TECHNICAL SPECIFICATION FOR GYPSUM DEWATERING EQUIPMENT (Sub-Assembly of FGD Package)

MAHAGENCO

BHUSAWAL 1 X 660 MW TPS

FGD PACKAGE

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CLAUSE NO.	DESCRIPTION		
1.0.00	**PROJECT INFORMATION**		
a)	Client Name	:	Maharashtra State Power Generation Co. Limited
b)	Plant Name	:	Bhusawal Unit-6: 1X660
c)	Project Name	:	Bhusawal 1X660 MW.
d)	Consultant Name	:	DCPL.
e)	Plant capacity	:	1X660 MW
f)	Plant location	:	Deepnagar, Bhusawal, Maharashtra 425307
g)	Buyer	:	BHEL-PE&SD (HYD)
	Site Condition		
a)	Ambient Temperature(Guarantee)	:	27 Deg C
b)	Ambient Temperature (Design)	:	45 Deg C
c)	Relative Humidity	:	60%
d)	Project Owner	:	Maharashtra State Power Generation Co. Limited
	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 of BHUSAWAL 1X660MW project.		
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 (1) units of 660 MW and this unit is envisaged with one (1) FGD system. Two (02) Sets of Gypsum Dewatering Equipment (1 working + 1 standby) shall be provided.	
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	20.1 tones per hour (wet cake) for each belt filter
3.	Moisture content	≤ 10%
4.	Electrical Power Supply Details: i. **Available Power supplies List:** a). Medium Voltage: 11KV/3.3KV AC ± 6% b). Low Voltage: 415V/240 AC ± 10% c). Frequency : 50 Hz ± 5% d). Combined variation of voltage and frequency: 10% (Absolute sum) e) DC Voltage : 220V DC, -15% to +10% f) System fault level: -11KV System: 44KA per 1 Sec --3.3KV System: 44KA per 1 Sec -415V System: 50KA per 1 Sec g) System grounding: HT System: Resistance ground & Lt System: Solid grounding	

	ii. **Power Distribution Philosophy:** a). Motors ≥ 1000KW: 11KV AC b). Motors >160KW to <1000KW: 3.3KV AC c) Motors ≥ 0.20KW to ≤ 160KW: 415V/240V AC s± 10% d) Motors <0.2KW :1-Phase,240V AC e) 1-Phase,240V AC ,Power outlet for welding receptacles, portable tools, Lighting Distribution, normal lighting, emergency lighting. f). Switchgear Control supply : 220V DC (-15% to +10%) g). Panel space heater & Illumination: 240V ± 10%	
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
	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
	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

4)	Vacuum receivers with Anchor bolts, nuts and washers	Two (2) numbers
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)	Cake wash pump with motor (IE3)	Refer sl.no 11
11)	Belt filter washing pump with motor(same pump is to be used for the cake wash and sealing of the vaccum pump also).	2 Nos (i.e. one working and one standby)
12)	Companion flanges with gaskets and fasteners	One (1) set*
13)	Belt filter 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 Qty : one no's
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) Note : Online Moisture analysis Instruments to be provided for de-watered Gypsum.	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 package
	ii. Cable Adapter chamber for higher size cables if required	As required.
	iii. Electric Actuators	As required for package
	iv. VFD & LCP for Vacuum Belt Filter	As required for package

	v. Cable glands, Lugs & Bimetallic washer for Power and control cables at Vendor's supplied equipment.	As required for package
18)	vi. OEM specific Local Control starter	As required for package
19)	vii. Paint Shade-Outside surface of Motors and other electrical equipment located outdoor:RAL7032 (Siemens grey)	--
20)	Instrumentation including but not limited to	
	i. Instruments	As required for package
	ii. Junction Box	As required for package
	iii. Instrumentation Cables	As required for package
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; same shall be included in the offer and shall be supplied by the Bidder/supplier.	

31)	Detailed Equipment and piping layout preparation and submission for customer approval shall be done by bidder (Post Bid).
	*** One set means complete requirement for both the Gypsum Dewatering Equipment**
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 GDS system utilities are in bidder's scope.
10.	Belt filter Vent fan outlet UPTO outside building wall is in vendor scope.
11.	Discharge of gypsum through discharge chute onto the gypsum belt conveyer is in bidder's scope. Please refer enclosed PFD, P&ID typical layout & elevation drawing of GDS for the details in the scope
	<u>Any piping even though not listed above but is coming inside the gypsum dewatering building is in vendor scope.</u>
12.	<u>Electrical Terminal Points:</u> - HT/LT Motor terminal box, Motor Space Heater terminal box of motor for termination of Purchaser's HT / LT power cables. - Equipment earthing terminals. Necessary hardware (nut/bolts/washers etc) at equipment end shall be provided by Vendor -VFD LCP Terminals for termination of purchaser's LT/control cables.
6.2.0	**Exclusions**
	<u>Electrical:</u> **following items are excluded from Bidder scope, same will be supplied by Purchaser.** 1. Power cables

	2. Control cables 3. Complete below ground and above ground earthing materials 4. Cable Trays & Supports **5.** Local Push button stations **6.** Termination Kits for HT cables **7.** Cable laying & termination **8.** Earth strip laying and termination
7.0.0	**PROCESS DESCRIPTION**
1.	Common Gypsum Dewatering Equipment is envisaged . The dewatering system shall receive the gypsum slurry from gypsum bleed pumps.
2.	The overflow from the primary sets of hydro-cyclone shall be taken to a secondary hydro-cyclone feed tank (BHEL Scope). Secondary Hydro cyclone feed pumps (BHEL Scope) shall transfer the slurry from tanks to secondary hydro cyclone. Two sets of Secondary hydro cyclones (1 working+1 stand by) and its accessories shall be in vendor scope.
3.	The underflow from the secondary hydro-cyclone shall be taken to the filtrate water tank. The over flow from the secondary hydro-cyclone shall be taken to a waste water storage tank.
4.	One no. of belt filter washing tank is envisaged for both the belt filters. Each belt filter-washing tank shall be provided with 2 nos (1W+1S) of belt filter wash pump. Belt filter wash pump shall supply water for cloth washing, belt washing &vacuum pump water requirement's .
5.	For maintenance of secondary hydrocyclone, a bypass line will be provided to divert the flow from primary hydrocyclone over flow to filtrate water tank.
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 20.1 TPH (Wet cake) produced by the FGD units operating at design point. All other stipulations with respect to sizing and design of the dewatering system, auxiliaries and other systems shall be in line with this specification.
8.1.0	**Hydro-cyclones**
1.	Two (2) sets of primary hydro cyclones are envisaged, each set shall be sized to dewater the gypsum slurry produced by the unit operating at design point.
2.	The primary hydro-cyclone shall be installed on a floor directly above the belt filters. The overflow of the primary hydro-cyclones shall be taken to secondary hydro-cyclone feed.
3.	Two (2) sets of secondary hydro cyclones are to be installed, each sets shall be sized to dewater the gypsum slurry produced by primary hydro cyclone overflow.
4.	Each set of primary/secondary hydro-cyclone shall be provided with 10% spare hydro-cyclones. The capacity defined in the previous clause shall be met with spare hydro-cyclones out of service
5.	Both primary and secondary hydro-cyclones shall be of modular construction. It shall be possible to remove and replace individual hydro-cyclone with the set in service. Individual isolation valve shall be provided for each hydro-cyclone for this purpose.

6.	The hydro-cyclone shall be of proven design and shall be provided with replaceable rubber lining. The feed chamber, overflow and underflow chamber shall be made of carbon steel of adequate thickness with a rubber lining of minimum **12 mm** thickness. Liners shall have a minimum wear life of not less than **7000 hrs.**
7.	All Hydro Cyclones clusters shall be made of polyurethane or urethane material only
8.	A 1 m (min.) wide platform with suitable approach shall be provided around Hydro cyclone.
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.	The vacuum belt filter shall be proven design in operation for similar capacities. The filter cloth shall be polyester or polypropylene as per the proven design of the supplier.
3.	The complete frame of the filter and all parts in contact with gypsum shall be made of corrosion resistant material .
4.	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.
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 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
16.	The MOC of all the components of the vaccum belt fiter shall be as per **Annexure-XII**
17.	Moisture trap upstream of the vaccum pump shall be provided .MOC FRVE
8.3.0	**Vacuum System**
1.	The filtrate from each belt filter, cake washing shall be taken to a separate receiver tanks as per the supplier's proven practice. Each belt filter shall be provided with an independent vacuum pump sized to meet the requirements of the belt filter operating at its maximum capacity. An additional 10% margin over the above shall be provided each vacuum pump.
2.	For each vacuum belt filter the vacuum pump shall be installed close to the vacuum belt filter. Each Vacuum pump shall have its own piping system, which connects the pump with the associated vacuum belt filter. Bidder to provide Equipment layout and GA of Gypsum dewatering building along with the offer
3.	The vacuum pump shall be of low speed liquid ring type of proven design. The design of the vacuum pumps shall avoid cavitation under all operating conditions.
4.	The seals shall be of proven design.
5.	Silencers shall be provided, if required, to limit the noise level to values stipulated elsewhere in this specification.
6.	The vacuum receiver and pump internals shall be suitably lined to protect against the corrosive environment. The material selected for vacuum pumps & vacuum receivers shall be proven for similar application.
7.	Each vacuum receiver tank(s) shall be provided with slide plate type pneumatic vacuum breaker. The plate shall be stainless steel with a min. thickness of 3 mm.
8.3.1	**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.	
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, equipment etc	
e.	Belt filter washing pumps shall have a minimum flow line to tank with a restriction orifice to control.	
f.	All Lube oil , Instrument Air piping shall be made up of Gr.304 Stainless Steel material	
g.	All process water & Cooling water piping shall be made up of Carbon Steel Pressure Piping	
h.	For details on Pipe schedule kindly refer to P&ID	
V	**VALVES**	
	For details on Valve schedule kindly refer to P&ID. For valve specification, bidder shall refer to the Annexure-XII-Pipe & valve material specification	
VI	**ACCESSORIES:**	
1)	**Expansion Joints:**	
i.	Expansion Joints shall be provided at suction and discharge of each pump and also for other equipment's wherever applicable.'''	
2)	**System control:**	
i.	Each equipment shall be furnished with required instrumentation and electrical accessory devices mounted and connected in a control cabinet.	
ii.	Provisions shall be made for the interface between the local cabinet and the DCS such that the operation of the equipment's can be controlled from the control console in the FGD Control room.	
VII	**ELECTRICALS**	
i.	Bidder shall provide cable glands, lugs, Bimetallic washers for all equipment in the scope of Bidder. Glands and lugs for power cable, control cable, Space heater cable and 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 as Annexure-XI**	

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 vendors scope .	
iv.	**LOCAL CONTROL PANEL:** A PLC based local control panel for the entire Gypsum Dewatering Equipment shall be supplied by the bidder. Bidder shall provide the control logic for the entire system.	
	For sub Vendor list of instrumentation and control refer Annexure -XV	
IX	**Sub Vendor List-Electrical**	
	1. HT Motors • ALSTOM • BHEL • CROMPTON GREAVES • KIRLOSKAR ELECTRIC CO. LTD. • SIEMENS • MARATHON ELECTRIC • ABB • HHI **2. LT Motors** • ALSTOM • BHEL • CROMPTON GREAVES • KIRLOSKAR ELECTRIC CO. LTD. • SIEMENS • MARATHON ELECTRIC • ABB • BHARAT BIJLEE • LAXMI HYDRAULIC LTD. **3. VFD for LT Motors** • ABB • SIEMENS • L&T • ALLEN BRADLEY • GE FANUC **4. Electric Actuators**	

	• ROTORK • AUMA • LIMITORQUE • ANTIREB **5. Cable Glands** • COMET • ELECTRO MAG • COSMOS • POWER ENGG **6. Cable lugs** • DOWELS	
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 system have to be supplied in containers and it should be suitable for storing in the outer yard of the plant for a minimum period of 12 months. Crates and packing material used for shipping will become the property of owner.	
5.	Packaging or shipping units shall be designed within the limitations of the unloading facilities of the receiving ports and the ship will be used. It shall be the 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 :** **BHUSAWAL, 1X660 MW.** **Deepnagar, Bhusawal, Maharashtra 425307. INDIA** **EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LIMITED, INDIA"** In addition, each package or shipping unit shall have the symbol painted in red on at least two sides of the package, covering one fourth of the area of the side.	
9.	Each part of the equipment which is to be shipped as a separate piece or smaller parts packed within the same case shall be legibly marked to show the unit of which it is part, and match marked to show its relative position in the unit, to facilitate assembly in the field. Unit marks and match marks shall be made with steel stamps and with paint.	
10.	Each case shall contain a packing list showing the detailed contents of the package. When any technical documents are supplied together with the shipment of materials no single package shall contain more than one set of such documents. Shipping papers shall clearly indicate in which packages the technical documents are contained.	
11.	The case number shall be written in the form of a fraction, the numerator of which is the serial number of the case and the denominator the total number of case in which a complete unit of equipment is packed.	
12.	Wherever necessary besides usual inscriptions the cases shall bear special indication such as "Top", "Do not turn over", "Care" , "Keep Dry" etc. as well as indication of the center of gravity (with red vertical lines) and places for attaching slings (with chain marks)	
13.	Marking for Safe handling: To ensure safe handling, packing case shall be marked to show the following: a. Upright position b. Sling position and center of Gravity position c. Storage category d. Fragile components (to be marked properly with a clear warning fc 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 consignment, sequence no. of dispatch, no. of consignment for each deliverable item against each billing break up units/ billable blocks. Without these details the BBU shall not be approved during detail engineering. Also, complete billing break-up with above mentioned details shall be submitted within 10days of LOI.	
19.	All items/equipment shall be dispatched in properly packed condition (i.e. no item shall be dispatched in loose condition such that it becomes difficult to store/identify its location at site at a later stage).	
20.	Cases which cannot be marked as above shall have metal tags with the necessary markings on them. The metal tags shall be securely attached to the packages with strong steel binding wire. Each piece, Skid, Case or package shipped separately shall be labelled or tagged properly.	
11.0.0	**SUPERVISION OF ERECTION, TESTING AND COMMISSIONING**	
1.	The erection of Gypsum 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.		Material certificate check	

	Vacuum Belt filter (with Accessories)	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.		Material certificate check	

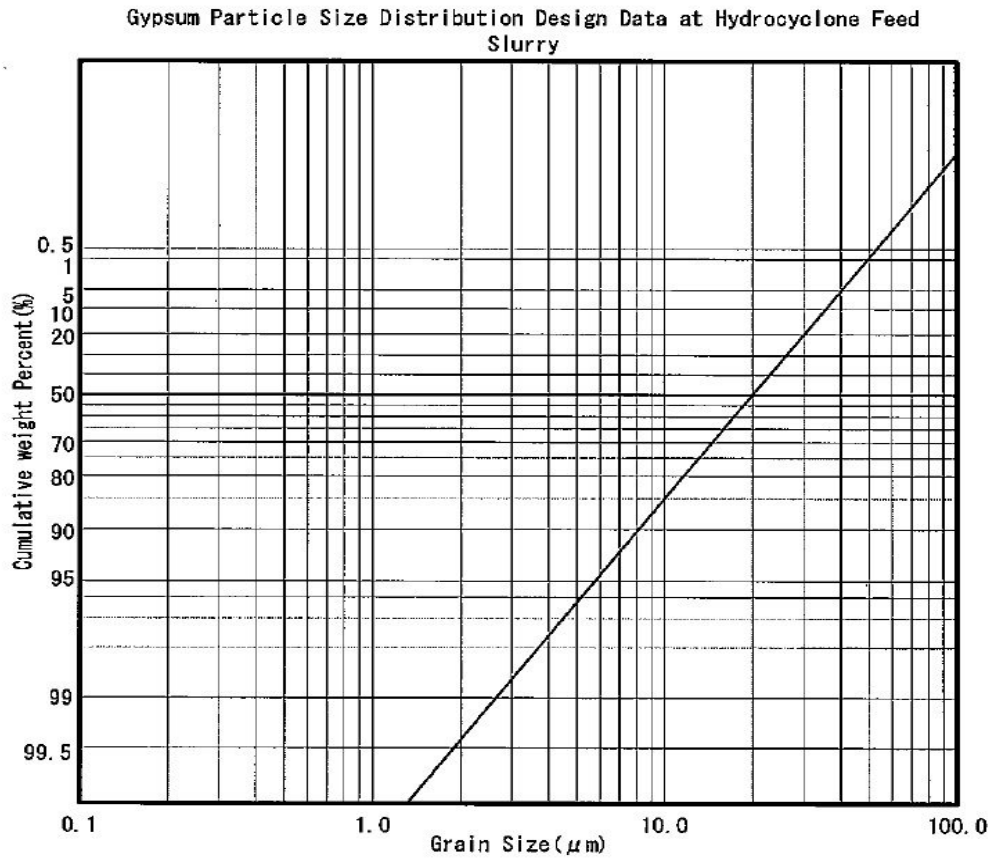
			Control valve & valves	Hydrostatic test	
				Seat leak test	
				Function test	
				Dimensional Inspection	
		12.	RTD	Material certificate check	
				Performance test	
				Hydrostatic test	
		13.	Shut off valve	Material certificate check	
				Hydrostatic test	
				Seat Leak test	
				Function Test	
				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 and Cake wash pump – 1 No. **The total power consumption for all the above power sources (a to d) put together shall not exceed 161.3 KW .**	
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 @4,50,000.0INR 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**				
S.no	**Parameters**	**Primary Hydro Cyclone Feed Slurry**	**Primary Hydro Cyclone Over Flow**		**Primary Hydro Cyclone Under Flow**
a.	Total Flow (m^3/hr.)	64.62	37.33 *1)		27.29 *1)
b.	Total Flow (t/hr.)	77.801	41.091*1)		36.710*1)
c.	Operating Temp (C)	54.2	54.2		54.2
d.	Design Temp (C)	70	70		70
e.	Solid (wt. %)	30	16.6 *1)		45 *2)
f.	Density (Kg/m^3)	1204	1101 *1)		1345 *1)
g.	Ph	4-7	4-7		4-7
h.	Cl^-(mg/l)	20000	20000		20000
14.0.2	**PROCESS PARAMETERS FOR SECONDARY HYDROCYCLONE AT OPERATING POINT**				
a.	**Parameters**	**Secondary Hydro cyclone – Feed Slurry**	**Secondary Hydro cyclone– Overflow**		**Secondary Hydro cyclone – 7Under flow**
b.	Total flow (m^3/hr)	37.33	23.33*1)		14.0 *1)
c.	Total flow (t/hr)	41.091	23.623*1)		17.466*1)
d.	Operating Temp (° C)	54.2	54.2		54.2
e.	Design Temp (C)	70	70		70
f.	Solid (wt %)	16.6	3 *2)		35 *1)
g.	Density (kg/m^3)	1104	1012.5		1247.5
h.	pH	4-7	4-7		4-7
i.	Cl^- (mg/l)	20000	20000		20000
14.0.3	**DATA SHEET OF BELT FILTER AT OPERATING POINT**				
	Parameters	**Belt Filter Feed Slurry**	**Product Gypsum**	**Filtrate**	**Washing Water ****
a.	Total Flow (m^3/hr)	27.29 *1)			
b.	Total Flow (t/hr)-Wet	36.710*1)	20.1		
c.	Operating Temp ©	54.2 Deg C			

d.	Design Temp(deg C)	70.0			
e.	Solid(% wt)	>45 *2)	>90 *2)	<0.2	
f.	Density (Kg/m^3)	1345*1)	-		
g.	pH	4~7	5~8		
h.	Cl	<20000	<200 ppm *2)		
i.	Belt filter and the peripherals shall be designed at 20.1 TPH (wet cake) discharge of product gypsum **a. **Quantity of water shall be finalized by the vendor.** **b. *Property of process & Clarified water is as below.**				
j.	*1) shall be finalized by vendor. *2) Shall be guaranteed by vendor				
	Note: 1.Required pressure at Prim hydro cyclone & Sec Hydro cyclone inlet shall be maintained <20.0 mWc 2. Each set of Hydrocylone shall be provided with 10% spares(applicabe for both Prim hydrocyclone & sec hydrocyclone				
14.0.4	**GYPSUM PARTICLE SIZE AT HYDRO CYCLONE FEED SLURRY IS SHOWN BELOW**				



14.0.6	**DESIGN CONDITIONS OF PRIMARY & SECONDARY HYDRO CYCLONES:**		
1.	Primary hydrocyclone quantity	:	2 sets (1W+1SB)
2.	Secondary hydrocyclone quantity	:	2 sets (1W+1SB)
3.	Primary hydrocyclone capacity	:	71.5 m3/hr each
4.	Secondary hydrocyclone capacity	:	38.0 m3/hr each
5.	Type of hydro cyclone	:	Vertical
6.	Material (MOC) of Cyclone Clusters	:	Polyurethane/Urethane
7.	MOC of Feed chamber	:	CS+25 mm rubber lining
8.	MOC of overflow chamber	:	CS+12mm rubber lining
9.	MOC of under flow chamber	:	CS+12mm rubber lining
14.0.7	**PROCESS WATER(CLARIFIED WATER) CHARACTERISTICS**		

S.no	Constituents	Unit	PROCESS & CLARIFIEDWATER
1.	Calcium as $caco_3$	Ppm	295
2.	Magnesium as $caco_3$	Ppm	77
3.	Sodium as $caco_3$	Ppm	203
4.	Potassium as $caco_3$	Ppm	10
5.	Total alkalinity as $caco_3$	Ppm	585
6.	Iron as Fe	Ppm	1.0
7.	Chlorides as $caco_3$	Ppm	149
8.	Sulphate as $caco_3$	Ppm	33
9.	Silica	Ppm	36
10.	PH		8.0-8.5
11.	TURBIDITY	Ppm	<15NTU

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 (If Applicable)**
	There are no mandatory spares applicable in this enquiry.
15.3.0	**Three Years O&M Spares (Recommended Spares):**
	Bidder shall provide, based on his own experience of the performance of Equipment, in the form of a schedule , the complete list of recommended spare parts for three (3) years operation of the Equipment covered under the proposal. In the list of recommended spare parts, the bidder shall identify the unit-wise population of each of items recommended and anticipated normal life of the spares. Such list will also indicate item-wise prices on Ex-works basis. The bidder shall further indicate price break-up on FOR Site basis. No other basis of prices will be quoted. The prices of these spare parts shall be on firm price basis and shall have extended validity not less than 12 (Twelve) months after the placement of order for Main Plant Package. The prices of the spare parts thus quoted shall not be taken into consideration for purpose of bid evaluation. Other relevant terms and conditions of these documents shall also be applicable to such spare parts. The spare list will be used by the Owner to decide about the spares to be procured against his spares requirements for the Equipment quoted. The Owner reserves the right for placement of order for O & M spares and shall order these spares within 18 (eighteen) months from the date of placement of Letter of Award for Main Plant package. These spares should be supplied within 12 (twelve) months from the date of Commissioning of the FGD system or date of the issuance of order for these spares whichever is later.
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**
	All performance tests for GDS shall be carried out in accordance with any latest international codes/standards. 1) Bidder shall furnish Performance guarantee for the design, manufacture, material, safe and trouble-free operation of the GDS and its accessories 2) Vendor shall Guarantee and demonstrate each Vacuum Belt Filter capacity of 20.1 TPH wet gypsum cake with an inlet solid concentration of not more than 45% wt. 3) The contractor shall guarantee and demonstrate that gypsum cake moisture content shall not be more than 10% and chloride content shall not be more than 200ppm. 4) The liners in hydro-cyclone shall have a minimum wear life of not less than 7000 hrs. 5) The Bidder shall ensure a design of the equipment to achieve an average target availability of 98% for 120 days.

