also be considered Qualified provided his associate or collaborator

meets the qualifying requirement stipulated at 5.02.01 above. The associate will be fully responsible for design, testing, supply, erection, commissioning and putting into satisfactory operation.

5.03.00 **Auxiliary Oil Filled/ Dry type Transformers**

5.03.01 Sub-vendor should have manufactured & supplied at least two numbers (one each at two different project sites) of at least highest offered rating oil filled transformers which must be in successful operation for a period of at least two (2) years as on date of Techno-Commercial bid opening.

5.03.02 Sub-vendor should have his own facilities for conducting all routine and type tests as per IS: 2026 (except short circuit test).

5.03.03 The transformer considered for the above (cl. no. 5.03.01) should have been successfully short circuit tested.

5.04.00 **11 kV & 3.3kV Switchgears**

5.04.01 Sub-Vendor should have designed, manufactured and supplied at least one hundred (100) numbers of 11kV and /or 3.3kV Switchgear panels complete in all respects with fault rating of at least 50kA for one (1) second and 125kA (peak), which are in successful operation for a period of at least two (2) years as on date of Techno-Commercial bid opening.

5.04.02 Sub-Vendor should have manufactured and supplied at least one hundred (100) numbers of Vacuum Circuit breakers for 11kV and /or 3.3kV panels with a rating of 50kA rms BREAKING, 125kA peak MAKING and 50kA withstand for one (1) second, which shall be in successful operation in 3.3kV or higher voltage application for a period of at least two years as on date of Techno-Commercial bid opening.

5.04.03 Sub-Vendor's associate or collaborator meets requirement stipulated at 5.04.01 & 5.04.02 stipulated under Route 1.

5.04.04 The associate will be fully responsible for design, supervision of manufacturing and testing, and satisfactory operation of the equipment.

5.05.00 **LT Switchgear**

5.05.01 Sub-Vendor should have manufactured and supplied at least a total of five hundred (500) nos. draw out type air circuit breaker panels and / or draw out motor control centre panels complete in all respects with fault rating of at least 50 kA for 1 sec. and 105 kA (peak) under a single order and these panels shall be in successful operation for a period of not less than two (2) years as on date of Techno-Commercial bid opening.

5.06.00 **Numerical Relays & Networking**

5.06.01 Numerical Relays shall be offered from a Manufacturer who has manufactured and supplied and successfully configured at least 100 No's of Numerical Relays complying with IEC 61850 used for application in Feeder Protections/Transformer Protections/Motor protections. These relays shall be in successful operation for at least one (1) year as on date of Techno-Commercial bid opening.

5.06.02 The Numerical Relay Network system be offered from a Integrator /Manufacturer who has designed and successfully done FAT for a network on IEC 61850 with least 100 nos of Communicable Numerical Relays prior to date of Techno-Commercial bid opening.

5.07.00 **HT Motor**

5.07.01 **CW Motor**

The CW pump drive motors should be sourced from a manufacturer who have supplied at least two nos. of 11KV or above, vertical, DOL started squirrel cage induction motors of cooling type specified having rating 2000KW or more and motor speed not exceeding 500 rpm synchronous, which are in successful operation for at least two (2) years as on the date of Techno-Commercial bid opening.

5.07.03 **BFP Motor**

The offered Squirrel cage Induction motor shall be from such a manufacturer who has manufactured and supplied motor of 10MW or above rating, which is in successful operation in at least one (1) plant for a period not less than one (1) year as on the date of Tech no-Commercial bid opening.

5.07.04 **ID Fan Motor**

The offered Squirrel cage Induction motor shall be from such a manufacturer who has manufactured and supplied motor of 4MW or above rating, which is in successful operation in at least one (1) plant for a period not less than one (1) year as on the date of Techno-Commercial bid opening.

5.08.00 **LT Control Cables**

Sub-Vendor should have manufactured and supplied as on date of Techno-Commercial bid opening the following:

(a) At least 300 km of PVC insulated, PVC sheathed stranded copper conductor 1.1 kV grade cables in one single contract

(b) At least one (1) km of Flame retardant low smoke cables.

5.09.00 **LT Power Cables**

Sub-Vendor should have manufactured and supplied as on date of Techno-Commercial bid opening the following:

a) At least 100 km of aluminium conductor, XLPE insulated, PVC sheathed power cables of 1.1 kV or higher grade in one single contract

b) At least 100 km of aluminium conductor, PVC insulated, PVC sheathed power cables of 1.1 kV or higher grade in one single contract

c) At least one (1) km of flame retardant low smoke cables.

d) 1.1kV or higher grade power cable of minimum 630sq.mm. conductor size.

5.10.00 **HT Cables**

Sub-Vendor should have manufactured and supplied following cables, as on date of Techno-Commercial bid opening

(a) At least 50kms of XLPE insulated power cables of 6.35/11 kV or higher

voltage grade, executed in one or more orders.

(b) At least one (1) km of flame retardant low smoke cables of any voltage level.

5.11.00 **DG Sets**

Sub-Vendor should have supplied at least two (2) numbers of DG set of rating not less than 1250 kVA, at least one (1) each at two (2) different installations, which should be in successful operation for at least two (2) years as on date of Techno-Commercial bid opening. The make of the DG set (Alternator and Engine) shall be same as that of reference plant DG set.

5.12.00 **DC Batteries**

Sub-Vendor should have manufactured and supplied at least two (2) numbers of highest offered rating or above of high discharge type Plante positive plate type battery at least one (1) each at two (2) different industrial installations, which should be in successful operation for at least two (2) years as on date of Techno-Commercial bid opening.

5.13.00 **Battery Charger**

Sub-Vendor should have manufactured and supplied at least two (2) numbers of static automatic voltage regulator type Battery Chargers of highest offered rating or above, at least one (1) each at two (2) different industrial installations, which should be in successful operation for at least two (2) years as on date of Techno-Commercial bid opening.

5.14.00 **Generator Circuit Breaker (GCB)**

Sub-Vendor should have designed, manufactured, tested, supplied, erected & commissioned/supervised erection and commissioning of at least two numbers of generator circuit breakers (sulphur hexaflouride) of ratings not below that offered for this project, which are in successful operation for at least two (2) years as on date of Techno-Commercial bid opening. The ratings will constitute of:

a) Rated voltage and current rating.

b) Rated short circuit current carrying capability for one (1) second.

c) Rated short circuit peak making and latching current carrying capability.

d) Rated symmetrical RMS short circuit current interrupting capability.

The type (sulphur hexaflouride) and rating of breaker offered should also have been successfully type tested as on date of Techno-Commercial bid opening.

5.15.00 **400kV Switchyard Equipment (AIS)**

5.15.01 SF6 Circuit Breakers being offered should be from manufacturer who has manufactured and supplied minimum fifteen (15) nos. of SF6 Circuit Breakers of offered voltage class or higher, and which must have been in successful operation for a minimum period of two (2) years as on date of Techno-Commercial bid opening.

5.15.02 Disconnecting switches being offered should be from manufacturer who has manufactured and supplied minimum thirty (30) nos. of Disconnecting switch of offered voltage class or higher, suitable for air insulated substation/ switchyard and which must have been in successful operation for a minimum period of two (2) years as on date of Techno-Commercial bid opening.

5.15.03 400kV Instrument Transformers being offered should be from manufacturer who has manufactured and supplied minimum fifteen (15) nos. of single phase Instrument Transformers of offered voltage class or higher, suitable for air insulated substation/ switchyard and which must have been in successful operation for a minimum period of two (2) years as on date of Techno-Commercial bid opening.

5.15.04 400kV Surge Arrestors being offered should be from manufacturer who has manufactured and supplied minimum fifteen (15) nos. of single phase Surge Arrestors of offered voltage class or higher, suitable for air insulated substation/ switchyard and which must have been in successful operation for a minimum period of two(2) years as on date of Techno-Commercial bid opening.

5.15.05 The Erection Contractor must have supplied, constructed, installed and commissioned at least two 400 kV substations each having at least 5 number bays as a turnkey supplier and such substations must have been in successful commercial operation for at least two years as on date of Techno-Commercial bid opening.

5.16.00 **Substation Automation System & Protective Relays**

5.16.01 The Substation Automation System offered with distributed architecture should have been in successful operation in at least one (1) Substation/Switchyard of not less than 220 kV class for a minimum period of one(1) year as on date of Techno-Commercial bid opening.

5.16.02 The Generator Protection Relays, the Bay Protection Units including the Busbar protection and the energy metering System offered should be from manufacturer(s) who have manufactured and supplied the offered type of devices for respective equipment, which must have been in successful operation in a 500 MW or above unit / 220 kV class or above Substation/Switchyard for a minimum period of one (1) year as on the date of Techno-Commercial bid opening.

ANNEXURE-A

TECHNICAL PARAMETERS FOR ELECTRICAL SYSTEM

1.00 E.H.V. SYSTEM DATA

a) 400kV SYSTEM

1	Type of busbar scheme to be adopted	Two main bus
2	System voltage to be adopted	400 kV
3	System Earthing	Solidly grounded
4	Short circuit level	40 kA
5	Maximum system voltage	420- kV
6	Minimum system voltage	380 kV
7	Number of outgoing feeder lines	Refer Specification.
8	B.I.L. for equipment	1425 kVp
9	Short circuit current duration for which the substation have to be designed	1 sec.

2.00 M.V. SYSTEM DATA

1	Voltage System	11 kV & 3.3 kV
2	System of earthing to be adopted for both unit and station system	Resistance grounding
3	Limiting Ground Fault current Value	300 Amp.
4	Type of Bus transfer scheme to be followed for change over from one source to other.	Fast bus transfer followed by slow bus transfer for 11kV for various Switchboard as specified. Slow bus transfer for 3.3kV or as specified.
5	Type of switchgear to be selected	Vacuum circuit breaker
6	a) Connection between transformer and 11 kV& 3.3 kV switchgear	Busduct
	b) Connection between transformer and 11 kV & 3.3 KV NGR	Cable
7	Short circuit current	11kV - 50 kA 3.3kV – 50kA
8	Duration of short circuit current	1 sec.

3.00 L.V. SYSTEM DATA

1	Nominal 3 phase voltage to be selected for L.V. system	415 V
2	System Earthing	Solidly grounded
3	Type of Breaker to be selected	Air break
4	Type of outgoing feeder switching device in L.T. MCC	MCCB
5	M.C.C. type	Single front/Double front Fully draw out type
6	Short circuit level for 1 sec	50 kA

4.00 **DC SYSTEM DATA**

1	Nominal voltage to be selected for DC system	220 V
2	Type of Incoming / outgoing feeder switching device	Double pole Switch-Fuse
3	DCDB type	Single front/Double front Fixed type
4	Short circuit level for 1 sec	To be decided by Bidder 25 kA (minimum)

5.00 **UPS SYSTEM DATA**

1	Nominal voltage to be selected for UPS system	240 V, 1-Ph, 50 Hz, AC
2	Type of Incoming / outgoing feeder switching device	MCCB
3	UPSDB type	Single front, Fixed type, Modular construction
4	Short circuit level for 1 sec	To be decided by bidder 25 kA (minimum)

VOLUME: V-A

SECTION-II

TECHNICAL SPECIFICATION FOR A.C. & D.C. MOTORS

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	CODES & STANDARDS
3.00.00	SERVICE CONDITIONS
4.00.00	TYPE AND RATING
5.00.00	PERFORMANCE
6.00.00	SPECIFIC REQUIREMENTS
7.00.00	ACCESSORIES
8.00.00	TESTS
9.00.00	DRAWINGS, DATA & MANUALS

ATTACHMENT

ANNEXURE-A	DESIGN DATA

VOLUME: V-A

SECTION-II

TECHNICAL SPECIFICATION FOR A.C. & D.C. MOTORS

1.00.00 SCOPE

1.01.00 This section covers the general requirements of the drive motors for power station auxiliary equipment.

1.02.00 Motors 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.

2.00.00 CODES & STANDARDS

2.01.00 All 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 Major standards, which shall be followed, are listed below other applicable Indian Standards for any component part even if not covered in the listed standards shall also be followed:

i) IS-325

ii) IS-12615

iii) IEC-60034

3.00.00 SERVICE CONDITIONS

3.01.00 The motors will be installed in hot, humid and tropical atmosphere highly polluted at places with coal 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.

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

4.01.00 A.C. Motors

4.01.01 Motors shall be general purpose, constant speed, squirrel cage, three/single phase, induction type.

4.01.02 All motors shall be rated for continuous duty. They shall also be suitable for long period of inactivity.

4.01.03 LT motor & HT motor name-plate rating at 50ºC shall have at least 15% margin and 10% margin respectively over the input power requirement of the driven equipment at rated duty point unless stated otherwise in driven equipment specification.

4.01.04 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.

4.01.05 Motors efficiency class shall be IE1, IE2 as per latest version of IEC-60034.

4.02.00 **D.C. Motors**

4.02.01 D.C. motor provided for emergency service shall be shunt/compound wound type.

4.02.02 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.

5.01.03 The motor shall be designed to withstand momentary overload of 60% of full load torque for 15 second without any damage.

5.02.00 **Starting Requirements**

Motor shall be designed for direct online starting at full voltage. Breakaway starting current as percentage of full load current for various motor rating shall not exceed the given below-

Motors up to 1500kW	-	600% subject to IS tolerance of plus 20%.
Motors above 1500kW	-	450% not subject to any positive tolerance.

5.02.01 The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.

5.02.02 Motor shall start with rated load and accelerate to full speed with 80% rated voltage at motor terminals except mill motor. Mill motor shall start with rated load and accelerate to full speed at 85% of the rated voltage at the motor terminals.

5.02.03 a) Two hot starts in succession with motor initially at normal running temperature.

b) Pump motor subject to reverse rotation shall be designed to withstand the stresses encountered when starting with shaft rotating at 125% rated speed in reverse direction.

5.02.04 The motors shall be designed to withstand 120% of rated speed for 2 minutes without any mechanical damage.

5.03.00 **Stress During Bus Transfer**

5.03.01 The motor may be subjected to 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 The locked rotor withstand time under hot condition at 110% rated voltage shall be more than motor starting time by at least 3 seconds for motors up to 20 seconds starting time and by 5 seconds for motor with more than 20 seconds starting time.

5.04.02 Starting time mentioned above is at minimum permissible voltage of 80% rated voltage.

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.

6.00.00 **SPECIFIC REQUIREMENTS**

6.01.00 **Enclosure**

6.01.01 All motor enclosures for outdoor, semi-outdoor & indoor application 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 with canopy.

6.01.02 For hazardous area approved type of increased safety enclosure shall be furnished.

6.02.00 **Cooling**

6.02.01 The motor shall be self ventilated type, either totally enclosed fan cooled IC 411(TEFC), totally enclosed tube ventilated IC 511(TETV) or closed air circuit air- cooled IC 611(CACA).

6.02.02 For large capacity motors not available with above type of cooling may be accepted with IC 81W or IC 91W, closed air circuit water cooled (CACW) subject to the approval of the owner.

6.03.00 **Winding and Insulation**

6.03.01 All insulated winding shall be of copper.

6.03.02 All motors shall have class F insulation but limited to class B temperature rise.

6.03.03 Windings shall be impregnated to make them non-hygroscopic and oil resistant.

6.04.00 **Tropical Protection**

6.04.01 All motors shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion.

6.04.02 All fittings and hardwares shall be corrosion resistant.

6.05.00 **Bearings**

6.05.01 Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application. Bearings shall be rated for minimum service life of 40,000Hrs.

6.05.02 Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred.

6.05.03 Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.

6.05.04 Sleeve bearings shall be split type, ring oiled, with permanently aligned, close running shaft sleeves.

6.05.05 Grease lubricated bearings shall be pre-lubricated and shall have provisions for in-service positive lubrication with drains to guard against over lubrication. LT motors 15kW and above shall be provided with external greasing arrangement.

6.05.06 Oiled bearing shall have an integral self cooled oil reservoir with oil ring inspection ports, oil sight glass with oil level marked for standstill and running conditions and oil fill and drain plugs.

6.05.07 Forced lubricated or water cooled bearing shall not be used without prior approval of Owner.

6.05.08 Lubricant shall not deteriorate under all service conditions. The lubricant shall be limited to normally available types with IOC equivalent.

6.05.09 Bearings shall be insulated as required to prevent shaft current and resultant bearing damage.

6.06.00 **Noise & Vibration**

6.06.01 All HT motors shall be provided with vibration pads for mounting of vibration detectors. Vibration monitoring devices shall be provided on DE and NDE side in x&y direction with remote DCS monitoring, alarm and tripping.

6.06.02 The maximum double amplitude vibrations for HT motors upto 1500 rpm shall be 25 microns and 15 microns upto 3000 rpm. For 415V motors, maximum double amplitude vibrations upto 1500 rpm shall be 40 microns and 15 microns upto 3000 rpm.

6.06.03 The noise level shall not exceed 85db (A) at 1.5 meters from the motor.

6.07.00 **Motor Terminal Box**

6.07.01 Motor terminal box shall be detachable type and located in accordance with Indian Standards clearing the motor base- plate/ foundation

6.07.02 Terminal box shall be capable of being turned 360 Deg. in steps of 180 Deg. for HT motors and 90 Deg. for LT motors unless otherwise approved.

6.07.03 The terminal box shall be split type with removable cover with access to connections and shall have the same degree of protection as motor.

6.07.04 The terminal box shall have sufficient space inside for termination/connection of XLPE insulated armoured aluminium cables.

6.07.05 Terminals shall be stud or lead wire type, substantially constructed and thoroughly insulated from the frame.

6.07.06 The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.

6.07.07 The terminal box shall be capable of withstanding maximum system fault current for a duration of 0.25 sec.

6.07.08 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.

6.07.09 Motor terminal box shall be furnished with suitable cable lugs and double compression brass glands to match with cable used.

6.07.10 The gland plate for single core cable shall be non-magnetic type.

6.07.11 Minimum clearances to be provided between phase to phase and phase to earth shall be as under-

Voltage Rating of Motor		Minimum Ph-Ph & Ph-Earth clearance
0.415 kV	:	25 mm
3.3 kV	:	65 mm
11.0 kV	:	140 mm

Note: In case it is not possible to maintain these clearances, the live parts shall be totally insulated from earth and other Phases. Adequate clearances shall be provided for cable connections.

6.08.00 **Grounding**

6.08.01 The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer.

6.08.02 The grounding connection shall be suitable for accommodation of ground conductors as follows:

Rating			Conductor Size
Above	Up to		
-------	5.5 kW	:	8 SWG GI Wires.
5.5 kW	22 kW	:	25mm X 4mm GS Flat.
23 kW	55 kW	:	40mm X 6mm GS Flat.
56kW	174kW	:	50mm X 8mm GS Flat.
175kW	ABOVE	:	75mm X 10mm GS Flat.

6.08.03 The cable terminal box shall have a separate grounding pad.

6.09.00 **Minimum Cable Size for LT & HT Motors shall as be as follows-**

a) For 415V, 3-Ph, LT Motors-

Rating			Cable Size
Above	Up to		
-------	5.5 kW	:	1R X 3C X 6 Sq.mm
5.5 kW	11 kW	:	1R X 3C X 10 Sq.mm
11 kW	22 kW	:	1R X 3C X 35 Sq.mm
22 kW	37.5 kW	:	1R X 3C X 70 Sq.mm.
37.5kW	55 kW	:	1R X 3C X 150 Sq.mm
55 kW	75 kW	:	1R X 3C X 300 Sq.mm
75 kW	110kW	:	2R X 3C X 150 Sq.mm
110 kW	175kW	:	2R X 3C X 300 Sq.mm

b) For 3.3kV & 11kV, 3-Ph, HT Motors-

Rating			Cable Size
Above	Up to		

175 kW	1000 kW	:	1R X 3C X 240 Sq.mm
1000 kW	2000 kW	:	2R X 3C X 240 Sq.mm
2000 kW	4500 kW	:	2R X 3C X 300 Sq.mm
4501 kW	10,000 kW	:	9R X 1C X 1000 Sq.mm.

Note: During detail engineering if higher cable size is required same shall be provided.

6.10.00 **Rating Plate**

In addition to the minimum information required by IS, the following information shall be shown on motor rating plate :

a) Temperature rise in Deg.C under rated condition and method of measurement.

b) Degree of protection.

c) Bearing identification no. and recommended lubricant.

d) 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 30 kW and above shall be provided with space heaters, suitably located for easy removal or replacement.

7.02.02 The space heater shall be rated 240 V, 1 Phase, 50Hz and sized to maintain the motor internal temperature above dew point when the motor is idle.

7.02.03 Minimum Cable Size for space heater shall be as listed-

i) For LT motors: 2.5 sq.mm, 2-Core copper cable complying with IS-1554(Part-1).

ii) For HT motors: 6 sq.mm, 2 Core aluminium cable complying with IS-1554(Part-1).

7.03.00 **Temperature Detectors**

7.03.01 All 11000V and 3300V motors shall be provided with twelve (12) nos. simplex type winding temperature detectors, four (4) nos. per phase.

7.03.02 11000V and 3300V motor bearing shall be provided with duplex type temperature detectors.

7.03.03 The temperature detector mentioned above shall be resistance type, 3 wire, platinum wound, 100 Ohms at 0°C.

7.03.04 Leads of all simplex type motor winding RTDS and motor bearing RTDS shall be wired up to respective switchgear metering & protection compartment. From which one set of RTDS will be connected to numerical protection relay and another set shall be kept free for DDCMIS connectivity.

7.03.05 0.5 sq.mm annealed tinned copper conductor complying with IS-1554(Part-1). shall be used for RTD/BTD wiring.

7.04.00 **Indicator/Switch**

7.04.01 Dial type local indicator with alarm contacts shall be provided for the following:

a) 11000 V 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. CACW motor shall be provided with water leakage detector with remote alarm and tripping.

7.04.03 Alarm switch contact rating shall be minimum 2.0 A at 220V D.C. and 10A at 240V A.C.

7.05.00 **Current Transformer for Differential Protection**

7.05.01 Motor 1000 kW and above shall be provided with three differential current transformers mounted over the neutral leads within the enclosure.

7.05.02 The arrangement shall be such as to permit easy access for C.T. testing and replacement. Current transformer characteristics shall match Owner's requirements to be intimated later.

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 owner’s cable connections.

7.07.00 **Drain Plug**

Motor shall have drain plugs so located that they will drain the water, resulting from the condensation or other causes from all pockets of the motor casing.

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**

For paint shade finish, refer Section-X of Volume: II-A : Lead Specification.

8.00.00 **TESTS**

Routine and Type Tests are to be conducted in presence of customer's representative as per IS:325 and in addition,any special test called for in the driven equipment specification shall be performed and required copies of test certificates are to be furnished for approval. In addition, following tests shall have to be carried out on the motors in presence of OWNER's representative on 3.3kV/11kV motors.

a. Impulse test by 1.2 / 50 micro sec. On sample coil of Stator winding insulation as type test as per IEC-60034, part -15 test voltages as under :

Voltage rating of motor	Impulse Test Voltage
3.3 kV	18 kV peak
11 kV	49 kV peak

b. Tan delta, charging current and dielectric loss measurements on each phase of motor stator winding as routine test.

c. Polarization Index Test as per IS: 7816 as routine test

d. Test for suitability of IPW– 55(Weather proof) as per IS 4691 as type test. Type test certificate for first numeral shall be acceptable in lieu to test, provided the test motor is identical to motor being supplied. Second numeral test shall be carried out on one motor of each type and rating.

e. Fault Withstand Test for main terminal box as type test. Type test certificate shall be acceptable, if the test is conducted on exactly identical terminal box.

f. Test for noise level as routine test.

g. Test for vibration as routine test.

h. Tan delta measurement on coils.

i. Surge withstand test for inter turn insulation.

j. Test to diagnose rotor bar failure during manufacture.

k. Over speed test as routine test.

l. Temperature rise test.

Temperature rise under normal condition above ambient temperature shall be limited to-

Specified Design Ambient temperature	Thermometer Method	Resistance Method
50 deg.C	60 deg.C	70 deg.C
45 deg.C	65 deg.C	75 deg.C
40 deg.C	70 deg.C	80 deg.C

Tests indicated at (h), (i), (j) shall be carried out during manufacture of the coils and shall be furnished for verification.

9.00.00 **DRAWINGS, DATA & MANUALS**

9.01.00 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'.

9.02.00 **To be Submitted 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

9.03.00 **To be submitted for Owner / Purchaser's Approval and Distribution**

All relevant drawings and data pertaining to the equipment like GTP, GA drawing, foundation plan, QAP, etc. shall be submitted by the Bidder for approval of Owner/Owner's consultant. Also refer clause no. 1.19.02(u) of Section-I of Volume – V-A: Technical Specifications for Electrical Equipment & Accessories.

ANNEXURE-A

DESIGN DATA

1.0 AUXILIARY POWER SUPPLY

Supply		Description	Consumer
H.V. Supply		11000 V, 3Ø, 3W, 50 Hz, Non-effectively earthed Fault level 44 kA symm. for 1 sec.	Motors 1500 kW & above
M.V. Supply		3300 V, 3Ø, 3W, 50 Hz, Non-effectively earthed Fault level 40 kA symm. for 1 sec.	Motors 175 kW and Up to less than 1500 kW.
L.V. Supply	(i)	415V, 3Ø, 3W, 50 Hz effectively earthed Fault level 50 kA symm. for 1 sec.	Motors above 0.2kW and below 175kW.
	(ii)	240V AC/415V AC	Motors upto 0.2kW.
		240V, 1Ø, 2W, 50 Hz effectively earthed	Lighting, Space heating , A.C supply for Control & protective devices.
D.C. Supply		220V, 2W, unearthed Fault level 25* kA. for 1 sec.	D.C. alarm, control & protective devices

* Indicative only, the actual value will be decided by the Bidder, after substantiating the same by calculation.

Note-

- 415V or 3.3 kV may be adopted by the bidder for the drives in the range of 160-210 kW.
- 3.3 kV AC supply for CHP conveyor motors of rating above 160 kW is to be used.
- The voltage rating of the drives indicated above is for basic guideline. Minor variations can be accepted on case to case basis based on techno-economic considerations of the various sub-systems.
- Voltage rating for special purpose motors viz, VFD and screw compressors, shall be as per manufacturer's standard. All the motors ratings on Stacker/ reclaimer shall be 415V ac supply only.

2.0 RANGE OF VARIATION

A.C. Supply :

Voltage	:	± 10%
Frequency	:	+3% to -5%
Combined Volt + frequency	:	10% (absolute sum)

During starting of large motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance.

D.C. Supply :

Voltage	:	187 to 242 Volt

VOLUME: V-A

SECTION-III

TECHNICAL SPECIFICATION FOR ELECTRIC MOTOR ACTUATORS

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	STANDARDS
3.00.00	SERVICE CONDITIONS
4.00.00	RATING
5.00.00	PERFORMANCE
6.00.00	SPECIFIC REQUIREMENT
7.00.00	ACCESSORIES
8.00.00	TEST
9.00.00	DRAWINGS, DATA & MANUALS

ATTACHMENT

ANNEXURE-A DESIGN DATA

VOLUME: V-A

SECTION-III

TECHNICAL SPECIFICATION FOR ELECTRIC MOTOR ACTUATORS

1.00.00 SCOPE

1.01.00 This Section covers the general requirements of Electric Motor Actuators for valves/dampers.

1.02.00 All electric motor actuators shall be furnished in accordance with this general specification and the accompanying driven equipment specification. All the electrical actuators shall be INTEGRAL type only.

2.00.00 STANDARDS

2.01.00 All electrical equipment shall conform to the latest applicable IS, ANSI and NEMA Standards, except when stated otherwise herein or in driven equipment specification.

2.02.00 Major standards, which shall be followed, are listed below. Other applicable Indian Standards for any component part even if not covered in the listed standards shall also be followed

i) IS-9334

ii) IS-325

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 coal 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 general specification.

3.03.00 For actuator motor 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 RATING

4.01.00 For isolating service, the actuator shall be rated for three successive open-close operation of the valve/damper or 15 minutes, whichever is longer.

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.

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 imparts 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, space heater and internal wiring.

6.01.02 The actuator enclosure shall be totally enclosed, dust tight, weather-proof suitable for outdoor use without necessity of any canopy. Degree of protection of enclosure for motor actuator shall be IP-65.

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, squirrel cage, induction machine with minimum class B insulation and IPW-55 enclosure, designed for high torque and reversing service. Canopy shall be provided for outdoor 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 Motor leads shall be terminated in the limit switch compartment.

6.02.05 Motor actuators for valves/dampers shall be with integral starter with 3phase/3wire, 415V AC and operable from remote.

6.02.06 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.

6.04.00 **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, 4-20 mA current signal as position feedback, 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. All wiring shall be done with 1100V grade fire resistance PVC insulated stranded copper conductor of not less than 2.5 Sq.mm cross section. All wiring shall be identified at both ends with ferrules. All the electrical actuators shall have uniform wiring.

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 2.5 Sq.mm copper conductor.

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 MCCB

7.02.00 One (1) reversing starter with mechanically interlocked contactors, 3 thermal overload relays, 2 NO + 2 NC 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.

7.05.00 415/240 V control transformer with primary & secondary fuses.

8.00.00 **TEST**

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.

9.00.00 **DRAWINGS, DATA & MANUALS**

9.01.00 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'.

9.02.00 **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. 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'.

9.03.00 **To be submitted for Owner / Purchaser's Approval and Distribution**

All relevant drawings and data pertaining to the equipment like GTP, GA drawing, foundation plan, BOM, control & schematics, QAP, etc. shall be submitted by the Bidder for approval of Owner/Owner's consultant. Also refer clause no. 1.19.02(u) of Section-I of Volume – V-A: Technical Specifications for Electrical Equipment & Accessories.

ANNEXURE-A

DESIGN DATA

1.0 AUXILIARY POWER SUPPLY

Supply		Description	Consumer
L.V. Supply	(i)	415V, 3Ø, 3W, 50 Hz Effectively earthed Fault level 50 kA symm. for 1 sec.	Motors above 0.2kW upto less than 175kW.
	(ii)	240V AC/415V AC	Motors upto 0.2kW.
		240V, 1Ø, 2W, 50 Hz effectively earthed	Lighting, Space heating , A.C supply for Control & protective devices.
D.C. Supply		220V, 2W, unearthed Fault level 25* kA. for 1 sec.	D.C. alarm, control & protective devices

* Indicative only, the actual value will be decided by the Bidder, after substantiating the same by calculation.

2.0 RANGE OF VARIATION

A.C. Supply :

Voltage	:	± 10%
Frequency	:	+3% to -5%.
Combined Volt + frequency	:	10% (absolute sum)

During starting of large motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance.

D.C. Supply :

Voltage	:	187 to 242

VOLUME: VI

SECTION-VII

TECHNICAL SPECIFICATION –

FIELD INSTRUMENTS & FLOW ELEMENTS , CONTROL VALVES , I&C CABLES , ERECTION HARDWARES , TOOLS & TACKLE

CONTENT

SECTION /SUBSECTION	DESCRIPTION
VII/A	FIELD INSTRUMENTS & FLOW ELEMENTS
VII/B	CONTROL VALVES
VII/C	INSTRUMENTATION AND CONTROL CABLES
VII/D	PANELS , DESKS , RACKS AND JUNCTION BOXES
VII/E	ERECTION HARDWARES
VI/F	TOOLS AND TACKLE

VOLUME : VI
SECTION-VII
SUB SECTION - A
FIELD INSTRUMENTS & FLOW ELEMENTS

1.00.00 SPECIFICATION FOR ELECTRONIC TRANSMITTERS

1.01.00 PRESSURE TRANSMITTER

1.	Working Principle	:	Smart (HART Compatible)
2.	Type	:	Microprocessor based, 2 – Wire
3.	Output Signal	:	4-20 mA DC along with superimposed digital signal
4.	Measuring Element	:	Capsule / Diaphragm
5.	Element material	:	SS-316 (Stainless Steel) or better
6.	Static Pressure	:	150 % of maximum span continuously, without affecting the calibration
7.	Turn-down ratio	:	100: 1
8.	Span and Zero	:	Continuous, tamper proof, remote as well locally adjustable with zero elevation and suppression by 100% of span
9.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
10.	Output Indicator	:	LCD (Integral indicator of 5 digit display)
11.	Nameplate	:	Tag number, service engraved in SS tag plate
12.	Body	:	SS
13.	Operating Voltage	:	24V DC
14.	Load	:	600 Ohms (min.) at 24 Volts D.C.
15.	Ambient Temperature	:	0 - 50 ^{O}C
16.	Performance:	:	
	i. Accuracy		$\pm$ 0.075% of Span or better

	ii. Repeatability		± 0.05% of Span or better
17.	Sealing/Isolation	:	Extended diaphragm (Silicon oil/ Flurolub filled) with 5 meters SS armoured capillary for corrosive/viscous/solid bearing or slurry type fluid applications
18.	Accessories	:	a. Universal mounting bracket suitable for 2" pipe mounting b. High tensile carbon steel U-bolts c. Siphon for steam and hot water services d. ½" NPT 2-valve stainless steel manifold, constructed from SS316 bar stock e. Companion flange with nuts, bolts and gaskets f. ½" NPT cable gland g. Handheld calibrator
19.	Adjustment/Calibration/ Maintenance	:	From handheld calibrator/ HART management system

Notes: For primary air/ secondary air/ flue gas applications, DP type transmitters shall be provided for pressure measurement.

LVDT type is not acceptable.

1.02.00 DIFFERENTIAL PRESSURE TRANSMITTER / FLOW TRANSMITTER

1.	Working Principle	:	Smart (HART Compatible)
2.	Type	:	Microprocessor based, 2 – Wire
3.	Output Signal	:	4-20 mA DC along with superimposed digital signal
4.	Measuring Element	:	Capsule / Diaphragm

5.	Element material	:	SS-316 (Stainless Steel) or better
6.	Static Pressure	:	150 % of maximum span continuously, without affecting the calibration
7.	Turn-down ratio	:	100: 1
8.	Span and Zero	:	Continuous, tamper proof, remote as well locally adjustable with zero elevation and suppression by 100% of span
9.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
10.	Output Indicator	:	LCD (Integral indicator of 5 digit display)
11.	Nameplate	:	Tag number, service engraved in SS tag plate
12.	Body	:	SS
13.	Operating Voltage	:	24V DC
14.	Load	:	600 Ohms (min.) at 24 Volts D.C.
15.	Ambient Temperature	:	0 - 50 ^{O}C
16.	Performance:		
	i. Accuracy	:	$\pm$ 0.075% of Span or better
	ii. Repeatability	:	$\pm$ 0.05% of Span or better
17.	Sealing/Isolation	:	Extended diaphragm (Silicon oil/ Flurolub filled) with 5 meters SS armoured capillary for corrosive/viscous/solid bearing or slurry type fluid applications
18.	Accessories	:	a. Universal mounting bracket suitable for 2" pipe mounting b. High tensile carbon steel U-bolts

c. Siphon for steam and hot water services

d. ½" NPT 5-valve stainless steel manifold, constructed from SS316 bar stock

e. Companion flange with nuts, bolts and gaskets

f. ½" NPT cable gland

g. Handheld calibrator

19. Adjustment/Calibration/ Maintenance : From handheld calibrator/ HART management system

1.03.00 Displacer Type Level Transmitters

1.	Type	:	Smart (HART Compatible)
2.	Stages of operation	:	Continuous
3.	Material	:	
4.	i. Displacer		SS-316
5.	ii. Suspension wire		SS-316
6.	iii. Torque tube housing		SS
7.	iv. Torque tube		Inconel
8.	v. Displacer chamber		SS
9.	vi. Transmitter Housing		SS
10.	Operating Voltage	:	24 V DC
11.	Transmission	:	Microprocessor based, 2-wire
12.	Output Signal	:	4-20 mA DC along with superimposed digital signal
13.	Static / overload	:	Maximum static pressure without

	pressure		permanent deformation or loss of accuracy
14.	Turn-down ratio	:	10 : 1 or better
15.	Zero & Span	:	Continuous, tamper proof, remote as well locally adjustable with zero elevation and suppression by 100% of span
16.	Enclosure Class	:	IP-65
17.	Output Indicator	:	LCD type (Integral indicator of 5 digit display)
18.	Nameplate	:	Tag number and Service engraved in stainless steel tag plate
19.	Ambient Temperature	:	0 - 50 ^{O}C
20.	Load Impedance	:	600 Ohms at 24 Volts (minimum)
21.	Process Connection	:	2" Flanged
22.	Performance - Accuracy	:	$\pm$ 0.075 % of span or better
23.	Accessories	:	a) Counter Flange, nuts, bolts, gaskets etc b) Weights for 5 point calibration of instruments c) Vent and drain plugs d) ½" NPT Glands e) Handheld calibrator
24.	Preferred Features	:	a) Test plug connection and cutout terminals physically separated from other electronics b) Electronic Damping facility (adjustable)
25.	Adjustment/Calibration/ Maintenance	:	From handheld calibrator/ HART management system

	26.	Applications	:	During detail engineering on Owner's approval

1.04.00 MASS FLOW METER

1.04.01 SENSOR

	1.	Measuring Principle	:	Coriolis Mass flow
	2.	Primary Element	:	Flow Tube of 316SS or better
	3.	Heating Arrangement	:	Integral
	4.	Temperature Control	:	For heavy fuel oil application
	5.	Process Connection	:	Flanged of rating as per process requirement
	6.	Drain	:	Self-draining facility
	7.	Enclosure	:	Stainless steel
	8.	Accessories	:	Counter flanges, Mounting nuts, bolts, gaskets etc.

1.04.02 TRANSMITTER

	1.	Measured quantities	:	Mass Flow rate, Total Mass Flow, Density
	2.	Input Signal Processing	:	Smart (HART compatible)
	3.	Display	:	LCD
	4.	Output	:	2 nos. isolated output of 4-20mA DC selectable from four measured quantities
	5.	Load	:	< 750 ohms
	6.	Power supply	:	240V AC, 50 Hz

7.	Turn Down	:	100:1
8.	Accuracy	:	± 0.2 % of measured value
9.	Housing	:	IP 65 (Explosion proof)
10.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
11.	Accessories	:	a) Handheld calibrator b) Mounting U-bolts, nuts, bolts, prefab cable etc c) ½"NPT cable gland
12.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system
13.	Applications	:	Fuel Oil service

1.05.00 RADAR TYPE LEVEL MEASUREMENT

1.	Type	:	Smart (HART Compatible)
2.	Antenna	:	Co axial / guided wave radar / Overspill protection
3.	Principle	:	TDR (Time Domain Reflectometry)
4.	Communication	:	Two wire 4-20mA DC with HART
5.	Environmental temperature	:	0 – 50 ºC
6.	Enclosure	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
7.	Calibration	:	a) Self calibration with internal reference b) Zero & Span calibration
8.	Process Connection	:	External cage mounting Flanged /screwed
9.	Electronic Housing	:	Epoxy painted Die-Cast aluminium

			alloy
10.	Antenna / Flange assembly	:	316 SS or Hestalloy (as required)
11.	Power supply	:	24 V DC
12.	Output Indicator	:	LCD
13.	Accuracy	:	5 mm or 0.1% of probe length
14.	Accessories	:	a) Handheld calibrator
		:	b) Counter Flange, nuts, bolts, gaskets etc
		:	c) ½"NPT cable gland
		:	d) SS Nameplate
15.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system
16.	Applications	:	Vessels under vacuum or low pressure applications, solid levels

1.06.00 ULTRASONIC LEVEL TRANSMITTER

1.	Type	:	Microprocessor based, 2-wire, Smart (HART Compatible)
2.	Operating Principle	:	Detection of reflected ultrasonic pulse
3.	Output Signal	:	4-20 mA DC along with superimposed digital signal
4.	Operating frequency	:	10 KHz to 50 KHz (typical)
5.	Display	:	LCD
6.	Temperature Compensation	:	Built in –Programmable
7.	Power supply	:	24 V DC
8.	Enclosure	:	SS, IP-65 (Explosion proof for NEC Class-1, Division 1 area)

9.	Zero & Span	:	Continuous, tamper proof, remote as well locally adjustable. It shall be possible to calibrate the instrument without any level in the sump/ tank	
10.	Accuracy & Repeatability	:	0.15 % of span or better	
11.	Resolution	:	0.1 % of span	
12.	Operating temp.	:	Transmitter- 500 C and Sensor - 800 C	
13.	MOC Sensor	:	SS-316/Body- PVC and Face – Polyurethene	
14.	Mounting	:	4" Flanged/ 2" NPT for sensor and Transmitter on panel	
15.	Accessories	:	a)	Handheld calibrator
			b)	Weather canopy for protection from direct sunlight and direct rain
			c)	½"NPT cable gland
			d)	All mounting hardware (SS-316), Prefab cable
			e)	SS Nameplate
16.	Diagnosis	:	On-line	
17.	Status Indication	:	Power On, HI, HI-HI, Lo, LO-LO, Fault	
18.	Output Contacts	:	2 SPDT, 230V, 5A	
19.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system	
20.	Applications	:	Coal Bunker, Water Service etc.	

1.07.00 ULTRASONIC FLOW TRANSMITTER

1.	Type	:	Ultrasonic – Clamp On
2.	Accuracy	:	+/- 1 % of reading
3.	Repeatability	:	+/- 0.3 % of reading
4.	Rangeability	:	400 : 1
5.	Output Signal	:	4-20 mA DC with HART
6.	Measured Parameter	:	Volumetric flow, Totalized flow and flow Velocity
7.	Display	:	LCD with internal Key Pad (Flow rate & Totalization)
8.	Power Supply	:	24 V DC (2 Wire)
9.	Enclosure	:	SS (IP- 68 – Submersible)
10.	Mounting	:	SS Chain or Strap
11.	Accessories		1. Handheld calibrator 2. ½"NPT cable gland 3. Transducer cable 4. All mounting hardware (SS-316) 5. SS Nameplate
12.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system
13.	Applications	:	Plant water service

Note: Multi-path insertion type (minimum 4 path) Ultrasonic Flow meter shall be provided for Raw water/ Cooling Water flow measurements.

2.00.00 **HART HAND HELD CALIBRATOR**

Hand held calibrators (5 nos. for each type) shall be provided for adjustment/ calibration/maintenance of the HART compatible

transmitters. The hand held calibrator shall be suitable for all types of transmitters supplied in the package. If one type of hand held type calibrator is not suitable for communicating with all types of transmitters then separate hand held calibrator will be provided.

3.00.00 PROCESS ACTUATED SWITCHES

3.01.00 PRESSURE SWITCH

1.	Type	:	i. Piston for high pressure application ii. Bellow / Diaphragm for low pressure application
2.	Sensing element material	:	SS-316. All other wetted part SS316
3.	Case Material	:	SSt
4.	Setter Scale	:	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points
5.	Over range	:	150 % of maximum pressure
6.	Adjustments	: :	a) Internal Set Point b) Differential adjustment
7.	End Connection	:	1/2" NPT bottom connected
8.	Switch configuration	:	Two SPDT (240V, 5A AC/220V, 0.5A DC)
9.	Switch Type	:	Snap acting, shock & vibration proof
10.	Terminal Block	:	Suitable for full ring lugs
11.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
12.	Performance	: :	a) Repeat accuracy ± 1.0% b) Accuracy of Setting Indication of ±1.5%
13.	Ambient temperature	:	0 – 50 Deg.C

14.	Nameplate	:	Tag number, service engraved in SS tag plate
15.	Accessories	:	a) Silicon oil/ Flurolub filled Remote diaphragm seal with SS-316 capillary for corrosive/ viscous/ solid bearing or slurry type fluid applications b) Snubbers for pulsating fluid applications c) Siphons for steam and hot water services d) Retention ring and screws for surface mounting e) 1/2" NPT 2 Valve SS-316 barstock manifold f) ½" NPT cable gland
16.	Applications	:	During Detail Engineering on Owner's approval

3.02.00 DIFFERENTIAL PRESSURE SWITCH

1.	Type	:	i. Piston for high pressure application ii. Bellow / Diaphragm for low pressure application
2.	Sensing element material	:	SS-316. All other wetted part SS316
3.	Case Material	:	SS
4.	Setter Scale	:	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points
5.	Over range	:	150 % of maximum pressure

6.	Adjustments	:	a) Internal Set Point
		:	b) Differential adjustment
7.	End Connection	:	1/2" NPT bottom/ back connected
8.	Switch configuration	:	Two SPDT (240V, 5A AC/220V, 0.5A DC)
9.	Switch Type	:	Snap acting, shock & vibration proof
10.	Terminal Block	:	Suitable for full ring lugs
11.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
12.	Performance	:	a) Repeat accuracy ± 1.0% b) Accuracy of Setting Indication of ±1.5%
13.	Ambient temperature	:	0 – 50 Deg.C
14.	Nameplate	:	Tag number, service engraved in SS tag plate
15.	Accessories	:	a) Silicon oil/ Flurolub filled Remote diaphragm seal with SS-316 capillary Diaphragm seals for corrosive/ viscous/ solid bearing or slurry type fluid applications b) Snubbers for pulsating fluid applications c) Siphons for steam and hot water services d) Retention ring and screws for surface mounting e) 1/2" NPT 5 Valve SS-316 barstock manifold f) ½" NPT cable gland
16.	Applications	:	During Detail Engineering on Owner's

approval

3.03.00 LEVEL SWITCH

3.03.01 FLOAT OPERATED

1.	Float material	:	SS-316
2.	Wetted parts	:	SS-316
3.	Float chamber	:	Stainless steel/Carbon steel, construction welded
4.	Float chamber mounting	:	Side mounted
5.	Fluid connection	:	Side – Side
6.	Fluid connection size	:	1" ANSI RF Flange (rubber line, if required)
7.	Drain	:	½ inch NPT with Plug
8.	Pressure rating of chamber	:	Minimum 1.5 times of design pressure
9.	Repeatability	:	+/- 1.5 mm or better
10.	Switch housing	:	Stainless Steel
11.	Switch housing type	:	IP- 65
12.	Type of switch	:	Snap acting magnetically operated hermetically sealed
13.	Switch configuration	:	2 SPDT (5A, 240 V AC, 0.5A, 220V DC)
14.	Accessories	:	a) Counter flange, nuts & bolts, suitable gasket etc. b) Steel globe type drain valve c) ½"NPT cable gland

			d)	Stainless steel nameplate with alpha-numeric engraved for service and tag
	15. Application	:	During Detail Engineering on Owner's approval	

3.04.00 FLOW SWITCH

1.	Type	:	Paddle /Piston/Disk	
2.	Wetted part material	:	Stainless steel or Hastelloy for acidic application	
3.	End connection	:	a)	Threaded upto 1" line size with integral Tee
		:	b)	Flanged for line size > 1 ½"
4.	Enclosure material	:	Stainless Steel	
5.	Enclosure class	:	IP 65	
6.	Switch configuration	:	2 SPDT (5A, 240 V AC, 0.5A, 220V DC)	
7.	Repeatibility	:	2%	
8.	Cable connection	:	½"NPTF	
9.	Accessories	:	a)	Tee, Counter flange, nuts & bolts, suitable gasket etc
			b)	½"NPT cable gland
			c)	Stainless steel nameplate with alpha-numeric engraved for service and tag

3.05.00 RF LEVEL SWITCH

1.	Type	:	RADIO FREQUENCY
	Sensing probe		
2.	Material	:	SS-316
3.	Mounting	:	Threaded
4.	Application Temperature	:	250°C (Max.)
	Electronic Controller		
5.	Input Supply Voltage	:	240V AC ±10%, 50 Hz.
6.	Relay Output	:	2 SPDT (240V AC, 5A)
7.	Ambient Temperature	:	50 °C
8.	Enclosure Protection	:	IP-66
9.	Enclosure Housing	:	SS
10.	Local LED Indication	:	Normal Level Power On Alarm Level Probe Healthy
11.	Switching Repeatability	:	±0.5%
12.	Accessories	:	Co-axial cable for probe connection to controller SS Tag plate ½" NPT Cable Glands
13.	Application	:	Solid level

3.06.00 CONDUCTIVITY TYPE LEVEL SWITCH

1.	Type	:	Conductivity discrimination
2.	Probe MOC	:	SS-316
3.	Mounting	:	Flanged on external cage
4.	Application Temperature	:	250°C (Max.)
5.	Test Pressure	:	Two times rated pressure

	6.	Input Supply Voltage	:	240V AC ±10%, 50 Hz.
	7.	Input	:	Four independent channel with selectable switching threshold for water conductivity
	8.	Relay Output	:	2 SPDT (240V AC, 5A)
	9.	Ambient Temperature	:	50 °C
	10.	Enclosure Protection	:	IP-65 (Explosion proof for NEC Class-1, Division-1 area)
	11.	Enclosure Housing	:	SS
	12.	Local LED Indication	:	HI,LO, HIGH-HIGH, LOW-LOW Power Fault
	13.	Accessories	:	a) Interconnecting cable from probe to electronics b) Mounting accessories c) External cage d) Washer & Gasket e) ½" NPT Cable Glands f) SS Tag Plate
	14.	Application	:	During Detail Engineering on Owner's approval

3.07.00 TEMPERATURE SWITCH

1.	Type	:	Bimetallic or gas filled
2.	Sensing Element Material	:	SS-316
3.	Bulb Material	:	SS-316
4.	Capillary	:	Stainless Steel armored

5.	Movement Material	:	Stainless Steel
6.	Case material	:	Stainless Steel with neoprene gasket and clear glass where applicable cover conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
7..	Scale	:	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points
8.	Over range Protection	:	120 %
9.	Instrument connection	:	Bottom
10.	Switch configuration	:	Two SPDT (240V, 5A AC/220V, 0.5A DC)
11.	Switch type	:	Snap acting, shock and vibration-proof
12.	Adjustability	:	Internal Set point adjustable over span range
13.	Compensation	:	a) Capillary compensation with invar wire throughout the capillary length b) Case compensation
14.	Performance		
	a) Scale Accuracy	:	±1.0 % of full scale
	b) Repeatability	:	< 0.5 % of full range
	c) Response time	:	Less than 40 seconds with thermowell
15.	Capillary length	:	5 meters (minimum) for local mounting/15 meters for local panel mounting
16.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
17.	Accessories	:	Mounting accessories, ½" NPT cable gland
18.	Applications	:	During Detail Engineering on Owner's

approval

4.00.00 LOCAL INSTRUMENTS

4.01.00 PRESSURE GAUGE AND DIFFERENTIAL PRESSURE GAUGE

1.	Type	:	Bourdon/Bellows/Diaphragm
2.	Sensing & Socket	:	SS-316
3.	Movement Material	:	SS-316
4.	Case Material	:	Stainless steel. IP-65 (Explosion proof for NEC Class-1, Division 1 area)
5.	Dial Size	:	Generally 150 mm
6.	Scale	:	Black lettering on white in 270 O arc.
7.	Window	:	Shatterproof glass
8.	Range Selection	:	Normal process pressure: 50~70 % of range
9.	Over-range Protection	:	125% of maximum range by internal stop. External stop at zero
10.	Adjustment	:	For Zero adjustment (Micrometer screw external) For Range adjustment (Micrometer screw internal).
11.	Element Connection	:	Argon welding
12.	Process Connection	:	1/2" NPT (M) Bottom for local, back for panel mounting
13.	Performance	:	Accuracy of $\pm$ 1.0 % of span or better
14.	Operating ambient	:	0 - 50 ^{O}C
15.	Safety Feature	:	Blow out disc /diaphragm at the back
16.	Accessories	:	a) Snubbers for pulsating fluid application.discharge b) Stainless steel Diaphragm seals

			for corrosive/ viscous/ solid bearing or slurry type fluid applications
		c)	3-Way SS316 Gauge cock for pressure gauges
		d)	5-valve SS316 manifold from barstock for differential pressure gauge
		e)	Siphons for steam and hot water services
	17. Nameplate	:	Tag number, service engraved in stainless steel tag plate

4.02.00 LEVEL INDICATOR (FLOAT & BOARD TYPE)

1.	Type	:	Float and Board
2.	Float Material	:	SS-316
3.	Float Cable	:	SS-316
4.	Indicator Assembly	:	Epoxy painted Aluminium
5.	Guide wire spring assembly	:	SS-316 (2 Nos.)
6.	Guide Wire Anchor	:	SS-316
7.	Scale Board	:	Anodized Aluminium with engraved marking (Minimum graduation 10mm), mounting brackets and suitable hardware required as per tank height
8.	Elbow Assembly	:	Anodized Aluminium
9.	Flanges	:	RF , ANSI 150 , SS (3 Nos.)
10.	Accuracy	:	± 10 mm or better
11.	Accessories	:	All mounting accessories including counter flange, nuts & bolts, suitable

gasket etc. as applicable, SS Tag plate

4.03.00 GAUGE GLASS

1.	Type	:	Reflex /Transparent
2.	Material		
	Glass	:	Toughened borosilicate resistant to thermal shock
	Body Material	:	~~Carbon Steel~~ Stainless Steel
	Enclosure	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
3.	Integral cocks & valves/Fittings	:	i. SS 316
4.		:	ii. Rubber lined corrosion resistant stainless steel (for DM/RO service)
5.	Vessel Connection	:	ANSI Flanged SS316
6.	Accessories	:	i. Integral cocks ii. Drain Valves iii. Companion Flanges, Bolts, nuts, gaskets, SS Tag plate iv. Illuminating lamps, Mica shield as required v. Calibrated scale
7.	Pressure rating	:	Twice the maximum working pressure
8.	Temperature	:	300 ^{O} C
9.	Other details	:	For larger lengths (greater than 1200mm), additional gauge glasses shall be provided with minimum of 50 mm overlap.

4.04.00 SLIGHT GLASS

1.	Type	:	Flap-type.
2.	End connection	:	Screwed / Flanged
3.	Material		
	a) Body	:	SS- 304
	b) Cover plate	:	SS- 304
	c) Indicator	:	SS- 316
4.	Sight Glass	:	Toughened Borosilicate
5.	Gasket	:	Neoprene
6.	Bolts & Nuts	:	High tensile steel.
7.	Hydraulic Test Pressure	:	1.5 times maximum working pressure
8.	Accessories	:	Companion Flanges, Bolts, nuts, gaskets as required, SS Tag plate.

4.05.00 ROTAMETER

1.	Type	:	ON-LINE for line upto and including 50 mm NB. Borosilicate BY-PASS for line size above 50 NB
2.	Metering tube	:	Toughened Borosilicate
3.	Float	:	SS-316
4.	End fittings	:	SS-316
5.	Packing material	:	Teflon / PTFE
6.	Casing	:	Stainless Steel
7.	Gland Rings /Followers/ Other wetted parts	:	Stainless Steel
8.	Orifice Plate	:	Stainless Steel (for bypass type)
9.	Operating Temperature	:	0-50 Deg. c

10.	Test Pressure	:	200% of maximum operating pressure
11.	Scale	:	250 mm nominal length
12.	Graduation	:	Direct reading
13.	Process Connection	:	Flanged (RF) to line size as per ANSI standards (150#)
14.	Tapping	:	D & D/2
15.	Accuracy	:	+/- 2% of full scale reading
16.	Reproducibility	:	Within 0.5% of instantaneous reading
17.	Accessories	:	SS Tag Plate, orifice plate

5.00.00 TEMPERATURE ELEMENTS & ACCESSORIES

5.01.00 RESISTANCE TEMPERATURE DETECTOR

1.	Type	:	Platinum (Duplex), Ungrounded
2.	Platinum (Duplex), Ungrounded	:	100 ohm at 0 ^{O}C
3.	Base	:	Wound on ceramic (anti-inductive)
4.	Wiring	:	3 Wire
5.	Protecting Tube		
	a) O.D.	:	6 mm
	b) Material	:	SS-316, Seamless
	c) Filling	:	Magnesium oxide (Purity above 99.4%).
6.	Response time	:	a) 15 sec. (bare).
			b) 30 sec. (with thermowell)
7.	Calibration	:	DIN 43760
8.	Accuracy	:	± 0.5%
9.	Head		
	a) Type	:	IP-65 universal screwed type

	b)	Material	:	Stainless Steel
	c)	Terminal blocks	:	Nickel plated Brass-screw type / silver plated
	d)	Cable connection	:	½" NPT gland and grommet
	e)	Others	:	Terminal head cover with SS chain and suitable gasket. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable).
10.	Accessories		:	a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT] with thermowell connection b) Compression fittings/unions c) Flanges etc. (for flanged connections only) d) Thermowell (As specified below)
11.	Thermowell connection		:	½" NPT (M) or 150 RF Flanged
12.	Nameplate		:	Tag number, service engraved in stainless steel tag plate

Note: The specifications for RTDs of winding/ bearing 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 Pt-100.