	6) Noise level ≤85 dB (A) at 1m horizontal distance from equipment/enclosures and 1.5m above operating floor is to be guaranteed. 7) 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. 8) Acceptance tests to be carried out as per the procedure defined by the bidder which shall be submitted for BHEL/ END CUSTOMER approval. 9) In the event that the performance test is unsuccessful, bidder shall take necessary remedial action at his cost and the performance test shall be repeated.
17.0.0	**WARRANTY**
1.	The Bidder warrants that the equipment/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 system - Operation & Maintenance, Troubleshooting etc.
20.0.0	**CONFLICT**
	Bidder's equipment shall be designed for and shall meet the service, performance and minimum level of quality requirements specified. Bidder shall be solely responsible for advising END CUSTOMER in writing of any conflicts between the specifications and Bidder's design, including performance and levels of quality. Bidder agrees that its obligations, liabilities and warranties shall not be diminished or extinguished due to its meeting the requirements of the Specification.
21.0.0	**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 one (1) 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 one (1) 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 one (1) 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/ MAHAGENCO 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/ MAHAGENCO.
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 MAHAGENCO's 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 MAHAGENCO.**

C. In case BHEL's end customer MAHAGENCO 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 MAHAGENCO.

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 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 equipment 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 equipment.

6. BHEL/ MAHAGENCO 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**		
	a. Client	:	Maharashtra State Power Generation Co. Limited
	b. Project	:	Bhusawal 1X660 MW.
	c. End Customer	:	Maharashtra State Power Generation Co. Limited
	d. Location	:	Deepnagar, Bhusawal, Maharashtra 425307
	e. Service	:	Continuous
	f. Installation	:	Inside the Building
	g. Quantity for all FGD units	:	2 sets (1W+1S)
2.0	**MANUFACTURER DETAILS**		
	a. Model	:	Bidder to Provide
	b. Type	:	Bidder to Provide
3.0	**OPERATING CONDITION**		
	Medium to be handled	:	Gypsum Slurry
4.0	**Technical Data**		
4.1.0	**PRIMARY HYDRO-CYCLONE**		
	i. Stage		Bidder to Provide
	ii. Manufacturer		Bidder to Provide
	iii. Number of Hydro cyclone		Bidder to Provide
	iv. Diameter of Hydro cyclone		Bidder to Provide
	v. Diameter of Vortex Finder		Bidder to Provide
	vi. Diameter of Apex Valve		Bidder to Provide
	vii. Diameter of Feed Inlet		Bidder to Provide
	viii. Design Pressure		Bidder to Provide
	ix. Working Pressure		Bidder to Provide
	x. Feed Flow rate		Bidder to Provide
	xi. Overflow Rate		Bidder to Provide

	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./mWCI)		Bidder to Provide
4.7	**VOID**		
4.8	**BELT ACCESSORIES**		
4.8.1	**Bearing**		
a.	Carrying	:	Bidder to Provide
b.	Return	:	Bidder to Provide
4.8.2	**Material**		
a.	Roller	:	Bidder to Provide
b.	Spindle	:	Bidder to Provide
4.8.3	**Pulleys**		
i)	General (for all types of Pulleys)	:	Bidder to Provide
a.	Pulley Shaft Diameter	:	Bidder to Provide
ii)	**Drive Pulleys**		

a.	Lagging	:	Bidder to Provide
b.	Lagging thickness	:	Bidder to Provide
c.	Minimum angle of wrap	:	Bidder to Provide
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.	Guaranteed a) Gypsum cake residual moisture content . b) Gypsum cake chloride content	% ppm		Bidder to Provide
4.	Guaranteed life of liners in hydro cyclone	hrs		Bidder to Provide
5.	Noise level at a distance of 1.0 meter from the equipment at site and 1.5 m above operating floor	dB(A)	:	
6.	Maximum vibration (peak to peak amplitude at site)	microns	:	1) For vacuum pump & Belt Filter Wash Pump:
7.	Equipment Availability for 120 days	%	:	98%

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-S curve	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

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

NAME ----------

DESIGNATION ----------

Annexure-VII Piping & Instrumentation Diagram

Bidder to confirm to the PFD and 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 ----------

Annexure-X Motor data sheet format

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

NAME ----------

DESIGNATION ----------

Annexure-XI MOTORS, CABLES, JUNCTION BOX & INSTRUMENTS SPECIFICATION

Refer to the specification enclosed.

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

NAME ----------

DESIGNATION ----------

Annexure-XII material specification

Refer to pipe,valve& VBF material specification enclosed.

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

Refer to the paint schedule enclosed.

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

NAME ----------

DESIGNATION ----------

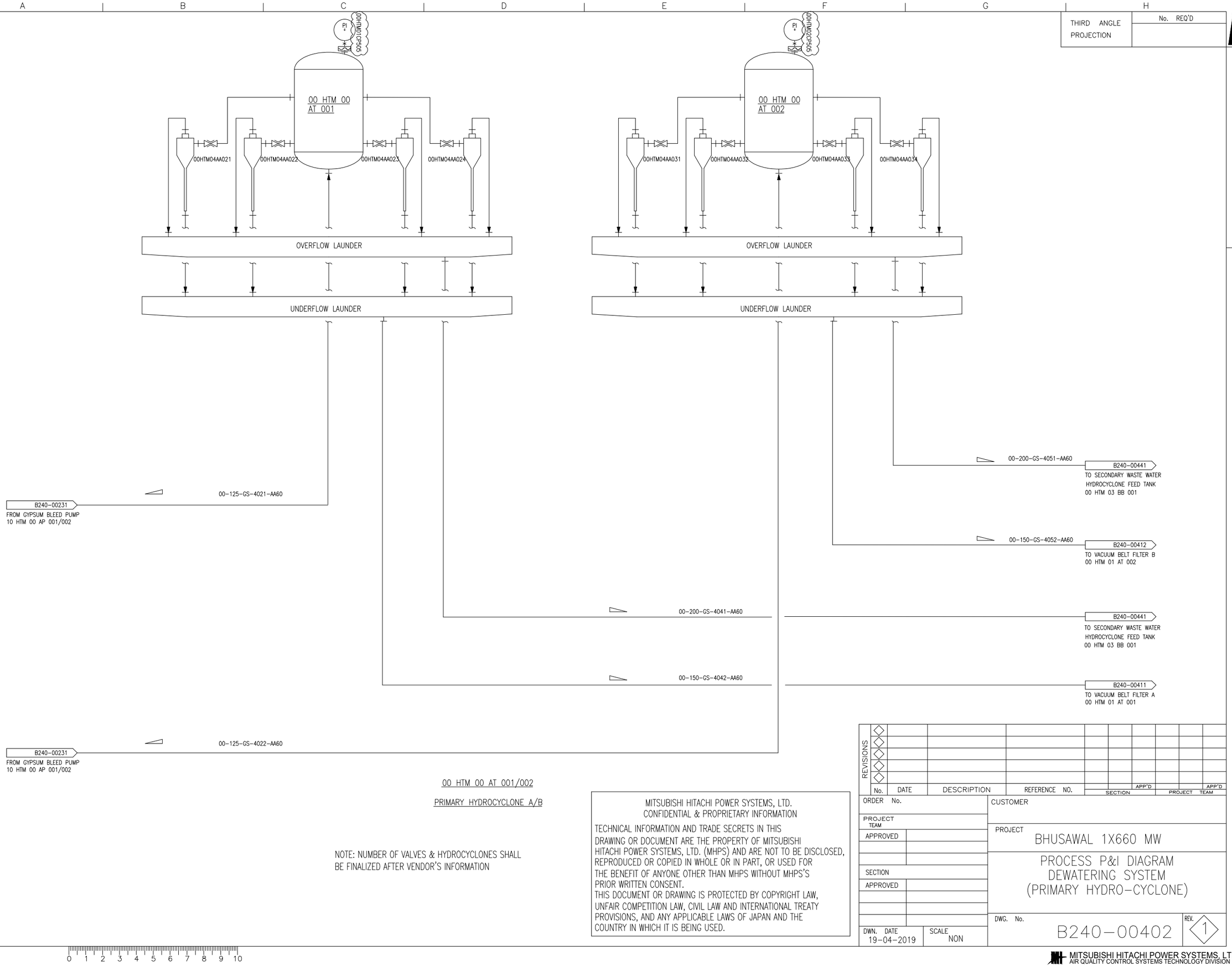
Annexure-XV Vendor List

Refer to the Vendor List enclosed.

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

NAME ----------

DESIGNATION ----------



00 HTM 00 AT 001/002

PRIMARY HYDROCYCLONE A/B

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

THIRD ANGLE PROJECTION

No. REQ'D

A3

DRAWING No.

REVISIONS

No.	DATE	DESCRIPTION	REFERENCE NO.	SECTION APP'D	PROJECT TEAM APP'D

ORDER No.

CUSTOMER

PROJECT TEAM

APPROVED

SECTION

APPROVED

PROJECT
BHUSAWAL 1X660 MW

PROCESS P&I DIAGRAM
DEWATERING SYSTEM
(PRIMARY HYDRO-CYCLONE)

DWN. DATE 19-04-2019

SCALE NON

DWG. No. B240-00402

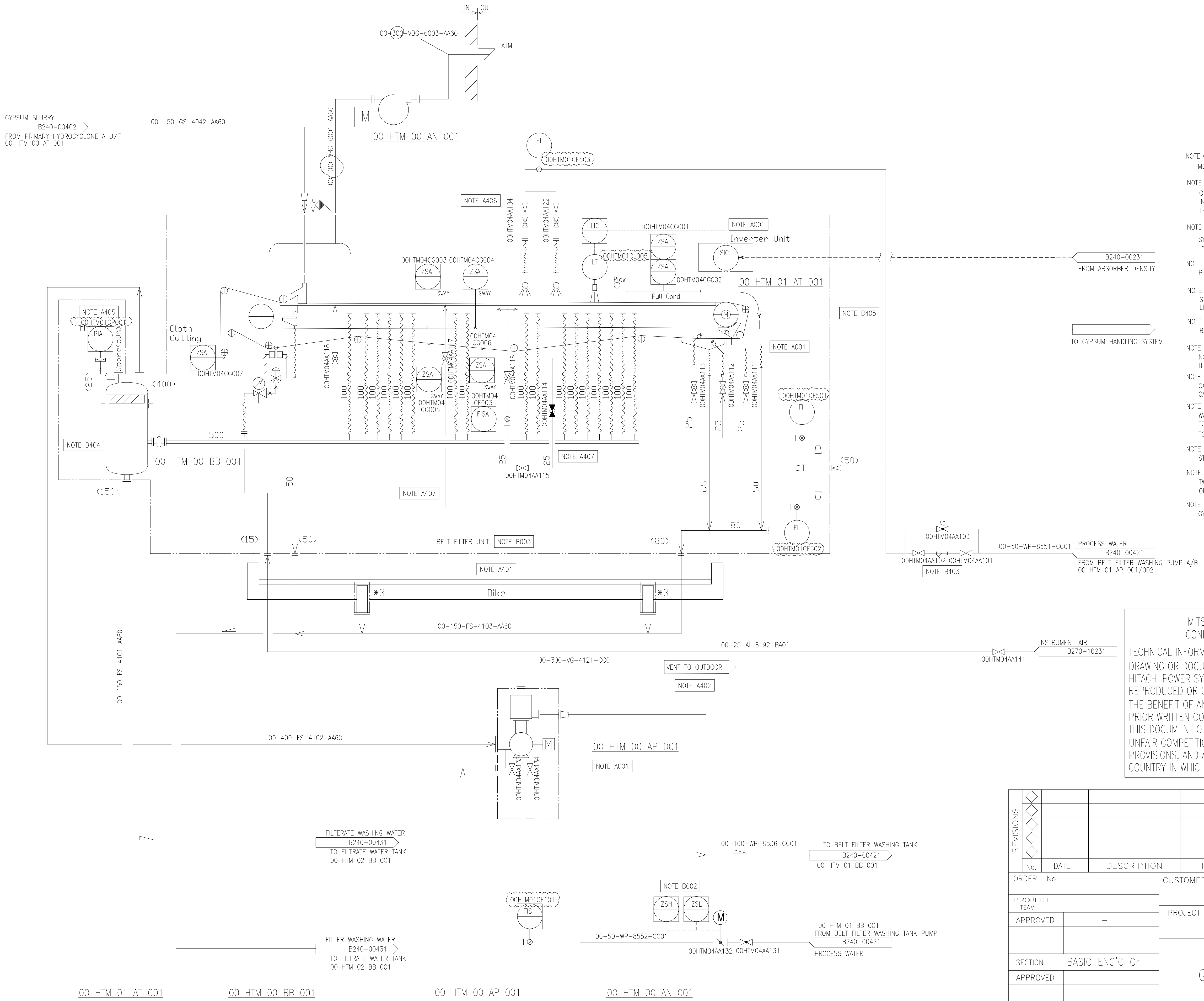
REV. 1

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

THIRD ANGLE | No. REQ'D

A3

DRAWING No.



00 HTM 01 AT 001 — VACUUM BELT FILTER A

00 HTM 00 BB 001 — VACUUM RECEIVER A

00 HTM 00 AP 001 — VACUUM PUMP A

00 HTM 00 AN 001 — BELT FILTER VENT FAN A

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.

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

NOTE A402
BIRD SCREEN SHALL BE INSTALLED.

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.

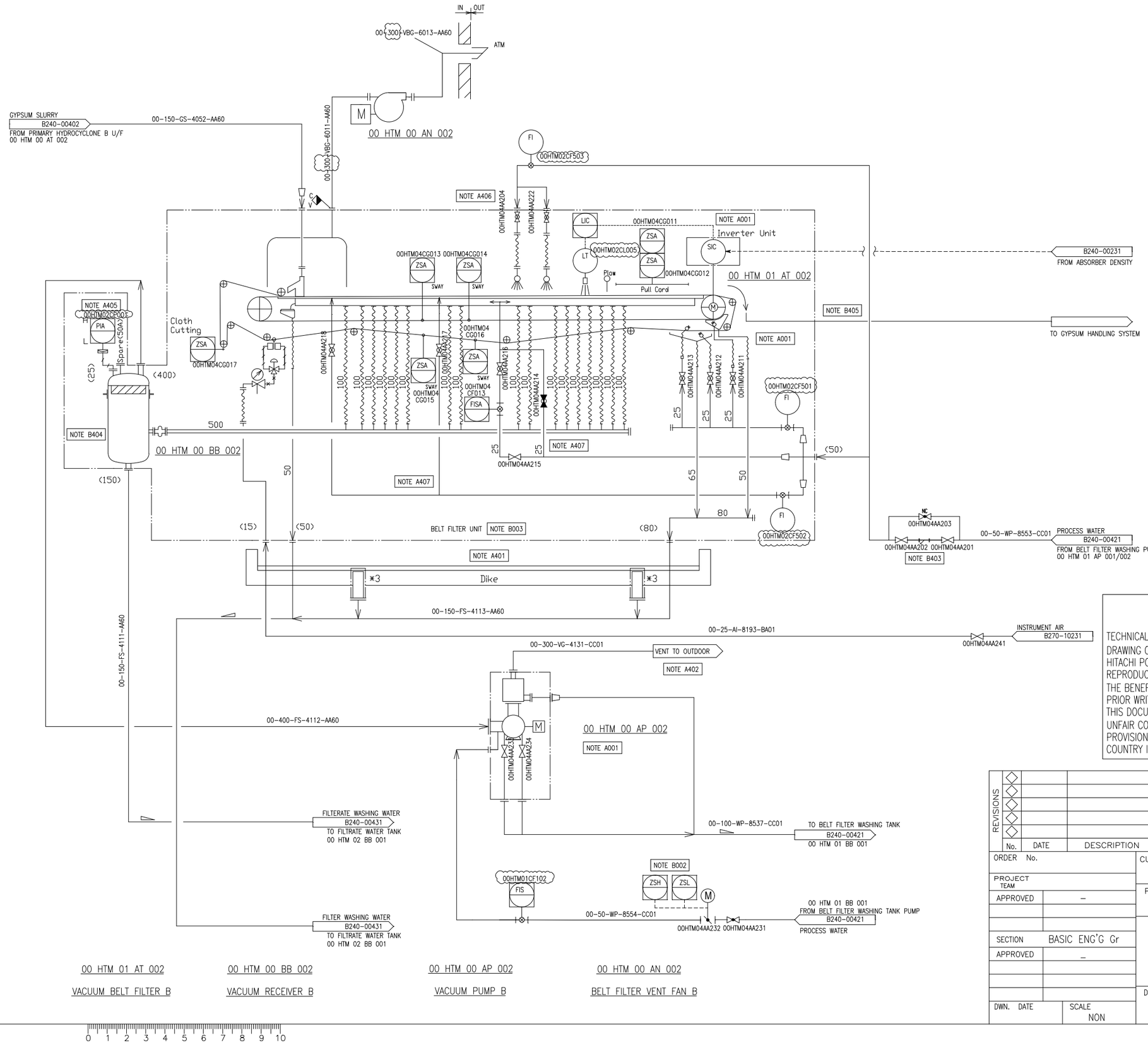
REVISIONS

No.	DATE	DESCRIPTION	REFERENCE No.	APP'D SECTION	APP'D PROJECT TEAM

ORDER No.	
CUSTOMER	MAHAGENCO
PROJECT TEAM APPROVED	–
PROJECT	BHUSAWAL1X660 MW
SECTION	BASIC ENG'G Gr
APPROVED	–
TITLE	PROCESS P&I DIAGRAM GYPSUM DEWATERING SYSTEM (GYPSUM BELT FILTER A)
DWN. DATE	9.11.2019
SCALE	NON
DWG. No.	B240-00411
REV.	1

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

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



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.
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NOTE B005
PIPE SIZE WRITTEN IN THE DRAWING IS TYPICAL. IT SHOULD BE REVIEWED.

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NOTE A402
BIRD SCREEN SHALL BE INSTALLED.

NOTE A405
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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
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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.

REVISIONS

No.	DATE	DESCRIPTION	REFERENCE NO.	SECTION APP'D	PROJECT TEAM APP'D

ORDER No.	
PROJECT TEAM	
APPROVED	–
SECTION	BASIC ENG'G Gr
APPROVED	–
DWN. DATE	SCALE NON

CUSTOMER: MAHAGENCO

PROJECT: BHUSAWAL1X660 MW

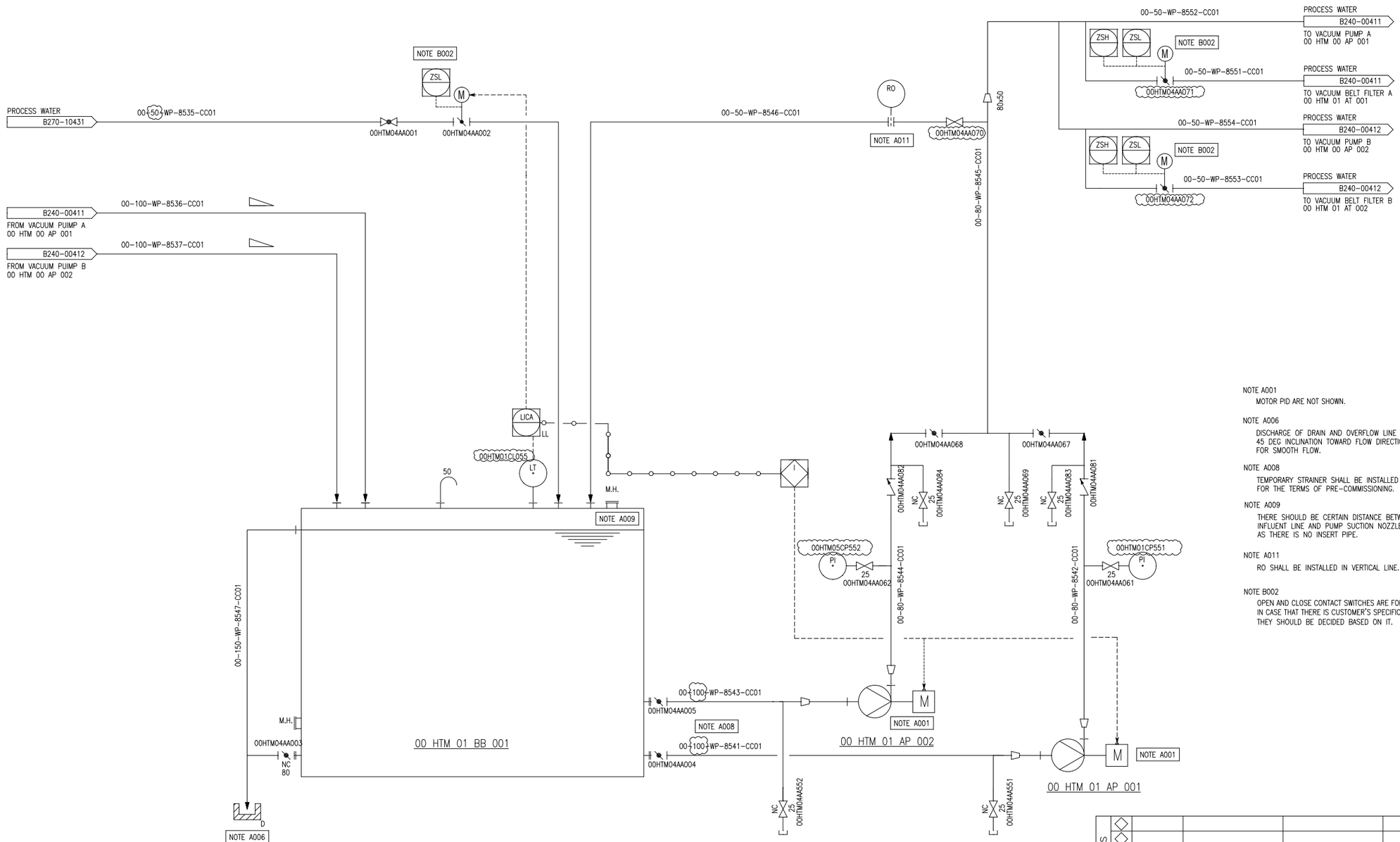
PROCESS P&I DIAGRAM
GYPSUM DEWATERING SYSTEM
(GYPSUM BELT FILTER B)

DWG. No. B240-00412 | REV. 1

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

THIRD ANGLE PROJECTION	No. REQ'D	A3

DRAWING No.



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.