5.02.00 THERMOCOUPLES

1.	Type	:	a) 16 SWG wire of Chromel Alumel) (Type-K) b) Duplex c) Ungrounded
2.	Protecting Tube		
	a) O.D.	:	6 mm
	b) Material	:	SS-316, Seamless
	c) Filling	:	Magnesium oxide (Purity above 99.4%).
3.	Response time	:	a) < 20 seconds for measurement b) < 10 seconds for control
4.	Accuracy	:	$\pm$ 1.1^{0} C up to 300 ^{0} C & 0.4% of measured temperature range above 300 ^{0}C
5.	Head		
	a) Type	:	IP-65 universal screwed type
	b) Material	:	Stainless Steel
	c) Terminal blocks	:	Nickel plated Brass-screw type / silver plated
	d) Cable connection	:	½" NPT gland and grommet
6.	e) Others	:	Terminal head cover with SS chain and suitable gasket.

			Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable).
7.	Accessories	:	a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT] with thermowell connection b) Compression fittings/unions c) Flanges etc. (for flanged connections only) d) Thermowell (As specified below)
8.	Thermowell connection	:	½" NPT (M) or 150 RF Flanged
9.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

5.03.00 TEMPERATURE GAUGE

1.	Type	:	Expansion type (Liquid filled system)
2.	Sensing Element Material	:	Bourdon – SS-316
3.	Bulb and Capillary Material	:	SS-316
4.	Capillary Tubing	:	Inner sheath - solid drawn Material copper tube Outer sheath - PVC tube
5.	Movement Materials	:	Stainless Steel / Direct Bourdon tip connection to pointer spindle
6.	Case Material	:	Stainless Steel stove enameled, black finish, threaded bezel ring, clear glass

			cover conforming to IP 65.
7.	Dial size	:	150 mm
8.	Scale	:	Black lettering on white background in 270 Deg.C arc
9.	Over range protection	:	125 percent of FSD
10.	Capillary Glanding	:	1/2" NPT(M) x compression fitting (SS) to suit capillary
11.	Instrument Connection	:	Bottom connection for local mounting, back connection for panel mounting
12.	Process Connection	:	½" NPT (M) or 150 RF Flanged
13.	Extension Neck Length	:	50 mm
14.	Compensation	:	a) Capillary compensation
15.		:	b) Case compensation
16.	Performance	:	a) Accuracy : + /- 1.0 percent of full scale Deflection
		:	b) Repeatability : Less than 0.5 percent of full range
		:	c) Response time: 15 seconds (max.).
17.	Capillary length	:	3.0 meters (local) / 15.0 metres (local panel)
18.	Other features	:	Shatter proof glass
19.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
20.	Accessories	:	SS316 Thermowell

5.04.00 THERMOWELL

1.	Material	:	SS-316
2.	Manufacture	:	Drilled from bar stock, Hex Head, Tapered design (As per ASME PTC 19.3)

3.	Process connection	:	M33x2
4.	Certification	:	Not applicable
5.	Bore concentricity	:	+5% of wall thickness
6.	Identification mark	:	Tag number punched on head
7.	Surface treatment	:	Polish after machining
8.	Element connection	:	½" NPT (M) or 150 RF Flanged
9.	Head	:	Hex
10.	Length of the hex head	:	31.75 mm (min.)
11.	Accessories	:	SS Plug and chain for test thermo wells SS Nameplate, Flange with companion flange & all required accessories for flanged connections.

Note: Wake frequency calculations shall be furnished for all thermowells for approval.

Thermowells shall be designed such that the resonant frequency is above the exciting frequencies generated by vortex shedding in the process fluid.

5.05.00 METAL TEMPERATURE THERMOCOUPLE

1.	Measuring medium	:	Metal temperature
2.	Type	:	Chromel Alumel (Type-K) Duplex, Ungrounded
3.	Insulation	:	Mineral Insulation Magnesium Oxide
4.	Wire gauge	:	16 AWG
5.	Protective sheath	:	SS
6.	Protective sheath diameter	:	8 mm O.D.
7.	Characteristics	:	Special limits of error as in ANSI thermocouple MC 96.01
8.	Accessories	:	½" BSP SS sliding end connector, weld pad, clamps of heat resistant steel

9.	Cold end sealing	:	SS pot weal with colour coded PTFE headed sleeve insulated flexible tails. Sealing compound Epoxy resin
10.	Minimum bending radius	:	30 mm
11.	Length of T/C	:	30 Mtr. (minimum)

Notes:

The specification for thermocouples of bearings metal temp measurements can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However, type of thermocouples shall be K-type.

6.00.00 FLOW ELEMENTS

6.01.00 ORIFICE PLATE

6.01.01 The orifice plate shall be either concentric square edge type or segmental bored type as per type of process .

6.01.02 Manufacturing, installation and use will be in accordance to the standard BS1042.

6.01.03 Orifice plates will be made of type 316 stainless steel.

6.01.04 The plate thickness of the orifice shall be 3 mm minimum. However the orifice thickness shall be determined by the actual process parameter.

ORIFICE FLANGE

6.01.05 Orifice flange rating will be the same as the piping class.

6.01.06 Flange shall be Standard / Slip on / socket weld/ weld neck raised face as per ANSI B 16.5

6.01.07 Gasket shall be CAF type depend on application.

CARRIER RING

6.01.08 Male female carrier ring of SS316 material shall be provided.

6.01.09 Beyond line size 500 mm, disc type orifice plate will be used.

PRESSURE TAP

6.01.10 Corner taps with Annular Grooves on Carrier Rings as per BS 1042

6.01.11 Numbers of tappings as per approved P&IDs of size ½" NPT shall be provided. However, one pair spare tapping shall also be provided with each orifice.

VENT HOLE/ DRAIN HOLE

6.01.12 Suitable Vent hole for water service shall be provided.

BETA RATIO

6.01.13 The ratio of throat diameter to inlet diameter (beta ratio) of the Orifice will be limited between 0.30 and 0.70.

ACCURACY

6.01.13 Accuracy (uncertainties on discharge coefficient 'c') of flow measurement shall be +/-1% for orifice plates according to BS 1042 except for critical measurement (performance calculation).

ISOLATION VALVES

6.01.14 Each tapping point shall be equipped with one primary isolating valve for low pressure and two primary isolating valves for high pressure installations (greater than 40 bar and/or 450 deg c).

6.01.15 Material of isolating valve shall be SS316

6.01.16 ½ inch NPT (M) SS316 Nipples shall be used to interface valve with orifice.

NUTS/BOLTS/ GASKETS

6.01.17 Jack bolt shall be provided for easier removal.

6.01.18 Studs and nuts material shall be ASTM A193 Gr. B7 / A194 Gr. 2H

TAGGING

6.01.19 Orifice plate will be provided with a Handle. Tag number, orifice plate material, measured bore and id of the pipe will be stamped or deep engraved on the upstream face of the Handle.

6.02.00 FLOW NOZZLE

6.02.01 The Flow Nozzle shall be ASME long radius type.

6.02.02 Manufacturing, installation and use will be in accordance to the standard ASME PTC CODE 19.5.

6.02.03 Nozzle shall be made of Forged 316 stainless steel.

6.02.04 Nozzle shall be machined on latest CNC machines to ensure accuracy.

END CONNECTION

6.02.05 End connection shall be Butt Welded.

BRANCH PIPE

6.02.06 Branch pipe material shall be of same process pipe material.

6.02.07 Length of the branch pipe shall be minm. 4D upstream and 2D downstream.

6.02.08 Branch pipe assemblies shall be properly machined to acquire required smoothness

TAPPINGS

6.02.09 D & D/2 tapping on pipe shall be provided.

6.02.10 Tapping size shall be of 15 NB and number of tappings shall be as per approved PID. However, one pair of spare tapping for each element shall also be provided for each nozzle.

BETA RATIO

6.02.11 Beta ratio shall be limited between 0.30 and 0.70.

ACCURACY

6.02.12 Accuracy (uncertainties on discharge coefficient) of measuring flow measurement shall be equal or better +/-2 % except for critical measurement (Performance calculation)

ISOLATION VALVES

6.02.13 Each tapping point shall be equipped with one primary isolating valve for low pressure and two primary isolating valves for high pressure installations (greater than 40 bar and/or 450 deg c).

6.02.14 Material and size of SW isolating valve shall be SS316 and 15 NB respectively.

6.02.15 Suitable Nipples and adaptors shall be used to interface valve with Flow Nozzle .

TAGGING

6.02.16 Nozzle tag no. , material, id , Flow direction will be stamped

TEST & EXAMINATION

6.02.17 All orifices and Flow Nozzles shall be tested in accordance with the quality assurance programme, which shall meet the requirements of applicable codes.

6.02.18 Instruments offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar product shall be furnished. Routine tests, Acceptance tests and all special tests (if any) shall be carried out for all the instruments as per quality plan and applicable standards.

6.02.19 Calibration shall be done in reputed laboratory like IIT.

6.02.20 IBR certification shall be provided wherever the process pipes come under IBR regulation.

6.02.21 The type, routine & acceptance tests shall be witnessed by Inspection agency as per requirements given by the quality plan. Contractors shall give at least 15 days advance notice for witnessing the test. Copies of the certified reports of all tests carried out at the works should be furnished. The equipments shall be dispatched from works, only after receipt of purchasers' written approval of the test reports.

Certified reports of all the tests carried out at the works shall be furnished for approval of Owner. Test reports shall be completed with all details and also contain specified limiting values, wherever applicable, to facilitate review. The instruments shall be dispatched from works only after receiving the owner's approval of the test reports. The bidders shall have to carry out all the tests within his quoted price and no extra payment can be claimed by bidders.

6.03.00 AEROFOIL

6.03.01 For airflow measurement, flow sensing element shall be aerofoil (steel) with ½" tappings.

7.00.00 CHP RELATED SPECIAL INSTRUMENTS

Technical specifications for some of the special instruments required for Coal Handling Plant are enumerated below.

7.01.00 ZERO SPEED SWITCHES

It shall be provided for all belt drives or indirectly driven equipment and shall be two-wire, inductive, proximity type. The probe housed in robust stainless steel enclosure of protection class IP 65 shall be installed either radially or axially. Sensing distance range shall be 1 to 25mm. The converter unit shall be dust & water tight, corrosion resistant and shall be mounted separately. The interconnecting cable length shall not be less than 3 meters. Following features shall be provided.

a) Speed setting accuracy	:	Within ±2% of desired value.
b) Repeatability	:	Within ±0.1%.
c) Differential	:	Within ±5% of set value
d) Contacts	:	2 C/O
e) 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

7.02.00 BELT SWAY SWITCHES

Auto reset type in IP 65 class enclosure 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 Mtr. 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 available shall be 2 NO + 2 NC. Contact roller support bearing shall be with high relative lubrication & low coefficient of friction. Local indicating lamp as a special feature is envisaged.

7.03.00 PULL CORD SWITCHES

a) Pull cord Switches in IP 65 class enclosure shall be provided for manual safety stopping of conveyors. Pull chord wire rope shall pass through cradle of switch. Movement of lever (45 o on either side) shall actuate the pull chord switch. It shall be provided at every 30 m 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. For conveyors trip indication shall be provided in the control room to identify exactly the switch that has operated.

b) Adequate length of PVC coated wire rope and all accessories shall be furnished. From either end of conveyor pull cord switches should not be more than 15M. A special canopy made of 5mm M.S. plate shall be provided over the lever of each pull cord switch so that spilled over coal lumps do not trip the belt by actuating the lever. Also a local trip indication (Cluster of LEDs) shall be provided with each pull cord switch.

c) 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.

7.04.00 PULL CORD & 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. System shall consist of sensor, indicator & transmitter units. Units will be installed at respective RIO location. There shall be analog 4-20 mA DC or soft communication link with the Main CHP PLC system for remote monitoring of the switch status in the operator station. System shall have the diagnostic to detect faulty switch and damaged cable.

7.05.00 BUNKER LEVEL INDICATION SYSTEM

7.05.01 GENERAL TECHNICAL REQUIREMENTS

Coal bunker level measurement shall be provided through 3D Level Scanner type level indication system employing 3D representation of the stored contents for display on a remote PC based workstation.

The system shall consist, but not limited to, the following major components.

7.05.02 3D LEVEL SCANNER

1.	Type	:	3D Non contact, dust penetrating type
2.	Operating Principle	:	Multiple Point, low frequency measurement (time/distance)
3.	Mounting	:	Top
4.	Supply Voltage	:	24V DC
5.	Signal Output	:	RS 485
6.	Local Display	:	LCD Display
7.	Operating Temperature	:	-40°C to +85°C
8.	Temperature Compensation	:	In-built
9.	Accuracy	:	±0.5%
10.	Housing	:	Die-cast Aluminium / SS
11.	Antenna	:	Die-cast Aluminium (minimum 3 nos./scanner)
12.	Protection	:	IP-67
13.	Process Connection	:	SS Flange with matching flange
14.	Cable Entry	:	2 x ½" NPT

7.05.03 3D LEVEL MAPPING SOFTWARE

This module shall have the functions/feature, but not limited to the following.

- Basic display including sensor connection status, information such as tag nos, model nos. polling address, communication traffic load etc.
- Measurements of parameters such as sensor-material distance, level, volume, mass, temperature, Signal to Noise Ratio (SNR) etc.
- Multiple scanner connection with pre-set unique polling address
- False echo mapping
- Measurements of advanced parameters such as output damping time, material slope, offset, minimal SNR, false echo sensitivity, restrain co-efficient, side margins, bottom margins, top dead

band, historic log sampling period, activate extrapolation, maximum emptying rate etc.

- Log viewer (single & multiple mode)
- Generation & display of 3 dimensional graphical representation of the visual mapping contour as scanned by the 3D Level Scanners
- Selection of different signal types downloaded from the scanner at a preferred time resolution and analysis of selected signals for each scan

7.05.04 REMOTE DISPLAY UNIT

Remote Display Unit shall be provided with PC, 24" colour TFT LCD monitor, keyboard, mouse & colour laser jet printer and shall be located in the CHP Control Room. The PC shall include the following minimum specification.

Pentium latest, minimum Intel core 5 Processor, 800x600 Graphic resolution, 4GB RAM, 500 GB SATA, DVD ROM, latest Windows operating systems, communication ports: 2 nos. minimum Ethernet (1000 MBPS) & 4 nos. minimum USB ports.

The PC shall be interfaced with CHP PLC located in the CHP Control Room through redundant OPC connectivity. The system shall also be time synchronized with GPS Master Clock. 4~20 mA DC isolated outputs shall also be connected to CHP PLC and DDCMIS.

Bidder shall also refer to the relevant sections of Volume II-E of this specification for technical requirements of different hardwares such as monitor, printer and interface cables & accessories.

7.05.05 BUNKER WEIGHT MEASUREMENT

Bunker weight measurement with strain gauge shall also to be included.

7.05.06 Bidder's scope shall also include 3D acoustic stockpile level detection system along with PC based monitoring unit, printer etc. this shall also provide mass volume & mass profile of the stock pile. System shall be provided with suitable interfaces with Stacker Reclaimer PLC, CHP PLC and Plant DDCMIS.

7.06.00 BELT WEIGHING SYSTEM

a) It shall be microprocessor based and shall have its own local panel.

Belt weigh scale shall be provided with four idler weighbridges. The local panel shall provide:

i) Local flow rate indication
ii) Integrated flow indication
iii) System alarm annunciation
iv) Local calibration facility
v) Power On/Off
vi) Start & stop command

b) Local displays shall be digital with six digits for Rate of flow and totalized flow; battery backup shall be provided.

c) PLC interface shall be provided for the following;

i) Remote totalizer pulse signal
ii) Remote flow rate indication

d) Accessories shall include special cables, cabinets, indicators etc. as required to make the system complete.

e) Load sensing sensor shall be hermetically sealed Strain Gauge type having resistance bridge sensor with temperature effect on zero & span less than ± 0.015%/ 10 K. Single load sensor with four idler mounting shall be used. The accuracy shall be better than ± 0.25% through out its range.

f) Speed sensor shall be Tacho-generator /Encoder. Signal outputs shall be provided for speed and computed flow rate. The overall accuracy shall be better than 0.5% FS range.

g) Inclinometer shall be used along with Belt weighing system for the boom conveyor of Stacker Reclaimer. Belt weigher provided on Stacker Reclaimer Boom Conveyor shall have accuracy (in the horizontal position of the Boom) of ±1% for the range of 20% to 120% of Boom conveyor rated capacity.

h) Two (2) in motion weighbridge on either side of Track hopper & One (1) integral weighbridge below each Wagon Tippler Platform for measurement of gross weight for each wagon shall be provided for the Track Hopper complex. Each weighbridge shall have built in diagnostics, computer with necessary weight management software, explosion protection device & lightning protection system. A central Weighbridge terminal complete with its computer, printer etc. shall be provided. This weighbridge terminal shall be suitably connected to

individual weighbridge terminals located at Track Hopper complex. The quantity & location however shall be decided during detail engineering stage. The accuracy of weighing shall fall within ± 0.25%.

7.07.00 **ANEMOMETER** shall be provided on the stacker & re-claimer to measure the wind velocity and direction of wind. Instrument shall comprise of sensors, control unit and display unit. Interface with PLC shall be furnished for alarm.

8.00.00 DEW POINT METER

1.	Type	:	Direct Mounting Capacitance type with change in output proportional to moisture present.
2.	Sensing Element	:	Ceramic / Aluminum Oxide sensor
3.	Service	:	Dry Air
4.	Range	:	-90 Deg.C to 10 Deg.C Dew Point Temperature
5.	Sensor Accuracy	:	± 2 Deg. C Dew Point
6.	Repeatability	:	0.5 Deg. C Dew Point
7.	Operating Ambient Temperature	:	-40 Deg C to 50 Deg C
8.	Operating Pressure	:	0- 10 kg/ Sq. cm
9.	Display	:	Combined enclosure with 5 Digit seven segments LED display.
10.	Element Filter	:	80 micron sintered stainless steel
11.	Output	:	4- 20 mA DC Loop powered
12.	Power Supply	:	24 VDC nominal
13.	Enclosure class	:	IP 65
14.	Interchangeability	:	Fully Interchangeable transmitters
15.	Accessories	:	Sampling system, cables, sensor holder, desiccant chambers, double compression fittings, ¾ " Cable gland, mounting fixture etc.

16. Application : Compressed Air system

9.00.00 WATER SYSTEM RELATED SPECIAL INSTRUMENTS

9.01.00 ANALYSERS

For Analysers please refer Section-VI of this volume of the specification.

9.02.00 PARSHALL FLUME

9.02.01 Bidder shall include in his scope complete equipment for flow measurement through Parshall flumes. Measurement shall be carried out by Ultrasonic Level measurement principle. Bidder shall provide primary sensors, transmitters, flow indicator & totalizer & shall include all required accessories. System shall be of reputed make and acceptable to Owner / Engineer.

The general components of this system are as follows.

9.02.02 Level Transmitter shall have 2 wire along output of 4 – 20 mA DC (600Ω load impedence) in direct proportion to level with an accuracy of + / - 0.16 % or better. The transmitter shall be SMART type with interface with HART management system. The flow compensation is to be implemented in the transmitter itself.

9.02.03 Flow signal from the system shall be in the form of analog output of 4 – 20 mA DC with an accuracy of + / - 1 % or better.

9.02.04 Field mounted local flow indication facility shall also be provided.

9.02.05 All necessary liberalization circuits must be integral to the field transmitter and the enclosure should conform to IP-65 and corrosion resistant.

9.03.00 CHLORINE LEAK DETECTOR

1.	Type	:	Electrochemical
2.	Resolution	:	0.1 ppm
3.	Response Time	:	Less than 1 second
4.	Operating Temperature	:	0 - 45 ° C
5.	Display Type	:	Digital Indicating meter

6.	Alarm Contacts	:	Dual Alarm setpoints (240V AC, 5A)
7.	Protection	:	IP 65
8.	Mounting	:	Wall Mounting
9.	Power Supply	:	240 V AC
10.	Output	:	4~20 mA DC
11.	Load	:	600Ω

9.04.00 RESIDUAL CHLORINE ANALYZER

1.	Type:	:	Amperometric
2.	Electrode	:	Platinum / Gold and copper electrode shall be provide with cell cleaning system
3.	Indication	:	LCD in analyzer panel
4.	Range	:	0 to 20.0 mg / L (ppm)
5.	Accuracy	:	2% or better
6.	Sensitivity	:	0.01 mg / L
7.	Output signal	:	4-20 mA DC (isolated) into 600 ohms
8.	Alarm annunciation	:	Dual Alarm setpoints (240V AC, 5A) (Field adjustable)
9.	Calibration	:	Zero and span adjustment Final calibration / adjustment of analyzer to be done at site and duly verified by titration.
10.	Temp. Compensation	:	0-50 °C
11.	Sample drain	:	Yes
12.	Enclosure	:	Stainless Steel (IP-65)
13.	Power supply	:	240 V AC, 50 Hz, 1 Phase (through UPS)
14.	Accessories	:	Chemical Reagents

9.05.00 DENSITY INDICATOR

1.	Type	:	Hydrometer Type
2.	Mounting	:	On line
3.	Accuracy	:	+/- 2% of range
4.	Scale	:	Black letter on white scale
5.	End connection	:	PVC flange

9.06.00 DENSITY/ CONCENTRATION METER

1.	Wetted Part		Stainless Steel
2.	Enclosure		Stainless Steel (IP-65)
3.	Power Supply		24 V DC
4.	Output signal	:	4-20 mA DC (isolated) into 600 ohms
5.	Accuracy		±0.001 g/cc
6.	Indication	:	LCD display
7.	Temp. Compensation	:	Integral
8.	Accessories		Mounting hardware, integral amplifier (if required), cable glands, tag plate etc.

10.00.00 **SOLENOID VALVES**

1.	Operating Principle	:	Electromagnetic (noiseless)
2.	Coil voltage rating	:	240 V AC /24 V DC (as required)
3.	Ways	:	2/3/4 way
4.	Port size	:	1/4" NPT all ports
5.	Body	:	SS bar stock
	Trim	:	SS-316
6.	Duty	:	Suitable for continuous energization
7.	Sealing	:	Airtight and leak proof
8.	Ambient Temperature	:	0 - 50 ^{O} C

9.	Fluid Temperature	:	0-150 ^{O} C (approx.)
10.	Coil Enclosure	:	Stainless Steel
11.	Insulation	:	Class-H
12.	Coil Casing	:	IP-65 (Explosion proof for NEC Class-1, Division-1 area)
13.	Mounting	:	On pipe or on panel
14.	Cable Connection	:	½" NPT
15.	Accessories	:	Cable glands, SS Tag plate

VOLUME : VI
SECTION-VII
SUB SECTION - B
CONTROL VALVES

1.00.00 **GENERAL**

1.01.00 Control valves for regulating service shall normally be globe body, preferably cage guided, metal-to-metal seated, pneumatically operated and shall be provided with characterized plugs

1.02.00 Where high stroking speed , high actuation forces and accurate positioning is critical for the operation of the plant, as in case of HP or LP bypass valves, Separator Drain Valves , hydraulic actuators with electro-hydraulic interface shall be offered.

2.00.00 **GENERAL TECHNICAL REQUIREMENTS**

2.01.00 Bidder shall exercise caution in selecting severe service control valves like BFP recirculation, HP & LP bypass, superheater & reheater attemperator, PRDS for Boiler & Turbine, Feed control station ,Soot blower steam pressure, Fuel oil heating and pressurizing ,minimum economizer flow control ,DM make up (emergency / normal), control valves whose down stream are connected to vacuum such as HP/LP heater emergency level control, condenser make up water, separator level control , CEP minimum flow control etc. For such critical applications, Bidder shall offer valves which are proven for similar application. Above valves shall have leakage class equal or better than class-VI with metal-to-metal seating.

2.02.00 Valve with ANSI leakage class-V shall be provided for all applications except for the control valves indicated above.

2.03.00 Bidder shall provide redundant control valves for some services such as Main condensate flow control, Superheat attemperation control and Reheat attemperation control as a minimum for high availability. For other application, if the availability criteria for the plant cannot be met even with the best established product, redundant control valves shall be provided.

2.04.00 Control valves shall be located near floor or platform for ease of access and with adequate clearances for maintenance and lay-down and shall be placed as station with upstream motorized isolating valve, down-stream motorized isolating valve, inching duty motorized bypass valve and manual drain valves. Each redundant control valve shall have its upstream motorized and down-stream motorised isolating valves. Where quick shut off requirement is foreseen such as in case of SH & RH attemperation valves, upstream isolation valve shall be pneumatic type.

2.05.00 Wherever, steam conditioning calls for , Pressure reducing & desuperheating, combined PRDS type valves shall be offered.

2.06.00 Control Valve shall be furnished with IBR certification wherever required .

2.07.00 Valve Body / End Connections

2.07.01 Valve end to end dimension and connection shall be according to ANSI standard, straight through pattern. However, Bidder may offer angle body valve for high pressure drop applications. For high pressure drop applications, construction of the valve shall be such that the gland is not exposed to inlet pressure.

2.07.02 Control valves of 40 mm. size and above with line pressure up to 50 Kg / Sq. cm may have flanged or welded end connections.

2.07.03 Control valves, used in high pressure services shall have butt welded end connections for size 65mm and above and socket weld end connection for size 50 mm or below.

2.07.04 Control valve body shall be selected as per the ISA GUIdeline. Generally control valve body shall be cast and machined for pressure rating up to 1500 lbs. Above 1500 lbs, valve body shall be of forged steel. For Demineralized Water application, valve body shall be Stainless Steel.

2.07.05 Bonnet joints for all control valves shall be of flanged and bolted type.

2.07.06 Flanged valve shall be rated at no less than class 300 lbs

2.07.07 The direction of flow shall be clearly engraved on the body . Valve tag no, , description or purpose, stroke time shall be painted on all control valve body with black letters on white background in Bold letters.

2.07.08 Valve Body Materialial shall match the process conditionrequirement as per ANSI. . General guideline shall be as follows

SR. NO.	SERVICE		MATERIAL
1.	Non corrosive, non-flashing and non cavitating service for fluid temperature up to 275ºC	:	Cast carbon steel ASTM A216 Gr. WCB , Trim material - 316 SS stellited faced GUIde posts and bushings.
2.	Non corrosive, non-flashing and non cavitating service for fluid temperature above 275ºC	:	Cast alloy steel ASTM A217 Gr. WC9 Trim material - 316 SS stellited faced GUIde posts and bushings.
3.	Severe flashing / cavitating services	:	Alloy steel ASTM A217 Gr. WC9 , Trim material - 440C
4.	Low flashing / cavitating services	:	Alloy steel ASTM A217 Gr. WC6 ,Trim material - 17-4 PH SS
5.	DM water application (condenser hotwell normal, emergency make up etc.)	:	316 stainless steel

2.07.09 Bidder may supply valves with body and trim materials with superior quality than specified material and in such cases Bidder shall furnish the comparison of offered material properties ,such as cavitation resistance , , hardness , tensile strength , strain energy , corrosion and erosion resistance etc. , with specified material for Owner's approval.

2.08.00 Valve Size

The control valve sizing (Cv / Kv) shall be based on following guidelines :

a) The valves shall pass normal flow (MCR condition) with 60 to 70 percent opening for linear characterised valves and between 70 to 80 percent opening for equal percentage characterised valves.

b) The valves shall have adequate rangeability to pass the minimum and maximum flows at 10% and 85% of the valve opening respectively. Valve stem travel range from minimum to maximum flow condition shall not be less than 50% of the total valve stem travel.

c) Valve Cv shall be selected in such a way that the valve shall be capable of handling at least 120% of required maximum flow.

d) The valve selection shall be based on the highest size dictated by the above considerations unless noise, flashing or other factors dictate the final selection.

e) Trim exit outlet velocity as defined in ISA handbook does not exceed 8 m / sec for liquid services , 150 m/sec for steam services anf 50/% of sonic velocity for flashing services The sizing procedure followed shall be as per latest edition of ANSI/ISA or equivalent standard.

2.09.00 Valve Top work

2.09.01 Top work shall be sized so that the valve shall operate properly when upstream pressure is 10 percent above maximum inlet pressure and downstream pressure is atmospheric.

2.09.02 Extended bonnet/ bonnet when maximum temperature fluid is greater than 280^0 C shall be provided and high temperature packing shall also be used for high temperature application.

2.09.03 The gland material shall be chosen to suit the operating temperature. PTFE may be chosen for lower temperature application (232ºC maximum) and for high temperature application graphited asbestos glands are to be provided. For vacuum services,. All valves connected to vacuum on downstream side shall be provided with packing suitable for vacuum applications eg. double vee type chevron packing.

2.10.00 Valve Trim

2.10.01 Valve trim for applications up to leakage class-V shall be stainless steel 316 SS for pressure drop up to 7 Kg/ Sq. cm. For pressure drops above 7 Kg/Sq. cm hard trim (stelliting or equivalent) shall be used. Other alloys or treatment such as nitride shall be used if severe erosion is expected.

2.10.02 Balanced trim valves shall be offered for high shut-off pressure or high pressure drop condition to reduce the size of the actuators.

2.10.03 For flashing services and two stage mixtures, the trim material shall be 17-4 PH SS or equivalent.

2.10.04 If cavitating condition is foreseen, Bidder shall offer multistage or labyrinth trims valves. Trim of severe service valves shall be of multistage and multipath design with number of discrete pressure drop stages to eliminate the chances of erosion, cavitation, noise and vibration throughout the control range of the valve.

2.10.05 Quick replacement type trim shall be considered for easy maintenance.

2.10.06 Plug shall be one-piece construction cast , forged or machined from solid bar stock .Plug shall be screwed or pinned to valve stems or shall be integral with the valve stems.

2.11.00 Noise Level

The equivalent sound level measured at 1.5M above nearest floor level in elevation and 1 M horizontally from the control valve expressed in decibels to a reference of 0.0002 microbar shall not exceed 85 dBA. The noise abatement shall be achieved by valve body & trim design and not by use of silenecers. Valve Actuators

2.12.00 Actuator

2.12.01 Spring-diaphragm type actuators shall generally be used. Piston type actuators shall be offered in case of high shut-off pressure & quick response requirement. Hydraulic actuation system shall be provided for Critical valves as described elsewhere in the specification.

2.12.02 The 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.

2.12.03 Diaphragms shall be designed for 200% maximum operating pressure.

2.12.04 Nylon reinforced neoprene is preferred as diaphragm material.

2.12.05 Valve actuators shall be capable of operating at 80^0 C ambient, continuously.

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

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

2.12.08 Bidder shall indicate the stroking time of the valve assemblies with ositioned and ensure that the stroke time shall meet the process and equipment dynamics and shall be better than 10 seconds.

2.12.09 All actuators shall be of fail safe 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.

2.12.10 Hydraulic actuation system

The system shall consist of , but not limited to , Hydraulic cylinder , proportional valve with blocking unit , SMART positioner with position transmitter , SOVs , safety bypass unit , safety control unit , Hydraulic supply unit and local controller cubicle with controller unit

2.13.00 Valve Positioners

2.13.01 All regulating service valves shall be offered with HART protocol based Smart Electro Pneumatic Positioners to ensure accuracy and repeatability of response.

2.13.02 Positioners shall have integral non contact type position transmitter, input and output gauges, local keypad & display and 4-20 mA DC output to DDCMIS in CCR.

2.13.03 Positioners shall be capable of functioning under hot, humid and vibrating conditions.

2.13.04 Positioner casings shall be dust tight, corrosion resistant and weatherproof to IP 65 .and explosion proof in hazardous areas.

2.13.05 In general, positioner shall operate at signal range 4 – 20 mA DC for the full travel of the valve. Split range operation in few cases may be required.

2.13.06 Remote calibration from control room shall be possible through HART management station.

2.14.00 Performance

2.14.01 Performance of the complete assembly of the control valves shall be better than +/- 1% of FS for linearity , +/- 0.5 % of FS for hysteresis , 1% for accuracy.

2.15.00 Valve Accessories

2.15.01 Accessories shall include side mounted hand wheels, open & close , intermediate (as applicable) limit switches for both regulating and On off valves ,, junction boxes with 20 % spare terminals , Air filter regulators , airlock relays , volume chambers etc. Solenoid valve (SOV) wherever required shall be furnished. Each limit switch shall have not less than 2 NO & 2 NC contacts with contact rating 5A , 240 V AC / 0.5 A , 220 V DC . SOV shall have SS bar stock body , SS316 Trim , SS coil enclosure , Class H insulation Air filter regulator shall have sintered bronze filter element with maximum 5 microns filter size & 2 inch dial size pressure gauges. .Protection class of all Limit switches , junction boxes , SOV etc. shall have protection class IP 65 and explosion proof for hazardous areas.

2.15.02 Air distribution line to all final control elements like control valves, pneumatic dampers (both regulating / on-off type) , SOV operated valves shall be through SS manifolds and SS isolating valves only. These valves shall be properly tagged also with KKS tag no. and description of final control element / instrument for which they are intended.

2.16.00 Test and Examination

All valves shall be tested in accordance with the Quality Assurance programme agreed between the Owner and Bidder , which shall meet the requirements of IBR and other applicable codes mentioned elsewhere in the specification . The test shall include but not be limited to Non destructive test , Hydrostatic shell test prior to seat leakage test , Seat leakage test , Valve closure test , Functional test of fully assembled valves including actuators and accessories. CV test etc. For all control valves Cv test shall be witnessed by Owner.

VOLUME : VI
SECTION-VII
SUB SECTION - C
INSTRUMENTATION AND CONTROL CABLES

1.00.00 **GENERAL TECHNICAL REQUIREMENTS**

1.01.00 Cables shall be flame retardant low smoke (FRLS) type. In hazardous areas cables of suitable R/L ratio shall be provided for intrinsic safety. Repaired cables are not acceptable.

1.02.00 FRLS marking shall be provided on the surface of the cable at intervals not exceeding 5 mtrs. Durable marking at intervals not exceeding 625mm shall include Manufacturer's name, Year of manufacture, Voltage grade, Type of cables (Conductor size & no. of pairs / type of compensating /extension cable), Insulation material, FRLS etc.

1.03.00 Progressive sequential length marking shall also be provided at every meter interval on outer sheath of cable.

1.04.00 Non returnable standard seasoned wooden drum containing minimum 500 /1000 M ± 5% length. Drum shall be anti rodent, anti termite and smooth finish. Both end of cable shall be capped by means of non hygroscopic sealing material.

1.05.00 Thermocouple Extension & Compensating Cable

01.	Conductor	:	Solid conductor
02.	Conductor size	:	16 AWG (1.31 Sq. mm)
03.	Type	:	KX (Compensating) (Chromel Alumel) RX (Compensating) (Copper-Copper alloy) JX (Compensating) (Iron Constantan)
04.	Conductor Insulation	:	HR PVC Type-C (IS-5831,1984) 0.6 mm thick
05.	Operating Voltage	:	650V
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. Size 0.5 Sq. mm. (No. of strands / size:- 7 / 0.3mm) (For both individual and overall screen)
10.	Inner Sheath	:	Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties)

			HR PVC Type ST2 of IS-5831,1984
			Thickness as per IS-1554Part-I 1976
11.	Rip Cord	:	Non metallic under sheath
12.	Armouring	:	GI wire / strip as per IS 3975
13.	Outer Sheath	:	Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties)
			HR PVC Type ST2 of IS-5831,1984
			Thickness 1.8 mm (Min)
14.	Filler	:	Non hygroscopic with FRLS property
15.	Temperature Range	:	Up to 85 °C
16.	Insulation at 20^0 C	:	100 MOhms/Km [Min]
17.	Capacitance at 800 Hz	:	200 nf/km
18.	Cross talk	:	60 dB
19.	Attenuation	:	1.2 dB/Km
20.	Codes & Standards	:	a) IEC 332-1
			b) ANSI MC 96.1
			c) IS-8784-1987
21.	Tests	:	a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863)
			a) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I
			b) Temp Index : Min 250 DEG C at 21Oxy. Ind. (ASTM-D-2863)
			c) Smoke Density Rating : Max.60% (ASTM-D-2843).
			d) Flammability Test : as per IEC 332 Part-I /IEEE-383
			Swedish Chimney Test - SS-424-1475 F3
			e) High voltage test
			Core to core- 2.0 KV for 1 min.
			Core to screen- 2.0 KV for 1 min.
			f) Insulation Resistance 100 M Ohm / Km Min
			g) Rodent & Termite repulsion test (Presence of lead shall be confirmed)

22. Conductor material & sheath color for thermocouple cable as per ANSI MC 96.1

CABLE TYPE	OVERALL SHEATH COLOR	WIRE	SHEATH COLOR	CONDUCTOR MATERIAL
KX	Yellow	Positive	Yellow	Nickel / Chromium
		Negative	Red	Nickel / Aluminum
JX	Black	Positive	White	Iron
		Negative	Red	Constantan
RX	Green	Positive	Black	Copper
		Negative	Red	Copper Nickel Alloy

23. Durable printed or embossed numbering at regular interval of 50mm shall be provided for identification of pairs. Each core printed with number or numbered binder tape shall be provided on each pair.

1.06.00 Instrumentation multi Paired Signal Cable

01.	Conductor type	:	Stranded (7) annealed tinned copper
02.	Conductor size	:	0.5
03.	Conductor resistance	:	39 Ω
04.	Conductor Insulation	:	HR PVC Type-C (IS-5831,1984) 0.6 mm thick
05.	Operating Voltage	:	650V
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. 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. Size 0.5 Sq. mm. (No. of strands / size:- 7 / 0.3mm)

10.	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
11.	Rip Cord	:	Non metallic under sheath
12.	Armouring	:	GI wire / strip as per IS 3975
13.	Outer Sheath	:	Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties) HR PVC Type ST2 of IS-5831,1984 Thickness 1.8mm (Min)
14.	Filler	:	Non hygroscopic with FRLS property.
15.	Temperature Range	:	85 $^{\circ}$C
16.	Insulation at 20 Deg.C	:	100 MOhms/Km [Min]
17.	Capacitance at 800 Hz	:	120 nf/km
18.	Cross talk	:	60 dB
19.	Attenuation	:	1.2 dB/Km
20.	Codes & Standards	:	a) IPCEA-S-61-402 b) BS 5308 c) IEC 332-1 d) ASTM-B-33 e) IS-8130-1984 f) IS 1554 Part-1 g) IS 10810
21.	Sheath colour	:	Inner- Black and Outer- Gray
22.	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 $^{\circ}$ 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

Core to core- 2.0 KV for 1 min.

Core to screen- 2.0 KV for 1 min.

i) Rodent & Termite repulsion test
(Presence of lead shall be confirmed)

23. Colour of core for Instrumentation Cable (As per IS-9938)

PAIR	CORE	COLOR
1st	1st	Blue
1st	2nd	Red
2nd	1st	Gray
2nd	2nd	Yellow
3rd	1st	Green
3rd	2nd	Brown
4th	1st	White
4th	2nd	Black

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.

1.07.00 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 ASTMD 2116. These cables shall be pair, multipair, and twisted & shielded.

1.08.00 Control & power Cable

Bidder shall refer to Volume IIF of the electrical specification for detail.

1.09.00 Optical Fiber Cable

Bidder shall supply and install optical fiber cable and all cable accessories and fittings like Light Interface Unit, Surge suppressors, Opto isolators, Interface converters, Fiber Optic Card Cage, Fiber Optic Line Driver, Repeater/ Modem, cable glands, grommets, lugs, termination kits etc on as required basis.

Optical Fiber Cable shall be 4/8/12 core. Each core shall be of ultra pure fused silica glass with UV cure acrylate suitable to withstand temperature between 20 and 80ºC. The cable shall have multiple mono mode fiber. On as required basis so as to avoid usage of any repeaters. . Fiber optic cable shall be of loose buffer tube design with 4 fibers per buffer tube (minimum). Interstices and buffer tubes shall be filled with water blocking compound such as thixotropic gelly to protect against moisture and vibration.Buffer tube shall

be made of materials like Poly-Butelene Terathylate (PBT). They shall be colored for easy identification.. Buffer tubes shall be stranded around Central Strength Member utilizing Reverse Oscillating Lay (ROL). Blank fillers shall be used as necessary to maintain circular cable structure.

The central strength member shall be Fiber Reinforced Plastic (FRP) or other material with equivalent mechanical strength to provide both tensile and anti-buckling strength to cable.

The interstices between buffer tube and jacket layers shall be protected from water intrusion by a combination of dry water blocking yarns and tapes. These dry materials shall be easily removable from core during cable preparation without use of cleaning solvent.

In addition to central strength member, additional strengthening substance like aramid yarns shall be applied helically over the cable core to provide additional tensile strength to cable.

The cable shall be of dual jacket and armoured. Inner sheath consists of medium density poly ethelyne extruded over cable core. Two highly visible ripcords are placed under the jacket to aid in sheath removal. Electrolytically chrome plated corrugated steel taped (ECCST) armouring is provided around inner jacket to provide additional cable compression strength and rodent protection. The armour is covered with outer black MDPE sheath with FRLS and UV resistance properties. A ripcord is also placed under neath the armour for easy outer sheathing removal. The cable shall be suitable for a maximum tensile force of 2000N during installation and once installed, a tensile force of 1000N minimum. The compressive strength of cable shall be 3000N minimum and crush resistance 4000N minimum. Minimum bending radius shall be equal to or more than 15D.

Specification for G.652 Monomode Fiber:

Sl. No.	Attribute	Value
1	Core Diameter	9±1 micrometer
2	Cladding Diameter	125±1 micrometer
3	Cladding non circularity	≤1.0%
4	Attenuation coefficient at (i) 1290 nm to 1340 nm (ii) 1525 nm to 1575 nm	 <0.36 Db/km <0.25 Db/km
5	Chromatic dispersion coefficient at (i) 1310 nm (ii) 1550 nm	 <3.5 ps/ nm.km <18 ps/ nm.km
6	Polarization Mode Dispersion (PMD)	≤0.5 ps/√km

	coefficient	
7	Mode field diameter at (i) 1310 nm (ii) 1550 nm	9.2±0.4 micrometer 10.50±1.0 micrometer
8	Mode field concentrality error	≤0.5 micrometer
9	Proof test	≥1%
10	Fiber Curl	≥ 4.0 m
11	Macro bend test on fiber at 1550 nm	≤0.1 dB

The entire length of the cable shall be marked with the manufacturer name, month and year of manufacture, coded description of the cable based on Telcordia's(Bellcore) SR-2014 Suggested Optical Cable Code (SOCC),progressive sequential length marking at every meter interval on outer sheath.

Following tests as per anty approved standards such as FOTP, IEC etc shall be carried out on the cables:

a. Attenuation and dispersion characteristics test
b. Proof test
c. Macro-Bend Resistance Test
d. Mechanical Tests
e. Low and High Temperature Cable Bend Test
f. Impact Resistance Test
g. Compressive Strength Test
h. Tensile Strength Test
i. Cable Twist Test
j. Cable Cyclic Flexing Test
k. Environmental Characteristics Test
l. Temperature Cycling Test
m. Color Performance Test
n. Cable Aging Test
o. Water Penetration Test
p. Lightning Test
q. Routine Test/ Sample Test
r. Site Test (Continuity and Attenuation)

s. FRLS Test

1.10.00 Coaxial Cable

1	Standard	: MIL-17G, IS-5026
2	Inner conductor	: Tinned copper (Cu Sn)
3	Size	: 0.94 mm dia (19 stranded)
4	Dielectric insulation	: Cellular foam polyethelyne
5	Overall diameter	: 2.95 mm
6	Shielding	: Aluminium mylar tape
7	Outer conductor	: Cu Sn- Braid, 96% lapping (Overall dia 3.60 mm)
8	Armoring	: Galvanized mild steel
9	Outer sheath	: FRLS PVC
10	Temperature range	: 85°C
11	Attenuation	: Up to max 39.5 Db/100 m

VOLUME : VI

SECTION-VII

SUB SECTION - D

PANELS , DESKS , RACKS AND JUNCTION BOXES

1.00.00 **GENERAL REQUIREMENT**

1.01.00 ENCLOSURES FOR INSTRUMENTS AND OTHER EQUIPMENT

1.01.01 All panels, cabinets, distribution boxes, junction boxes, terminal boxes and all other field mounted equipment / enclosures shall have suitable environmental protection as detailed in Section-I of this volume of the specification.

1.02.00 SURFACE PREPARATION & PAINTING

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

1.02.02 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.

1.02.03 Two spray coats of inhibitive epoxy primer surfacer shall be applied to all exterior and interior surfaces, each coat of primer surfacer 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. The finish colors for exterior and interior surfaces shall conform to the following shades:

- Exterior – Opaline green shade 275 of IS: 5 or equivalent international code..
- Interior - Brilliant White.

1.02.04 Paint films, which show sags, cheeks, blisters, teardrops, fat edges or other painting imperfections, shall not be acceptable.

1.03.00 WIRING

1.03.01 All spare contacts of relays, switches and push buttons shall be wired up to the terminal blocks. All intercommunications between sections of panels/desks shall be furnished.

1.03.02 Each wire shall be identified at both ends with wire designation as per approved wiring diagram. Heat shrinkable type ferrules with indelible computerized ink print shall be used with cross- identification.

1.03.03 All wire termination shall be made with insulated sleeve and crimping type lugs. Wire shall not be spliced or tapped between terminals. Open-ended terminal lugs will not be accepted. Wires shall not be looped around the terminal screws or studs.

1.03.04 Internal wiring should be terminated uniformly on one side of the terminal block leaving the other side available for termination of outgoing cables. Internal wiring shall be grouped so that all outgoing wiring to each particular remote location is terminated on adjacent terminal blocks. Interior wiring and jumperings shall be arranged so that external connections can be made from internal side of terminal blocks. Common connections shall be limited to two (2) wires per terminal.

1.03.05 Wiring shall be arranged to ensure free access to all instrument or devices for maintenance. No wire shall be routed across the face or rear of any device in a manner, which will impede the opening of covers or obstruct access to leads, terminals or devices

1.03.06 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.

1.03.07 Shield wires shall be terminated on separate terminal blocks. Common connections shall be limited to two wires per terminal. Signal circuit shields shall be grounded at the power supply end only or as recommended by manufacturer.

1.03.08 All low level signal cables shall be separately bundled to from control cable and maintained at 300 mm minimum spacing from control bundles.

1.03.09 Panel internal wiring shall follow distinct color-coding to segregate different voltage levels viz. 24V DC, 48V, 110V AC, 240V AC, 220V DC etc.

1.03.10 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 shall be electrically and physically isolated from other AC and DC wiring. Shielded wires used in such cases for panel internal wiring shall be continuous and ungrounded with the shield terminated individually and separately in panel terminal block.

1.03.11 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 will not cause fatigue failure of the conductor.

1.03.12 Internal wiring in factory pre-wired electronic systems cabinets may be installed according to the Contractor's standard wire size, insulation, and method of termination on internal equipment. Insulation for all wiring, including circuit board wiring, back panel wiring, power supply wiring and interconnecting cables between devices shall pass the vertical flame test per IPCEAS-1981. Identification of conductors may be done by insulation color-coding identified on drawings or by printed wiring lists.

1.04.00 TERMINAL BLOCKS

1.04.01 All terminal blocks shall be rail mounted/ post mounted type, cage clamp type with high quality non-flammable insulating material of melamine suitable for working temperature of 105 Deg C. The terminal blocks in field mounted junction boxes, instrument enclosures racks etc. shall be suitable for cage clamp connections. The terminal blocks in Control Equipment Room termination/ marshalling cubicles shall be suitable for post mounted cage clamp connection at the field input end. The exact type of terminal blocks to be provided by Bidder shall be subject to Owner.

1.04.02 All terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, small partitions, transparent covers, support brackets, distance sleeves, warning level, marking etc. For RTDs ring - tong type lugs shall be used at Junction Boxes.

1.04.03 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

1.04.04 The insulation of the terminal blocks shall be of suitable thermoplastic material.

1.04.05 The spacing between Terminal blocks channels in panels and cubicles shall be adequate for routing the cable troughs and to allow adequate free workspace for termination and removal of wires. The terminal blocks shall be arranged with atleast 100 mm clearance between two sets of terminal blocks and junction box walls.

1.04.06 Signals of different voltage levels shall be clearly segregated by providing separate rows to each type of signal and by using terminal blocks of different color for each type of signal and by providing barrier strips between them.

1.04.07 Terminal blocks shall be provided with white marking strips / self-adhesive marker cards and where permitted by the safety codes and standards, shall be without covers. Power terminals and high voltage (above 48 volts) terminals shall have protection covers. All terminals shall be provided with permanent terminal identification numbers on both sides.

1.04.08 At least 20% spare unused terminals shall be provided on each terminal block for circuit modifications and for termination of all conductors in a multi-conductor control cable.

1.04.09 The bottom of the terminal block shall be at least 200 mm above the cable gland for bottom entry type panels.

1.04.10 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.

1.04.11 Other requirements of the terminal blocks are as follows:

i) The last terminal in a rail-mounted assembly shall be closed with an end plate and end bracket.

ii) For visual and electrical separation of terminal groups, partition plates shall be provided, which can be push fitted after forming an assembly.

iii) Design shall permit testing of incoming and outgoing signals by using suitable test plug and socket without disconnecting the cable connections.

iv) It shall 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.

v) Where more than one connection to a terminal block is required, two tier terminals shall be used.

1.05.00 GROUNDING

1.05.01 Separate Protective and Electronic system ground as required shall be provided.

1.05.02 All panels, desks, cabinets shall be provided with a continuous bare copper ground bus (Frame ground), bolted to the panel structure at bottom on both sides and effectively ground the entire structure. The bolts shall face inside of panels.

1.05.03 For electronic system cabinets the electronic system ground bus (Electronic ground) shall be similar but insulated from the cabinet and shall be separately connected to the system ground .The same ground may be used to earth the shield of shielded signal cables, otherwise a separate ground bus shall be provided for connecting the signal cable shields. Cable shields shall be grounded at the panel end only and shall never be left open .The electronic ground between panels of a shipping section shall be firmly looped.

2.00.00 **CONTROL DESKS & PANELS**

2.01.00 GENERAL

2.01.01 All control desk, panels etc. shall be furnished fully wired with necessary provision for convenience outlets, internal lighting, utility receptacles, grounding, ventilation, space heating, anti-vibration pads, internal piping &

accessories as required for completeness of the system.

2.01.02 The design shall conform to the EN ISO 11064 (Ergonomical design of Control Room), Part 1, 2 and 3.

2.01.03 The exact dimensions, material, construction details, grounding, general arrangement etc. shall be as per actual requirement and shall be finalized during detail engineering and subjected to Owner's approval.

2.01.04 Incoming power supply feeders shall be duplicated. Alarm shall be provided for failure of a power supply feed.

2.01.05 For Control desk/ panel mounted instruments/ devices etc. which are to be powered from UPS, all required conversion of interface equipments/ accessories to make such devices compatible with UPS supply shall be provided. All necessary hardware like input switches/ fuse unit for each feeder as well as switch fuse unit for each instrument/ device on the power supply line shall be provided. From UPS redundant feeders shall be provided wih suitably rated MCB and provision of fast auto changeover of UPS feeders.

2.01.06 Crating of the panels and desks shall be suitable for protection against shock, vibration, inappropriate handling and inclement weather conditions during transportation and warehousing. Mounted equipment shall have adequate protection against damage during handling, transit and storage. Suitable desiccant shall be used inside the packing case.

2.01.07 Nameplate

a) Nameplate shall be provided for instrument or device mounted on the panel.

b) Nameplates for panels shall be provided both in front and rear.

2.02.00 CONTROL DESK

2.02.01 Control desk shall be free standing, floor mounting, table top type with doors at back and shall be constructed of 3 mm thick (minimum) CRCA steel or Aluminium extrusion. Aluminium structure shall be anodized or powder coated paint finish. The top surface of control desk shall be 30 mm (minimum) thick with the top 12 mm (minimum) of acrylic solid surface and the remaining 18 mm of laminated medium density fibre (MDF) board.

2.02.02 Monitors with retractable keyboard shall be provided on the desk. Desk shall be arranged in arc-like shape without any sharp edges. Edges shall be extruded PVC or rounded post-formed laminate.

2.02.03 Desks shall be of modular, scalable and industrially ruggedized design and shall have connections for PA system handsets & telephone sets.

2.02.04 Desks shall have concealed cable trays for wire dressing. Both Horizontal & Side Managers (2 separate horizontal cable routing wire baskets for power & data cables) shall be provided.

Each User station will be provided with 2 separate power distribution units (1 for Main line & 1 for UPS line). Each power distribution unit will have 6 points of 5/13 Amp sockets, Mains MCB On/Off Switch & Indicator.

Adequate heat management provision for Exhaust of heat from within the Console Desk Assembly shall be provided. There will be multiple fans provided in the Main Control Desk. Each Fan will be of 230 VAC 250 CFM Ball Bearing based. Ventilation louvers will be provided on both Front & Rear Modesty with special Air Filters. Adequate space for CPU & Other equipments placed with in the desk.

2.02.05 Design shall include Earthing bolts.

2.02.06 Back installed items shall be suitably concealed from front view.

2.02.07 All operator workstations for SG, TG, Auxiliaries & Off-site Plants shall be mounted on this Control Desk. The cabling / wiring between OWS & CPUs, power supply cables etc. shall be aesthetically routed and concealed from view.

2.02.08 HARDWIRED DEVICES ON CONTROL DESK (DRAW OUT SECTION)

Release and Lamp Test push buttons shall be provided for a set of push buttons (decided during detail engineering stage). Depending on the type of control/ function, required number of push buttons/ indicating LEDs & their color, push button stations shall be selected. The size of push button stations shall be 24 x 48 mm or 25 x 50 mm and shall have service inscription details at the front. Emergency push buttons (with cover) shall be mounted on top of Control Desk.

2.03.00 BACK UP PANEL

2.03.01 Construction shall be from CRCA steel of thickness not less than 3mm.

2.03.02 Upright back-up panel shall be provided where hardwired devices shall be mounted on a mosaic grid type console. The mosaic grid tiles shall be of 24 mm x 48 mm (or 25 mm x 50 mm) size, made of heat & flame retardant, self extinguishing and non-hygroscopic material with flat matt finish without glare and non reflecting type.

2.03.03 DDCMIS Back-up Panel (referred as Unit Control Panel-UCP) shall also mount annunciation fascia (minimum 500 nos.) and the flame monitoring cameras along with other hardwired devices as decided during detail engineering stage by Owner. Color coding shall also subject to Owner's approval.

2.03.04 Colored Mimic for different Off-site plant control systems (as enumerated elsewhere in this specification) and hardwired annunciation system shall also

be mounted on the back up panels.

2.04.00 PANELS/CABINETS

2.04.01 All DDCMIS system modules, power supply components and other Local Control panels (PLC/Relay based) shall be housed in cabinets as specified below.

2.04.02 The cabinet mounted equipments shall be fully assembled, installed in mounting racks, wired and fully tested as per specification requirements and Owner approved drawings prior to shipment to the project site.

2.04.03 The Bidder shall ensure that the cabinets are complete & ready for installation before dispatch from manufacturing works. The installation work at project site for these cabinets shall only involve connections through multi-pair cables from marshalling cabinets (wherever provided) to system cabinets and inter-cabinet/cabinet to Control Desk/ Back up Panel.