00 HTM 01 BB 001
BELT FILTER WASHING TANK

00 HTM 01 AP 001/002
BELT FILTER WASHING PUMP A/B

REVISIONS

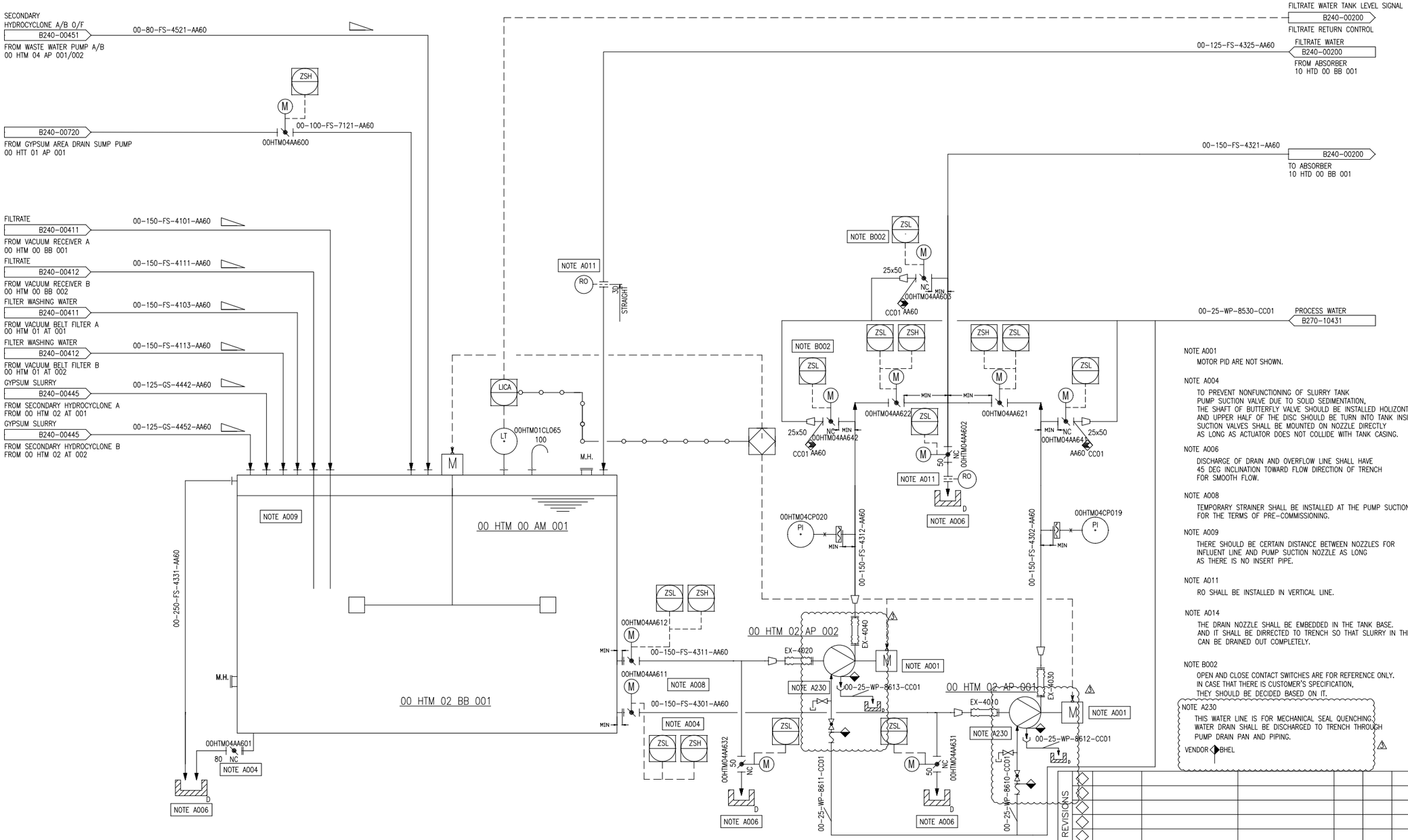
No.	DATE	DESCRIPTION	REFERENCE NO.	SECTION APP'D	PROJECT TEAM APP'D
◇					
◇					
◇					
◇					
◇					

ORDER No.	CUSTOMER MAHAGENCO
PROJECT TEAM	PROJECT BHUSAWAL 1X660MW
APPROVED –	
SECTION BASIC ENG'G Gr	PROCESS P&I DIAGRAM GYPSUM DEWATERING SYSTEM (BELT FILTER WASHING TANK)
APPROVED –	
DWN. DATE 9.11.2019 / SCALE NON	DWG. No. B240-00421 / REV. 1

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

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

00 HTM 02 BB 001
FILTRATE WATER TANK

00 HTM 00 AM 001
FILTRATE WATER TANK AGITATOR

00 HTM 02 AP 001/002
FILTRATE WATER PUMP A/B

REVISIONS

No.	DATE	DESCRIPTION	REFERENCE NO.	SECTION APP'D	PROJECT TEAM APP'D

ORDER No.	
PROJECT TEAM	
APPROVED	
SECTION	BASIC ENG'G Gr
APPROVED	
DWN. DATE	

CUSTOMER
MAHAGENCO

PROJECT
BHUSAWAL 1X660MW

PROCESS P&I DIAGRAM GYPSUM DEWATERING SYSTEM (FILTRATE WATER TANK)

DWG. No. B240-00431

REV. 3

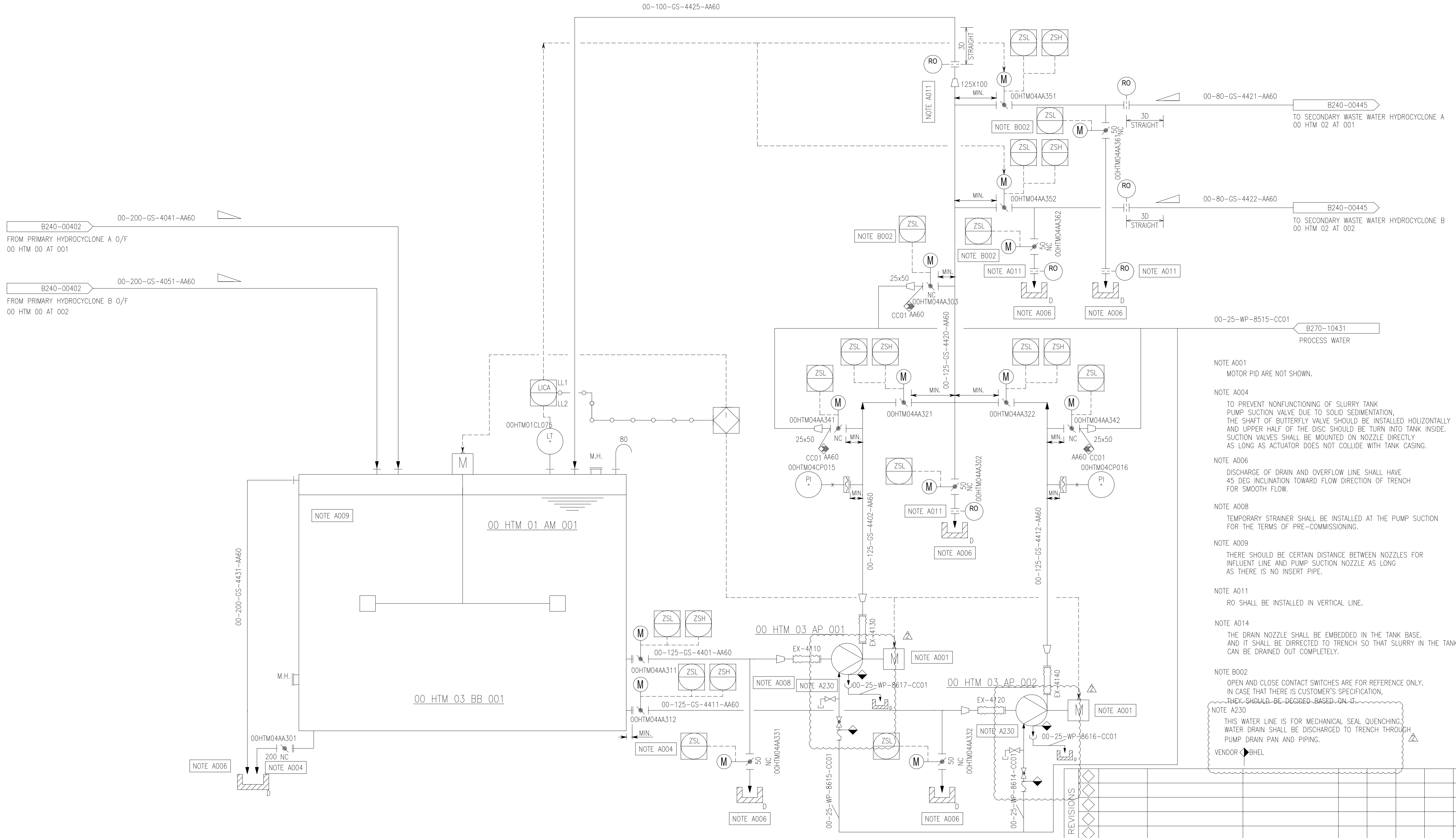
MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

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 DIRECTED 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.~~

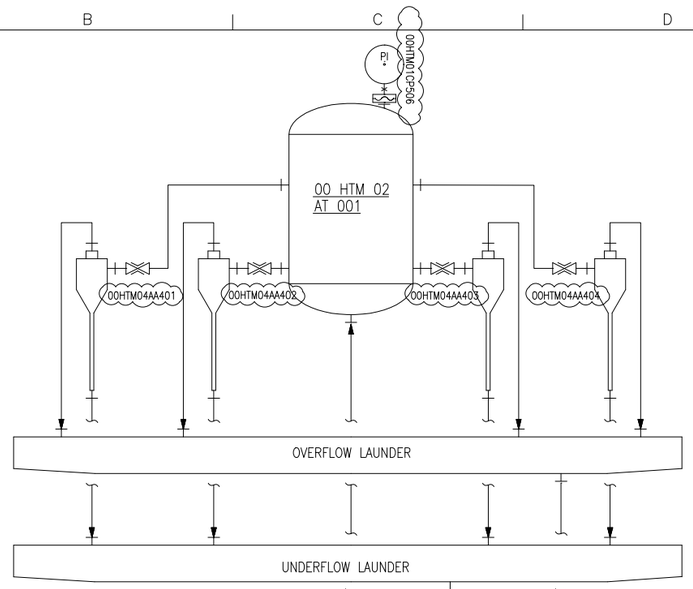
NOTE A230
THIS WATER LINE IS FOR MECHANICAL SEAL QUENCHING. WATER DRAIN SHALL BE DISCHARGED TO TRENCH THROUGH PUMP DRAIN PAN AND PIPING.
VENDOR : BHEL

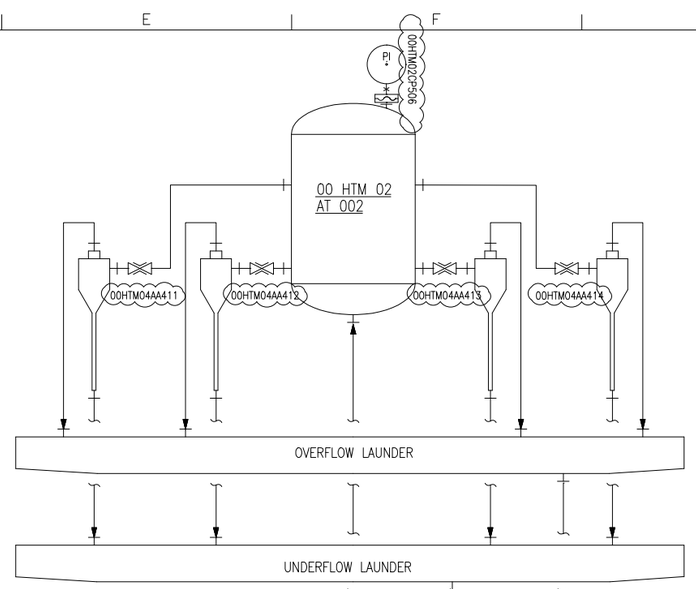
00 HTM 03 BB 001	00 HTM 01 AM 001	00 HTM 03 AP 001/002
SECONDARY WASTE WATER HYDROCYCLONE FEED TANK	SECONDARY WASTE WATER HYDROCYCLONE FEED TANK AGITATOR	SECONDARY WASTE WATER HYDROCYCLONE FEED TANK PUMP A/B

REVISIONS							
No.	DATE	DESCRIPTION	REFERENCE No.	SECTION	APP'D	PROJECT TEAM	APP'D

ORDER No.	
PROJECT TEAM APPROVED	–
SECTION APPROVED	–
DWN. DATE	19-04-2019
SCALE	NON
CUSTOMER	MAHAGENCO
PROJECT	BHUSAWAL 1X660MW
TITLE	PROCESS P&I DIAGRAM GYPSUM DEWATERING SYSTEM (SECONDARY HYDROCLONE FEED TANK)
DWG. No.	B240-00441
REV.	2

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





GYPSUM SLURRY
B240-00441
FROM SECONDARY HYDROCYCLONE FEED TANK PUMP A/B
00 HTM 03 AP 001/002

00-80-GS-4421-AA60

00-150-FS-4441-AA60

00-125-GS-4442-AA60

GYPSUM SLURRY
B240-00441
FROM SECONDARY HYDROCYCLONE FEED TANK PUMP A/B
00 HTM 03 AP 001/002

00-80-GS-4422-AA60

00-150-FS-4451-AA60

SECONDARY HYDROCYCLONE B O/F
B240-00451
TO WASTE WATER STORAGE TANK
00 HTM 04 BB 001

00-125-GS-4452-AA60

SECONDARY HYDROCYCLONE B U/F
B240-00402
TO FILTRATE WATER TANK
00 HTM 02 BB 001

SECONDARY HYDROCYCLONE A O/F
B240-00451
TO WASTE WATER STORAGE TANK
00 HTM 04 BB 001

SECONDARY HYDROCYCLONE A U/F
B240-00402
TO FILTRATE WATER TANK
00 HTM 02 BB 001

00 HTM 02 AT 001/002

SECONDARY
HYDROCYCLONE A/B

NOTE:

NUMBER OF VALVES & HYDROCYCLONES SHOWN IS PRELIMINARY.
TO BE FINALIZED BASED ON VENDOR INFORMATION

REVISIONS								
No.	DATE	DESCRIPTION	REFERENCE NO.	SECTION APP'D		PROJECT TEAM APP'D		

ORDER No.

PROJECT TEAM

APPROVED	–

SECTION

APPROVED	–

DWN. DATE 19-04-2019

SCALE NON

CUSTOMER
MAHAGENCO

PROJECT
BHUSAWAL 1X660MW

PROCESS P&I DIAGRAM
GYPSUM DEWATERING SYSTEM
(SECONDARY HYDRO-CYCLONE)

DWG. No. B240-00445

REV. 1

THIRD ANGLE PROJECTION

No. REQ'D

A3

DRAWING No.

0 1 2 3 4 5 6 7 8 9 10

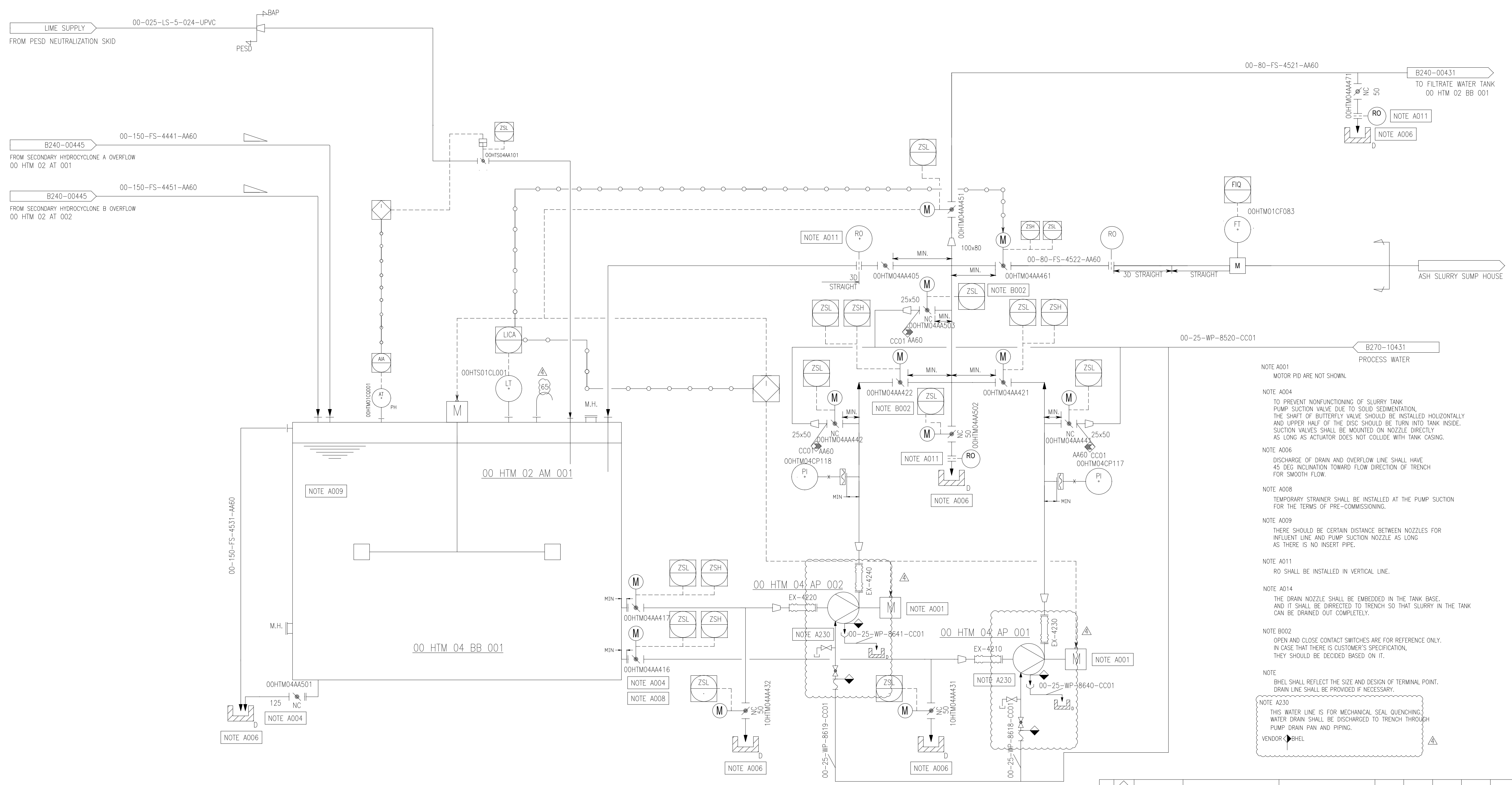
MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

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.

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

00 HTM 04 BB 001
WASTE WATER STORAGE TANK

00 HTM 02 AM 001
WASTE WATER STORAGE TANK AGITATOR

00 HTM 04 AP 001/002
WASTE WATER PUMP A/B

REVISIONS No.	DATE	DESCRIPTION	REFERENCE No.	SECTION	APP'D	PROJECT TEAM	APP'D

ORDER No.	
PROJECT TEAM	
APPROVED	–
SECTION	BASIC ENG'G Gr
APPROVED	–
DWN. DATE	9.11.2019
SCALE	NON
CUSTOMER	MAHAGENCO
PROJECT	BHUSAWAL 1X660MW
TITLE	PROCESS P&I DIAGRAM GYPSUM DEWATERING SYSTEM (WASTE WATER TANK)
DWG. No.	B240-00451
REV.	4

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

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

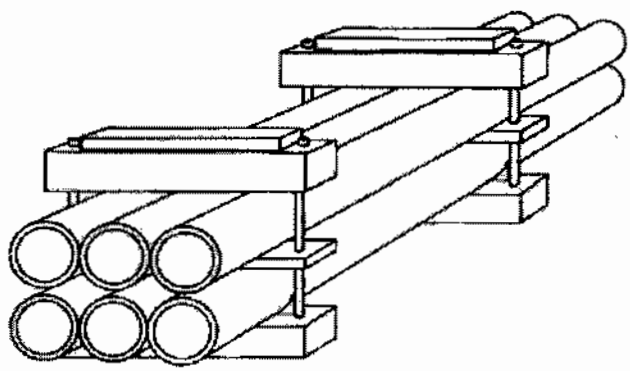
Structural Steel, reinforcing rods, bars, etc., should be packed in bundles of uniform length. Refer to articles 8.1.2, for strapping requirements. Bundle weight not normally to exceed 2,000 kg. Fabricated structures and structural steelwork, etc, should be bundled and packed using wooden beams and long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

8.2 Bundling – Packing Category I

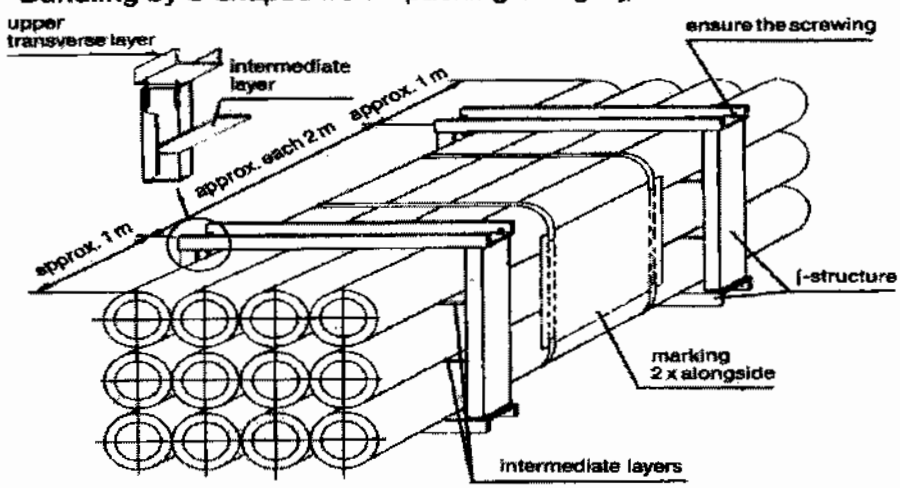
8.2.1 Type of Equipment

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)

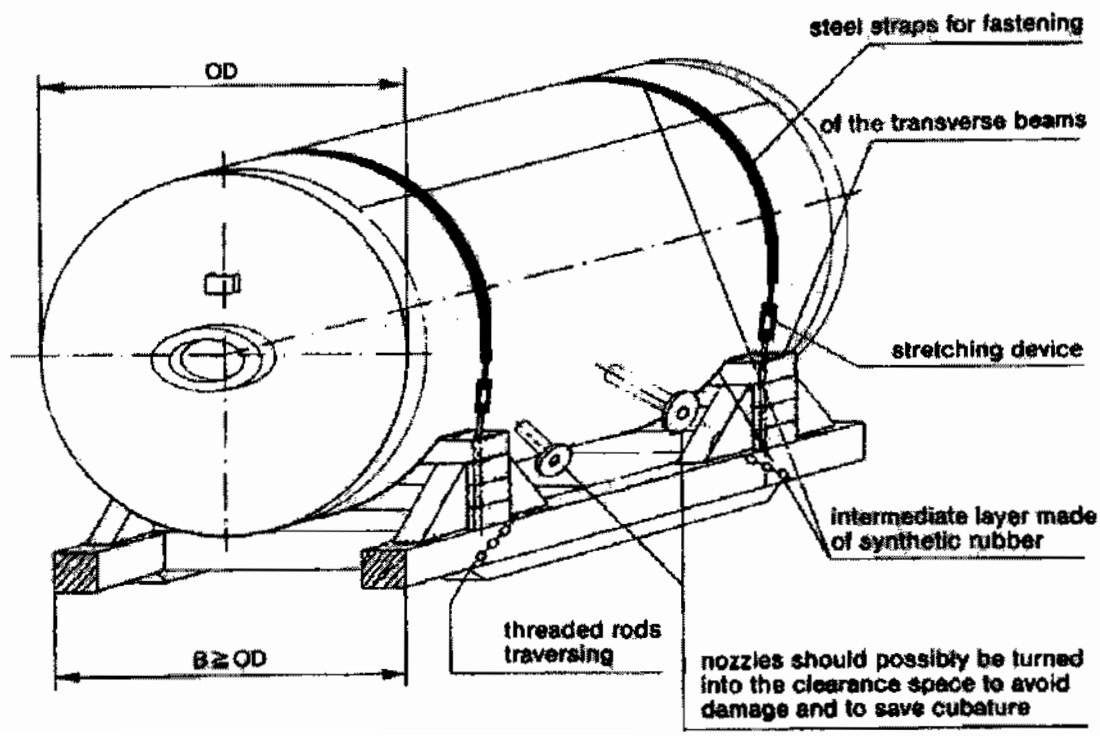
8.3.1 Type of Equipment

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

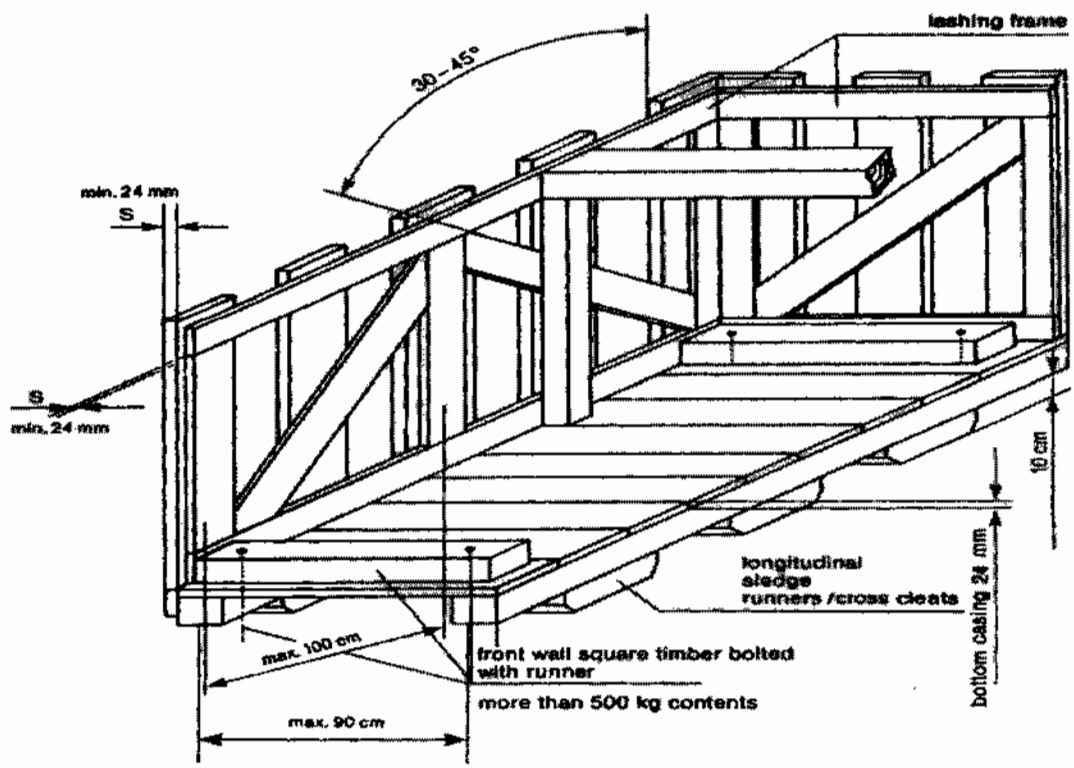
Fabricated equipment, which cannot be transported on cradles; frame-works, prefabricated piping and fittings, mechanical and electrical assemblies. *This type of packing is recommended where many parts of the equipment/component/assembly are not protruding out.*