2.04.04 All electronic cards, network components, power supply modules etc. located shall be suitably housed in cabinets and shall be neatly arranged in sub-racks. Network components shall be visible in door closed condition (e.g. Glass doors etc.) as approved by Owner.

2.04.05 Bidder shall design the cabinet internal arrangement, floor cutout and cable gland plate such that all the cables entering or leaving the cabinet can be properly glanded in the gland plate.

2.04.06 The packaging density of panels shall be such that the temperature rise within the panels shall never exceed 10°C above ambient even under worst operating conditions. Cooling Fans shall be provided wherever required and this shall be of industrial grade.

2.04.07 TECHNICAL PARTICULARS

1.	Material of Construction	:	Cold Rolled Coal Annealed (CRCA) steel sheet	
2.	Thickness of Sheet	:	a)	2.0 mm for faces supporting instruments / terminals
		:	b)	1.6 mm for other sides and top
3.	Construction	:	Welded throughout as per approved National Standards	
4.	Post welding operation	:	a)	Grounding of all welds to smoothness
		:	b)	Rounding of corners

		:	c)	Cleaning of weld spatters
5.	Panel height	:	2300 mm (approx)	
6.	Corners	:	7 mm inner radius	
7.	Dimensional Tolerances	:	a)	In height & length - 3 mm
			b)	In height between adjacent sections - 2 mm
			c)	Total for a group - 6 mm
8.	Doors	:	Double, recessed, turned back edges, full height front & rear	
	i) Thickness of Sheet	:	2 mm	
	ii) Hinges	:	Stainless steel	
	iii) Door latches	:	Three point type	
	iv) Door gaskets	:	Neoprene rubber on fixed frame to result dust proof/weatherproof enclosure	
	v) Opening of the doors	:	Outward	
	vi) Louvers	:	With removable wire mesh to ensure dust and vermin proof	
9.	Gland plates	:	Removable in sections 4 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) Lifting hook / Eye bolt

g) Drawing pocket

h) Door switch, lamps, thermostat, heaters and industrial grade cooling fans,, illumination fixures

12.	Name Plate	:	Both at front and back surface of the panel
13.	Fixing of name plate	:	Stainless steel pan head screws
14.	Name plate material	:	Laminated phenolic (3 layers)
15.	Lettering	:	Black with white engraved
16.	Mounting of terminal blocks	:	Vertical angle support bracket tack welded on sheet steel plate, screwed on internal wall of enclosure

2.05.00 FURNITURE

All the furnitures in the Central / Local control Room (s), Engineers' rooms, Instrument laboratory , SWAS Room & any other rooms with C&I equipments located in different plant buildings under Bidder's scope shall be included in Bidder's scope of supply. 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.

2.05.01 WORK STATION FURNITURE

Modular work station furniture, suitable for mounting servers & historians, programmer stations, PC based systems, printers (A4/A3 color laserjet) etc. shall be provided.

2.05.02 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.

2.05.03 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.

2.05.04 TABLES

Industry standard computer tables shall be provided & shall be as approved by Owner during detailed Engineering. Glass top teak wood horse shoe shaped table with vertical file mounting arrangement (two layers to house approx. 40 Nos of files and lockable drawers at both ends) for Engineering Room shall be provided.

2.05.05 ALMIRAHS

Steel Almirahs shall be provided for keeping documents in the documentation room. Glass doors for each rack shall be provided such that the documents are visible from outside. Size of the rack shall be sufficient to easily fit technical manuals. The exact details shall be approved by Owner during detailed Engineering.

2.05.06 KEYPAD

One keypad per unit shall be provided for the storing of keys of relevant areas of the unit in the control room.

2.05.07 LOCKERS

Suitable lockers shall be provided in the room adjacent to the control room for storing of personal articles of control room personnel. Also, lockers of bigger size shall be provided in documentation Room for storing of personal documents. Details shall be finalized and approved by Employer during detailed engineering.

3.00.00 LVS PANEL

3.01.00 An arc shaped Large Video Screen (LVS) panel shall be supplied for mounting large video screens in number of tiers in various Control rooms as specified elsewhere in this specification.

Biddr shall provide and fix ACP cladding around the LVS screen including covering the LVS back side and LVS stand. The cladding will be from floor finish to 600 mm above LVS screen like a self-standing partition with necessary openings for system requirement. ACP paneling shall be with 304 grade & approx. 0.5 mm mirror finish SS strip.

3.02.00 The profile, dimensions and the general arrangement shall be finalized & approved by Owner during detailed engineering. Recommendations, if any, for the control room lighting in order to ensure continuous proper viewing of the LVS screen by the operator & shift incharge (without any fatigue) shall be

clearly brought out by the Contractor in his offer, alongwith all relevant details/basis.

3.03.00 Any other requirement for proper LVS mounting & functioning & viewing shall also be specifically brought out by the Contractor in his offer, along with all relevant details.

4.00.00 **LOCAL INSTRUMENT RACK (LIR) & LOCAL INSTRUMENT ENCLOSURE (LIE)**

4.01.00 GENERAL

4.01.01 Devices (Transmitters/ Switches) located in the field shall be suitably grouped together to the extent possible and installed in the LIE (Closed Rack) and LIR (Open Rack) in Boiler/TG Building and Off-site plant areas.

4.01.02 Racks and enclosure shall be factory prefabricated & painted and shall complete with internal piping, tubing, manifold, isolation valves, blowdown valves, integral junction box, illumination etc.

4.01.03 No more than six instruments shall be grouped in a single rack / enclosure.

4.01.04 Racks shall be installed above the tapping points for air, flue gas and coal air mixture application whereas for applications such as for water and steam, racks to be installed below the source point.

4.01.05 Attention shall be paid in the layout to avoid air traps in liquid piping and water accumulation in air /gas piping.

4.01.06 Racks used for furnace, flue gas and air application shall be provided with intermittent & continuous air purging

4.01.07 Welding of impulse lines shall comply with the provisions of the latest applicable ANSI Code for Pressure Piping.

4.01.08 Earth stud shall be furnished at rack for safety grounding.

4.02.00 LOCAL INSTRUMENT ENCLOSURE (LIE)

4.02.01 Enclosure shall be free standing type. Racks shall be adequately reinforced to ensure true surfaces and to provide support. Major load - bearing posts shall be suitably supported by gusset plates or moment members.

4.02.02 Enclosure outer shall be constructed from at least 3 mm thick steel plate and epoxy painted to shade gray. Base frame shall be made of ISMC 100 and black colour finish.

4.02.03 2” NB galvanized pipes shall be laid horizontally and supported at two end channels to mount transmitters at accessible height. Center posts or any

member, which would reduce access, shall be avoided.

4.02.04 Double leaf interlocking front opening doors with three point locking shall be provided and shall be arranged for maximum possible access to the interior. Key shall be of identical for all enclosures.

4.02.05 Doors shall have concealed quick removal type pinned stainless steel hinges and locking handles. Gaskets shall be used between all mating sections to achieve dust and weather proof enclosure rated for IP-65 including the internal junction box. All enclosures shall have access doors on front side.

4.02.06 Removable type bulkhead plates of thickness not less than 6 mm shall be mounted at the racks with suitable high temperature gasket. Impulse lines within the enclosures shall be properly clamped.

4.02.07 All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings within transmitter racks both open and closed type, is admissible.

4.02.08 Racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. Header (2" NB ASTM A 106, Sch-80 Gr. C) shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header..

4.02.09 Each rack shall be provided with one receptacle, light fixtures with wire guard and one lighting switch each at instrument & Junction box compartments with wire guard. Lighting switches may be door actuated & mounted inside the panel. Outlet box, switch box and device covers shall be of galvanized stamped steel. Light switches and receptacles shall be installed inside the enclosure on the wall near the latch side of the enclosure door. Light fixtures shall be installed on the ceilings of the enclosures.

4.02.10 Power supplies for miscellaneous devices shall be provided with MCB located within the enclosures. MCB shall be mounted in fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.

4.02.11 Vibration dampeners shall be installed for supporting each enclosure. The loading at each corner of the enclosure shall be determined by actual test weighting when construction is complete to determine the correct length of each dampener for proper loading of the dampener in accordance with manufacturer's recommendations

4.03.00 LOCAL INSTRUMENT RACK (LIR)

4.03.01 Rack shall be free standing type constructed from 6 mm thick steel channel frame provided with a canopy to protect the instrument from dripping water or

falling objects and shall be epoxy painted. Canopy shall be of CRCA steel sheet of at least 3 mm thickness.

4.03.02 Rack Major load-bearing posts shall be suitably supported by gusset plates or moment members. Suitable fenders grill shall be welded to the end-posts of the rack to outline a boundary beyond which no mounted equipment shall project to protect instrument from accidental contact during personnel movement. Center posts or any member, which would reduce access, shall be avoided.

4.03.03 2" NB galvanized pipes laid horizontally and supported at two end channels shall be employed at working accessible height for mounting of instruments.

4.03.04 All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings are admissible.

4.03.05 Racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. Header (2" NB ASTM A 106, Sch-80 Gr. C) shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header..

Each rack shall be provided with one receptacle, one light fixture with wire guard and one lighting switch. Outlet box, switch box and device covers shall be galvanized stamped steel. Light fixtures shall be installed on the canopy of the rack

4.03.06 Power supplies for miscellaneous devices shall be provided with MCB located within the enclosures. MCB shall be mounted in fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.

4.04.00 JUNCTION BOX

1.	Type of Enclosure	:	Dust tight & weatherproof conforming to IP 65
2.	Material	:	3 mm sheet steel / fiberglass reinforced polyester(UV stabilized)
3.	Type of Cover	:	Solid unhinged with retention chain / Screwed at all four corners
4.	Paint	:	i) Exterior : Opaline green shade 275 of IS: 5 ii) Interior - Brilliant Glossy White.

			Surface / Two (2) inch Pipe stanchion
5.	Mounting	:	(At a dry compartment at one side of the enclosure / rack with front opening type door)
6.	Cable Entry	:	3 mm (min) Bottom / side Gland plate
7.	Gasket	:	Neoprene
8.	Grounding	:	Brass earth lug with green screw head External-2 nos , Internal-1no. (M6)
9.	Number of Drain Holes	:	Two at bottom capped
10.	Identification	:	Label for JB and Tags for cable
11.	Accessories	:	a) Rail mounted cage clamp type screwless terminals (suitable for conductor size up to 2.5sq.mm of suitable voltage grade) with markers and 20% spare terminals b) Cable gland (Brass) & raceways c) Ferrules & lugs (Brass) d) Aluminum back panel e) Canopy at top f) Mounting brackets g) bolts and nuts made of brass etc.

VOLUME : VI
SECTION-VII
SUB SECTION - E
ERECTION HARDWARES

1.00.00 GENERAL TECHNICAL REQUIREMENTS

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.

However, any item required for erection of Bidder supplied system but not categorically indicated in this section, shall be supplied by the Bidder and all these items shall conform to International / National standards / codes.

1.01.00 Electrical Accessories

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 IS:9537 Part-I (1980) and Part-II(1981).. The conduit interior and exterior surfaces shall have a continuous zinc coating with an over coat of transparent enamel lacker or zinc chromate. Conduits shall be furnished in standard length of 3 meters, threaded at both ends.

iv) All rigid conduit fittings shall conform to requirements of IS:2667,1976. Galvanised steel fittins shall be used wth steel conduit. All flexible conduit fittings shall be liquid tight, galvanized steel. The end fitting shall be compatiable with the flexible conduit supplied.

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.

1.02.00 Electrical Junction Box:

Please refer to Section VII , Subsection – D of this volume of the Specification.

1.03.00 Cable Gland

1.	Type	: Double compression
2.	Entry Thread	: NPT / ET
3.	Material	: Brass
4.	Finish	: Cadmium Plated.
5.	Protection	: IP 54 or better
6.	Accessories	: Neoprene gasket, locknuts, reducers etc

1.04.00 Cable Tray

1.	Material	: Mild steel, slotted
2.	Thickness	: not less than 2.0 mm
3.	Finish	: Hot dip galvanized
4.	Perforation	: As per MFR standard
5.	Cover	: Suitable for tray

1.05.00 Process Hook Up Accessories & specification

Material and rating of the hook up items shall suit the piping and fluid condition. Hook up materials shall be IBR certified for applicable cases. Bidder shall furnish hook up drawings and the drawings for open racks & closed racks for owner's approval.

1.05.01 Seamless Stainless Steel Pipe

1.	Reference	: ASTM A-312 TP 316
2.	Material Grade	: TP 316
3.	Type	: Seamless /Plain end
4.	Size	: As applicable (e.g.½" NB etc)
5.	Schedule	: 40
6.	Standard Length	: 5 meter

1.05.02 Stainless Steel Pipe Fittings

	1.	Reference	: ASTM A-182 F 316 / ANSI B16.11
	2.	Type	: Forged
	3.	Rating	: 3000 lbs / 6000 lbs / 9000 lbs
	4.	Size	: To suit related SS pipe.
	5.	End connection	: Generally socket weld
	6.	Type of Fittings	: Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

1.05.03 Seamless Stainless Steel Tube

	1.	Reference	: ASTM A-213 , ASTM A-249 or ASTM A-269
	2.	Material Grade	: TP 316
	3.	Size	: As applicable (e.g.½" OD X 0.083" wall thickness / ¼" OD X 0.049" wall thickness etc.)
	4.	Type	: Cold drawn annealed, pickled, passivated, de-scaled, hydraulically cleaned seamless tube.
	5.	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.
	6.	Test Pressure	: 400 Kg/Sq. cm (minimum)
	7.	Tolerance	: $\pm$ 0.13 mm for outside diameter
			: $\pm$ 15 % for wall thickness
	8.	Standard Length	: 5 meter
	9.	Test	: Flare, Hardness, Ball and Bubble Test

1.05.04 Stainless Steel Tube Fittings

	1.	Reference	: ASTM-A-182
	2.	Type	: Double ferrule double compression
	3.	Material	: 316 Stainless steel forged
	4.	Ferrule	: 316 Stainless Steel

	5.	Type of Fittings	: Male / female connector, elbow, cross /equal tee, straight connector, bulkhead union, ferrule etc. as required to suit installation.
	6.	Size	: To suit SS tubing and NPT end connection

1.05.05 C.S. Pipe

	1.	Reference	: ASTM-A 106 Gr. C
	2.	Material	: Cold drawn seamless black C.S.
	3.	Type	: Seamless / Plain ends
	4.	Size	: As applicable (e.g. ½" NB etc)
	5.	Schedule	: 80, 160, XXS as required
	6.	Standard Length	: 5 meter

1.05.06 C.S. Pipe Fittings

	1.	Reference	: ASTM-A 105 / ANSI B16.11
	2.	Type	: Forged
	3.	Rating	: 3000 lbs / 6000 lbs / 9000 lbs
	4.	Size	: Suitable to related C.S.Pipe
	5.	End connection	: Generally socket weld
	6.	Type of Fittings	: Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

1.05.07 A.S. Pipe

	1.	Reference	: ASTM-A 335 P22 AS PER ANSI B 36.10
	2.	Material	: Cold drawn seamless A.S.
	3.	Type	: Seamless / Plain ends
	4.	Size	: As applicable (e.g. ½" NB etc)
	5.	Schedule	: XXS
	6.	Standard Length	: 5 meter

1.05.08 A.S. Pipe Fittings

1. Reference : ASTM-A 182 F22 AS PER ANSI B 16.11
2. Type : Forged
3. Rating : 9000 lbs
4. Size : Suitable to related A.S.Pipe
5. End connection : Generally socket weld
6. Type of Fittings : Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

1.05.09 G.I.Pipe

1. Reference : IS-1239, Part-I
2. Type : Medium grade, threaded at both ends protected with end caps
3. Material : Continuous ERW galvanized MS pipe
4. General : Pipe shall be galvanized both inside and outside
5. Size : As applicable (e.g 1/2”/3/4”/1” etc.)

1.05.10 G.I.Pipe Fittings

1. Reference : IS-1239, Part-II for material, dimension, thread etc.
2. Style : Threaded
3. Type of Fittings : Equal tee, three piece union, unequal tee, straight socket, 90 Deg. elbow, reducing socket cap. etc. to suit installation.
4. Size : Suitable to related G.I.Pipe

1.05.11 Carbon Steel Globe Valve

1. Reference : ASTM A-105
2. Type : Globe
3. Construction : Forged Body Cadmium Plated
4. End Connection : As applicable (eg. ½” Socket Weld etc.)
5. Rating : Cl. 800 / CL. 2500

	6.	Material	: Body - Carbon steel
			: Stem - Hardened Steel
			: Plug - AISI 316 SS
			: Seat- Stainless steel stellited
	7.	Packing	: Teflon / Grafoil as required
	8.	Yoke	: ASTM A105
	9.	Hand wheel	: Carbon steel
	10.	Design standard	: As per ANSI B 16.34

1.05.12 Stainless Steel Globe Valve

	1.	Reference	: ASTM A-182 F316
	2.	Type	: Globe
	3.	Construction	: Forged Body
	4.	End Connection	: As applicable (eg. ½" Socket Weld etc.)
	5.	Proof Pressure	: 400 Kg/Cm2
	6.	Material	: Body - Stainless steel
			: Stem - Hardened Steel
			: Plug - AISI 316 SS
			: Seat- Stainless steel stellited
	7.	Packing	: Teflon as required
	8.	Yoke	: ASTM A182 F316
	9.	Handwheel	: Carbon steel
	10.	Design standard	: As per ANSI B 16.34

1.05.13 Alloy Steel Globe Valve

	1.	Reference	: ASTM A-182 F22
	2.	Type	: Globe
	3.	Construction	: Forged Body

4.	End Connection	: As applicable (eg. ½" Socket Weld etc.)
5.	Rating	: CL. 2500
6.	Material	: Body - Alloy steel
		: Stem - Hardened Steel
		: Plug - AISI 316 SS
		: Seat- Stainless steel stellited
7.	Packing	: Grafoil as required
8.	Yoke	: ASTM A182 F22
9.	Handwheel	: Carbon steel
10.	Design standard	: As per ANSI B 16.34

1.05.14 Structural Steel

Steel supports for JB's, trays; tubes and related equipments shall not be limited to the following:

a) MS Angle
b) MS Channel
c) I-Beam
d) Hexagonal head Bolt & Nut with washer
e) Foundation Bolt & Nut
f) Expansion Bolt
g) Steel Plates / Flats
h) CRCA sheet
i) 50 NB Pipe
j) Pipe clamps, U Bolts & Nuts
k) Checker plate

1.05.15 Condensate Pot

1.	Reference	: ASTM A182 F22 /ASTM A105
2.	Material	: Alloy steel / carbon steel as per application
3.	Construction	: Drilled from barstock
4.	End connection	: As applicable (e.g 3 nos. ½" socket weld end etc.)

	5.	Accessories	: Vent valves

1.05.16 Instrument Valve Manifold

1.	Type	: Two valve manifold
		: Five valve manifold
2.	Mounting	: Remote 2” Pipe Mounting / Transmitter Rack mounting
3.	Construction	: Single block (bar stock)
4.	Material	: Forged body and bonnet AISI 316 stainless steel
5.	Ports	: Mfg std. (e.g 1/2 " NPT (F) etc.)
6.	Rating	: 420 Kg/Sq. cm at ambient
7.	Operating Temperature	: (-)30 to (+)170 Deg C
8.	Packing	: PTFE Wafer
9.	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	: Plugs for all ports, Mounting Bracket , bolts , nuts

1.06.00 Pneumatic Hook Up Accessories

1.07.00 Air Header

Technical Particulars	**For Panel**	**For Field**
Material of Construction	: Stainless steel	: Stainless steel
Inlet Connection	: 2" NPT (M)	: 1" NPT (M)
Header Take-off Material	: Stainless steel	: Stainless steel
Take off connection	: 1 / 2” NPT (M)	: 1/ 2” NPT (M)
Take-off Valves Material	: stainless steel	: stainless steel

Tube Take-off	: Tube adapter on valve	: Tube adapter on valve
Drain	: SS drain valve at lowest point	: SS drain valves at lowest point

02	27.04.2021	Revised as per approved Design Memorandum	KB	PR	PNR
01	13.07.2019	Revised the document as per the comments	PR	RB	RSB
00	28.06.2019	Fresh Issue	PR	RB	RSB
REV	DATE	DESCRIPTION /NOTE	PRD	CHD	APD

REVISIONS

TITLE: **MATERIAL OF CONSTRUCTION (MOC)**

OWNER/PROJECT: **TELANGANA STATE POWER GENERATION CORPORATION LTD.**

BHADRADRI (4X270 MW) THERMAL POWER PLANT–
FGD SYSTEM PACKAGE

CONSULTANT:

DESEIN PRIVATE LIMITED.
NEW DELHI

EPC CONTRACTOR:

BHARAT HEAVY ELECTRICALS LTD.
BOILER AUXILIARIES PLANT,RANIPET

COLLABORATOR:

MITSUBISHI HITACHI POWER SYSTEMS, LTD
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

	BHEL	Date	
PREPAREDBY	Kabilash	27.04.2021	STATUS : *FOR APPROVAL*
CHECKEDBY	Raju	27.04.2021	BHEL CUST NO : G301,G302,G303,G304
APPROVED BY	Naveen	27.04.2021	BHEL DOC NO: 04-FW-000-00532
			REV NO :02

The following are the FGD Equipment Material selected to suit the operating condition of FGD:

S. No.	Description	Material
1)	Absorber & Oxidation Tank (Absorber Bottom)	Minimum 7 mm thick Carbon Steel (IS 2062) + 3.0 mm (Minimum) thick glass flake Lining
2)	W/D interface zone	Solid Alloy C276 (6 mm thickness)
3)	Spray pipe	Fiber Re-in forced Plastic (FRP) with ceramic coating (on wetted parts)
4)	Spray Nozzles	Silicon Carbide (SiC)
5)	Jet Air Sparger	FRP with ceramic coating (wetted parts)
6)	Absorber Tank Agitator	Blade: Alloy 926(1.4529) or better Shaft: Alloy 926 (1.4529) or better
7)	All other Tank Agitators	Shaft - CSRL Blades- Alloy 926 (1.4529) or better
8)	Absorber Mist Eliminator	ME Panel – Polypropylene (PP)
		Washing Spray pipe & Nozzles –FRP / PP
9)	Absorber Recirculation Pump	Casing- C.S/C.I + Rubber Liner / Hi-chrome / SiC / Highly Alloyed Stainless Steel
		Impeller- Hi-chrome / SiC
		Shaft- Carbon Steel + sleeve made of CD4M Cu ASTM A-743 (Duplex Stainless Steel).
		Base Plate – Carbon Steel
10)	Oxidation Air Blower	Casing- Carbon Steel

		Impeller- Stainless Steel
		Shaft- Alloy Steel
		Base Plate – Carbon Steel
11)	Absorber internal structural members	6 mm C.S (IS 2062) + 3 mm Glass Flake Lining
12)	Auxiliary Absorbent Tank	Minimum 6 mm CS (IS2062) + 2 mm thick Glass Flake Lining
13)	Other Slurry Tanks 1. Primary Hydro Cyclone feed tanks 2. Secondary hydro cyclone feed tank 3. Waste water tank 4. Limestone slurry storage tanks 5. Filtrate water tanks 6. Mill circuit tanks	6 mm thick CS (IS 2062)+ 2 mm thick Glass Flake Lining
14)	Process water Tanks	6 mm thick C.S (IS 2062) + Epoxy Painting
15)	Belt filter washing tanks	6 mm thick CS (IS 2062) + Epoxy Painting
16)	Water Pumps 1. Process Water Pumps. 2. Mist Eliminator wash pumps 3. Belt filter washing pumps. 4. Cake washing	Casing- 2.5 Ni Cast iron to IS 210 Grade FG 260. Impeller- SS 316 Grade Shaft- SS 410

	pumps.	
17)	All Drain Sumps	Concrete + 2 mm thick Glass flake lining
18)	Slurry Pipes 1. Gypsum Slurry line. 2. Limestone slurry line. 3. Filtrate water slurry line. 4. Waste water slurry line.	CSRL or For slurry pipes size up to 400NB made up of FRP with silicon carbide coating on slurry exposed surface. Rubber lining material: 4 mm thick- IIR rubber
19)	Limestone grinding system	All parts of wet ball mill in contact with limestone slurry provided with replaceable rubber wear liners.
		Mill Hydro cyclones Hydro cyclones: Polyurethane material Feed, Overflow & Underflow launder: CS (IS 2062) + Rubber Lining of 12mm thick.
20)	Gypsum Dewatering System	**Primary /Secondary Hydro cyclones** Hydro cyclones: Polyurethane material Feed, Overflow & Underflow launder: CS (IS 2062) + Rubber Lining of 12mm thick.
		Vacuum Belt Filter Filter Frame – Mild Steel with Epoxy painted Filter cloth – Polypropylene / Poylester Belt – Syrene Buadiene rubber
		Vacuum Receiver C.S (IS 2062) + Rubber lining of 5 mm thick rubber

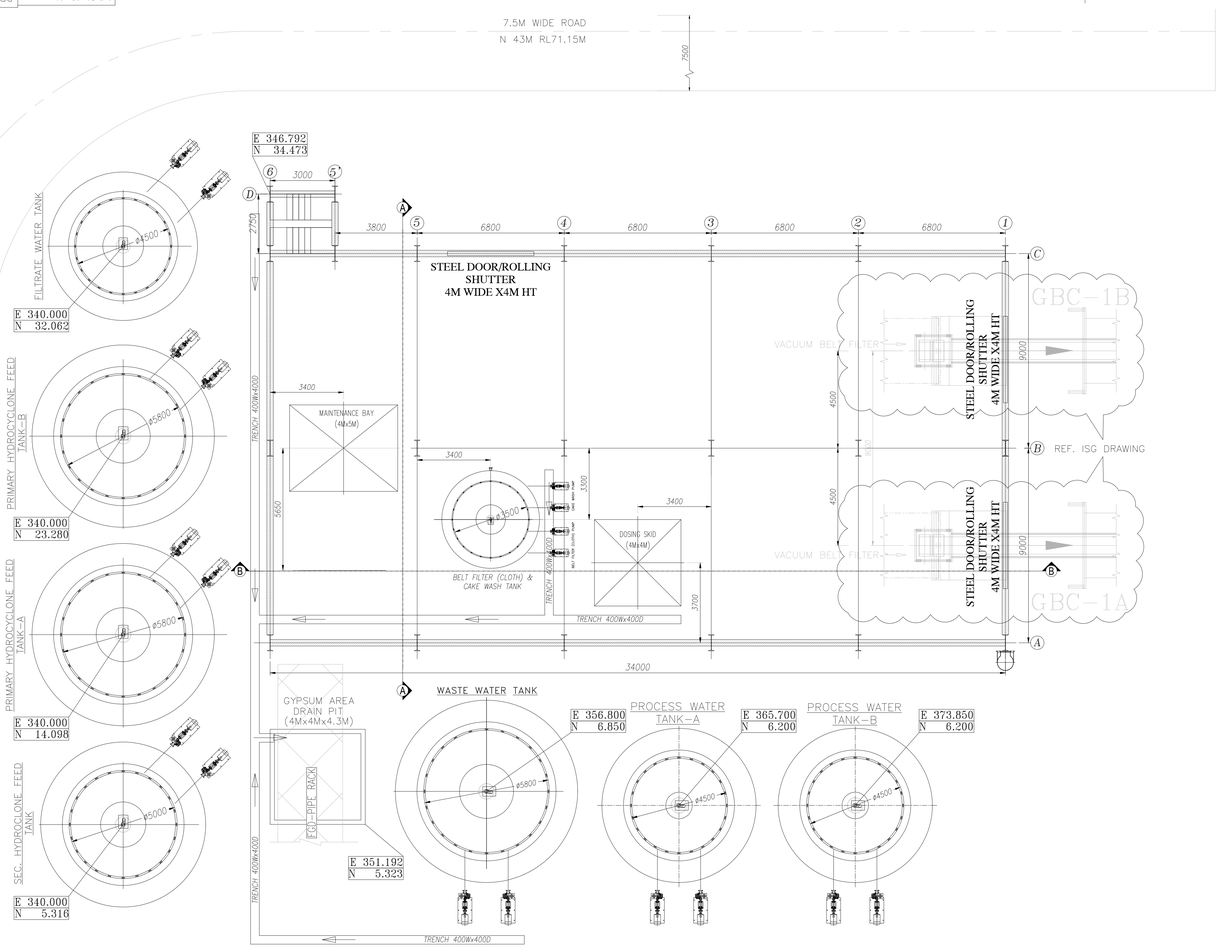
		lining.
		Vacuum Pump Casing – C.I or better material Rotor/Impeller – C.I or better material Shaft – EN24 or better material Shaft sleev-SS304 or better material.
21)	Limestone Storage Silo / Lime Storage Silo	10 mm (min) thick CS (IS 2062) In Conical portion CS (IS 2062) + 4 mm thick SS304 lining
22)	Thermal insulation	Lightly resin bonded rock wool mattress with density of 100 kg/m3
23)	GGH (Gas Gas Heater)	**Rotor & Baskets:** Corten steel or better material **Heating elements:** Enameled steel **Rotor Housing and other components in gas path:** Carbon steel lined with flake glass lining.
24)	All horizontal Slurry Pumps 1. Gypsum Bleed pumps 2. Auxiliary absorber tank feed pumps 3. Primary Hydro Cyclone Feed Pumps	Casing- C.S/C.I + Rubber Liner / Hi-chrome / SiC / Highly Alloyed Stainless Steel Impeller- Hi-chrome / SiC Shaft- Carbon Steel + sleeve made of CD4M Cu ASTM A-743 (Duplex Stainless Steel).