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

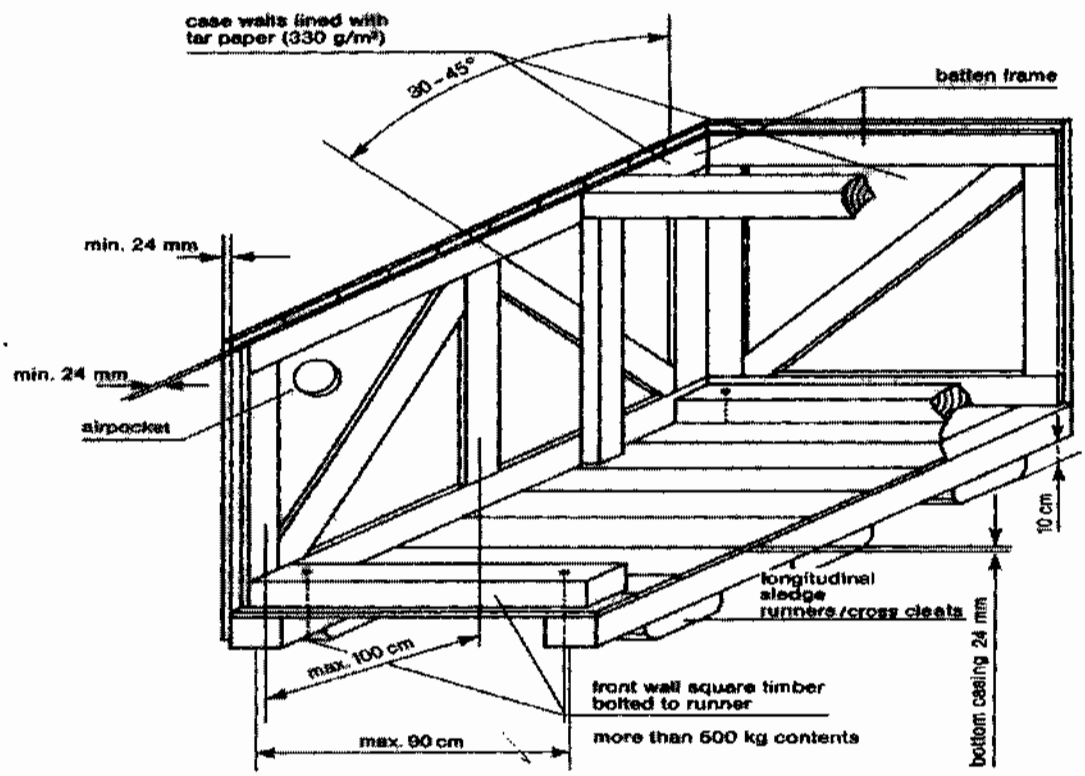
8.4.2.1 Type of Equipment

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

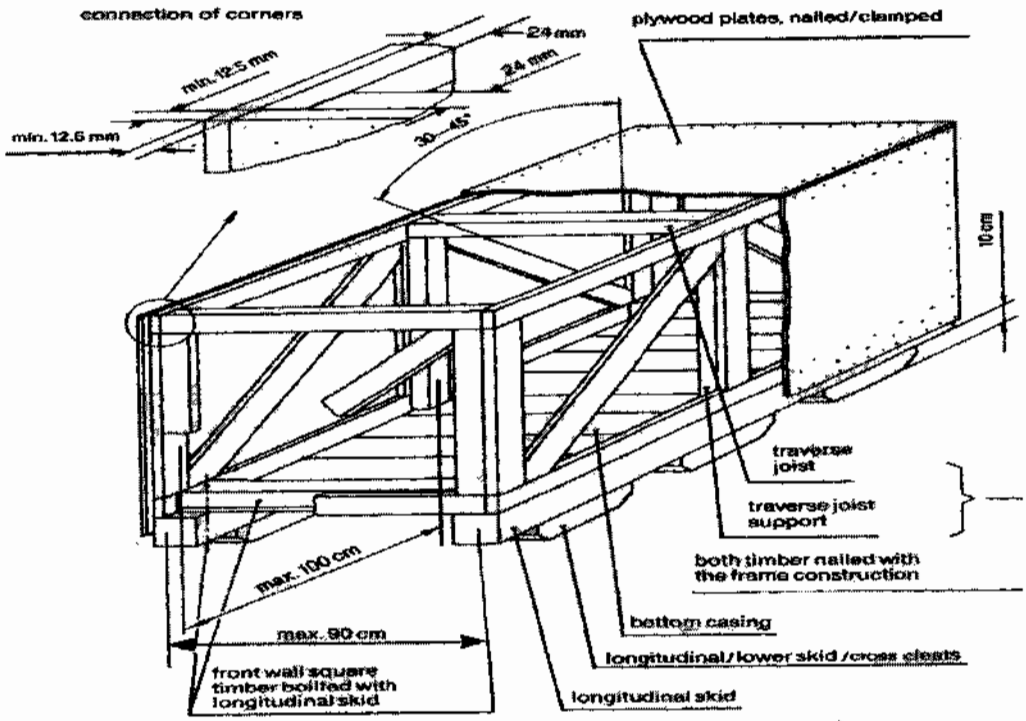
The same type of construction as article 8.4.1.2, but with all sides completely boarded without space between the boards. Sides to be provided with waterproof lining; fabric-reinforced waterproof tar paper or polyethylene-foils resistant to ultraviolet rays can be used. Polyethylene-foil shall be fixed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

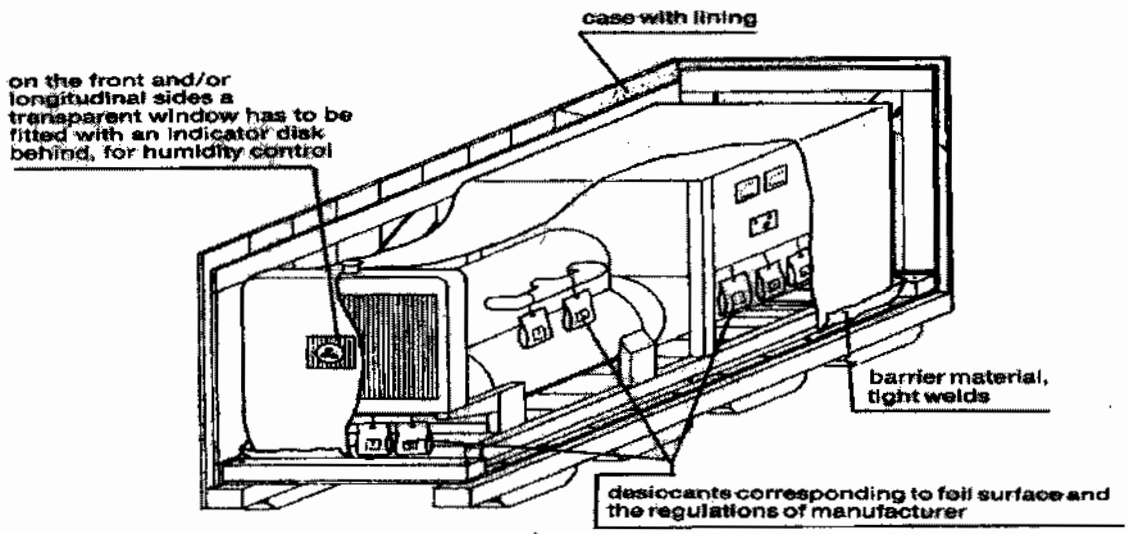
8.4.5.2 Type of Construction

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

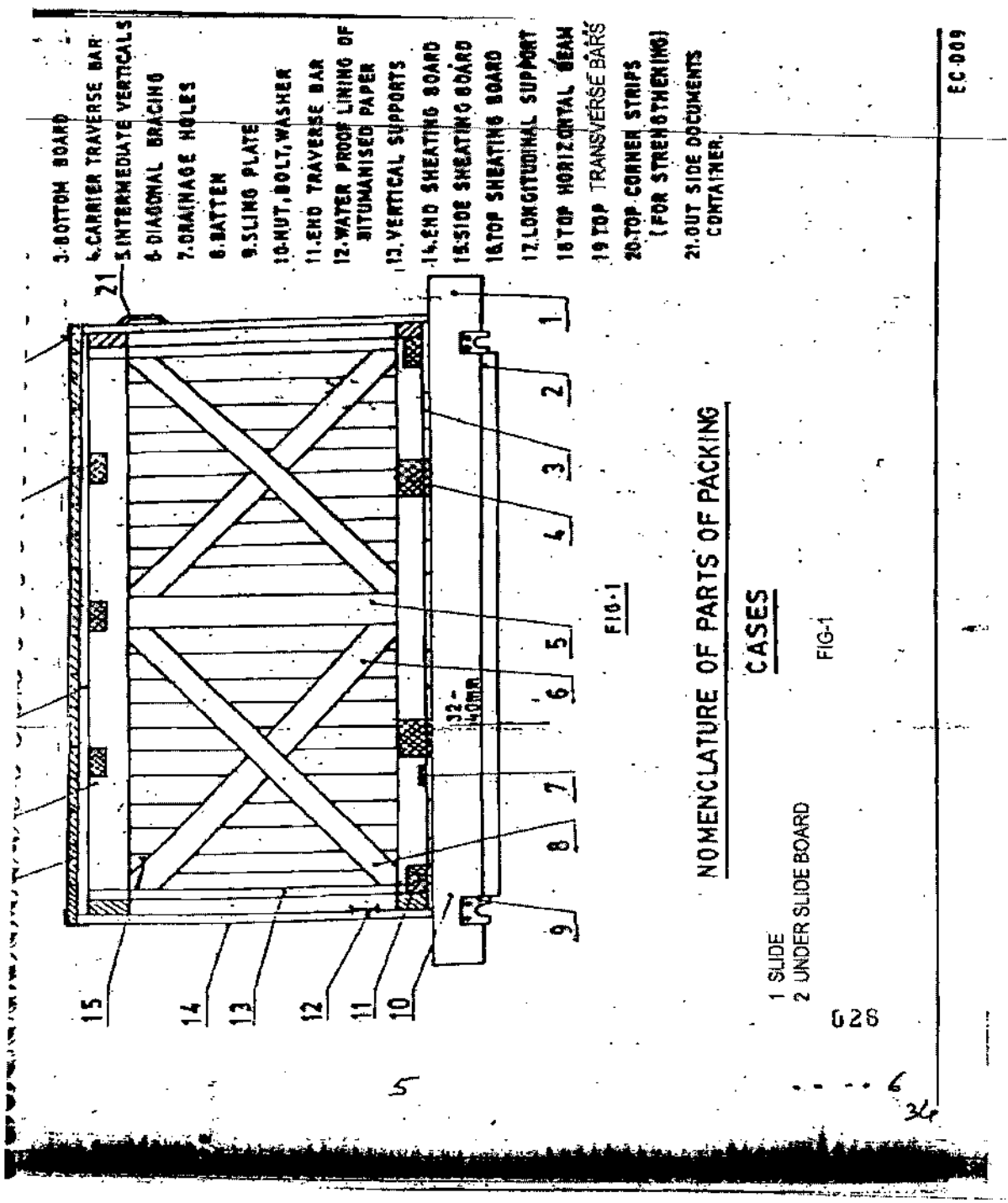
shall be filled with rubberized coir with distance between consecutive supports less than 500 mm (ref fig15). For other equipment suitable support from sides of the casing shall be provided.

- 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

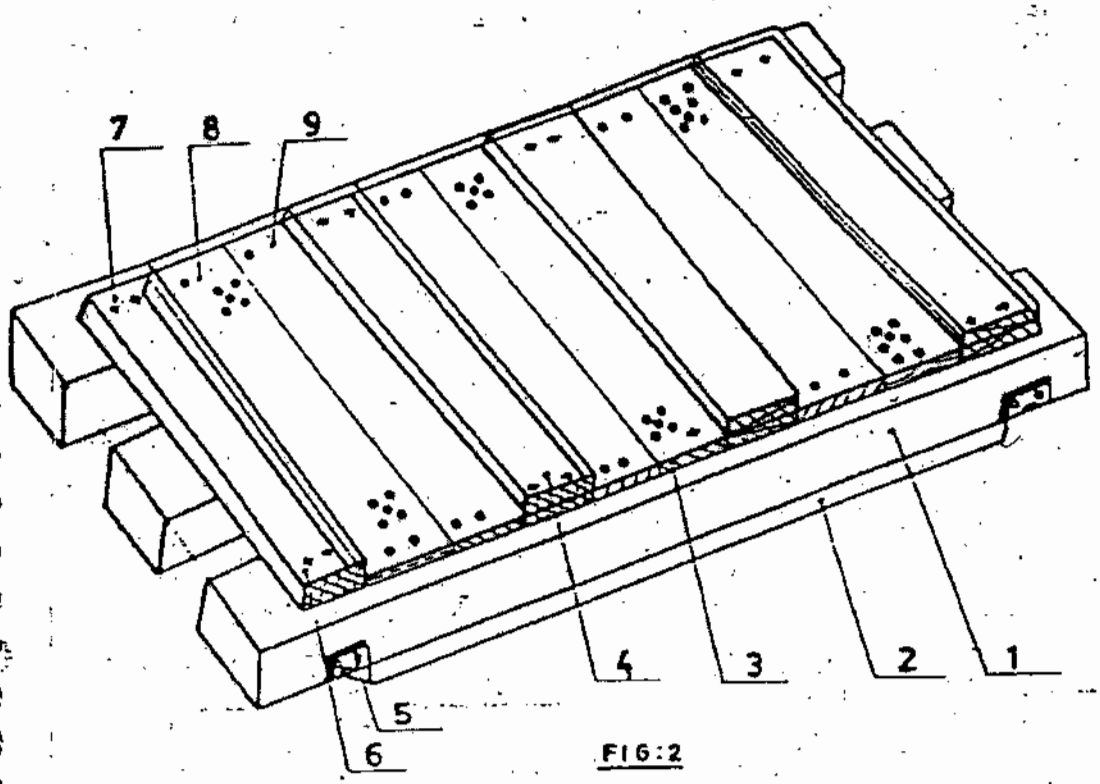


FIG:2

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

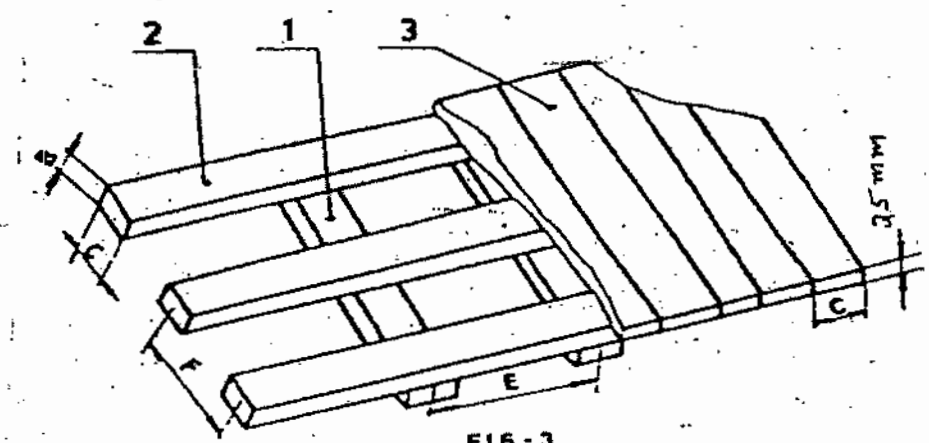
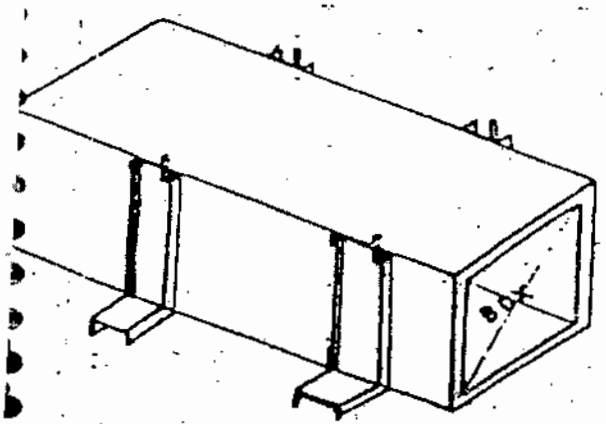


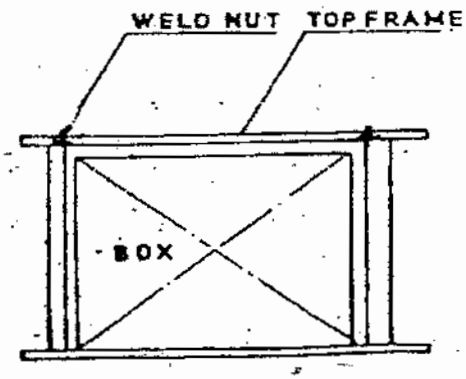
FIG-3

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

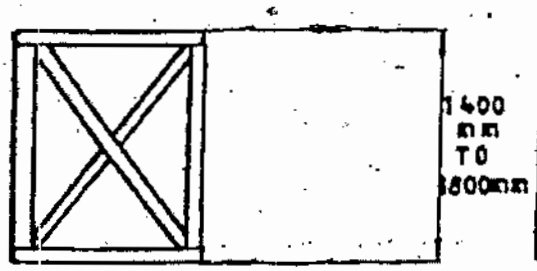


FIG:6

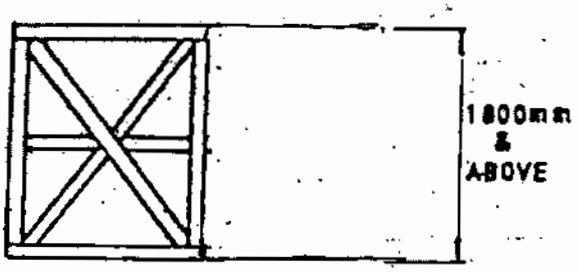


FIG:8

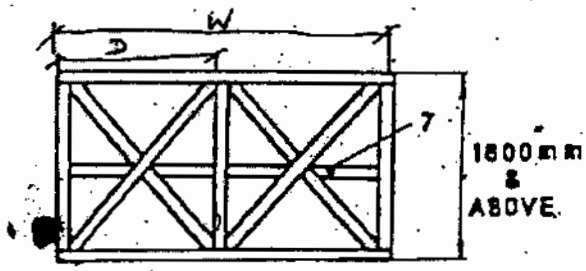


FIG:9

7- Middle Horizontal Support

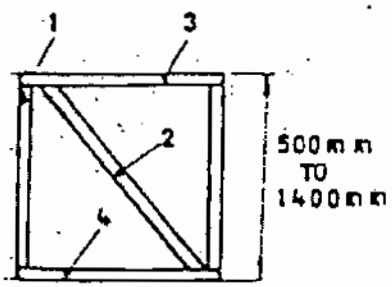


FIG:5

1- Vertical Support

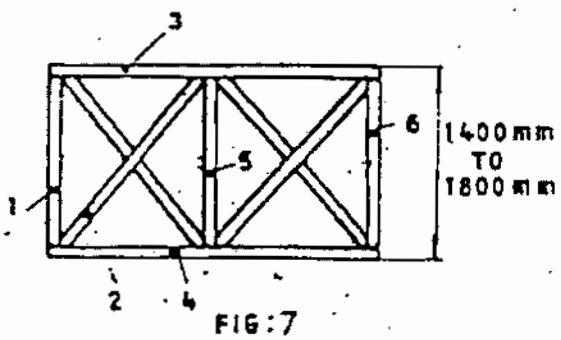
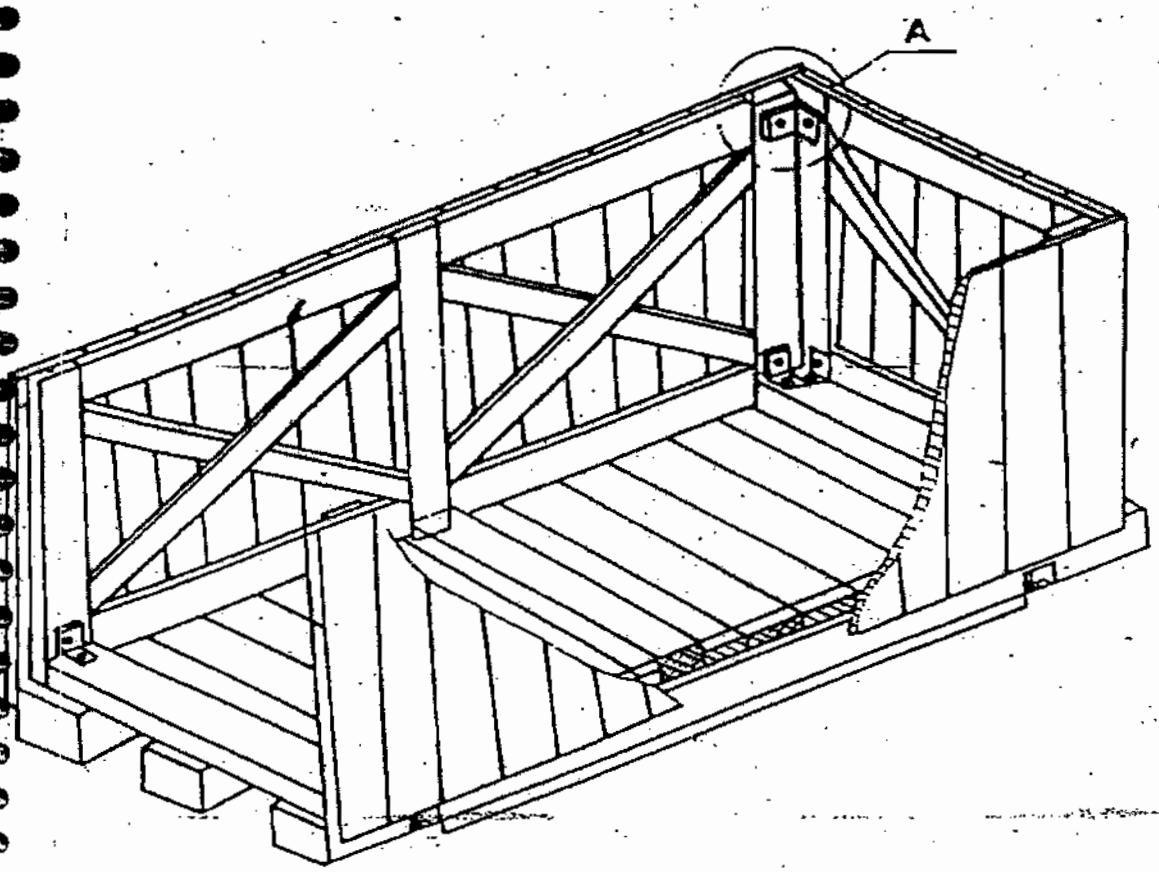
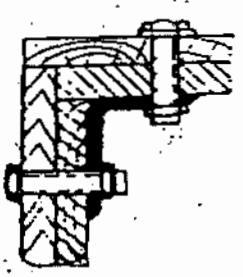