	4. Secondary hydro cyclone feed pumps 5. Waste water feed pumps. 6. Limestone slurry feed pumps 7. Filtrate water pumps	
25)	All vertical Slurry Pumps 1. Absorber area drain pumps 2. Gypsum dewatering area sump pumps 3. Limestone grinding area sump pumps	Casing- C.S/C.I + Rubber Liner / Hi-chrome / SiC / Highly Alloyed Stainless Steel Impeller- C.S/C.I + Rubber Liner /Alloy steel Shaft- Carbon Steel + Rubber Liner /alloy steel
26)	Duct MOC	Bypass Duct tap-off to GGH inlet : **6 mm thick CS** GGH outlet to Absorber inlet: **7 mm thick CS with 1.20 mm thick Glass Flake lining** Absorber outlet to GGH inlet: **7 mm thick CS with 1.20 mm thick Glass Flake lining** GGH outlet to bypass duct: **6 mm thick CS with 1.20 mm thick Glass Flake lining**
27)	Air-supply headers	a) Carbon steel (IS 2062) b) CS+ Rubber lining (for the lines comes in contact with slurry)

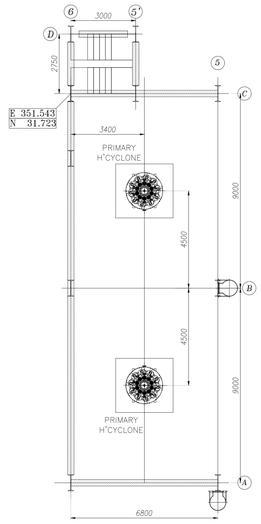
FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

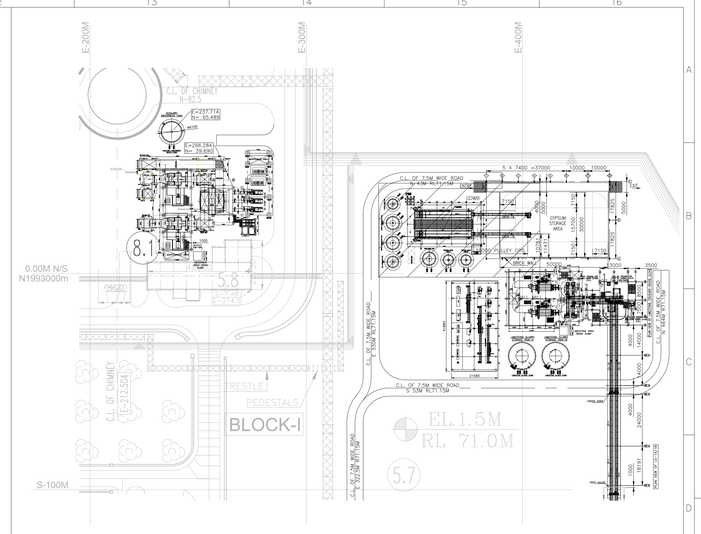
DRG. NO. PY-LE-0-M113-2043-01 SHT. 01 OF 02



PLAN @ EL(±)0.000



PLAN @ EL(+)19.500M



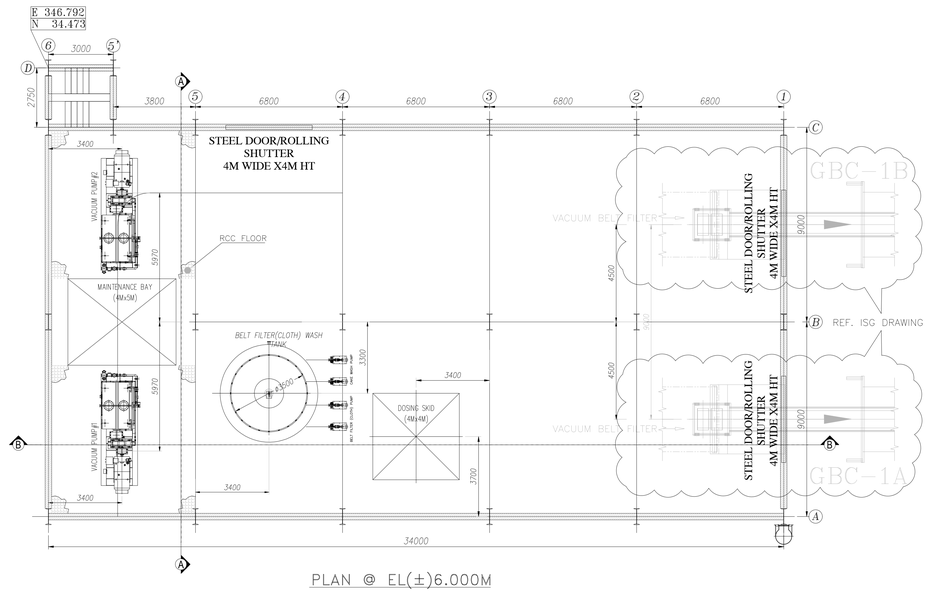
KEY PLAN

LEGEND:-

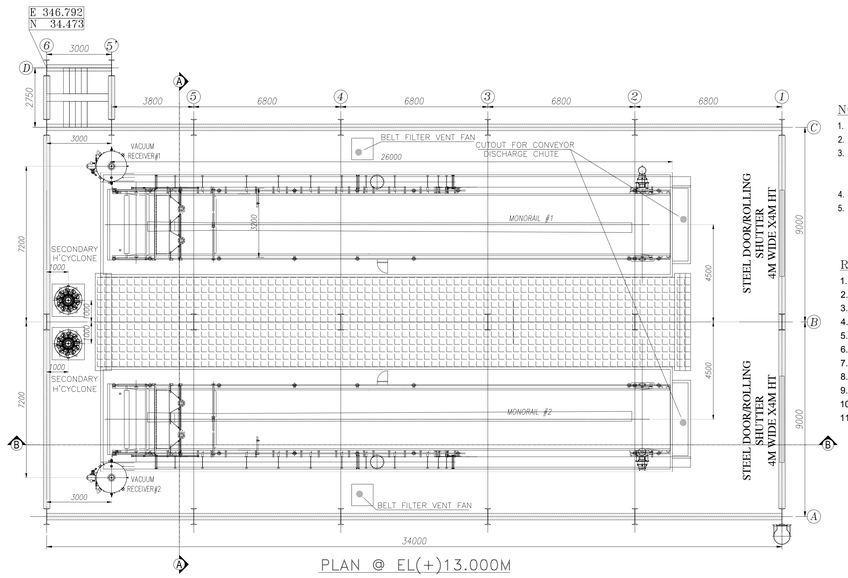
FGL	- FINISHED GROUND LEVEL
FFL	- FINISHED FLOOR LEVEL
T.O.PF	- TOP OF PLATFORM
TOC	- TOP OF CONCRETE
OPENG	- OPENING
MR	- MONORAIL
THK.	- THICK
TYP	- TYPICAL
GDWB	- GYPSUM DEWATERING BUILDING.
VBF	- VACUUM BELT FILTER

EQUIPMENT LIST:

Sl No.	Equipment Description	Quantity (Number)	Weight (Per Equipment)
1.	Primary Hydrocyclone	2	6 Tonne
2.	Belt Filter(Cloth) & Cake Wash Tank Pump	4	Later
3.	Belt Filter Washing Tank	1	Later
4.	Vacuum Belt Filter	2	100 Tonne
5.	Vacuum Receiver	2	10 Tonne
6.	Vacuum Pump	2	30 Tonne
7.	Belt Support Fan A/B	2	Later
8.	Secondary Hydrocyclone	2	5 Tonne
9.	Vent Fan	2	6 Tonne



PLAN @ EL(±)6.000M



PLAN @ EL(+)13.000M

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS IN METRES.
2. FGL IN GYPSUM DEWATERING BUILDING AREA IS RL (+)71.0M / EL 1.5M.
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.

REF. DWGS

1.	03-FW-747-00658	: PLANT LAYOUT OF FGD SYSTEM
2.	03-FW-744-00662	: P&ID - FILTRATE WATER SYSTEM
3.	03-FW-738-00663	: P&ID - VACUUM BELT FILTER & ACCESSORIES
4.	03-FW-738-00664	: P&ID - BELT FILTER WASHING TANK & PUMP
5.	03-FW-701-00654	: P&ID - GYPSUM BLEED PUMPS
6.	03-FW-747-00658	: P&ID - PRIMARY HYDRO CYCLONE FEED TANK AND PUMPS
7.	03-FW-738-00659	: P&ID - PRIMARY HYDRO CYCLONE SYSTEM
8.	03-FW-747-00660	: P&ID - SECONDARY HYDRO CYCLONE FEED TANK AND PUMPS
9.	03-FW-738-00661	: P&ID - SECONDARY HYDRO CYCLONE SYSTEM
10.	03-FW-745-00665	: P&ID - WASTE WATER TANK & PUMPS
11.	IS-1-GA-719-101-M107	: LHP/GHP CONVEYOR PROFILE

CUSTOMER: TELANGANA STATE POWER GENERATION CO. LTD.

CUSTOMER'S CONSULTANT: DESEIN PRIVATE LIMITED

PROJECT: BHADRADRI TPS, UNITS # 1 TO 4 (4X270 MW), MANUGURU, KHAMMAM DISTRICT
FGD PACKAGE

BHARAT HEAVY ELECTRICALS LTD. HYDERABAD
PROJECT ENGG & SYSTEMS DIVISION

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	RAVI	-sd-	27.09.2021	
CHD.	PARAMESH	-sd-	27.09.2021	
APPD.	UDAY KUMAR V	-sd-	27.09.2021	

REV.	DATE	ALTERED	RAVI
01	07.10.2021	CHD/APPD	UDAY KUMAR V

ZONE: REVISED AS PER LATEST INPUTS.

DEPT. PE&SD | CODE 450 | UNTOL. DIMS. OR g/m/y | SCALE 1:100 | WEIGHT (KG) --- | REF. TO ASSY. DRG. | ITEM NO. | NO.OF ITEMS

TITLE: GYPSUM DEWATERING BUILDING (PLAN)

CARD CODE NA

BHEL DRG. NO. PY-LE-0-M113-2043-01 REV. 01

CUST. DRG. NO.

SHT. No 01 NO. OF SHT. 02

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GENERAL DIMENSIONAL LIMITS,FITS & TOLERANCES AS PER HY0230261

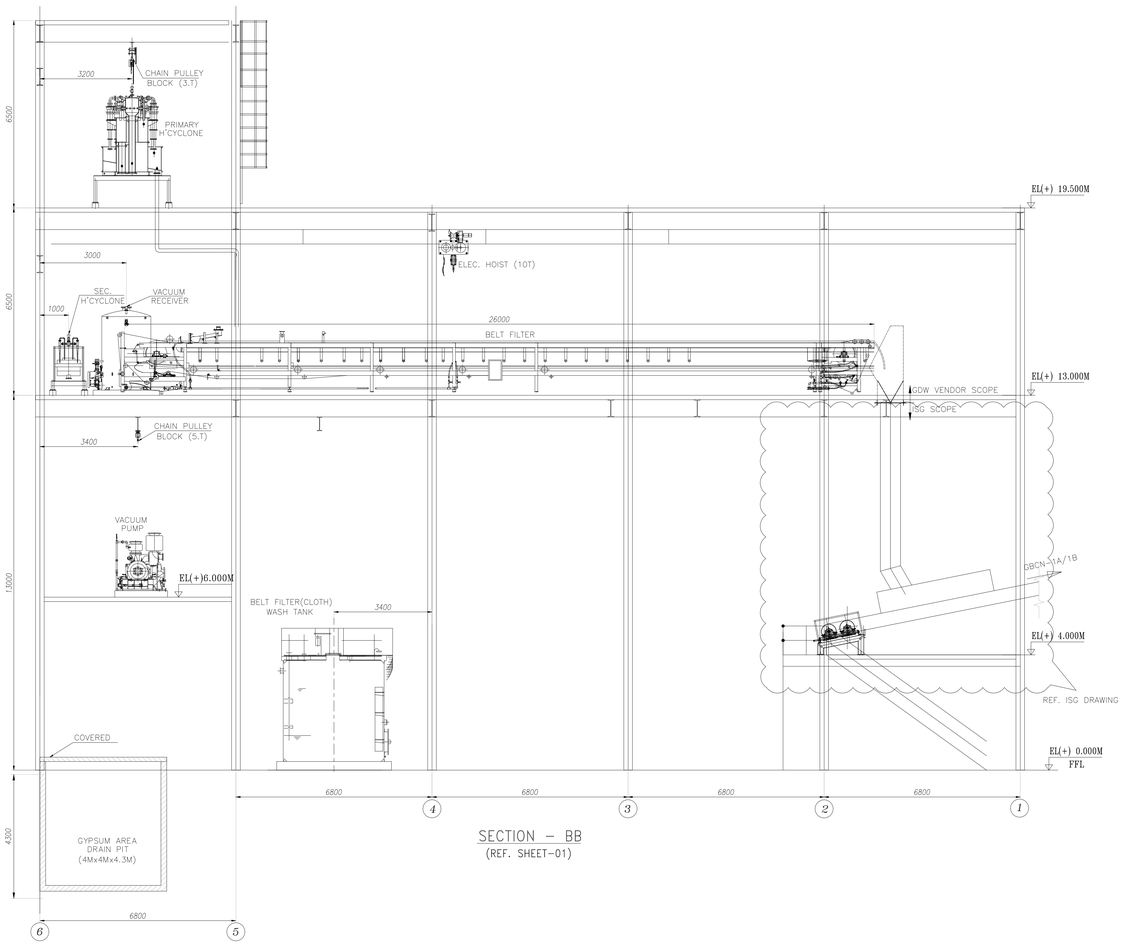
INVENTORY NO | SIGN. AND DATE | REF. DRG. NO. | COMPUTER FILE NAME

FIRST ANGLE PROJECTION

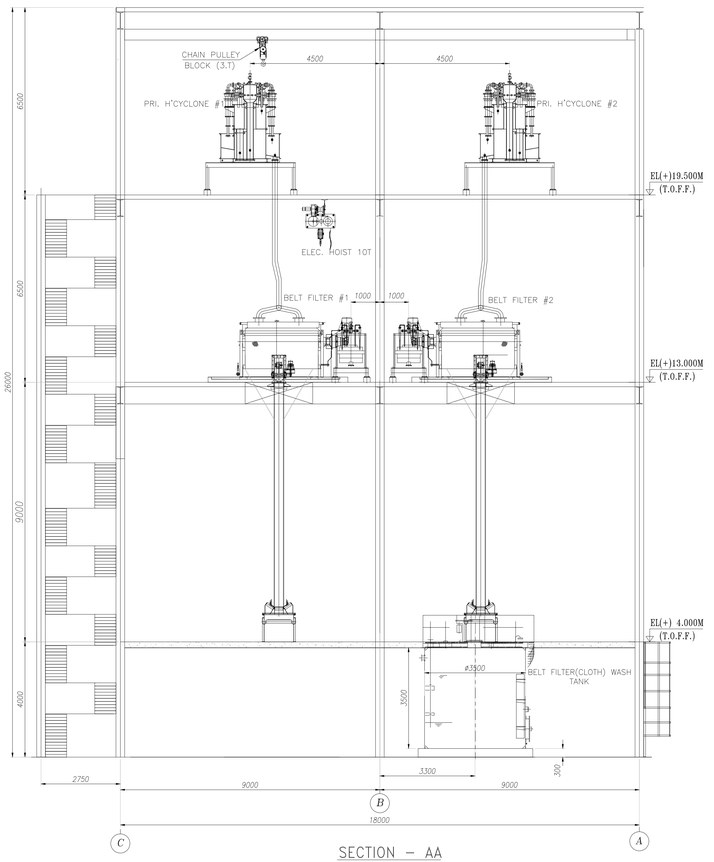
(ALL DIMENSIONS ARE IN mm)

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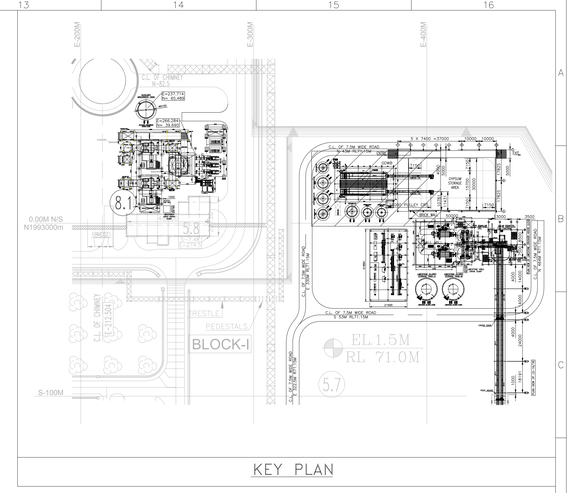
SHT. 02 OF 02



SECTION – BB
(REF. SHEET-01)



SECTION – AA
(REF. SHEET-01)



KEY PLAN

LEGEND:–

FGL	- FINISHED GROUND LEVEL
FFL	- FINISHED FLOOR LEVEL
T.O.PF	- TOP OF PLATFORM
TOC	- TOP OF CONCRETE
OPENG	- OPENING
MR	- MONORAIL
THK.	- THICK
TYP	- TYPICAL
GDWB	- GYPSUM DEWATERING BUILDING.
VBF	- VACUUM BELT FILTER

EQUIPMENT LIST:

Sl No.	Equipment Description	Quantity (Number)	Weight (Per Equipment)
1.	Primary Hydrocyclone	2	6 Tonne
2.	Belt Filter(Cloth) & Cake Wash Tank Pump	4	Later
3.	Belt Filter Washing Tank	1	Later
4.	Vacuum Belt Filter	2	100 Tonne
5.	Vacuum Receiver	2	10 Tonne
6.	Vacuum Pump	2	30 Tonne
7.	Belt Support Fan A/B	2	Later
8.	Secondary Hydrocyclone	2	5 Tonne
9.	Vent Fan	2	6 Tonne

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS IN METRES.
2. FGL IN GYPSUM DEWATERING BUILDING AREA IS RL (+)71.0M / EL 1.5M.
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.

REF. DWGS

1. 03-FW-747-00658 : PLANT LAYOUT OF FGD SYSTEM
2. 03-FW-744-00662 : P&ID - FILTRATE WATER SYSTEM
3. 03-FW-738-00663 : P&ID - VACUUM BELT FILTER & ACCESSORIES
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5. 03-FW-701-00654 : P&ID - GYPSUM BLEED PUMPS
6. 03-FW-747-00658 : P&ID - PRIMARY HYDRO CYCLONE FEED TANK AND PUMPS
7. 03-FW-738-00659 : P&ID - PRIMARY HYDRO CYCLONE SYSTEM
8. 03-FW-747-00660 : P&ID - SECONDARY HYDRO CYCLONE FEED TANK AND PUMPS
9. 03-FW-738-00661 : P&ID - SECONDARY HYDRO CYCLONE SYSTEM
10. 03-FW-745-00665 : P&ID - WASTE WATER TANK & PUMPS
11. IS-1-GA-719-101-M107 : LHP/GHP CONVEYOR PROFILE

REV.	DATE	ALTERED	RAVI
01	07.10.2021	CHD/APPD.	UDAY KUMAR V

REVISED AS PER LATEST INPUTS.

CUSTOMER	TELANGANA STATE POWER GENERATION CO. LTD.				
CUSTOMER'S CONSULTANT	DESEIN PRIVATE LIMITED				
PROJECT	BHADRADRI TPS, UNITS # 1 TO 4 (4X270 MW), MANUGURU, KHAMMAM DISTRICT FGD PACKAGE				
BHARAT HEAVY ELECTRICALS LTD. HYDERABAD PROJECT ENGG & SYSTEMS DIVISION		NAME	SIGN.	DATE	NO.OF VAR.
	DRN.	RAVI	-sd-	27.09.2021	
	CHD.	PARAMESH	-sd-	27.09.2021	
	APPD.	UDAY KUMAR V	-sd-	27.09.2021	

DEPT. PE&SD	UNTOL. DIMS. OR g7/N/f	SCALE 1:75	WEIGHT (KG) ---	REF. TO ASSY. DRG.	ITEM NO.	NO.OF ITEMS
CODE 450						

ZONE	TITLE	CARD CODE	BHEL DRG. NO.	REV.
NA	GYPSUM DEWATERING BUILDING (ELEVATION)		PY-LE-0-M113-2043-01	01
			CUST. DRG. NO.	
			SHT. No 02	NO. OF SHT. 02

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GENERAL DIMENSIONAL LIMITS,FITS & TOLERANCES AS PER HY0230261

INVENTORY NO | SIGN. AND DATE | REF. DRG. NO. | COMPUTER FILE NAME

01	10.07.2019	Revised the documents as per the comments	PR	RB	RSB
00	28.06.2019	Fresh Issue	PR	RB	RSB
REV	DATE	DESCRIPTION /NOTE	PRD	CHD	APD

REVISIONS

TITLE: **FGD SYSTEM DESIGN BASIS**

OWNER/PROJECT: **TELANGANA STATE POWER GENERATION CORPORATION LTD.**

BHADRADRI (4X270 MW) THERMAL POWER PLANT–
FGD SYSTEM PACKAGE

CONSULTANT:

DESEIN PRIVATE LIMITED.
NEW DELHI

EPC CONTRACTOR:

BHARAT HEAVY ELECTRICALS LTD.
BOILER AUXILIARIES PLANT,RANIPET

COLLABORATOR:

MITSUBISHI HITACHI POWER SYSTEMS, LTD
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

	BHEL	Date	
PREPAREDBY	Raju.P	10.07.2019	STATUS : *FOR APPROVAL*
CHECKEDBY	Babu R	10.07.2019	BHEL CUST NO : G301,G302,G303,G304
APPROVED BY	Balaji R S	10.07.2019	BHEL DOC NO: 04-FW-000-00527
			REV NO :01

Document title: Reply to comments of M/s Desein on FGD System – Design Basis

BHEL Drg No: 04-FW-000-00527 (Rev 00)

a) Clause 2.3 & 2.4: Pressure drop across FGD (315 MMWC) and waste water flow rate shall be guaranteed. Add the same in the document.

Reply:

Revised the documents as per the comments.

b) Gas to Gas heater leakage is mentioned as 1.5 or less. Please add the units for the same.

Reply:

It is measured in terms of percentage (%) of inlet flue gas volume

Revised the documents as per the comments.

CONTENTS

1 Project Outline
- 1.1 General
- 1.2 Symbol and Numbering System
- 1.3 Unit
- 1.4 Codes and Standards

2 Performance Requirement
- 2.1 Emission Requirement
- 2.2 Gypsum Requirement
- 2.3 Plant Performance

3 Site Condition
- 3.1 Climatic Condition
  - 3.1.1 Barometric Pressure
  - 3.1.2 Ambient Temperature
  - 3.1.3 Relative Humidity
  - 3.1.4 Rain Fall
  - 3.1.5 Wind
- 3.2 Site Elevation

4 Flue gas and Utility
- 4.1 Inlet Gas Condition
- 4.2 Absorbent
- 4.3 Water
  - 4.3.1 Process Water
  - 4.3.2 Cooling Water
- 4.4 Air
  - 4.4.1 Instrument Air
  - 4.4.2 Service Air

5 Electric Design Condition
- 5.1 Power Source Condition
- 5.2 Power Distribution
- 5.3 Design Ambient conditions for Electricals

1. Project Outline

1.1 General

Client Name		**Telangana State Power Generation Corporation Limited**
Plant Name		**BHADRADRI 4X270 MW.**
Project Name		**BHADRADRI 4X270 MW.**
Consultant Name		**DESEIN PRIVATE LIMITED.NEW DELHI**
Process Name		**WET LIMESTONE / GYPSUM RECOVERY PROCESS**
Plant capacity		**4X270MW**
Plant location		**Edulla Bayyaram, Manuguru, Khammam, Telangana**
Warrantee Period		
Language	Contractual Language	**ENGLISH**
	Correspondence	**ENGLISH**
	Document	**ENGLISH**
	Drawing	**ENGLISH**
	Manual	**ENGLISH**

1.2 Symbol and Numbering System

Equipment numbering	☑ Purchaser's practice ☐ Contractor's practice ☐ Others :	**KKS System**
Instrument numbering	☑ Purchaser's practice ☐ Contractor's practice ☐ Others :	**KKS System**
Electric equipment numbering	☑ Purchaser's practice ☐ Contractor's practice ☐ Others :	**KKS System**
Document numbering	☑ Purchaser's practice ☐ Contractor's practice ☐ Others :	**As per Contract**

1.3 Unit

Measurement unit	☑ SI system ☑ MKS system ☐ Others :

Item		Unit of Measurement	
		SI System	MKS System
Capacity, Output		kW, MW, kVA, MVA	kcal/h
Power Consumption		kWh/h, MWh/h	Same as left
Concentration, Composition		vol %, wt%, mg/l, mg/m^3N, ppm, ppb	Same as left
Conductivity (electric)		μS/cm, mS/cm	Same as left
Heat		J, kJ, MJ	Cal, kcal
Pressure	- absolute	MPa, kPa, Pa	kgf/cm^2, bar, mbar, mmH2O, mmHg
	- gauge	MPaG, kPaG, PaG	
	- vacuum	Pa (vacuum), PaG (negative)	
Mass		mg, g, kg, t	Same as left
Quantity, Consumption,Flow (related to units of time)		m^3/hr, m^3/min, m^3N/h, kg/s, l/s, kg/h, t/h, t/year	Same as left
Rotation Speed		rad/s	rpm, min^{-1}
Temperature		°C, deg.C, K	Same as left
Viscosity (static)		Pa·s	CP
Volume		m^3	Same as left
Volume of gases related to normal measure (N)		m^3N	Same as left

(N) 1 atm = 0.101325 MPa and normal temperature 0°C

1 kcal = 4.18605×10^3J

1 Ω^{-1} = 1 A/V = 1S

1 mmH_2O = 9.80665 Pa

1 kgf/cm^2 = 9.80665×10^{-2} MPa

1 cP = 1 mPa·s

1.4 Codes and Standards

Design is carried out in accordance with the Law, applicable national and international engineering, environmental, construction, health and safety and other applicable standards, which are internationally recognized.Contractor will select and employ one of the most recent versions of standards shown in the

	Material	Design and others
Piping	**IS, AISI, ASTM, ASME, DIN, EN, BS**	**IS, AFNOR, ANSI, API, ASME, ASTM, AWWA, BS, DIN, EN, EJMA, Manufacturer's standard**
Absorber internal	**IS, AISI, ASTM, ASME, DIN, EN, BS**	**IS, AFNOR, ANSI B16.5, ASTM, ISO, BS, DIN, EN, UNE, Manufacturer's standard**
Machinery	**IS, AISI, ASTM, ASME, DIN, EN, BS**	**IS, AFNOR, AFBMA, AGMA, ANSI, API, ASTM, AWS, BS, DIN, IEC, HI, HEI, ISO, NEC, NEMA, EN, TEMA, VDI, Manufacturer's standard**
Instrumentation	**IS, AISI, ASTM, ASME, DIN, EN, BS**	**IS, AFNOR, ANSI, API, ASME, BS, DIN, EN, IEC, IEEE, ISA, ISO, NEC, Manufacturer's standard**
Electrical	**IS, AISI, ASTM, ASME, DIN, EN, BS**	**IS, BS, VDE, IEC, EN, ANSI, IEEE, NEMA**
Civil	**IS**	**IS**
Building	**IS**	**IS**
Performance Test		**ASME PTC 40, JIS, EPA, Manufacturer's standard**

2. Performance Requirement

2.1 Emission Requirement

		Guarantee or Requirement		Note
		Guarantee Item		
SO_2 emission	mg/Nm^3, 6%O_2, dry		<100	at stack inlet

2.2 Gypsum Requirement

		Guarantee or Requirement			Note
		Guarantee Item	Minimum	Maximum	
Moisture Content (free)	wt%		**-**	**10**	
Gypsum Purity	wt%-d		**90***	**-**	***If limestone purity is 89%**
Cl^-	ppm-d		**-**	**100***	***If Cl- in clarified water is < 100 ppm**

2.3 Plant Performance

	Guarantee or Requirement		Note
	Guarantee Item		
Wet ball mill capacity at rated finess		24 TPH	i) Limestone fineness: 90% or higher through 325mesh
Wet ball mill wear parts guarantee		8000 Hrs	
Wet ball mill ball consumption		700 gm/Ton of Limestone	
Vacuum belt filter capacity		39.7 TPH	WET
Performance characteristics of fans (capacity, head developed, etc.)		N/A	
Capabilities of all drives			
Passenger cum goods elevator for FGD absorber (Over load tests, travel and hoist speed checks)			
Noise (*1)			
Equipment -Building Inside- dB(A)		**-**	
Equipment -Building Outside- dB(A)		**85 or less**	**Ball Mill - 90 dB(A)**
Electrical Equipment dB(A)		**-**	
Electrical Room dB(A)		**-**	
Gas to Gas Heater leakage		**1.5 % or less**	
Availability (*2) %		**98% or over**	
Capacity of Lime &Gypsum handling equipment (bucket elevators, belt conveyors and lime crusher)			
Pressure drop across FGD(Max)		315 mm WC	BMCR Design Coal

(*1) Sound level must be measured at 1m from surface and 1.5m height.