FIG:7

1, 5, 6 - Vertical Support

ARRANGEMENT OF PACKING CASE





DETAIL-A

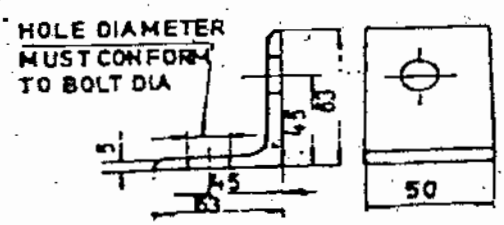


FIG:10

ARRANGEMENT OF SLING PLATE ON CASES

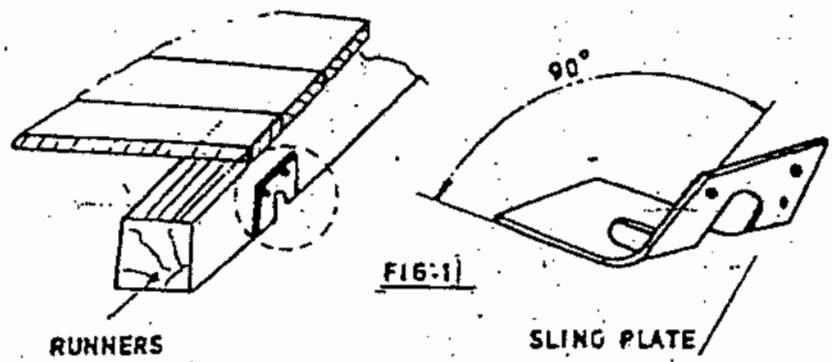


FIG:1

TABLE-1

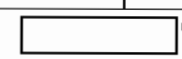
LOADS	LENGTHS OF SLIDES						
	600	800	1000	1200	1300	1500	2000
	Cross section b x c						
500	50 X 100	50 X 100	50 X 100	50 X 100	75 X 100	75 X 100	100 X 100
800	50 X 100	50 X 100	75 X 100	75 X 100	75 X 100	75 X 100	100 X 100
1000	75 X 100	75 X 100	75 X 100	100 X 100	100 X 100	100 X 110	100 X 150
1500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

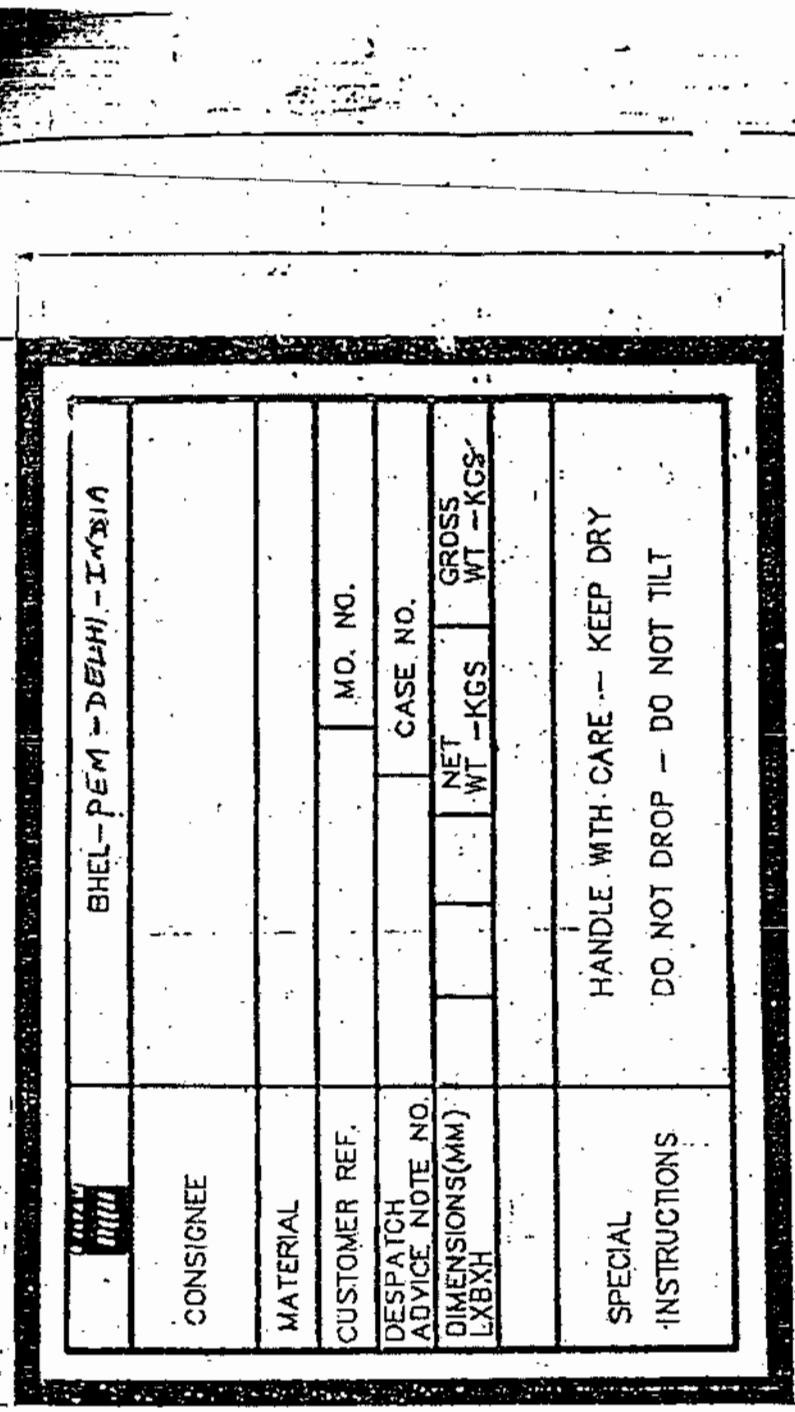
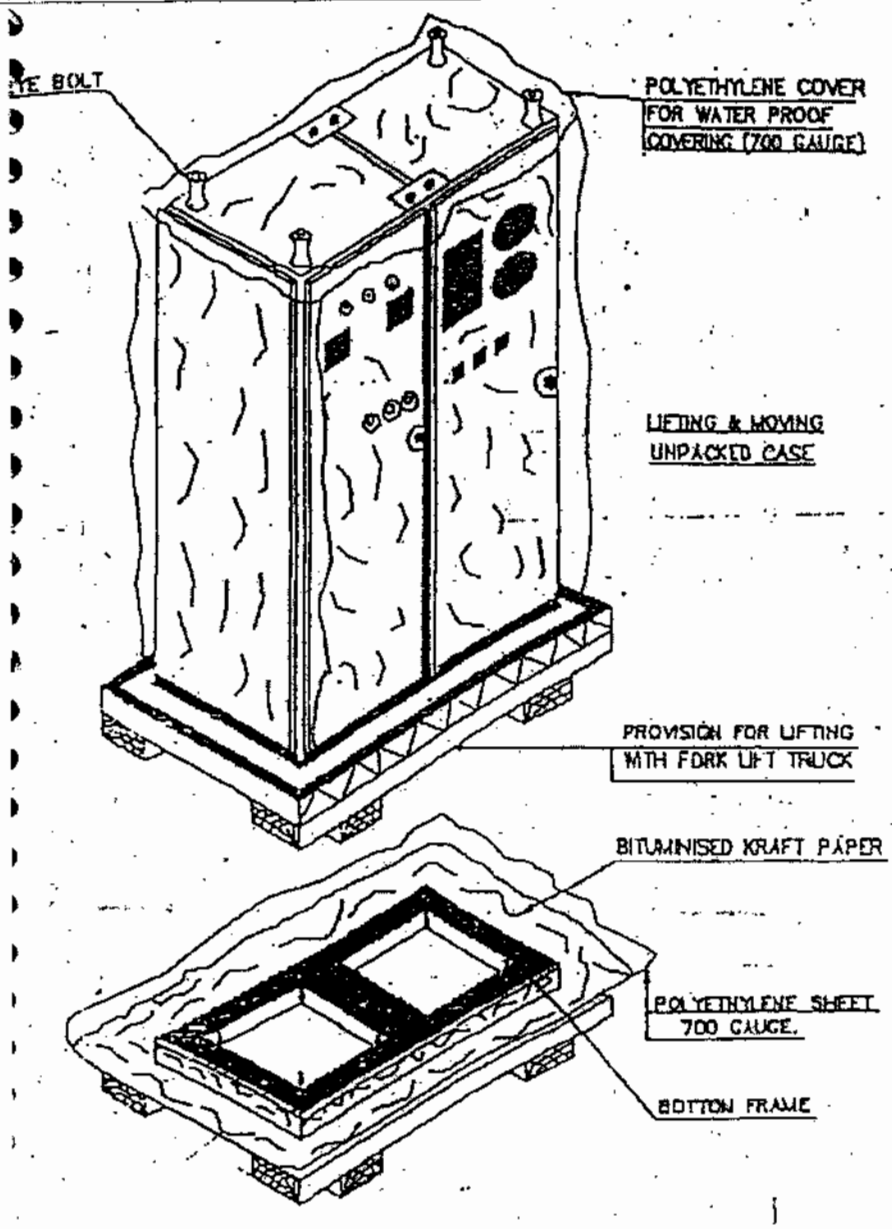


FIG-13: MARKING PLATE


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

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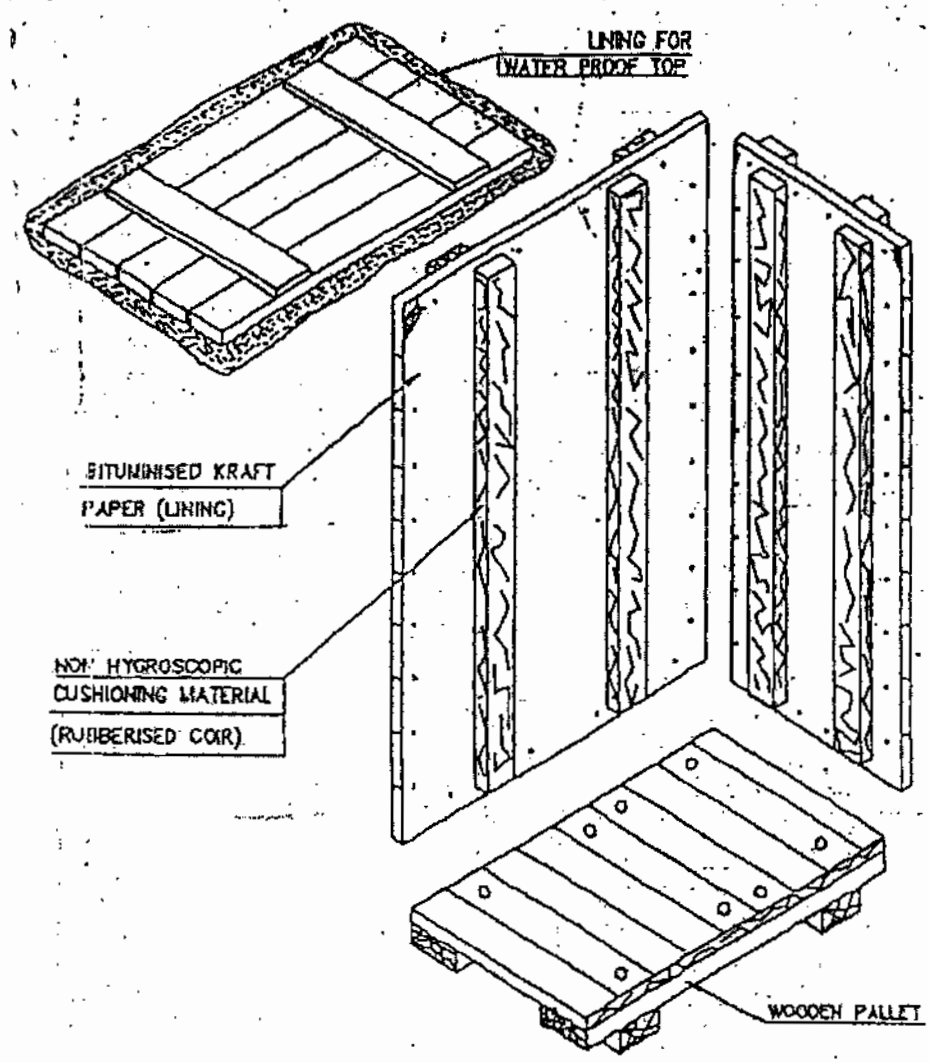


FIGURE-15

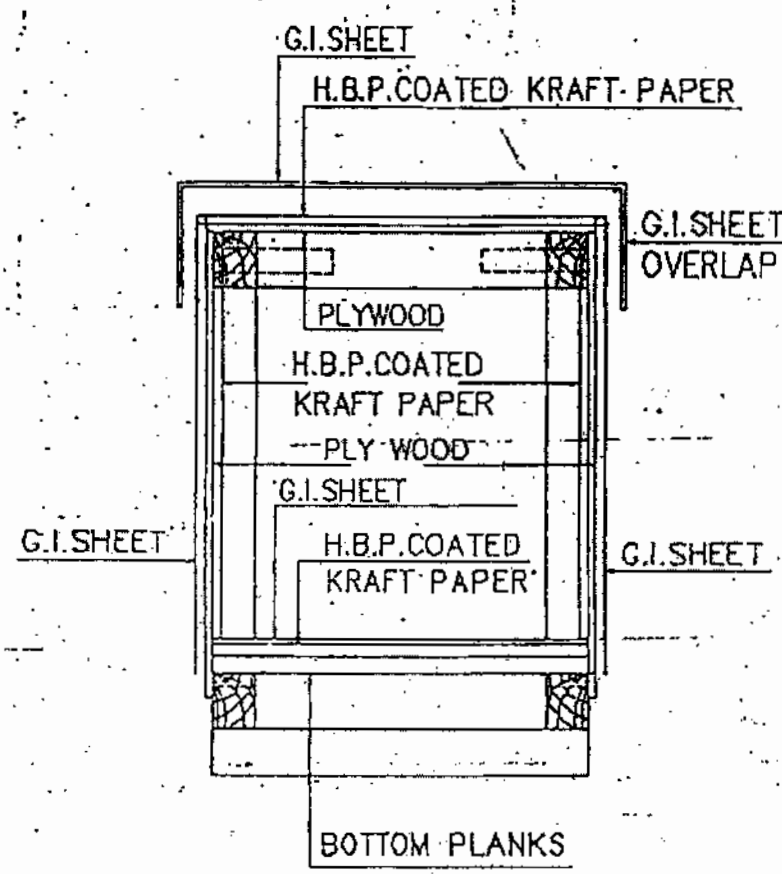


FIG-16 : CLOSED PACKING CASE WITH G.I.SHEET SHOWING LAYERS OF PACKING MATERIALS.

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

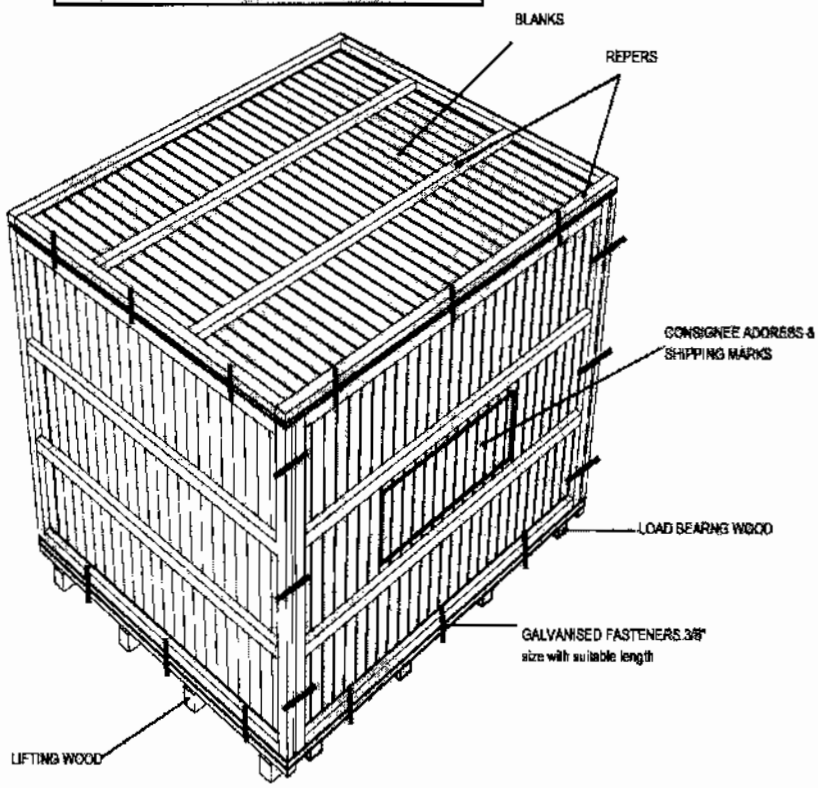
This procedure is applicable for the shipment of Onload Tube Cleaning System and accessories by sea.

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.

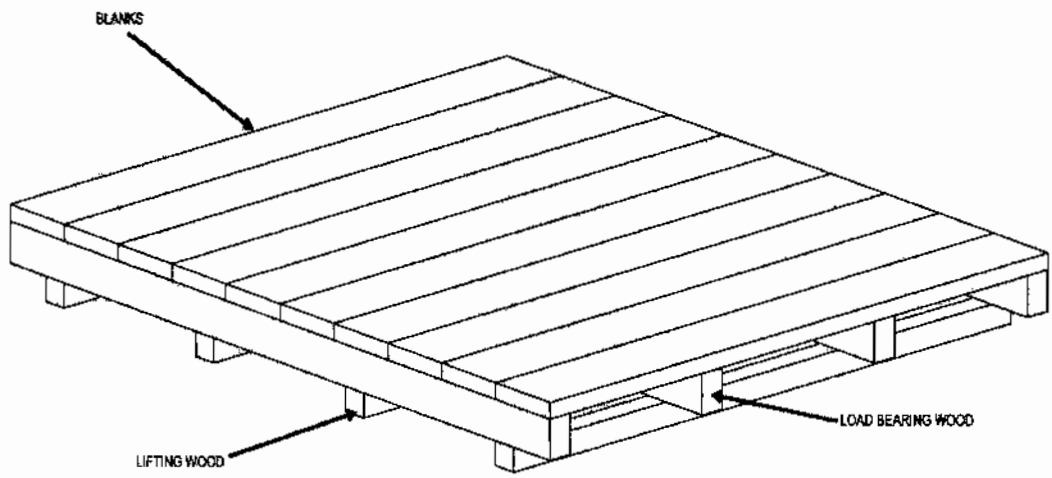
MODEL: FASTNERS TYPE (BASE, SIDE &TOP ATTACHED WITH BOLT, NUT & WASHER)



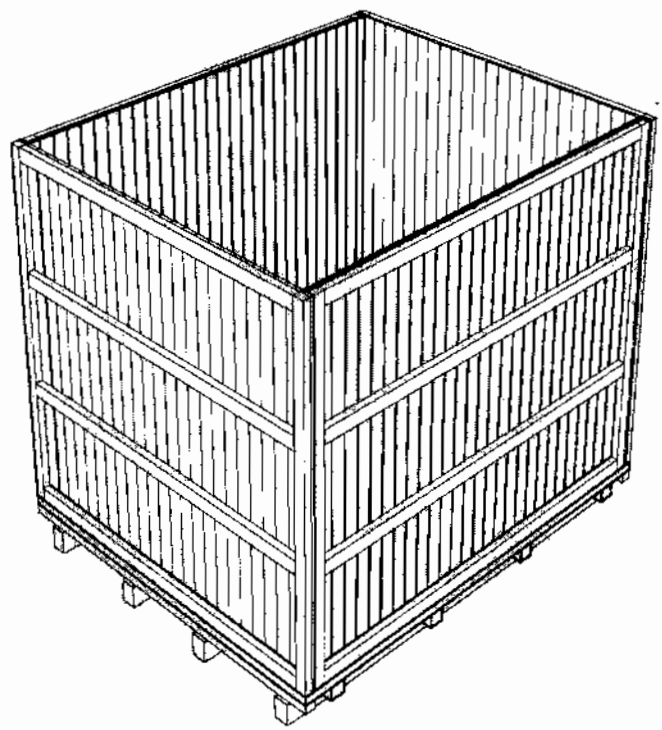
This Type of case to be used for following items:

1. BALL SEPERATOR
2. BALL COLECTOR SKID

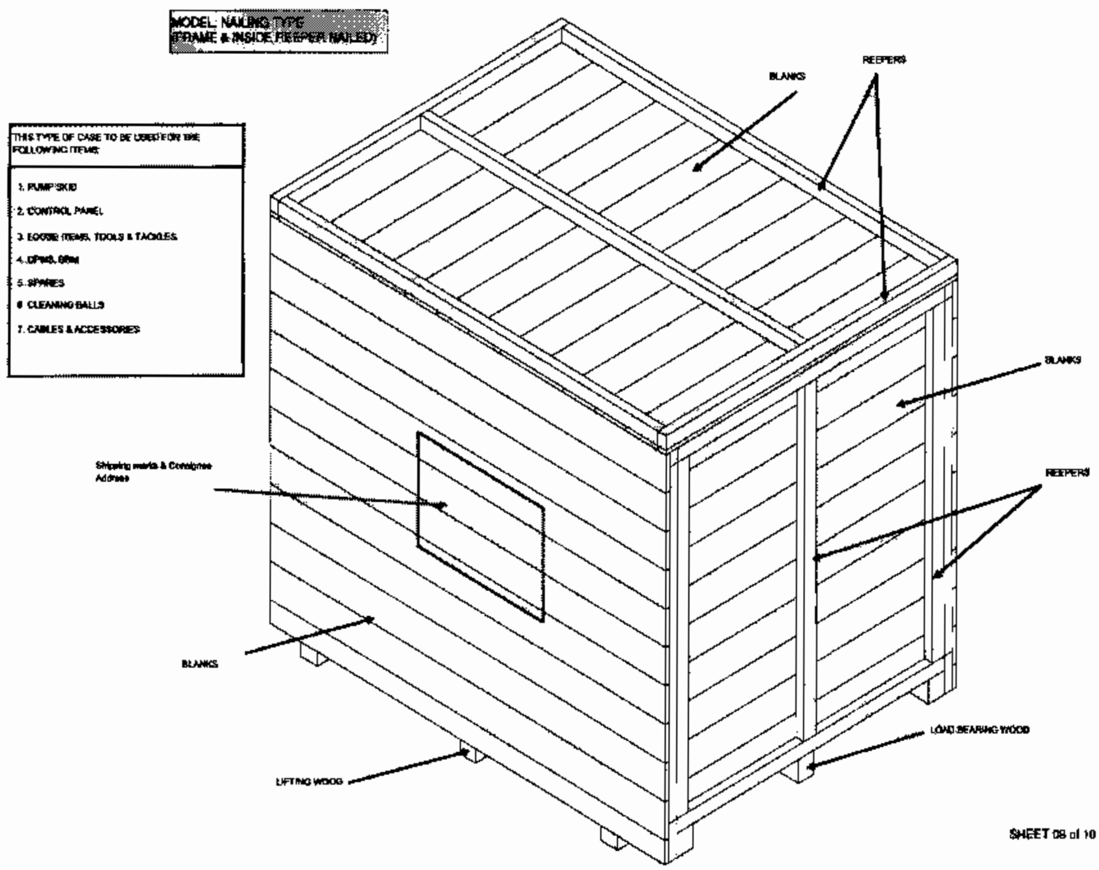
BASE FRAME

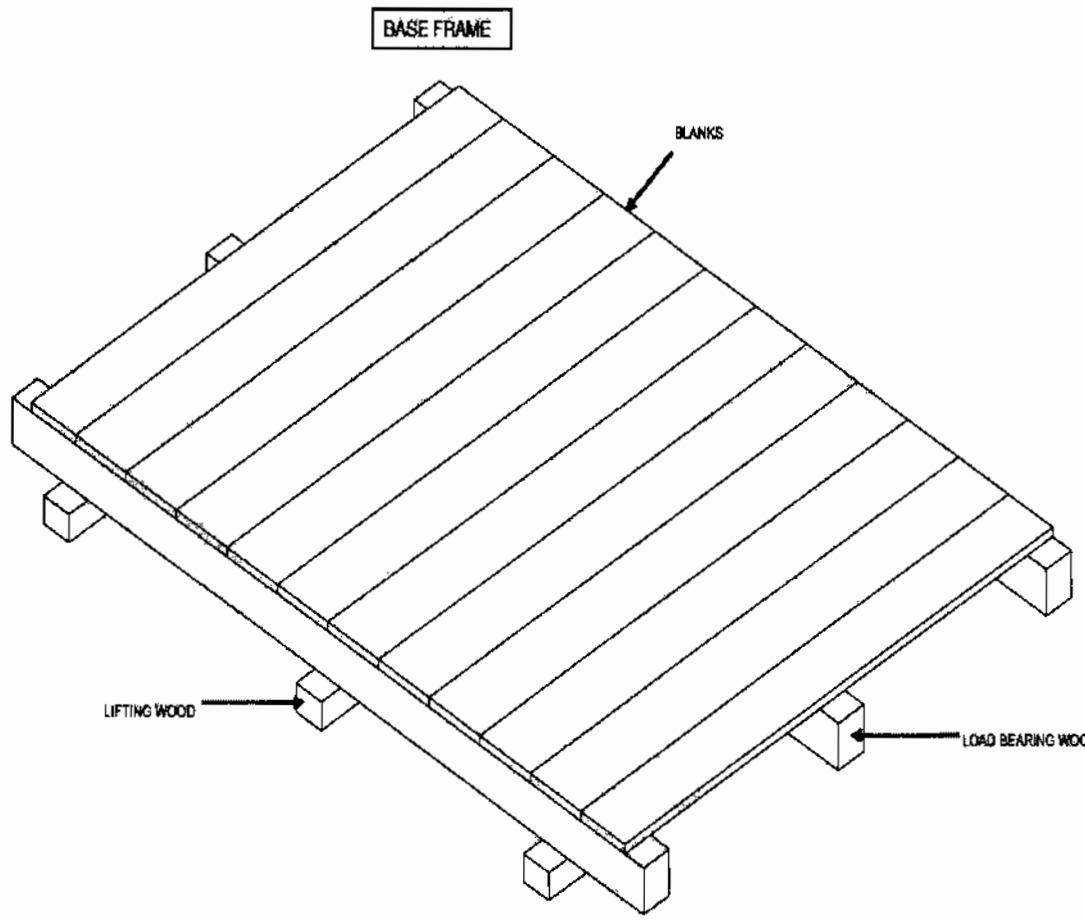


MODEL: FASTNERS TYPE - WITHOUT TOP



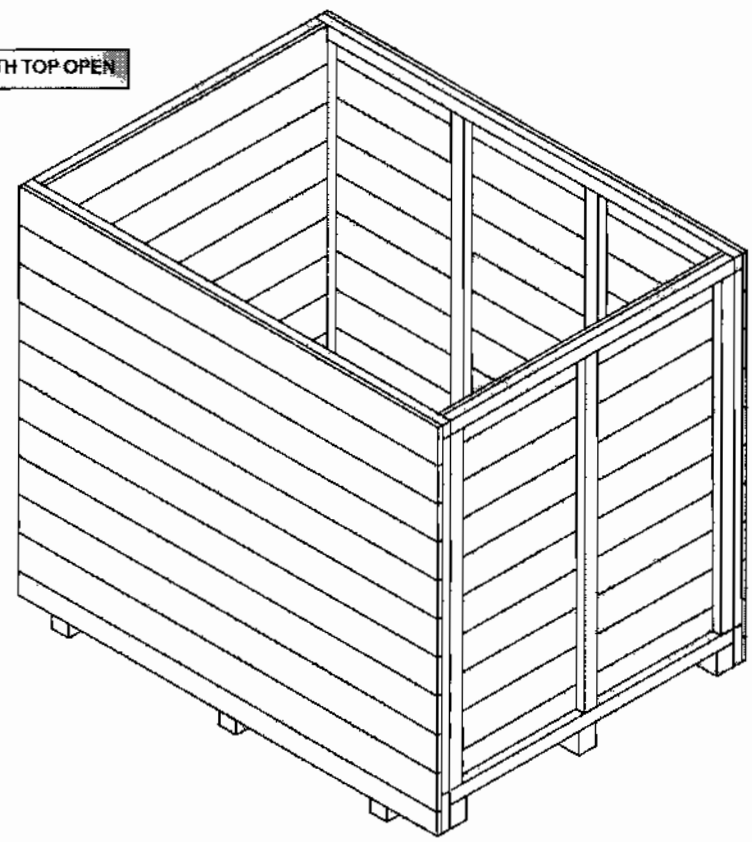
	TITLE	SPECIFICATION NO. **PE-TS-888-100-A001**
	TECHNICAL SPECIFICATION FOR SEAWORTHY PACKING FOR EXPORT JOBS	VOLUME II B
		SECTION D
		REV. NO. 0 DATE 10/08/2010
		SHEET 36 OF 52





SHEET 09 of 10

NAILING TYPE MODEL WITH TOP OPEN



SHEET 10 of 10

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.

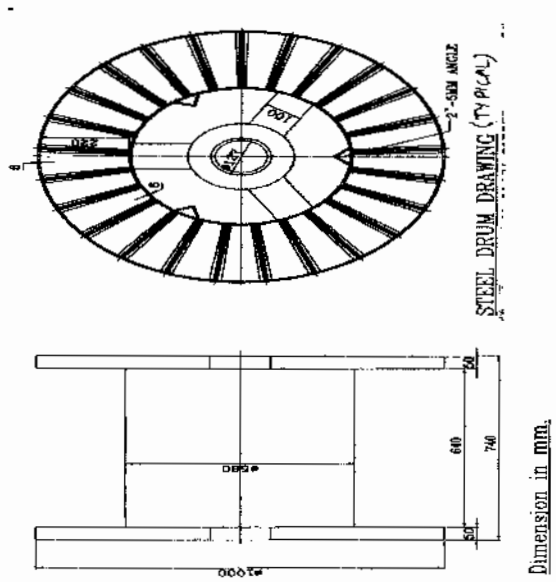
11.0 PACKING OF ELECTRICAL ITEMS

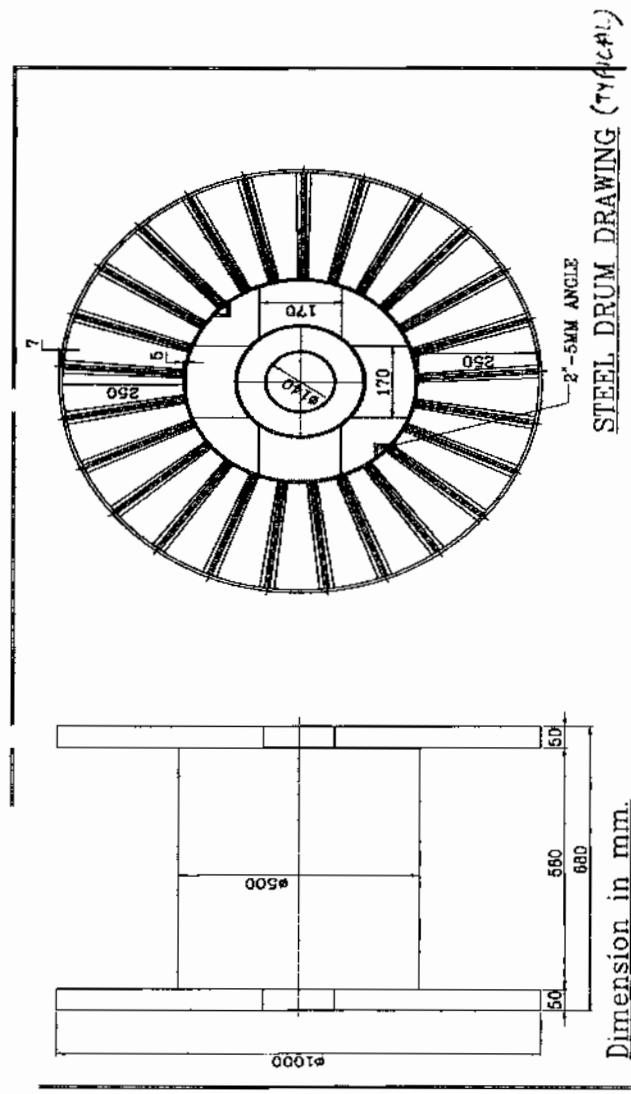
11.1 CABLES

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

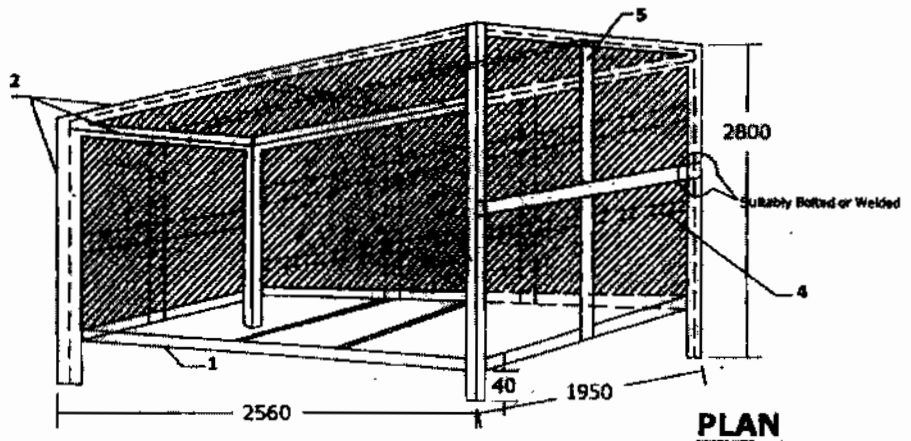
8) One copy of packing slip wrapped in polythylene bag covered with suitable aluminium .packing slip holder to be nailed on the external surface of the box. One more copy 9f the packing Slip wrapped in polythylene bag to be kept inside the box at the prominent place.

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.

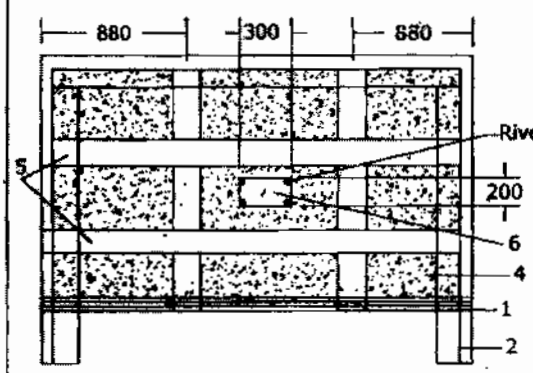
10) Each item as mentioned in BOQ shall be packed & supplied as a set comprising of required numbers of associated fasteners & hardware etc

	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

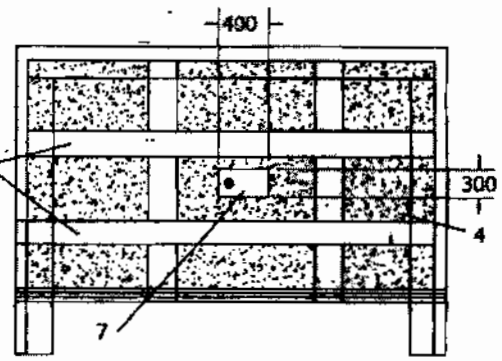
STEEL PACKING (TYPICAL DETAILS)



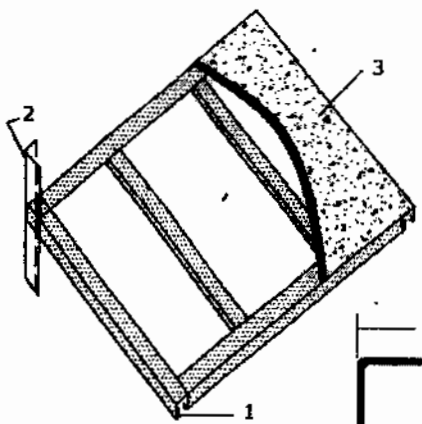
PLAN



FRONT SIDE OF BOX



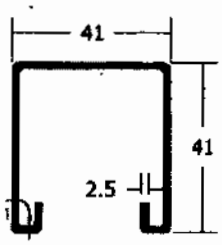
BACK SIDE OF BOX



BOTTOM FRAME ARRANGEMENT

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.



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

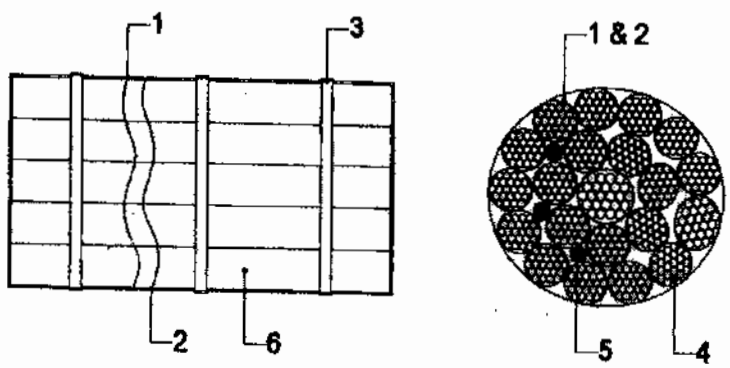


FIGURE "A"

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

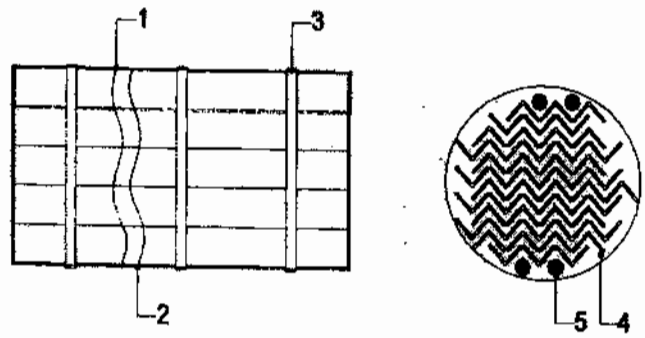


FIGURE "B"

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

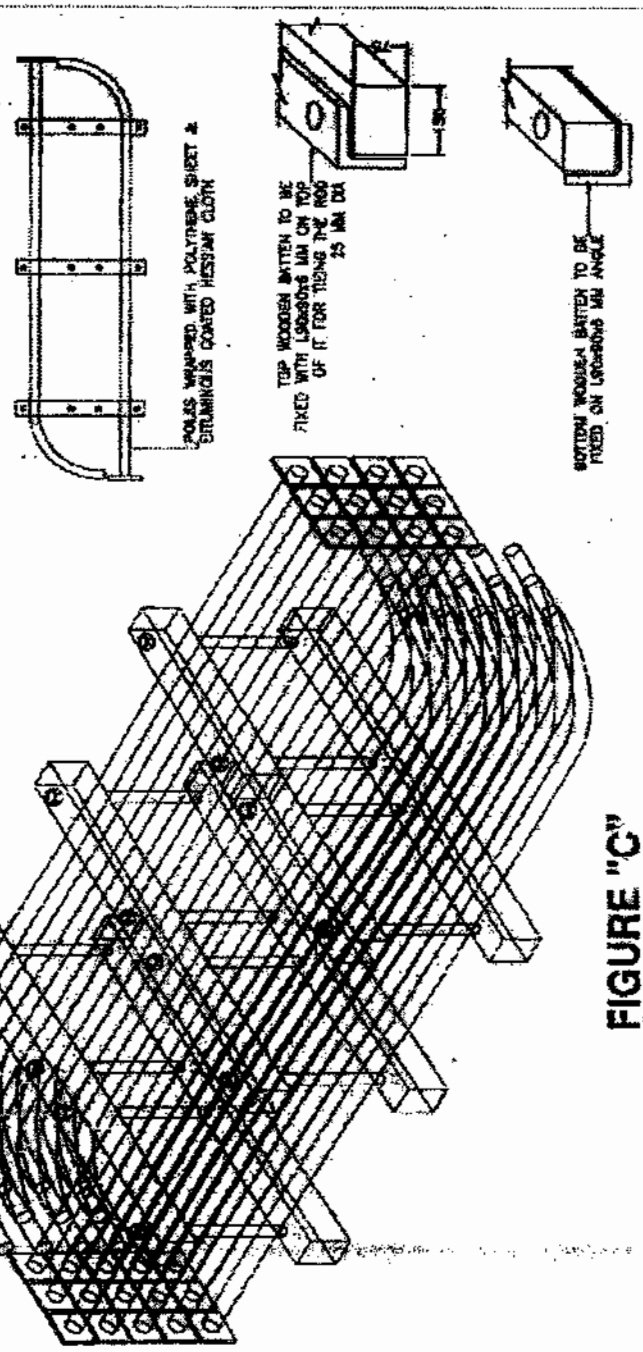


FIGURE "C"

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.

Annexure to Enquiry no: Date		
Sl.No	**BHEL / Customer Requirement**	**##Specific confirmations by the manufacture**
1	**Quality Plan Requirement:**	
	(i) MQP (Manuafcutering Quality Plan) shall be submitted in attached format for BHEL/Customer review & approval. Typical MQP is attached for indicative purposes for guidance & use.	
	(ii) MQP shall invaribly cover w.r.t Inward inspection including on Raw materail Procurement, In process and Final inspection in elaborated way/details.	
	(iii) Bidder shall also to give specific confirmation that on need basis, their competent officials shall visit to BHEL/customer for finalization of Quality plan including test procedure/methodology during preaward / post award approval / detailed engineering in the event of an order.	
	(iv) No deviation on BHEL/Customer approved MQP is acceptable.	
	(v) Bidder shall agree to submit all cross referred documents other than codes/standrads to BHEL/Customer/Consultant.	
	Important Notes shall be included in MQP : (a) Latest revision of Standard s & Specification shall apply. Only International Standards are applicable. Indian & Chinese Standards are not applicable (b) Materials shall be procured in compliance to Functional Technical Specification. (c) Inspection shall be in compliance with Approved Quality Control Procedure for the Product. (d) NDT shall be carried out by Qualified Personnel with compliance to Approved NDT Procedures and Acceptance Norms, as per ASME Section V. (e) Gauges and measuring Instruments, with valid calibration only shall be used. (f) Cleaning and Painting of products shall be carried out as per Approved Painting Schedule. (g) Finished Products shall be packed to comply with Approved Packing Schedule. (h) Welding shall be carried out by Qualified Personnel with compliance to Approved NDT Procedures and Acceptance Norms, as per ASME Section V.	
2	**Domaetic / Inland Inspection** will be carried out by BHEL/BHEL apointed Third Party Inspection Agency (TPIA) / Customer/Customer Apointed Inspection Agency/Consulatnat. This is applicable for all Stage inspection and Final Inspection identified as "W" - Witness or "CHP" - Customer Hold Point as per customer approved Quality Plan/ Technical specification / Approved Drawing/ Approved Data sheet / Scheme / PID / PFD / SLD (Process Instrumentaion Diagram / Process Flow Diagram / Single Line Diagram) etc (As applicable).	
3	**Inspection Agency for Foreign Bidders and also for Indian Bidder but importing from Forgign Sources :** (1) Any one of the fllowing Third Party Inspection Agency (TPIA) shall be appointed by the bidder and same shall be furnished by the bidder in techno commercial bid itself. (2) The details of TPIA with contact details like Name of the official, Phone no, Email id shall also to be submitted during pre/post award. However cost for such inspection agency shall be borne by the bidder **List of TPIA** 1.M/s Bureau Veritas 2.M/s TUV-Nord 3.M/s TUV-SUD 4.M/s TUV Rheinland 5.M/s Lloyds Register 6.M/s SGS 7.M/s Germanischer Lloyds 8.M/s QUEST 9.M/s Certification Engineers International 10.M/s Intertek 11.M/s IR Class Systems and Solutions 12.M/s DNV 13. M/s Fichtner 14. M/s ABS Inspection Services	

Sl.No	BHEL / Customer Requirement	##Specific confirmations by the manufacture
4	**Stage Inspection during manufacturing Process :** Stage Inspection during manufacturing shall be carried out as per approved quality plan and all necessary documents shall be provided for review,verification and clearanace for further processing. This inspection call shall be given well in advance (atleast 2 weeks before) to TPI/Bidder's own inspection agency to avoid delay in the manufacturing processes.	
5	**Inspection before despatch for domestic supplier :** Inspection before despatch at supplier's works shall be carried out by BHEL/BHEL appointed Inspection agency. Inspection shall be done as per approved Quality plan/ Technical specification/ Approved Drawing/ Approved Data sheet .	
6	Inspection at Forign Source/Supplier: (a) As in sl no: 3. shall be ensured without fail (b) No materail / items shall be despatched without getting the written communication from BHEL / Customer inspection carried out by BHEL/BHEL apointed Third Party Inspection Agency (TPIA) / Customer/Customer Apointed Inspection Agency/Consulatnat. This is applicable for all Stage inspection and Final Inspection identified as "W" - Witness or "CHP" - Customer Hold Point as per customer approved Quality Plan/ Technical specification / Approved Drawing/ Approved Data sheet / Scheme / PID / PFD / SLD (Process Instrumentaion Diagram / Process Flow Diagram / Single Line Diagram) etc (As applicable). Inspection before despatch for Foreign supplier : Inspection before despatch at supplier's works shall be carried out by bidder appointed inspection agencies having international presence at vendors and or vendor's sub vendor works. Inspection shall be done as per approved Quality plan/ Technical specification/ Approved Drawing/ Approved Data sheet by TPIA mentioned in Sl no: 03 at supplier's cost.	
7	**Painting** shall be done strictely as per BHEL/Customer approved painting schedule / scheme only. Paint Thickness / Paint shade shall be ensured as per BHEL / Customer approved painting schedule / specification / data sheet etc. No deviation is acceptable unless otherwise accepted by BHEL/Customer in writing. Any conflict if any among BHEL / Customer approved painting schedule / Spec / data sheet etc shall be brought to the notice to BHEL well in adavnce before proceding including the BOI being procured for assy / skid like motors etc	
8	Specific conformation for document package in the event of an order (2 Hard copies & soft copy in PDF file) is to be given containing the following with proper linkages (i) Index Sheet (ii) MQP/RQP/Endorsemment Sheet (As applicable) (iii) TCs identfied by BHEL/ Customer for record for "CHP" / "W" and Verification portion ("V") as given in approved QP. (iv) Final inspection report + TC including Chemical + Mechnaical + HT + NDT etc (v) Third party Inspection report + TC (vi) Customer CHP/ MDCC (vii) Type test / Performance Test reports conducted (viii) Type test / Performance Test approval/ clearance obtained from BHEL/Customer (ix) BOM with As Build Drgs with actual make / rating used with BHEL/customer approved drawings.	
9	**Packing / Seaworthy Packing** shall be as per BHEL Packing schedule / approved drg / sketch. This shall be ensured to take care tarnsit / handling / transhipment in Road / Sea / Air. Photographs are to be submitted for BHEL review before despatching the material as per contract conditions.	
10	**Outsourcing of test facilities:** Bidder shall ensure all the testing facilities in house. However If any of the test facilities are not available with successful bidder, then bidder shall ensure the same at NABL accreadted third party lab / Govt / Govt Lab for major testing such as NDT, Electrical & Mechanical testing.	
11	**Important Note:** No deviation on the above requirement 01 to 10 is acceptable w.r.t Quality Requirement and those offers not meeting these specific customer requirement is liable for rejection and hence the bidder shall submit all the required documentary evidances in the offer itself.	
12	## Necessorily to be filled up by the bidder at the time of offer itself otherwise the offer may not be considered w.r.t Quality Requirement being customer specific requirement.	