(*2) Availability 'A'

$$A = \frac{Tc \times 100\%}{Tk}$$

Tc: Recorded time of FGD operation, expressed in hours,

Tk: Recorded time of boiler operation, expressed in hours,

Conditions for FGD in operation

(i) Outlet SO2 : 100mg/Nm3(dry,6%O2)

(ii) If FGD is out of operation during the boiler operation time as a result of the Employer's decision, this time will not be counted as boiler operation time for calculating the FGD availavility.

2.4 Waste Water Requirement

	Requirement	Note
Waste Water flow rate	5 m^3/h/unit	Will be demonstarted at FGD Gurantee Point

3. Site Condition

3.1 Climatic Condition

3.1.1 Barometric Pressure

			Barometric Pressure		
			Minimum	Reference	Maximum
Observational Record		hPa	-	-	-
Design Value	Outdoor	hPa		**999.28**	

3.1.2 Ambient Temperature

			Ambient Temperature		
			Minimum	Reference	Maximum
Observational Record		deg.C	-	-	-
Design Value	Outdoor	deg.C	**27**	-	**34.4**
	Indoor	deg.C			

3.1.3 Relative Humidity

			Humidity		
			Minimum	Reference	Maximum
Observational Record		%	-	-	-
Design Value	Outdoor	%		**60**	
	Indoor	%			

3.1.4 Rain Fall

		Rain Fall		
		Minimum	Average	Maximum
Observational Record	mm/y	-	-	-
Design Value	mm/y	-		

3.1.5 Wind

	Wind		
	Minimum	Average	Maximum
Prevailing Direction			
Basic Wind Velocity @ 10 m height			44 m/sec
Wind load calculation			

3.1.6 Seismic

Seismic Zone : III as per IS 1893-2002,

Importance Factor :1.75, Response Reduction factor :4 As per IS:1893 (Part-4) 2005.

Type Of Soil: HARD

3.2 Site Elevation

Site Elevation Basis	**+126 meters above sea level**

4. Flue gas and Utility

4.1 Inlet Gas Condition

Position			ID Fan Outlet	
Case			**Guarantee Point**	**Design Point**
Boiler Load		MW	**270MW**	**270MW**
Type of coal			**TMCR DC**	**BMCR WC**
Ambient condiiton			**27° C temp & 60% RH**	**34.4° C temp & 60% RH**
Flow rate		Nm^3/sec	**272.5**	**273.5**
		m^3/sec	**424.138294**	**410.6755446**
Temperature				
	Nor.	°C	**152**	**137**
	Max.	°C	**300 (1*)**	**300 (1*)**
Composition				
	H_2O	% v/v wet	**9.632**	**9.867**
	CO_2	% v/v wet	**13.716**	**13.781**
	O_2	% v/v wet	**4.32**	**4.357**
	N_2	% v/v wet	**72.254**	**71.616**
	SO_2	% v/v wet	**0.078**	**0.114**
	Inlet SO_2	mg/Nm^3 wet	**2136.2**	**2702**
	SO_3	ppm wet	**3.2**	**5.9**
	NOx	mg/Nm^3 at 6% O_2	**<100**	**<100**
	HCl	ppm wet	**13**	**14**
	HF	ppm wet	**1**	**1**
	Dust	mg/Nm^3 at 6% O_2	**<30**	**<30**

***The components not listed above are not taken into consideration in the FGD design.**

(1*) short excursion temperature (for approximately 30 minutes)

4.2 Absorbent

Absorbent Name	**LIMESTONE**
Grain Size	**Medium**
Bond Index	**13kWh/short-ton**

Type of Absorbent	☑ Rock ☐ Powder ☐ Slurry ☐ Others :

Feed Condition to Absorber	☐ Powder ☑ Slurry **30** wt% ☐ Others :

Absorbent Composition**(*1)**			**Limestone**			Note
			Design	Normal	Guarantee	
CaCO3		wt%-d	**83.88**	**-**	**91.02**	
Dolomite($MgCa(CO_3)_2$)		wt%-d	**N/D**	**N/D**	**N/D**	
	CaO	wt%-d	**47**	**47-51**	**51**	
	MgO	wt%-d	**2.35**	**0.9-3.8**	**2.35**	
Inert	Cl_2	wt%-d	**<0.015**	**<0.015**	**<0.015**	
	Al_2O_3	wt%-d	**1.19-2.1**	**1.19-2.1**	**1.19-2.1**	
	Si_2O_3	wt%-d	**2.1**	**2.1-4.5**	**2.1**	
	Fe_2O_3	wt%-d	**0.45-1.0**	**0.45-1.0**	**0.45-1.0**	
	TiO_2	wt%-d	**<0.02**	**<0.02**	**<0.02**	
	Na_2O	wt%-d	**<0.16**	**<0.16**	**<0.16**	
	K_2O	wt%-d	**<0.01**	**<0.01**	**<0.01**	
	P_2O_5	wt%-d	**Traces**	**Traces**	**Traces**	
	LOI	wt%-d	**38.0-41.3**	**38.0-41.3**	**38.0-41.3**	
	Total Sulphur	wt%-d	**<0.1**	**<0.1**	**<0.1**	
	Mn_2O_3	wt%-d	**<0.12**	**<0.12**	**<0.12**	
Density		kg/m^3	**1400**			For volume
		kg/m^3	**1700**			For torque, drive calculation and structual load calculation
Limestone Slurry Density		kg/m3	**1219**			30% Concentration

N/D : Not detectable

(*1) Assumed value

4.3 Water

4.3.1 Process Water

			CLARIFIED WATER ANALYSIS		
			Minimum	Normal	Maximum
Temperature at B.L.		deg.C		**27**	**34.4**
Pressure at B.L.		MPaG	**-**	**-**	**-**
pH		-		**7.79**	
S.S.		ppm	**-**	**10**	**-**
Composition					
	Ca^{2+}	ppm as $CaCO_3$	**-**	**96**	**-**
	Mg^{2+}	ppm as $CaCO_3$	**-**	**52**	**-**
	$Na^{+} + K^{+}$	ppm as $CaCO_3$	**-**	**76.6**	**-**
	K^{+}	ppm as $CaCO_3$	**-**	**N/D**	**-**
	Oil and Grease	mg/l	**-**	**<1**	**-**
	N_2H_4	mg/l	**-**	**-**	**-**
	HCO_3^{-}	ppm as CaCO3	**-**	**136**	**-**
	CO_3^{2-}	ppm as CaCO3	**-**	**-**	**-**
	Cl^{-}	ppm as CaCO3	**-**	**72**	**-**
	SO_4^{2-}	ppm as CaCO3	**-**	**15**	**-**
	Slica	SiO_2	**-**	**3.1**	**-**
	To-NH_4	mg/l	**-**	**-**	**-**
	Fe^{2+}	ppm as CaCO3	**-**	**Traces**	**-**
	Cd	mg/l	**-**	**-**	**-**
	NO_3^{-}	ppm as CaCO3	**-**	**1.6**	**-**
	B	mg/l	**-**	**-**	**-**
	To-Inorganic	mg/l	**-**	**-**	**-**
	Cu	microg/l	**-**	**-**	**-**
	Hg	microg/l	**-**	**-**	**-**
	Pb	microg/l	**-**	**-**	**-**
	NO_2^{-}	microg/l	**-**	**-**	**-**
	F^{-}	ppm as CaCO3	**-**	**-**	**-**
	Cr^{6+}	microg/l	**-**	**-**	**-**
	Ni	microg/l	**-**	**-**	**-**
	To-Zn	microg/l	**-**	**-**	**-**
BOD		mg/l	**-**	**-**	**-**
COD	Cr	ppm	**-**	**-**	**-**
P alkalinity		ppm CO_3Ca	**-**	**Nil**	**-**
M alkalinity		ppm CO_3Ca	**-**	**136**	**-**
Total Hardness		ppm CO_3Ca	**-**	**148**	**-**
Total Dissolved Solids		ppm	**-**	**282**	**-**
Tubidity		NTU	**-**	**10**	**-**
Conductivity		micro s/cm	**-**	**-**	**-**

***FGD plant is designed under the condition that no oxidation inhabitors are included in process water.**

4.3.2 Cooling Water

Water Source		-					
		Available Value			Design Value		
		Minimum	Normal	Maximum	Minimum	Normal	Maximum
Supply Temp. at TP	deg.C	-	-	-	-	**38**	-
Return Temp. at TP	deg.C	-	-	-	-	**47**	-
ΔT	deg.C	-	-	-	-	**9**	-
Supply Press. at TP	MPaG	-	-	-	-	**0.6(*1)**	-
Return Press. at TP	MPaG	-	-	-		**0.3(*1)**	-

(*1) Assumed value

4.4 Air

4.4.1 Instrument Air

Air Source		-
Dew Point (atmospheric)	deg.C	≦-40
Oil Mist Contamination		Contaminated Not Contaminated

		Available Value			Design Value		
		Minimum	Normal	Maximum	Minimum	Normal	Maximum
Temperature at TP	deg.C	-	-	-	-	**45(*1)**	-
Pressure at TP	MPaG	-	-	-	**0.55**	-	**0.8**

(*1) In summer

4.4.2 Service Air

Air Source	-

		Available Value			Design Value		
		Minimum	Normal	Maximum	Minimum	Normal	Maximum
Temperature at TP	deg.C	-	-	-	-	**45(*1)**	-
Pressure at TP	MPaG	-	-	-	**0.55**	-	**0.8**

(*1) In summer

5. Electric Design Condition

5.1 Power Source Condition

AC

	Medium Voltage SWGR				Low Voltage SWGR			
	Nominal		Range		Nominal		Range	
Voltage (Steady State)	**11/ 3.3**	kV	+/- **6**	%	**240 / 415**	V	+/- **10**	%
Voltage (Transient)	**-**	V		%		V		%
Frequency	**50**	Hz	**-5 to +3**	%	**50**	Hz	**-5 to +3**	%
Phase	**3**			φ	**1φ for 240V, 3φ for 415V**			φ
Number of Line	**-**				**-**			

DC

	Medium Voltage SWGR			
	Nominal		Range	
Voltage (Steady State)	**220**	V	**-15 to +10**	%
Voltage (Transient)	**-**	V		%

5.2 Power Distribution

Distribution of Power Cable	☐ Under Ground ☑ Over Ground

		Voltage		Phase	Emergency Power Source	Note
Motor	**AC**	**11**	kV	**3P**		**≥1500 kW**
		3.3	kV	**3P**		**≥200** kW- **<1500** kW
		415	V	**3P**		**≥0.2** kW- **<200** kW
		240 (1 Phase) / 415	V	**3P**		**0.2** kW and under
Power outlets for welding	**AC**	**415**	V	**3P**		
Power outlets for portable tools	**AC**	**240**	V	**3P**		
Safety power outlets	**AC**	**240**	V	**3P**		
Lighting Distribution	**AC**	**415**	V	**3P**		
Normal Lighting Apparatus	**-**	**240**	V			
Emergency Lighting Apparatus	**-**	**240**	V			
Control Voltage for						
Switch gear	**DC**	**220 / 110**	V	**1P**		
	AC	**110**	V	**1P**		**For control supply**
Breaker Controls	**DC**	**24**	V	-		

5.3 Design Ambient conditions for Electricals

1) Design Ambient Temperature	50 Deg C
2) Design Ambient Temperature for equipment installed in A/C Rooms	35 Deg C

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.)	128.36	74.15*1)	54.23 *1)
b.	Total Flow (t/hr.)	155.92	82.36 *1)	73.56 *1)
c.	Operating Temp (°C)	53.9	53.9	53.9
d.	Design Temp (°C)	70	70	70
e.	Solid (wt. %)	30	16.6 *1)	45 *2)
f.	Density (Kg/m^3)	1215	1111 *1)	1357 *1)
g.	pH	4-7	4-7	4-7
h.	Cl^-(mg/l)	20000	20000	20000
i.	Number of hydro cyclones : 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 : 142 m3/hr**.(including 10 % margin on capacity)**			
l.	Each set of primary hydrocyclone shall be provided with 10% spare hydro-cyclones.			
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)	74.15 *1)	46.33 *1)	27.808 *1)
b.	Total flow (t/hr)	82.36*1)	47.36 *1)	35.0*1)
c.	Operating Temp (° C)	53.9	53.9	53.9
d.	Design Temp (°C)	70	70	70
e.	Solid (wt %)	16.6*1)	3 *2)	35 *1)
f.	Density (kg/m^3)	1111	1022	1258
g.	pH	4-7	4-7	4-7
h.	Cl^- (mg/l)	20000	20000	20000
i.	Number of hydro cyclones : 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 : 81.60 m3/hr. **(including 10 % margin on capacity)**			
l.	Each set of secondary hydrocyclone shall be provided with 10% spare hydro-cyclones.			

SELECTION PARAMETERS FOR GYPSUM DEWATERING SYSTEM

1.3 PROCESS PARAMETERS FOR VACUUM BELT FILTER OPERATION					
S.no	**Parameters**	**Belt Filter Feed Slurry**	**Product Gypsum**	**Filtrate**	**Washing Water ****
a.	Total Flow (m^3/hr)	54.23*1)			
b.	Total Flow (t/hr)-Wet	73.56*1)	36.60		
c.	Design Temp(deg C)	70.0			
d.	Solid(% wt)	45 *2)	>90 *2)	<0.2	
e.	Density kg/m^3	1357*1)			
f.	pH	4~7	5~8		
g.	Cl	<20000	<100 ppm *2)		
h.	Belt filter and the peripherals design capacity = 40.3 t/h (wet cake) **(including 10 % margin on capacity)**				
i.	Number of vacuum belt filters : 2 numbers (1 W + 1 S)				

Note:

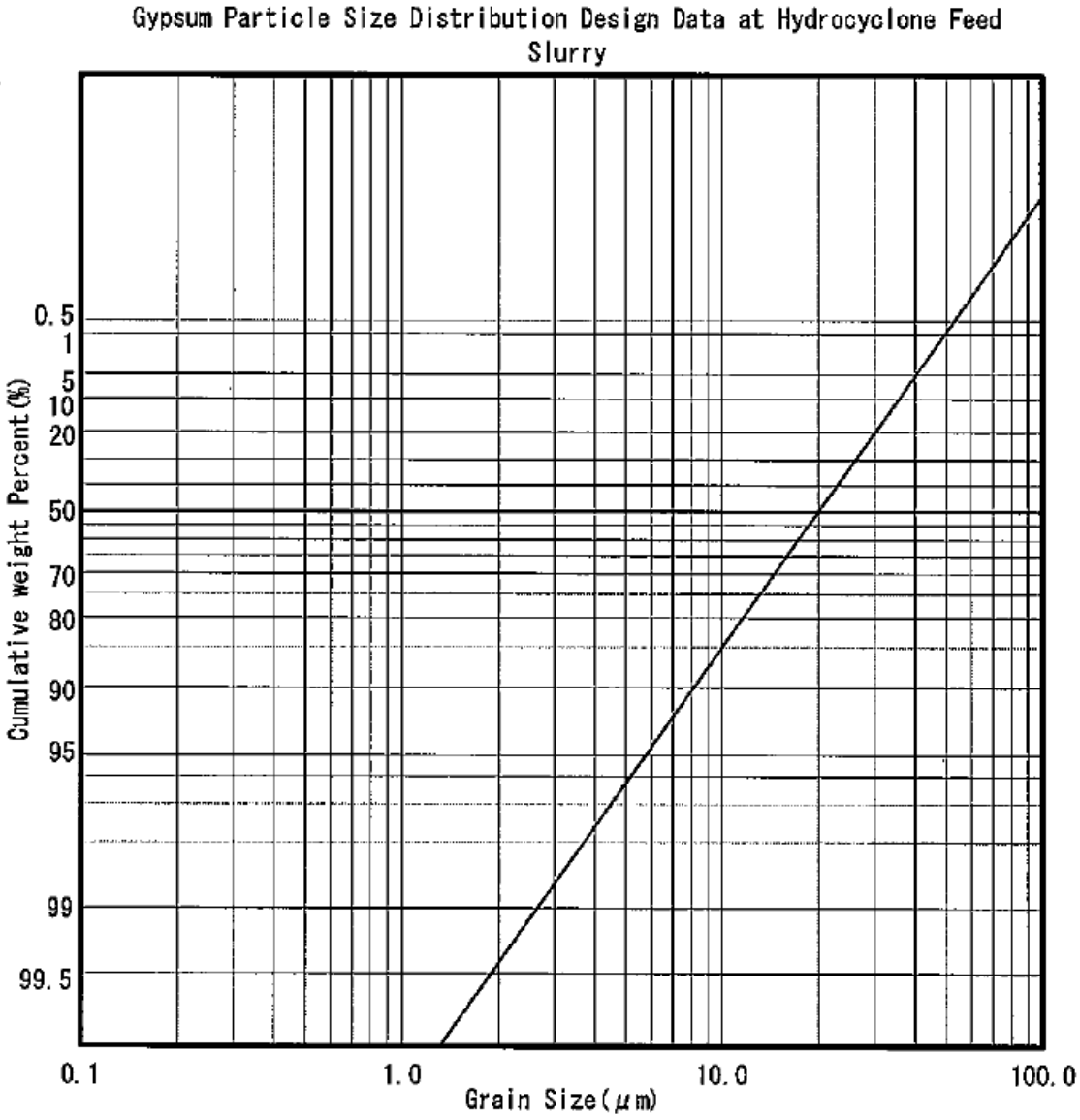
- **Quantity of water shall be finalized by the vendor. Property of process water (Clarified water) is given in section 2.0
- *1) shall be finalized by vendor
- *2) Shall be guaranteed by vendor
- Inputs furnished for vacuum belt filter in Section 1.3 are based on the customer approved document 04-FW-738-00541 , 04-FW-738-00542 & 04-FW-738-00543.

2.0 WATER ANALYSIS

S.no	Constituents as CaCO3	Unit	Value
1.	Calcium	ppm	136.5
2.	Magnesium	ppm	52.0
3.	Sodium + Potassium	ppm	76.6
4.	Iron	ppm	0.00
5.	Total hardness	mg/l	188.50
6.	Total Cations	mg/l	265.10
7.	P-Alkalinity	mg/l	0.00
8.	M-Alkalinity	mg/l	140.77
9.	Bicarbonates	mg/l	140.77
10.	Chlorides	ppm	76.23
11.	SO4	ppm	46.50
12.	NO3	ppm	1.60
13.	EMA	mg/l	124.33
14.	Total anions	mg/l	265.10
15.	Silica(reactive)	ppm	1.10
16.	pH @25 deg C	-	7.5-8.0
17.	Turbidity (maximum)	NTU	10
18.	Suspended Solids	mg/l	10
19.	TDS Calculated	mg/l	375.90
20.	Conductivity @ 25 deg C	uS/cm	400
21.	TDS (given)	mg/l	282.0
22.	Temperature	deg C	25

Note: Process water will be used for belt/cloth & gypsum cake washing.

3.0 PARTICLE SIZE DISTRIBUTION



Note:

1. This curve is applicable at primary hydro cyclone feed only.
2. Vendor to submit the PSD based on their design for PHC & SHC underflow and overflow.

Project: TSGENCO BHADRADRI FGD (4X270 MW)							
Cont No: G301 to G304		Rev 00		Rev 01		Rev 02	
		Sign	Date	Sign	Date	Sign	Date
Engineer	Kabilash	sd	28.02.20	sd	02.03.20		12.07.21
Reviewer	Raju	sd	28.02.20	sd	02.03.20		12.07.21
Approver	Naveen	sd	28.02.20	sd	02.03.20		12.07.21

4.0 Water Pit Pumps:

Vacuum pump is generally kept in the elevated floor from ground level, because the sealing water from vacuum pump flow by gravity to the belt filter washing tank. If vacuum pump is kept in the ground floor, a pit of size (LXWXH-2mX2mX2m) and additional water pit pumps (3 nos, 2W+1S) shall be provided by PESD.

5.0 SCHEDULE OF GUARANTEES

Sl. No	Description			Data
1.	Rated capacity of Vacuum Belt Filter (VBF)	TPH	:	40.3
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.	Equipment Availability in % (avg. target 98%) Continuous for 120 days		:	Bidder to Provide

6.0 GENERAL NOTES

1. Power consumption to be guaranteed corresponding to rated capacity of 40.3 TPH shall not exceed 270 kW for one (01) no of working gypsum dewatering system and its auxiliaries. Operating equipments considered for power consumption calculation:
   a) Belt filter wash pump
   b) Cake wash pump
   c) Vacuum belt filter
   d) Belt filter vent fan
   e) Vacuum pump
   f) Water pit pump(if applicable)
2. Scope of supply for gypsum dewatering system includes all equipments associated with gypsum dewatering system except primary hydro cyclone feed pumps, secondary hydrocyclone feed pumps, waste water pumps and filtrate water pumps which are in BAP's scope of supply.

3. Refer approved design memorandum for MOC and other technical information related to gypsum dewatering system and its accessories.
4. PID will be submitted later after obtaining the approval from customer.
5. Instruments and valves to be provided as per the approved P&ID.
6. Mandatory Spares to be supplied as per contact requirement. (As per the recent MOM, there is a change in the scope of mandatory spares. Hence, Request PESD to obtain latest mandatory spares list from PSM).

Note: current revision changes typed in red colour.

Project: TSGENCO BHADRADRI FGD (4X270 MW)							
Cont No: G301 to G304		Rev 00		Rev 01		Rev 02	
		Sign	Date	Sign	Date	Sign	Date
Engineer	Kabilash	sd	28.02.20	sd	02.03.20		12.07.21
Reviewer	Raju	sd	28.02.20	sd	02.03.20		12.07.21
Approver	Naveen	sd	28.02.20	sd	02.03.20		12.07.21

SELECTION PARAMETERS FOR GYPSUM DEWATERING SYSTEM

Annexure: 1
As per the agreed MOM between BHEL and TSGENCO mandatory spares for Bhadradri FGD shall be double the quantity of Kothagudem FGD project mandatory spares list.

In view of the above KTPS FGD mandatory spares list (annexure-2) is attached for your ready reference.
Snap shot of MOM copy :

S.No	BHEL offer reference (section/ page/ clause)	Exclusion/clarification as per BHEL offer	Final resolutions
31	Part-3, LHP & GHP, Clause 5.2.1(Civil Work)	we have not considered any pay loader shed or bulldozer shed in our scope	Sheds required are to be provided by BHEL. Accepted by BHEL
32	Part-3, LHP & GHP, Clause 5.2.2(Civil Work)	Not considered any modifications/Dismantling/strengthening work of any existing structure	TSGENCO informed that there are No existing structures at BTPS
33	Part-3, LHP & GHP, Clause 5.3.1(Electrical and C&I)	No hardwired Mimic/Conrol desk/LVS has been cosidered seperately for LHP GHP.	BHEL informed that Valmet DNA DCS panels have been considered as per process requirwement for limestone handling plant. TSGENCO requested to consider the hard wired alarm annunciation system. BHEL agreed
34	Part-3, LHP & GHP, Clause 5.3.2(Electrical and C&I)	Only normal AC lighting shall be envisaged. DC lighting/emergency lighting/portable lights are not considered	Noted by TSGENCO
35		Connectivity/cable between data concentrator to upper level system (e.g DCS) is not included in this offer. In case this connectiv ty is provided by DCS vendor- the communication protocal for link shall be IEC60870-5-104/OPC/Modbus.	In line with KTPS-VII stage (1x800MW)
36		Mandatary spares	For FGD the quantity of mandatory spares shall be twice the quantity of KTPS FGD.
37		Training	BHEL agreed to arrange training programme for TSGENCO Engineers
38		Requirement of coating /lining/painting on the steel flue aries at latter stage same can be met with additional implications	TSGENCO requested to Treatment shall be provided to shel and flue -can as per standered design procedure by M/s BHEL. This shall be further finalised during detail engineering.