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	

LEGEND: * RECORD, IDENTIFIED WITH "TICK" (√) UNDER COLUMN 'D' SHALL BE SUBMITTED TO CUSTOMER AS A QA DOCUMENTATION PACKAGE. **M:** MANUFACTURER / SUB SUPPLIER, **C:** MAIN CONTRACTOR. **N:** CUSTOMER/CONSULTANT **P:** PERFORM **W:** WITNESS **V:** REVIEW OF RECORDS **MA:** MAJOR AND **MI:** MINOR	**PREPARED BY** **Rakesh Kumar Madhu,(SEr/QA)**	**REVIEWD & APPROVED BY** **K C Gandhi Parimalam,(DGM/QA)**

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 2 of 6**

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C/N					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

LEGEND: * RECORD, IDENTIFIED WITH "TICK" (√) UNDER COLUMN 'D' SHALL BE SUBMITTED TO CUSTOMER AS A QA DOCUMENTATION PACKAGE.
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MA: MAJOR AND **MI:** MINOR

PREPARED BY

Rakesh Kumar Madhu,(SEr/QA)

REVIEWD & APPROVED BY

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**
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			DATE:	**12.02.2019**
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SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C/N					M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.	D *	** 10.			11.
														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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M: MANUFACTURER / SUB SUPPLIER, **C:** MAIN CONTRACTOR.
N: CUSTOMER/CONSULTANT **P:** PERFORM **W:** WITNESS **V:** REVIEW OF RECORDS
MA: MAJOR AND **MI:** MINOR

PREPARED BY

Rakesh Kumar Madhu,(SEr/QA)

REVIEWD & APPROVED BY

K C Gandhi Parimalam,(DGM/QA)

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

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Ranipet	MANUFACTURER'S NAME AND ADDRESS **M/S BHEL: BAP: RANIPET** **632 406** **TAMIL NADU**	**STANDARD QUALITY PLAN** **ITEM: VACCUM BELT FILTER** **SYSTEM: FGD**	**QP NO**	**FGS:725**
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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	

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

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ANNEXURE-X

TECHNICAL SPECIFICATION OF ELECTRICAL MOTORS & ELECTRIC ACTUATORS

SECTION : 3.1- MOTORS

1.0.0 INTENT OF SPECIFICATION

This section covers the technical requirements of HT and LT Motors.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the following Indian Standards (IS), IEC publications and other codes except where modified and /or supplemented by this specification.

-

a)	IS: 325	Three phase induction motors
b)	IS: 12615	Energy efficient induction motors
c)	IS: 900	Code of practice for installation and maintenance of induction motors
d)	IS: 996	Single-phase AC induction motor for general purpose
e)	IS: 1231	Dimensions of three-phase foot-mounted induction motors
f)	IS: 2223	Dimensions of flange mounted AC induction motors
g)	IS: 4029	Guide for testing three-phase induction motors
h)	IS: 8789	Values of performance characteristics for three-phase induction motors
i)	IS: 13555	Guide for selection and application of 3-phase AC induction motors for different types of driven equipment
j)	IS: 5571	Guide for selection of electrical equipment for hazardous areas
k)	IS: 12065	Permissible limits of noise level for rotating electrical machines
l)	IS: 12075	Mechanical vibration of rotating electrical machines
m)	IS: 9334	Electrical motor operated actuators
n)	IS 60034-5	Degree of protection provided by Integral design of rotating electrical machines
o)	IS 60034-8	Terminal marking and direction of rotation
p)	IS 60079-1	Equipment protection by flame proof enclosure
q)	IS 60034-1	Rotating electrical machines.
r)	IS 60079	Explosive atmospheres
s)	IS/IEC 60529	Degrees of protection provided by enclosures (IP code)
t)	IEC 60034	Rotating electrical machines.

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Design ambient temperature

Motors shall be suitable for an ambient temperature of 50 degree C and relative humidity of 95% and shall deliver the rated output without exceeding its guaranteed temperature limits.

3.2.0 Supply voltage

Motors rated up to and including 415V are termed as LT motors and the motors rated higher than 415V are termed as HT motors.

Motors shall be capable of delivering the rated output under following voltage and frequency variations without exceeding its guaranteed temperature limits.

- Frequency variation : (+) 3% and (-) 5%
- Voltage variation for LT motors : (±) 10%
- Voltage variation for HT motors : (±) 10%
- Combined variation of voltage and frequency : 10% (absolute sum)

All the motors shall be so designed that maximum inrush currents, locked rotor torque and pullout torque developed at extreme voltage and frequency variations do not endanger the motor and the driven equipment.

3.3.0 System Parameters

Sl. No.	Description	HT System	LT System
1.	Voltage level	3.3kV Above 160 kW	240 V : up to 0.2 kW 415 V : >0.2 kW and up to 160 kW.
2.	System earthing	Earthed through resistance. Earth fault current : 300 Amps	415V: Solidly grounded.
3.	System fault level	44 kA for 3 sec	50 kA for 1 second
4.	Fault withstand rating of motor terminal box (Breaker operated)	44 kA for 0.25 sec	50 kA for 0.25 second

3.4.0 Type

- AC Motors shall be squirrel cage induction type unless otherwise it is specified. All the motor shall be bi-directional.

3.5.0 Duty

- All AC motors shall be squirrel cage three phase/single phase induction motors. All the motor shall be designed for bi-directional rotation.
- Motors shall be suitable for installation in hot, humid and tropical atmosphere and polluted at places with coal ash and or fly ash.

3.6.0 Design margin

- Motor rating shall be selected higher than the maximum load demand of the driven equipment, as per the criteria stated in mechanical section of this specification, under entire operating range, including voltage and frequency variation.
- The motor name plate rating shall have more than 10% margin over the input power requirement of the HT driven equipment and 15% for LT driven equipment at rated duty point.
- The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating; pull up, breakdown and full load torques are available for the intended service.
- Service shall be considered as 1.0 only.

3.7.0 Method of Starting

- All the motors shall be suitable for direct on-line starting on full load.
- HT Motors will be controlled through vacuum circuit breaker.
- LT motors rated up to 90kW will be controlled through MPCB/MCCB and contactor. LT motors rated more than 90 kW will be controlled through air circuit breaker

3.8.0 Efficiency

All the continuous duty motors shall be energy efficient type. For LT motors, it shall be IE2 class as per IS 12615. For HT motors, efficiency shall be more than 95%.

3.9.0 Temperature rise

- Winding Insulation shall be Class F.
- Temperature rise of motors shall not exceed 70°C over air temperature of 50°C by resistance method, while delivering its maximum rated output.

3.10.0 Starting voltage

a) Motors shall be capable of starting and accelerating the load at following starting voltage, with direct on line starting, without exceeding specified winding temperatures.

- HT Motors : 85% of rated voltage
- LT motors : 80% of rated voltage

b) During fast changeover of power supply source, vector difference between the motor residual voltage and the incoming supply voltage will be about 150% of the rated voltage and the motors shall withstand voltage stress and torque stress developed during that time, which may last for a period of one (1) second.

c) The motor shall be capable of operating at full load at a supply voltage of 80% of the rated voltage for 5 minutes.

d) The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.

e) Motor shall not stall if the supply voltage drops to 70% of the rated voltage two (2) second duration

3.11.0 No. of Starts

Continuous duty motors shall be suitable for the following starting requirements under the specified conditions of load, torque and inertia.

- No. of consecutive hot starts shall be 2 (with initial temperature of the motor at full load operating level).
- No. of consecutive cold starts shall be 3 (with initial temperature of the motor at ambient temperature).
- For conveyor motors, no. of consecutive hot starts shall be 3 (with initial temperature of the motor at full load operating level).

3.12.0 Starting current

- Motor shall be designed for direct online starting at full voltage. Starting current shall not exceed 6 times full load current for all auxiliaries. No further tolerances are applicable on starting current specified above for HT motors.
- For LT motors, the applicable starting current shall be limited to 7.2 times of full load current including all tolerance.

3.13.0 Locked rotor withstand time

- The locked rotor withstand time for HT motors under hot conditions at 110% rated voltage shall be more than the starting time at minimum permissible voltage specified above by atleast three seconds or 15% of the accelerating time whichever is greater.
- For the LT motors having starting time upto 20 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 seconds more than the starting time.
- For the motors having starting time more than 20 seconds and up to 45 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 seconds more than the starting time.
- For motors having starting time more than 45 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.
- The motors shall be designed to withstand 120% of rated speed for 2 minutes without any mechanical damage

3.14.0 Torque Requirements

- Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.
- Pull out torque at rated voltage shall not be less than 205% of full load torque.
- Motors subjected to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% of rated speed in reverse direction.
- The motor shall be designed to withstand momentary overload of 60% of full load torque for 15 second without any damage.

3.15.0 Enclosure

a) All motor enclosures shall conform to the degree of protection IPW 55 unless otherwise specified. Motor for outdoor or semi outdoor service shall be of weather proof construction.

b) For hazardous location, the enclosure of motors shall have flame proof construction conforming to applicable standard.

3.16.0 Cooling

- LT motors shall be totally enclosed fan cooled (TEFC), type IC411. The cooling shall be effected by self driven bi-directional centrifugal fan protected by fan cover.

- HT motors can be totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or closed air circuit air cooled (CACA) type.
- Motors rated >3000kW can be closed air circuit water cooled (CACW).
- Motors with CACA/CACW heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate the following:
  - Hot and cold air temperatures of the closed air circuit for CACA motors.
  - Hot and cold, air and water temperatures for CACW motors.
- The Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 5A at 240 V AC.

3.17.0 Winding

- Winding shall be class F insulation with temperature limited to class B. Insulation shall be Non-hygroscopic, oil resistant, and flame resistant. Winding, fittings and hardware shall be corrosion resistant. Winding shall be tropicalized and suitably varnished, baked and treated for operating satisfactorily in humid and corrosive atmosphere.
- For the VFD operated drives, insulation shall be designed to take care of stresses due to high dV/dt. Motors shall be wound with dual coated winding wires and impregnated with VPI process. Further for such application, insulated bearings shall be provided to avoid circulating current caused by shaft induced voltages.
- Space heaters rated for 240V AC, 50 Hz supply shall be provided for motors rated 30kW and above to maintain windings in dry condition when motor is standstill.
- For HT motors, insulation shall be Vacuum Impregnated (VPI).
- HT motors shall withstand 1.2/50 microsec impulse Voltage wave of 4U+5 kV (U=Line voltage in kV). The coil inter-turn insulation shall be as per IEC-60034 – Part 15 followed by 1 min power frequency high voltage test of appropriate voltage on inter turn insulation.

Temperature Detectors

- All HT motors shall be provided with six (6) nos. duplex, or twelve (12) nos. simplex type winding tempera¬ture detectors, i.e. two (2) nos. duplex or four (4) nos. Simplex per phase.
- HT motor bearing shall be provided with duplex type temperature detectors.
- The temperature detector mentioned above shall be resistance type, 3 wire, platinum wound, 100 Ohms at 0□C.
- Leads of all simplex type motor winding RTDS and motor bearing RTDS shall be wired up to respective switchgear metering & protection compartment. From which one set of RTDS will be connected to numerical protection relay and another set shall be kept free for DCS connectivity.
- Five number of Temperature detectors / thermisters shall be provided for L.T. motors above 90 KW (3 numbers winding temperatures & 2 numbers bearing temperatures)

3.18.0 Bearings

- Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application. Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.

- Sleeve bearings shall be split type, ring oiled with permanently aligned, close running shaft sleeves. Grease lubricated bearings shall be pre-lubricated and shall have provisions for in-service positive lubrication with grease nipple and relief holes.
- Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred. However, if anti-friction bearings can take vertical thrust, thrust and guide bearings are not required.
- Lubricant shall not deteriorate under all service conditions. The lubricants shall be limited to normally available types. For motors rated 30kW and above re-lubrication facility shall be provided.
- For motor with forced lubrication, a shaft driven oil pump shall be provided along with an electrical auxiliary pump. Alternatively, two motor driven pumps may be provided, one working and one standby. All necessary auxiliaries and accessories shall be provided to complete the system. A pressure gauge and pressure switch for low oil pressure warning and to start the standby oil pump automatically shall also be provided. A motor driven jacking oil pump may be provided, for heavy shaft loads.
- Flow switches shall be provided for monitoring oil flow of forced lubrication bearings, if used. Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10A at 230 V AC.
- For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired upto the terminal box.
- Each bearing shall be provided with dial type thermometer.
- For all VFD operated motors and motors rated above 1000KW having shaft length more than 1.5M shall have insulated bearings to prevent flow of shaft currents.

3.19.0 Terminal Boxes

- Separate terminal boxes of IP 55 degree of protection shall be provided for stator leads. For single core cables, gland plate shall be non-magnetic material. Terminal box shall be capable of being turned 360° in steps of 90°, unless otherwise approved. The terminal boxes shall be split type with removable cover with access to connections.
- Terminals for motors shall be stud type, thoroughly insulated from the frame. The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.
- The terminal box shall be capable of withstanding maximum system fault current for 0.25 sec for all breaker operated motors and shall be provided with explosion vent.
- For contactor operated LT motors, the terminal box shall be capable of withstanding the fault current for 0.2 sec minimum and operating time of MPCB/MCCB.
- Removable gland plates of thickness not less than 2.5 mm sheet steel or 3 mm aluminium (for single core cables) shall be provided for cable boxes.
- Cable spreader box shall be provided for larger cable sizes.
- Cable boxes of HT motors shall be phase segregated type. The terminals of three phases shall be segregated by barriers of metal or fibre glass. For HT motors, cable box design shall be suitable for accommodating cable termination kits.
- Separate terminal box for space heaters shall be provided.

- A separate terminal box of IP 55 degree of protection shall be provided for temperature detectors.
- Motor 1000 KW and above shall be provided with three differential current transformers mounted over the neutral leads within the enclosure. Loose 3 numbers CT for mounting on switchgear side shall be in bidder's scope. The arrangement shall be such as to permit easy access for C.T. testing and replacement. Current transformer characteristics shall match Owner's requirements to be intimated later to the successful bidder. The CT details shall be finalized during detail engineering. Neutral terminal box shall have IP 55 degree of protection.
- The secondary leads of CT shall be wired to separate auxiliary terminal box of IP 55 degree of protection
- All the accessory terminal boxes shall be located on the same side of the main (power) terminal box.
- For LT motors, terminal box shall be located on top, unless otherwise specified.

3.20.0 Earthing Terminals

The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer. The terminal box shall have a separate grounding terminal.
The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer.

The grounding connection shall be suitable for accommodation of ground conductors as follows :

- Motor above 90 KW : 75 x 10 mm GS Flat
- Motor above 30 KW up to 90 KW : 50 x 6 mm GS Flat
- Motor above 5 KW up to 30 KW : 25 x 3 mm GS Flat
- Motor up to 5 KW : 8 SWG GI Wire

3.21.0 Noise and Vibration

- Motors shall be selected with low noise levels in accordance with IS 12065.
- The peak amplitude of the vibration shall also be within the specified limits of IS: 12075.
- All HT motors shall be provided with vibration pads for mounting vibration detectors.

3.22.0 Name Plates

Motor shall have stainless steel nameplate(s) showing diagram of connections, all particulars as per IS: 325 / IS: 12615 and shall also have 'BEE' marking.

In addition to the minimum information required by IEC/IS, the following information shall be shown on motor rating plate:

- Temperature rise in ºC under rated condition and method of measurement.
- Degree of protection.
- Bearing identification no. and recommended lubricant.
- Location of insulated bearings.

3.23.0 Drain plug

Motor shall have drain plugs so located that they will drain the water, resulting from the condensation or other causes from all pockets of the motor casing.

3.24.0 Lifting provision

Motor weighing 25 Kg. or more shall be provided with eyebolt or other adequate provision of lifting.

3.25.0 Dowel pins

The motor shall be designed to permit easy access for drilling holes through motor feet or mounting flange for installation of dowel pins after assembling the motor and driven equipment

4.0.0 INSTALLATION

Installation shall be carried out as per IS: 900.

5.0.0 PAINTING

Painting shall be carried out by an approved process. Pretreatment shall conform to applicable standard. The equipment shall be subject to a coat of red oxide primer paint. All inside and outside surface shall be painted with epoxy based paint. The final thickness of paint film on steel shall not be less than 100 microns. Paint Shade for the Motor shall be RAL 7032 (Siemens Grey). Sufficient quantity of touch-up paint shall be furnished for application at site.

6.0.0 TESTING AND INSPECTION

5.0.0 Tests shall be performed in presence of Owner's representatives. Successful Bidder shall give atleast fifteen (15) days advance notice for witnessing the tests. Copies of certified reports of all tests carried out at the works shall be furnished. The equipment shall be dispatched from works, only after receipt of Owner’s written approval of the test reports.

5.1.0 Routine and Type Tests are to be conducted for all HT motors and for LT motors above 60 KW rating in presence of customer’s representative as per IS:325 and required copies of test certificates are to be furnished for approval.

5.2.0 Test certificates for Routine tests conducted as per IS-325 for motors of rating 60 KW and below shall be submitted for Mahagenco review, approval and dispatch clearance.

SECTION–3.2: ELECTRICAL ACTUATORS

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of motor operated electrical actuators.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the applicable Indian Standards (IS), IEC publications and other codes except where modified and /or supplemented by this specification.

3.0.0 TECHNICAL REQUIREMENTS

Electric actuators shall be provided where specified/required. It shall be equipped with 3 phase induction motor, rated for intermittent duty S4-25%.

Motor shall be class F insulated with temperature rise limited to class B. Motor shall be of class H insulation with temperature limited to class B..

Motor shall be surface cooled designed for enclosure protection class of IP 68. Motor shall be suitable for starting direct on line.

For installation in potentially hazardous areas, the actuators shall have suitable explosion proof / flame proof type enclosure.

Actuators shall be suitable for operation at an ambient temperature of 50 degree C and relative humidity of 95%.

Motors shall be capable of operating under following supply variations without exceeding its guaranteed temperature limits.

- Frequency variation : (+) 3% and (-) 5% of 50 Hz
- Voltage variation for LT motors : (±) 10% of 415 V
- Combined variation of voltage and frequency: 10% (absolute sum)

All actuators shall be of integral type. Duty cycle of actuators shall suit the system requirement. The actuators shall be capable of giving the required torque at the output shaft. The actuators shall be designed to take the full thrust.

Actuators shall be of totally enclosed weather proof and dust proof construction with NEMA-6/IP 68 enclosure and shall be suitable for outdoor application without the necessity for a canopy. The actuator shall be suitable for mounting directly on the valve. The actuator shall be capable of giving the required torque, rpm and thrust without the help of any spur gear arrangement. The actuator shall be suitable for mounting in any position. Actuators shall be provided with integral starters.

The actuator shall be complete with motor, reduction gears, change gears, terminal compartment, switch compartment with limit switches and torque switches, local position indicator, position transmitter for remote position indicator, thermistor, space heaters, cable glands, mechanical position indicator, hand wheel for manual operation, valve attachment etc.

Each actuator shall have a hand wheel fitted on it for emergency operation. The hand wheel shall be designed such that it is declutched automatically when the power supply to the motor is restored. The material of the hand wheel shall be either malleable iron or steel. The hand wheel shall have adequate clearance from housing for each gripping and operation. Actuators offered shall be with self-locking worm.

Two number adjustable torque switches (one for open and one for close) each with 2 NO and 2 NC potential free contacts shall be provided. It is required to have calibration for the torque switches so that the switches can be easily set to any value desired.

Two numbers of position limit switches (one for open and one for close) each with 2 NO and 2 NC potential free contacts shall be provided. Two auxiliary limit switches (one for open and one for close) with 2 NO and 2 NC potential free contacts shall also be provided. The limit switches shall be of independently adjustable type. Limit switches and actuating mechanism shall be rust proof suitable for damp atmospheres. Limit switch compartment shall be weather proof and spacious enough for easy setting. The limit switches shall be suitable for the following ratings, both 240 Volts AC, 10 A and 220 V DC, 0.5 Amps.

Each actuator shall have a space heater in the limit switch compartment suitable for 240 V AC 50 Hz single phase supply.

The wiring from the limit switches, torque switches etc. shall be brought out in a separate terminal box of adequate size, so as to easily terminate the control cables.

Each actuator shall have a hand wheel fitted on it for emergency operation. The hand wheel shall be designed such that it is declutched automatically when the power supply to the motor is restored. The material of the hand wheel shall be either malleable iron or steel. The hand wheel shall have adequate clearance from housing for each gripping and operation. Actuators offered shall be with self-locking worm.

Actuators shall be supplied with integral starter which shall have sophisticated electronic controls with field programming feature.

A three position selector switch (marked as LOCAL-OFF-REMOTE) and push buttons OPEN-STOP-CLOSE (for local operation) with indication lamps for running OPEN and running CLOSE shall be provided.

The Remote command signal (OPEN-STOP-CLOSE) from DCS/PLC/Control panel shall be isolated from control electronics through opto-isolator.

The following individual status annunciation LED's (Colour-Green) shall be provided locally (Integral to actuator) to annunciate the following for easy local monitoring.

- Actuator in local mode
- Actuator in remote mode
- Actuator running in OPEN direction
- Actuator running in CLOSE direction
- Actuator in inching mode.
- Actuator in self-retaining mode
- Limit switch OPEN trip
- Limit switch CLOSE trip
- Control voltage availability

View port shall be provided on integral starter unit to monitor the above status annunciation.

The following individual fault annunciation LED's (Colour-Red) shall be provided locally. (Integral to Actuator)

- Torque switch OPEN
- Torque switch CLOSE
- Thermo switch trip
- Electronic overload relay trip
- Motor single phasing
- Common fault (Inclusive of any one or combination of above fault)

View port shall be provided on integral starter unit to monitor the above status annunciation.

Electronic overload relay shall be provided to trip actuator in case of overload.

Plug in connections/design shall be provided between:-

- Integral starter unit and basic actuator
- Between external customer connections and actuator.

OPEN-CLOSE indication /LED shall be provided for indication of full open/close position.

Automatic phase correction facility and potential free contact for annunciation of power failure shall be provided.

The following individual potential free relay contacts shall be provided in the actuator for remote annunciation to facilitate continuous monitoring of the actuator.

- Actuator (valve) running in OPEN direction.
- Actuator (valve) running in CLOSE direction.
- Actuator in remote mode.
- Actuator in local mode.
- Actuator power switched off /single phasing.
- Torque switch trip, thermo switch trip and thermal overload relay trip

4.0.0 TESTING AND INSPECTION

Equipment offered shall be of type tested and proven type. Routine tests shall be carried out for all the equipment as per applicable standards.