ED/TPC Page 8 of 8 ED/Civil

Project: TSGENCO BHADRADRI FGD (4X270 MW)							
Cont No: G301 to G304		Rev 00		Rev 01		Rev 02	
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Engineer	Kabilash	sd	28.02.20	sd	02.03.20		12.07.21
Reviewer	Raju	sd	28.02.20	sd	02.03.20		12.07.21
Approver	Naveen	sd	28.02.20	sd	02.03.20		12.07.21

Annexure-2

PROJECT: KOTHAGUDEM 1X800MW - List of Mandatory Spares for FGD System

Sr. No.	Description	Qty.	Remarks
1	**Gates in Flue Gas System**		
	Actuator	1 no. of each type	
2	**Booster Fan**		
a)	Fan bearings	1 set of each type	
b)	Spares for blade bearing Assembly		
	i) Bearings	1 set	
	ii) 'O' rings, Sealing rings , Labyrinth sealing rings	1 set	
	iii) Bushes	1 set	
	iv) Locking ring, retaining ring, bearing cover, support cover	1 set	
	v) Locking key, connecting bolts	1 set	
	vi) Blade shaft	1 set	
c)	Lube Oil / Hydraulic Oil system		
	i) Pump assembly with motor	1 set	
	ii) Filters	1 set	
	iii) Pressure relief valve	1 set	
d)	Fan Blades	1 set	
3	**Gas-Gas Heater**		
	Regenerative Ljungstrom Type (if applicable)		
a)	Support Bearing	1 no.	
b)	Guide Bearing	1 no.	
c)	Lubricating system of support & Guide Brg		
	i) Pressure regulator	1 no. of each type	
	ii) Filters	1 no. of each type	
d)	Radial seals	1 set	
e)	Axial Seals	1 set	
f)	Circumferential or bypass seals	1 set	
g)	Rotor post seals	1 set	
h)	Speed reducer Bearings	1 set	
i)	Speed reducer Seals & gaskets	1 set	
4	**Absorber**		
a)	Absorber Spray nozzles	Spray nozzles-58 no's	
b)	Absorber Mist Eliminator Washing Nozzles	5% of each type	
c)	Absorber Mist Eliminator	5% of each type	
5	**Oxidation Air Compressor**		
a)	Bearings	1 no. of each type	
6	**Agitators**		
	(For Absorber Oxidation Tank, Mill Separator Tank, Limestone Slurry Preparation Tank and any other tank provided with agitators)		
a)	Bearing Assembly	1 no. of each type	
7	**Slurry Pumps**		
	(Absorber Slurry Recirculation Pump, Gypsum Bleed Pumps, Mill Circuit Pump, Limestone Supply Pumps and any other slurry pumps)		
a)	Casing Liners	1 no. of each type	
b)	Seals	1 set of each type	
8	**Hydro-cyclones**		
	(Mill, Gypsum Primary Dewatering, Secondary Waste Water and any other Hydrocyclone)		
a)	Hydro-Cyclone	10% of each type OR 1 no. whichever is higher	
9	**Limestone Mills**		
a)	Mill Wear Parts (Liners) & Grinding element (needed for complete replacement of one mill)	1 set	
b)	Mill motor Bearings	1 set	
c)	Lube Oil / Grease System		
	i)Pressure regulator	1 no. of each type	
	ii)Filters	1 no. of each type	
10	**Slurry Valves**	**1 nos of each type and size**	
11	**Slurry Line Bends**	**1 nos. of each type and size**	
12	**Vacuum Belt Filter**		
a)	Filter Cloth	1 set	
b)	Vacuum Box Seals	1 set	
13	**Vacuum Pumps**		
a)	Pump Bearing	1 set	
b)	Seals	1 set	
14	**Vacuum Breaker Valves**		
a)	Valve Assembly	1 no.	
b)	Actuator	1 no.	
15	**Sump Pumps**		
a)	Casing Liners	1 set of each type	
b)	Bearing	1 set	

NOTE 1: SPARE QUANTITY SHALL BE CONSIDERED DOUBLE THE VALUE OF THAT INDICATED IN QTY COLUMN
NOTE-2 :SPARES APPLICABLE FOR GDW ARE SL.NO : 8,10,11,12,13,14, 16,23,33

PROJECT: KOTHAGUDEM 1X800MW - List of Mandatory Spares for FGD System

Sr. No.	Description	Qty.	Remarks
16	**Horizontal Centrifugal Pumps**		
a)	Casing Liners	1 set of each type	
b)	Bearing	1 set	
17	**Idlers**		
a)	**Trough carrying Idlers complete with base boards & mounting brackets etc.**		
	For Belt Feeder/Belt Weigh Feeder - 800 mm Belt Width (20 deg troughing angle)	5% of total population	
b)	**Flat type return idlers complete with mounting base boards & mounting bracket etc.**		
	For Belt Feeder/Belt Weigh Feeder- 800 mm Belt Width	5% of total population	
c)	**Impact Idlers complete with mounting base boards and brackets etc.**		
	For Belt Feeder/Belt Weigh Feeder - 800 mm Belt Width	5% of total population	
d)	**Trough carrying training idlers complete with base boards & mounting brackets etc.**		
	For Belt Feeder/Belt Weigh Feeder - 800 mm Belt Width (20 deg troughing angle)	5% of total population	
e)	**Flat return trainer complete with mounting base boards & mounting bracket etc.**		
	For Belt Feeder/Belt Weigh Feeder - 800 mm Belt Width	5% of total population	
f)	**Transition idlers complete with base boards & mounting brackets etc.**		
	For Belt Feeder/Belt Weigh Feeder - 800 mm Belt Width	5% of total population	
g)	**Rubber discs for impact idlers**	5% of the Rubber disc as fitted on the Impact Idlers	
h)	**Rollers for the above idlers**	5% of the Installed Quantity	
18	**Conveyor System**		
a)	**Gear Box**		
	Gear box internals complete including input, output shafts and gears etc.	1 set of each type & rating	
	Oil Seal	1 set of each type & rating	
	Bearings	1 set of each type & rating	
	Hold Back (if applicable)	1 set of each type & rating	
b)	**Conveyor Drive System (as applicable)**		
	Coupling (Flexible)	1 no. of each type & rating	
	Coupling bolts (Pins with bushes)	1 sets of each type & rating.	
c)	**Brakes**		
	Complete Brakes	1 no. for each type and size	
	Brake Shoes	2 sets for each type and size	
d)	**Pulleys**		
	Pulley complete with shaft (excluding bearing & plummer block)	1 no. for each size of pulley & shaft	
	Plummer block complete with bearing	2 nos for each type and size	
e)	**Belt Cleaner & Skirt Board**		
	Rubber/nylon strip for belt cleaners and skirt board	5% of total quantity used	
	Complete Belt Scrapper (Primary & Secondary)	1 set for each conveyor	
f)	**Belting**		
	Conveyor Belt for Belt Feeder/Belt Weigh Feeder	1 complete length of each type	
19	**Magnetic Separator (ILMS)**		
a)	Drive Gear Box Complete unit	1 sets	
b)	V-belt	1 sets	
c)	Cleated rubber belts	4 nos.	
d)	Drive & Non-drive Pulley	1 nos. each type	
e)	Bearing of Drive & Non-drive Pulley	1 sets for each type & size	
f)	Cooling Oil Pump	2 nos.	
g)	Cooling Oil flow control Valve	2 nos.	
h)	SS Cleat	20 nos.	
i)	SS Bolt for Cleat	200 nos.	
20	**Rack & Pinion Gate**		
a)	Rollers with bearings	4 nos.	
b)	Sprockets	2 nos.	
21	**Bucket Elevator**		
a)	Buckets	2 nos.	
b)	Belt for bucket elevator	5% of total length	
c)	Linkages	10% of total population	

PROJECT: KOTHAGUDEM 1X800MW - List of Mandatory Spares for FGD System

Sr. No.	Description	Qty.	Remarks
22	**Hammer Mill Crusher**		
a)	Plummer Block assembly complete including bearing, lock nut, lock washer (DE+NDE)	1 set	
b)	Shaft Seal	1 set	
c)	Hammer sets	1 set (i.e. hammers required for one crusher)	
d)	Rotor assembly complete consisting of rotor shaft & keys, End discs, Centre discs, distance rings, suspension bars, disc clamping nuts and shaft extension etc. but without hammers, bearings and pillow blocks	1 set	
e)	Cags bars/Perforated screen plates as applicable	1 set	
f)	Breaker plate	1 set	
g)	Liners	2 sets	
h)	Suspension bars	2 sets	
i)	Kick-off plate	2 sets	
j)	Screen plate upper & lower	1 no. each	
k)	Tramp iron pick up plate	1 no.	
l)	Fluid coupling		
m)	Fluid coupling complete	1 set	
n)	Bearings	2 sets	
o)	Seal kit (sealing rings)	2 sets	
p)	Oil pump motor set (if applicable)	1 set of each type	
q)	Oil filter (if applicable)	2 sets	
r)	Complete actuator and engaging assembly (including motor, gear box etc.)	1 set	
23	**Motors**		
a)	Booster Fan motor bearing	1	
b)	RC pump motor bearing	1	
c)	Oxidation blower motor bearing	1	
d)	Wet Ball Mill motor bearing	1	
e)	Booster Fan motor Terminal Box	1	
f)	RC pump motor Terminal Box	1	
g)	Oxidation blower motor Terminal Box	1	
h)	Wet Ball Mill motor Terminal Box	1	
24	**SP Bus duct**		
a)	Bus support Insulator	50 Nos	
b)	Bolted Disconnet Link (3H) for each rating	1 set	
c)	Cu Flexible for termination (3PH) Complete with hardware for each rating	1 set	
d)	Seal off bushing	6 Nos	
e)	Rubber Bellows	6 Nos	
25	**UPS System (for each UPS System)**		
a)	HRC Fuse	2 (Three) sets of each rating	
b)	Semiconductor Fuse	2 (six) sets of each rating	
c)	SCR	10% of total quantity of each type used in the system or minimum 2(two) nos. whichever is more.	
d)	Power Diode	One (1) sets of each rating	
e)	IGBT	2 (two) nos.	
f)	Electronic Module/ PCB		
	Static Switch	1 (one) no. each type of Electronic Card/PCB/modules used in the system	
	Inverter	1 (one) no. each type of Electronic Card/PCB/modules used in the system	
	Static voltage Regulator	1 (one) no. each type of Electronic Card/PCB/modules used in the system	
	Charger	1 (one) no. each type of Electronic Card/PCB/modules used in the system	
g)	UPS Battery		
	Battery Cell (Uncharged, Dry)	8 nos.	
	Inter connecting cell strips	10 nos.	
	Vent cap	10 nos.	
	Hydrometer	1 no.	
	Rubber gloves	1 pair	

PROJECT: KOTHAGUDEM 1X800MW - List of Mandatory Spares for FGD System

Sr. No.	Description	Qty.	Remarks
	Voltmeter for measuring cell voltage (Center zero type)	1 no.	
	Funnel	1 no.	
	Jug	1 no.	
	Appron & Goggles	1 set	
	Cell lifting puller	1 no.	
	Insulated socket spanner with handle	1 no.	
	Terminal screw with bellaville washer	5% of total quantity used	
	Plastic filling bottle	1 no.	
	Thermometer	1 no.	
h)	Filter Capacitors	One (1) set	
i)	Filter Chokes	One (1) set	
j)	Auxiliary Relay	Two (2) nos. each rating	
k)	System Control card	One (1) no.	
26	**Field Instruments**		
a)	Transmitters/ Gauges/Switches etc. along with relevant accessories	5% of total or at least one (whichever is higher) for eachtype along with accessories.	
b)	Temperature Element (RTD/Thermo-couple) with thermowell	5% of each type , range and immersion length . Minimum 2 nos.	
27	**DDCMIS**		
a)	Electronic Modules (IO cards, Remote IO cards, communication interface cards, controller cards, CPU module, logic cards, network switches etc.)	5% of total quantityor minimum 2 nos. whichever is higher	
b)	Relays	5% of total quantity or minimum 4 nos. whichever is higher	
c)	Power Supply Modules & Power Packs for control system	5% or minimum 2 nos. whichever is higher for each typeand rating.	
d)	Industrial grade ethernet switches	2 nos. for each type minimum.	
e)	Any other system specific Module/Cards used in the system but not mentioned in this list	5% of total nos. used in the system or minimum 1(one) no. whichever is more for each type and model.	
f)	Network Items (Network switch/ LIU unit/ Transceiver/ FO patch cord etc.)	5% of total nos. used for each type and model in the system or minimum 1(two) no. whichever is more.	
g)	MCB (Miniature case circuit breaker)	5% of total quantity or minimum 4 nos. whichever is higher for each type and rating.	
h)	Fuses	100% or minimum 20 no's for each type and rating	
i)	Racks for housing I/O & Processor Modules	1(One) no. each type used in the system	
j)	Prefab interconnecting cables with connectors	5% of total nos. used in the system or minimum 2(two) nos. whichever is more for each type.	
k)	Network communication cable with end connectors	5% of total nos. used in the system or minimum 2(two) nos. whichever is more for each type.	
l)	I/O bus cables with connectors for remote I/O units	1 no. of each type & length	
m)	Cooling Fans	1 no. for each cabinet	
n)	Loose Connectors	2 nos. of each type	
o)	Printers	1 no. Complete set	
p)	Key Board & Cursor control device	1 no.	
q)	Complete Set of Operators Work Station	1 no. complete set	
r)	Colour TFT Monitor	1 no. complete set	
s)	Hard Disk Drive for the work Station	1 no complete set	
t)	Toner for colour Laserjet Printer	5 (five) nos. each colour other than black & 10nos. black	
w)	Memory Module/ EEPROM Chip	5% of total nos. used in the system or minimum 2(two) nos. whichever is more.	
u)	Battery for RAM Backup	1 (one) no.	
v)	Terminal Block	5% of total nos. used in the system for each type and rating.	
x)	Read-Write CD/DVD	1 (one) no. complete set	
y)	Blank CD/DVD	20 nos.	

PROJECT: KOTHAGUDEM 1X800MW - List of Mandatory Spares for FGD System

Sr. No.	Description	Qty.	Remarks
1)	**220V DC BATTERY**		
a)	Complete dry cell	2% or 2 Nos. whichever is more for each battery set	
b)	Intercell connectors with hardware	10% or 5 nos. whichever is more for total puplation of 2 sets of battery	
c)	Vent plug	10% or 5 nos. whichever is more for total puplation of 2 sets of battery	
d)	Acid level indicating float (for opaque containers only)	10% or 5 nos. whichever is more for total puplation of 2 sets of battery	
e)	Stand insulator	10% or 5 nos. whichever is more for total puplation of 2 sets of battery	
f)	Cell insulator	10% or 5 nos. whichever is more for total puplation of 2 sets of battery	
28	**220V DC BATTERY CHARGER**		
a)	MANDATORY SPARES FOR FLOAT CUM BOOST CHARGER	1 SET	
b)	FUSES & FUSE LINKS	1 SET	1 SET REFERS TO "100% OF TOTAL QUANTITY FOR EACH TYPE AND RATING OF FUSES USED IN THE SYSTEM"
c)	SCR	4 NOS	FOR EACH TYPE AND RATING
d)	DIODE	4 NOS	FOR EACH TYPE AND RATING
e)	INDICATING LAMP	5 NOS	ASSORTED TYPE
f)	ELECTRONIC MODULE/ PCB/ CARD	1 NOS	1 (ONE) NO. OF EACH TYPE USED IN THE SYSTEM
g)	PULSE TRANSFORMER	2 SET	
29	**Neutral Grounding Resistor**		
a)	BROWN GLAZED PORCELAIN INSULATORS FOR SUPPORTING BETWEEN MOUNTING FRAME AND EACH RESISTOR ASSEMBLY	2 NOS. OF EACH TYPE & SIZE	
b)	INTERPOSING INSULATOR ASSEMBLY	2 NOS. OF EACH TYPE & SIZE	
c)	CERAMIC AND MICANITE INSULATOR FOR SUPPORTING BETWEEN RESISTOR AND MOUNTING FRAME	2 NOS. OF EACH TYPE & SIZE	
30	**DMCW Pumps**		
a)	Key for impeller	1No. for each application and ratings of Pumps	
b)	Bearings	1Set (comprising of Drive & Non-drive end) for each application and ratings of Pumps	
c)	Wear Ring for Shaft & Impeller	1Set for each application and ratings of Pumps	
d)	Mechanical seal with Sleeves	1Set for each application and ratings of Pumps	
e)	Coupling	1No. for each application and ratings of Pumps	
31	**Plate Type Heat Exchanger**		
a)	Plate	2% of each type	HT plates only
32	**MISC. Pumps**		
	Spares for Vertical Wet Pit Pumps		
a)	Casing wear rings	1 Set for each type	
b)	Impeller wear rings	1 Set for each type	
c)	Shaft sleeves	1 Set for each type	
d)	Shaft coupling	1 Set for each type	
e)	Shaft nuts and keys	1 Sets for each type	
f)	Lantern rings	1 Set for each type	
g)	Bearings Various types as applicable	Complete 1(One) Set (one set meanstotal requirements for one Pump) for each type	
h)	Coupling set (between pump and motor) with accessories	1 Set for each type	
33	**Spares for Horizontal Centrifugal Pumps**		
a)	Shaft Sleeve	1 No.	
b)	Impeller wear ring	1 No.	
c)	Casing wear ring	1 No.	
d)	Gland Packing	1 No.	
e)	Lantern Ring	1 No.	
f)	Coupling	1 Nos.	

Annexure-2

PROJECT: KOTHAGUDEM 1X800MW - List of Mandatory Spares for FGD System

Sr. No.	Description	Qty.	Remarks
34	**VENTILATION**		
a)	Wall mounted supply/ Exhaust fan		
b)	Fan-motor Bearing	1 set for each rating of fan	
c)	Vibration Isolators	1 set for each fan	
d)	Fan Motor	1 set for each rating of fan	
35	**Air Conditioning System**		
a)	Split Air Conditioners		
b)	Fan-motor bearing for outdoor unit	1 set for each rating of SAC unit	
c)	Vibration Isolators	1 set each for outdoor unit & Indoor unit for each SAC unit	
d)	Filter	1 set for each SAC unit	
e)	Expansion valve	1 set for each rating of SAC unit	
36	**HOISTS (for each type and rating, hoists)**		**Applicable for Electric Hoist**
a)	Bearings for long travel wheels	2 sets	
b)	Bearings for gear boxes for each type of hoist	2 sets	
c)	Break liners for all the brakes	100% of total population of each type & size	
d)	Oil seals	100% of total population of each type,size rating	
e)	Brake springs for all brakes	-do-	
f)	Wire ropes for hooks	100% installed on each crane and hoist	
g)	Solenoid coils for brakes	2 sets	
h)	Overload relay for motors	2 Nos.	
i)	Limit switches for hoists and travel mechanisms	2 sets	
j)	Spare motors for hoists	2 Nos.	
k)	Long travel machinery		
	i. Gear wheel	1 set	
	ii. Internal clip	2 Nos.	
	iii. Pinion	1 No.	
37	**415 Volt Motor (Upto 30KW Rating)**		
a)	Driving End & Non-Driving End Bearing	2 Set for each type and rating of Motor	
b)	Cooling Fan	2No. for each type and rating of Motor	
c)	Motor Terminal Block	5No. for each type and rating of Motor	
d)	Complete Set of Coupling	1Set for each Application	
	Control Panel/ Desk		
a)	Back-up panel mounted devices (Selector switches/ Push buttons/ Indicators etc.)	5% of installed capacity	
b)	Lamps/ LEDs	100% of the total quantity	
c)	Blank Tiles	10% of installed capacity	
d)	MCBs	10% of each type & rating	
e)	Fuses/ Fuse holder	100% of each type & rating	
38	**Sump Pump**		
a)	Pump set	1No.	
39	**11 kV & 3.3 kV Switch Gear**		
a)	Trip Coil	3 Nos. Each voltage level	
b)	Closing Coil	3 Nos. Each voltage level	
c)	Spring Charging Motor	2 Nos. Each voltage level	
d)	Spring Charging Motor with complete Mechanisim	1 No. Each voltage level	
e)	Spring Charging Limit Switch	3 Nos. Each voltage level	
f)	Thermal Overload for Spring Charging Motor	2 Nos. Each voltage level	
g)	Breaker Complete Pole Assembly (set comprising 3 nos. Eaton VI)	1 set each (1 set consists of 3 nos)	
h)	Breaker Auxiliary (A & B) Contact Assembly	2 Nos. Each voltage level	
i)	Breaker Auxiliary (C & D) Contact Assembly	2 Nos. Each voltage level	
j)	Plug Socket with Prefab cable	2 Nos. Each voltage level	
k)	Position Limit Switch	3 set Each voltage level	
l)	Surge Arrester	2	

PROJECT: KOTHAGUDEM 1X800MW - List of Mandatory Spares for FGD System

Sr. No.	Description	Qty.	Remarks
m)	Indicating Lamps complete assembly		
	Red	5	
	Amber	5	
	Green	5	
	White	5	
	Blue	5	
n)	CT (Set comprising 1 no. each of assumed 15 types)	1	1 no. for each type and rating
o)	Transducer (Set comprising 1 no. each type)	1	1 No. for each type and rating
p)	Breaker Control Switch		
	Trip / Neutral / close Switch	2	2 Nos. for each type and rating
	Swgear / Trial / Normal Switch	2	2 Nos. for each type and rating
	AC Supply On / Off Switch	2	2 Nos. for each type and rating
	DC Supply On / Off Switch	2	2 Nos. for each type and rating
	Motor Heater On /Off Switch	1	1 No. for each type and rating
	DC Supply Source Selector Switch (3-position)	1	1 No. for each type and rating
	Ammeter Selector Switch (1 type)	1	1 No. for each type and rating
	Voltmeter Selector Switch (1 type)	1	1 No. for each type and rating
q)	Voltmeter (1 type)	1	1 No. for each type and rating
r)	Ammeter	1	1 No. for each type and rating
s)	Breaker Jaw Contact (Bus-end & Breaker- end) assembly (Set comprising 1 no. each of 3 types)	1	1 Set for each type and rating
t)	Energy Meter	1	1 No. for each type and rating
40	**Protective Relaying system**		
a)	Numerical Relay		
b)	Feeder/Transformer Protection	1	1 No. each type and rating
c)	Motor Protection	1	1 No. each type and rating
d)	Conventional (Electromagnetic/Static type) Relay	1	10% for each type and rating or minimum one (1) no. whichever is more
41	**415V System**		
	Air Circuit Breaker		
a)	Trip Coil	5 Nos	
b)	Closing Coil	5 Nos	
c)	Spring Charging Motor	2 Nos	
d)	Spring Charging Motor with complete Mechanisim	2 Nos	
e)	Spring Charged Limit Switch	2 Nos	
f)	Thermal Overload for Spring Charging Motor	1 Nos	
g)	Breaker Contact		
	Main Contact (Fixed and moving) assembly	1	Sets for each type and rating
	Arcing Contact (Fixed and moving) assembly	1	Sets for each type and rating
	Breaker Jaw Contact (Bus-end & Breaker- end) assembly	1	Sets. for each type and Rating
	Sliding Contact (Fixed & Moving)	5	Sets. for each type and Rating
	Breaker Auxiliary Contact Block	1Nos.	
h)	Arcing Chute	1	Sets for each type and rating
i)	Plug Socket with Prefab cable	1 Nos	
j)	Position Limit Switch	2 Nos	
k)	**Indicating Lamps complete assembly**		
	Red	10 Nos	
	Amber	10 Nos	
	Green	10 Nos	
	White	10 Nos	
	Blue	10 Nos	
l)	**CT**	1	No. for each type and Rating
m)	**Transducer**	1	Nos. for each type and Rating
n)	**Breaker Control Switch**		
	Trip / Neutral / close Switch	2	Nos. for each type and Rating
	Sw.gear / Trial / Normal Switch (Local/Remote)	2	Nos. for each type and Rating
	AC Supply On / Off Switch	2	Nos. for each type and Rating
	DC Supply On / Off Switch	2	Nos. for each type and Rating
	Motor Heater On /Off Switch	2	Nos. for each type and Rating
	DC Supply Source Selector Switch (3-position)	1	Nos. for each type and Rating
	Ammeter Selector Switch	1	Nos. for each type and Rating
	Voltmeter Selector Switch	1	Nos. for each type and Rating
o)	**Voltmeter**	1	Nos. for each type and Rating
p)	**Ammeter**	1	No. for each type and Rating for BTG Area & 1
q)	**Auxiliary Control Contactor**		
	Auxiliary Control Contactor DC complete	5 Nos	
	Auxiliary Control Contactor DC spare kits	5 Nos	
	Auxiliary Control Contactor DC Coils	5 Nos	
42	**PMCC/MCC/ACDB**		
	Contactor		
a)	Power Contactor (AC)		
	Power Contactor Complete Assembly	1	Nos. for each type and Rating
	Power Contactor spare kits	2	Sets for each type and rating

Annexure-2

PROJECT: KOTHAGUDEM 1X800MW - List of Mandatory Spares for FGD System

Sr. No.	Description	Qty.	Remarks
	Power Contactor AC Coils	2	Nos. Coils for each type and rating
b)	Auxiliary Control Contactor (AC)		
	Auxiliary Control Contactor Complete Assembly	5	Nos.for each type and rating
	Auxiliary Control Contactor spare kits	5	Sets for each type and rating
	Auxiliary Control Contactor AC Coils	10	Nos.for each type and rating
	MCCB (Power Circuit)	1	Nos. for each type and rating
	MCB (Control Circuit)	5	Nos.for each type and rating
c)	**Switch**		
	Local / Remote Selector Switch	2 Nos	
	MCCB Status (On/off) Monitoring Switch/Contact	1 Nos	
	Trial / Normal /MCC Selector Switch	5 Nos	
	MCC module Service Position Limit Switch	1 Nos	
d)	**Thermal Overload Relay**	1	Nos. for each type and rating
e)	**Sliding Contact (Fixed & Moving)**	5 sets	
f)	**Bus bar to MCC module Lira Contact Assembly (Bus**	1	Sets for each type and rating
g)	**Indicating Lamps complete assembly**		
	Red	5 sets	
	Amber	5 sets	
	Green	5 sets	
h)	**Push Button (On/Off) Complete Assembly**	5 sets	
i)	**CT**	1	No.for each type and rating
j)	**Ammeter**	2	No.for each type and rating (Consider 10Nos)
k)	**Control Transformer**	1	No.for each type and rating
l)	**Off Delay/ On Delay Timer**	1	Nos for each type and rating
m)	**Switch Fuse Unit**	1	Nos.for each type and rating
n)	**Terminal Block**		
	Power Terminal Block	1	10% of total nos. for each type and rating used
	Control Terminal Block	1	10% of total nos. for each type and rating used
	End Plate for Power & Control Terminal Block	5	Each type 25Nos.
o)	**Energy Meter**	1	No. For each type &rating
43	**DC Starter Panel/DCDB**		
a)	**DC Power Contactor complete assembly-**	1	No. For each type &rating
b)	**Power Contact Spare Kit**	2	Sets for each type and rating
c)	**Coil for Power Contactor**	2 Nos	
d)	**Control Contactor complete assembly**	1 Nos	
e)	**Control Contact Spare Kit**	1	Sets for each type and rating
f)	**Coil for Control Contactor**	1 Nos	
g)	**On/Off Delay Timer**	1	No. for each type and Rating
h)	**Indicating Lamps complete assembly**		
	Red	3 Sets	
	Amber	3 Sets	
	Green	3 Sets	
i)	**Push Button (On/Off) Complete Assembly**	2	Nos.for each colour
j)	**MCCB**	1	No. for each type and Rating
k)	**Power Fuse**	1	Nos. for each type and Rating
l)	**Control Fuse**	1	Nos each type and rating
m)	**Thermal Over Load Relay**	1	No. each type and rating
n)	**Ammeter**	1	No. each type and rating
o)	**Switch Fuse Unit**	1	Nos.for each type and rating
p)	**Terminal Block**		
q)	**Power Terminal Block**	100%	10% of total nos. for each type and rating used
r)	**Control Terminal Block**	100%	10% of total nos. for each type and rating used
s)	**End Plate for Power & Control Terminal Block**	5 Nos	
44	**415V System**		
	Numerical Relay		
a)	**Feeder/Transformer Protection**	1	Nos.each type and rating
b)	**Motor Protection**	1	Nos.each type and rating
c)	**Conventional (Electromagnetic/Static type) Relay**	1	10% for each type and rating or minimum 1no, whichever is more (considered 5 Nos)
45	**415V BUSDUCT**		
a)	Aluminium Flexible	1	set for each type and rating
b)	Copper Flexible	1	set for each type and rating
c)	Rubber (Neoprene Bellow)	1	set for each type and rating

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

PROJECT ENGINEERING & SYSTEMS DIVISION

PRICE FORMAT FOR GYPSUM DEWATERING EQUIPMENT (Sub -Assembly of FGD Package)

BTPS FGD (4X270 MW)

	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**	**PRICE WEIGHTAGE IN PERCENTAGE**
A	**MATERIAL SUPPLY-(MAIN)**				
A.1	**Gypsum Dewatering Equipment 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	**80%** **(FOR TOTAL A.1,A.2)**
A.2	**Special Tools & Tackles for Gypsum Dewatering Equipment** (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 Equipment 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	**15%** **(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	**5%** **(FOR C)**
	TOTAL LUMPSUM 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 Equipment 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 EQUIPMENT (Sub -Assembly of FGD Package)

BTPS FGD (4X270 MW)

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 offe**r 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 evalution 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 commisioning spares, during commissioning shall be supplied free of cost by the equipment vendor.

8) Reference document: BHEL Tender Specification (PY52326) & 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-REGION (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.