Tests shall be performed in presence of Owner's representatives. Successful Bidder shall give atleast fifteen (15) days advance notice for witnessing the tests. Copies of certified reports of all tests carried out at the works shall be furnished. The equipment shall be dispatched from works, only after receipt of Owner's written approval of the test reports.

10.0.0 FIELD AND MEASURING INSTRUMENTS

10.1.0 General Requirements

10.1.1 Instruments, control devices and other equipment accessories covered under this specification shall be furnished in accordance with I&C specification sheets and drawings enclosed herewith and the requirements of all applicable clauses of this specification.

10.1.2 The Instrumentation and Control equipment shall conform to all applicable codes and standards. All equipment and systems shall also fully comply with the design criteria stated.

10.1.3 The Instrumentation & Control equipment and accessories shall be from the latest proven design for which the performance and high availability have been demonstrated by a considerable record of successful operation in power station service for similar applications. The bidder shall furnish sufficient evidence to fully satisfy the Owner in this regard.

10.1.4 The Bidder shall furnish all Instrumentation & Control equipment and accessories under this specification as per technical specifications, ranges, makes and model numbers approved by the Owner during detailed engineering.

10.1.5 All instruments, devices and accessories furnished by the Bidder as per this specification shall be designed and constructed to perform normally and meet all guarantee when subjected to the environmental and service conditions and other applicable specification documents.

10.1.6 The necessary root valves, impulse piping, drain cocks, gauge zeroing cocks, valve manifolds and all other accessories required for mounting/erection of all local field instruments shall be provided by Bidder as per approved hook up drawings.

10.1.7 In general front draw out type instruments with plug-in facility at the rear for connecting flexible cables for power supply and signal shall be provided. Separate plugs shall be provided for connecting power supply and signal wires.

10.1.8 The plug & sockets shall be polarized to prevent wrong connections and have facility for secure coupling in plug-in position to prevent loose connections.

10.1.9 Every instrument requiring power supply shall be provided with a pair of easily replaceable glasses cartridge fuse of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.

10.1.10 All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified (Explosion proof for NEC class 1, Division 1 area) and an anti-corrosive paint shall be applied to the field mounted enclosures / instruments. All the field instruments shall also be provided with SS tag nameplate and double compression type nickel-plated brass cable gland. Gaskets, fastener, counter and mating flange shall also be included wherever required with instruments.

10.2.0 Minimum Requirement of Field Instruments

10.2.1 Following minimum requirement of field instruments shall be fulfilled by Bidder (In addition, Redundancy criteria for instruments shall be as specified elsewhere in specification): -

1) Level Transmitter, Level switches for very high / high / normal / low / very low interlocks (type as per Owner approval).

2) Tapping points/test points shall be provided.

3) All Thermocouples & RTDs shall be Duplex.

4) All Field Instruments used in acid or alkaline atmosphere shall be with standard anti-corrosion coating i.e. the combination of polyurethane and epoxy resin baked coating (ANSI/ISA-71.04).

5) All primary instruments installed at “Minus level or Floor” shall be with protection class of IP 68.

6) Transmitters (all type) as on required basis for monitoring interlocks & controls as per redundancy criteria.

7) 6 no. duplex or 12 no. simplex embedded temperature detectors for various motor stator windings and duplex RTDs for motor/pump bearing temp.

8) All field mounted push button, selector switch etc. shall be as per IEC or NEMA 4X protection.

9) All limit switches shall be conforming to IEC-60947-5-1.

10) For all instruments envisaged for sea water applications, they shall be provided with wetted parts of Monel / Hastelloy C.

11) Primary Elements: Flow nozzles shall be made of stainless steel, with three sets of pressure taps installed in the pipe wall where required. Installation of flow nozzles and pressure taps shall be made in the pipe

12) Paddle type orifice plates shall be used for other flow measurements where flanged construction and higher pressure loss are acceptable. Orifice plates shall be made of stainless steel. Orifice flanges shall be of the raised face weld neck type with dual sets of taps.

13) Construction and installation of flow nozzles and orifices shall conform to the requirements of ASME Performance Test Code PTC-19.5, and discharge coefficients shall be predicted in accordance with data published in ASME Research Report on Fluid Meters.

14) Orifice plates shall be supplied with carrier rings as per process requirement.

15) Secondary Elements: Secondary elements for differential type flow sensors shall be strain gauge or capacitance type differential pressure transmitters. Square root extraction required for the DP transmitters shall be performed electronically in the transmitter itself.

16) Instrument and Service Air – Vortex/Swirl type flow meter

17) Any other flow element/meter required for system shall be finalized as per system requirement and as per approved drawings/documents.

18) At each inlet and outlet lines of gas to gas heat exchanger, the following instruments shall be provided as a minimum:

(a) Pressure indicator – 1 no and pressure transmitter – 2 nos
(b) Differential pressure transmitter across inlet and outlet lines
(c) Temperature transmitters – 2 nos

19) Redundant SOx analyzers shall be provided at inlet (untreated flue gas) and outlet (treated flue gas) of Gas to Gas Heater (GGH).Temperature measurements for GGH shall be considered on all the sides.

20) pH analyzers (redundant) to be provided for each oxidation tank and waste water tank. Density analyzers (redundant) to be provided for oxidation tank and limestone slurry preparation tank. Density measurements in hydro cyclone feed lines, slurry feed lines etc shall also be provided.

21) Online Moisture analysis instruments to be provided for dewatered gypsum. Dew point analyzer to be provided for instrument air service and auto drain trap to be considered for air receiver.

22) CEMS - CO, Sox, NOx, Opacity & Oxygen analyzers at the inlet and outlet duct of the FGD system. Humidity analyzer shall also be included in the outlet of FGD system

23) All instruments shall be provided with durable epoxy coating for housings and all exposed surfaces of the instruments.

10.2.2 Above are the min. requirements, however actual quantities shall be as decided during detailed engineering based on redundancy criteria. Other pressure gauges for systems shall be decided during detailed engineering.

10.2.3 It is envisaged to use separate instrument / switches for initiation of interlock and trip circuits. The proposal shall include adequate number of pressure, differential pressure, level, flow and temperature switches to meet the systems functional requirements. Where blind type of pressure, differential pressure and flow switches are employed, the necessary provision shall be made for connection of test gauge. All switches shall be provided with snap action DPDT contacts and shall be equipped with plug in type connections for terminating field wiring.

10.2.4 Switch actuation point shall be field adjustable with a calibration scale to indicate the set point. Switches shall have capacity of 5.0 amps at 240V AC or 0.5 amps at 220V DC. Level switches for general service shall be float type. Float material shall be stainless steel SS316.

10.2.5 Thermowells, sight-flow indicators, level gauges etc. shall be of a reputed make and type and shall be subject to the Owner's approval. The switches should be of type designed for alarm and interlock purposes. Thermometers and pressure gauges with contacts attached to perform these functions will not be acceptable.

Field instruments shall be supplied & offered as per data sheets specified below:

10.3.0 Transmitters, Switches, Gauges and Panel Mounted Instruments

10.3.1 **Pressure, Differential Pressure, Level and Flow Transmitters (PT, DPT, LT & FT)**

a. Smart Transmitters of the electronic type shall be furnished.

b. Transmitters shall be equipped with mounting brackets suitable for a mounting in transmitter enclosures.

c. In general, Transmitters are envisaged to be grouped at several places as to be decided during detailed engineering stage. For this purpose, suitable enclosures complete with all tubing, fittings, purge meters, loop cable trays etc. shall be provided.

Type/Construction	:	Sealed capacitance/ Inductance/ Silicon resonance type
Material		
Body	:	Die cast Aluminum with epoxy coating for air & flue gas SS316 for other services

Diaphragm	:	316 SS
Measurement element	:	Teflon seal
Valves	:	Carbon steel for non-corrosive Applications SS316 for corrosive applications.
Output signal	:	4 to 20 m Amp. DC (Two wires) HART Compatible
Local Indicator	:	LCD indicator (5 digit) with scale of Engg. Unit
Overall Accuracy	:	± 0.075% or better of FSR
Turn down ratio	:	10:1 for vacuum / very low pressure application 30:1 for other applications
Stability	:	± 0.15% for 5 years.
Response time	:	100 msec.
Power supply	:	24V DC nominal
Drive capability	:	500 Ohms minimum
Enclosure Class	:	IP-65 (Explosion proof as per NEC article 500 for hazardous area)
Span and Zero	:	Locally adjustable, non-interacting
Zero suppression / elevation:		At least 100% of Span

Connection

Process	:	Half (1/2) inch NPT (F)
Electrical	:	Plug and socket, unused entry with blind plug.
Accessories	:	Span and zero adjustment facility
For Absolute Pressure Transmitters	:	Two (2) valve SS316 manifold
For Gauge & Vacuum pressure transmitter	:	Three (3) valve SS316 manifold
For DP, level & flow Transmitter	:	Five (5) valve SS316 manifold
For oil and corrosive liquids	:	Separator diaphragm seals
For all transmitters	:	Mounting bracket
Mounting	:	Local (in LIE/LIR)

d. In case it becomes necessary to use a DP transmitter for pressure measurement, then a 3-Valve manifold shall be used in place of 2-valve manifold. Manifold shall not be mounted on the transmitter; It shall be non-integral type. Pulsation dampeners shall be used where the process media is unstable for measurement such as the

discharge of a pump. Overrange protection shall be used where necessary. The coil siphons & condensate pots shall be used for steam services. Transmitters shall be provided with suitable drain & vent points.

e. As for the water flow/ steam flow measurements, necessary flow elements/ transmitters are chosen in the process line and supplied such that their algebraic summation shall be mass balanced for calculating the system efficiency.

f. Contacts less, electronic 2-wire position transmitters shall be provided for all inching type motorized valve and dampers.

g. For acid and alkali applications, only non-contact type level transmitters like acoustic, ultrasonic, radar based shall be provided by bidders.

h. Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application. For hazardous area, explosions proof enclosure as described in NEC article 500 shall be provided.

i. LVDT type is not acceptable.

j. Transmitters & other HART based instruments shall be supplied along with 3 Nos. of universal type hand held/portable pressure calibrators. Temperature transmitters shall be supplied along with 3 Nos. of hand held/portable mV source generators.

10.3.2 **Pressure Switches (PS) & Differential Pressure Switches (DPS)**

Applicable Standards	:	IS3624 – 1966/ISA-RP-8.1 except as modified in spec.
Type/Construction	:	Bellows /Sealed Diaphragm for low pressure / vacuum and Piston Actuated preferable for high pressure. Indicators with contacts are not acceptable.
Materials-		
Bellows	:	316 SS
Bourdon tube	:	316 SS
Movement	:	316 SS
Protective Diaphragm	:	Die-cast aluminum with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere.
Accuracy	:	± One (1) percent or better
Repeatability	:	± 0.5(half) percent or better
Setting & Differential	:	Adjustable
Over pressure range	:	Fifty(50) percent of full scale.
Contact	:	
Number	:	DPDT /2 SPDT
Type	:	Auto reset with internal Adjustable snap action micro switch
Rating	:	5 Amp, 240V AC / 0.5 Amp, 220V DC

	Connection – instrument	:	Half (1/2) inch NPT male Process
	Electrical	:	Suitable for Plug & socket connection. All the switches are internally connected and brought to the surface with amphenol male/female connection. Cabling need not terminated inside the switch. Cable ends are to be soldiered in connector and to be inserted for easy maintenance.
	Over range protection	:	Fifty (50) percent of full scale
	Enclosure	:	IP 65
	Accessories		
	3 / 5 valve manifold	:	For all switches
	Self-cleaning type Pulsation dampeners/Snubber (Material SS316)	:	Pump and compressor discharge lines
	Syphon	:	For all steam lines
	Protective separating diaphragm	:	For Corrosive liquid lines.
	Mounting	:	Local (in LIE/LIR)

10.3.3 **Pressure & Differential Pressure Gauges (PG & DPG)**

	Applicable standard	:	IS: 3602-1966, IS/3624, ASME B 40.1
	Sensing Element and Materials	:	Bourdon for high pressure, diaphragm/bellow for low pressure of all materials in SS 316
	Case	:	SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere.
	Protective Diaphragm	:	Teflon
	Dial size	:	150mm with shatter proof glass
	Scale Details	:	Graduations in black lines on white dial, 270 Deg pointer defection scale provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller. Pointer stop for all gauges.
	Accuracy	:	± One (1) percent or better
	Connection – Instrument Process	:	1/2 inch NPT Male Bottom
	Mounting	:	Local
		:	1/2 inch NPT Male (Back entry) mounted on local gauge board.
	Accessories		
	3 way needle valve/manifolds	:	For all gauges

Self-cleaning type Pulsation dampener/snubber	:	Pump and compressor discharge lines
Syphon	:	For all steam lines
Protective separating	:	For fuel oil and corrosive liquid lines
Other particulars		
Zero & span adjustment Safety device	:	For all gauges
Housing	:	IP 65
Ranges 5 to 20 Kg/cm²	:	Rubber blow out disc with open front construction
Ranges above 20 Kg/cm²	:	Neoprene safety diaphragm at the back with solid front construction
Over range protection	:	Fifty (50) percent of full scale
	:	Movement mechanism shall be glycerin filled for oil services & vibration prone area.
	:	For corrosive liquid lines diaphragm type sensors required. Armored capillary of 10 mtrs for Corrosive liquid service
	:	Contact type pressure gauges are not acceptable for interlock & protection.
Identification	:	Identification engraved with service legend or laminated phenolic name plate.

10.3.4 **Resistance Temperature Sensors with thermowells**

Applicable Standard	:	ASME PTC 19.3 / DIN 43760 for RTD -Latest Revision
Element	:	Platinum, R0=100 ohm 4 –wire Duplex
Sheath Material/ Insulation	:	316SS metal sheathed /Compacted Magnesium Oxide
Sheath OD	:	8 MM
Terminals	:	Spring loaded
Calibration	:	As per DIN Standard – 43760, Class A
Head	:	Die Cast Aluminum (Screwed) with galvanized chain
Response Time	:	< 20 Sec for measurement < 10 Sec for Control
Accuracy	:	±0.35° C or class A DIN 43760 whichever is better.

Electrical connection	:	Plug in connector type
Enclosure	:	IP 65

Thermo well

Applicable Standard	:	ASME PTC 19.3 TW – 2010
Construction	:	Tapered drilled from Bar stock for SS316 material thermowell. (Straight for Air & Gas systems)
Material	:	- 316 SS – water and steam services - Inconel for air & flue gas services Bidder shall provide calculation for thermo well as per ASME – PTC-19.3.
Process Connection	:	i) M33 x 2 ii) Flanged for Air & Gas systems with mating flanges
Immersion Length	:	Within ±10 mm of center line of pipe
Extension neck length	:	Minimum 100 mm above Insulation of pipe and Minimum 160 mm when there is no insulation on pipe.
IBR Certification	:	For high pressure service, Steam Temp., Fuel oil temp. Measurement as per IBR rules and regulations

Note :
Extension/Compensating cable exposed to atmosphere in the conventional method melts away in the high temperature. Hence The terminals of temperature sensors shall not be at the high temperature zone. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB.

10.3.5 **Thermocouples with thermowells**

Applicable standard	:	ASME PTC 19.3- Latest Revision
Element	:	Duplex
- Sheath	:	8 MM OD
- Sheath Material	:	316 SS
- Spring Loaded	:	Yes
- Nipple/Union	:	Yes
- Packed connector	:	Compacted magnesium Oxide ungrounded
- Type	:	i. Type K (Chromel – Alumel) ii. Type R (Platinum Rhodium-Platinum)
- Gauge	:	16 AWG wire of Chromel – Alumel (Type – K) or 24 AWG wire Pt-Rhodium Pt(Type R) depending on operating temperature range (Ungrounded type)
Head	:	IP 65 / Die Cast Aluminum

Electrical connection	:	Plug in connector type.
Thermowell		
Applicable Standard	:	ASME PTC 19.3 TW (latest)
- Construction	:	Tapered Drilled from Bar stock for SS316 material thermowell. (Straight for Air & Gas systems)
- Material	:	- 316SS for water/steam services - Inconel for air & flue gas services For furnace zone, impervious ceramic protecting tube of suitable material along with Inconel supporting tubes and adjustable flanges. For Mill outlet temperature long life solid sintered tungsten carbide material of high abrasion resistance. Bidder shall provide calculation for thermowell as per ASME – PTC-19.3.
- Process Connection	:	(i) M 33 x 2 (ii) SS316 Flanged, for Air & Gas systems, with mating flanges.
- Extension	:	Threaded union 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT (M) threads at both ends
Accuracy (For Type K T/C)	:	±1.1 deg.C (for 0 to 277 deg.C) ± 0.4 percent (for 277 to 1280 deg.C) Class-A
For Type S & R T/C	:	± 0.6 deg.C or + 0.1%
For Type T T/C	:	± 0.5 deg.C or + 0.4%
Accessories	:	Bolts, nuts and gaskets for flanged connections.
Response Time	:	< 20 Sec for measurement < 10 Sec for Control
Immersion length	:	Within ± 10 mm of center line of pipe
Extension neck length	:	minimum 100 mm above insulation of Pipe and minimum 160 mm when there is no insulation on pipe.
IBR Certification	:	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations.

Note :

Extension/Compensating cable exposed to atmosphere in the conventional method melts away in the high temperature. Hence The terminals of temperature sensors shall not be at the high temperature zone. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB.

10.3.6 **Temperature Switches (TS)**

Type/Construction

- Switch	:	Industrial type Mercury in steel with capillary and separable thermowell and contacts directly connected to Bourdon element/vapour pressure sensing, liquid filled bellows type preferred.
- Thermowell	:	Bar stock

Material

- Thermowell & Bulb	:	316 SS
- Capillary	:	Armoured Stainless Steel
- Bourdon	:	316 SS
- Bourdon Movement	:	SS 316
- Casing	:	Die-cast aluminum with stoved enamel black finish Epoxy coating shall be provided for corrosive atmosphere.
Setting and Differential	:	Adjustable
Accuracy	:	± One (1) percent of setting and differential
Repeatability	:	One half (1/2) percent of setting

Contacts

- Number	:	DPDT/2 SPDT
- Type	:	Auto reset with internal Adjustable snap action micro switch
- Rating	:	5 Amp, 240V AC / 0.5 Amp, 220V DC

Connection

Pipe	:	M33 x 2
Thermowell	:	To suit switch
Electrical	:	Suitable for Plug in type. All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not terminated inside the

			switch. Cable ends are to be soldiered in connector and to be inserted for easy Maintenance.
	Enclosure protection	:	IP 65
	Other Particulars		
	- Capillary length	:	As per requirement
	- Immersion Length	:	Within ± ten (10) mm of center line of pipe with adjustable nuts.
	- Extension neck length	:	Minimum 50 mm above insulation of pipe / As per approved hookup drawings.
	- Packing glands	:	Yes
	IBR Certification	:	For high pressure service, Steam Temp, Fuel oil temp. measurement as per IBR rules and regulations
	N.B	:	Switches designed for cross ambient operation shall be used in applications where the ambient temperature will approximate or exceed the switch set point.

10.3.7 **Temperature Gauges (TG)**

	Applicable standard	:	IS : 3602,BS:5235 ISA:RP:8.1 except as modified in this specification
	Type/Construction		
	- Thermometer	:	Industrial type, Inert gas type
	- Thermowell	:	Bar stock
	Material		
	- Thermowell & Bulb	:	316 SS
	-Movement	:	316 SS
	- Capillary	:	Armoured SS (Applicable for capillary Type)
	- Casing	:	SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere
	Dial Size	:	150mm with shatter proof glass
	Scale Details	:	270 degree dial rotation/deflection. Graduations in black lines on white dial provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller. Pointer stop for all gauges
	Accuracy	:	± One (1) percent or better

	Response time	:	Maximum 15 seconds without thermowell
	Connection		
	- Pipe	:	M33 x 2
	- Thermowell	:	To suit instrument
	Other Particulars		
	- Capillary length	:	5Meters/10 Meters as required
	- Immersion Length	:	Within ± ten (10) mm of center line of pipe with adjustable nuts.
	- Extension neck length	:	Minimum 50 mm above insulation of pipe /As per approved hookup drawings.
	- Stop at Maximum value	:	For all gauges of scale
	- Pointer	:	Externally adjustable
		:	Contact type Temp. gauges are not acceptable for interlock & protection.
	IBR Certification	:	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations
	Enclosure protection	:	IP 65

10.3.8 **Test Thermowells (TT)**

	Applicable Standard	:	ASME PTC 19.3 TW (latest)
	Type/Construction	:	Machined from Bar Stock
	Material	:	316 SS
	Connection		
	- Pipe	:	M33 x 2
	- Test Instrument	:	To suit test instruments
	Accessories	:	Plug with chain
	IBR Certification	:	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations Bidder shall provide calculation for thermowell as per ASME – PTC-19.3 TW – 2010.

Test wells shall be provided as required to meet ASME test requirements.

10.3.9 **Ultrasonic Level Transmitter (for Water sump/Tank level measurement)**

	Type	:	Non-contact Microprocessor based 2 wire type, HART protocol compatible

Principle of Operation	:	Detection of reflected ultrasonic pulse
Measuring Ranges	:	Up to 30 meters (typical)
Signal Processing	:	Microprocessor Controlled Signal Processing
Operating Freq.	:	10 KHz to 50 KHz (typical)
Display	:	Head mounted Large alpha-numeric back lit LCD/LED
Calibration & Configuration	:	Accessible from front of panel
Diagnosis	:	On-line
Status	:	For power, Hi / Lo / V. Hi / V. Lo-level indication, fault etc.
Construction	:	Plug-on board
Power supply	:	24 V DC +/- 10% or 230 VAC 50 Hz
Signal Output	:	Galvanically isolated 4-20mA DC with **HART protocol**
Hysteresis	:	Fully adjustable preferred
False signal tolerance	:	Transmitter shall be capable of ignoring false echos
Output contacts	:	2SPDT Potential free changeover contacts @ 8A 230V AC.
Accuracy & Repeatability	:	±0.25% of span or better
Temperature compensation	:	To be provided with transducer
Resolution	:	±0.1% of span
Operating temp.	:	Transmitter-50 deg C and Sensor –80 deg C
MOC Sensor	:	Body- PVDF and Face – Polyurethane or Corrosion resistant material to suit Individual application requirement
Humidity	:	1% to 95% non-condensing.
Enclosure	:	IP-65 Epoxy painted die cast Aluminum or SS316L housing.
Cable Connection	:	Plug and socket.
Mounting	:	2” – 4” NPT or flanged
Accessories	:	Cable gland, prefab cable, mounting accessories like EPDM seal, SS316 flanged etc.

			Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided during detailed engineering. All weather canopy for protection from direct sunlight and direct rain. All mounting hardware and accessories required for erection and commissioning mounting fittings material shall be SS 316.

10.3.10 **Guided Wave Radar/Radar Level Transmitter**

Type	:	Guided wave Radar (Contact type)/Radar (Non-contact type).
Application	:	For Low pressure Vacuum vessels.
Environment Class	:	Highly abrasive with Gases and Fumes
Orientation	:	Vertical
Probe Type	:	Flexible Single lead with chuck
Probe Material	:	SS 316L
Connection Size & Type	:	2” Flanged ANSI 300 lb SS316L material
Connection material	:	SS 316L
Accuracy	:	±5 mm
Resolution	:	±1 mm
Type (Transmitter)	:	SMART, 2 Wire
Operating Principle	:	Time Domain Reflectrometry
Signal Output	:	4-20mA DC with **HART protocol** and
Electrical Connection	:	1/2” NPT
Enclosure Class	:	IP 65
Electrical Power	:	11-42 V DC
Housing material	:	Die Cast Aluminum
Vent & Drain Plug material	:	SS
Side Flange Material	:	SS
Local Display	:	Provided (LCD Digital)
Units of Measurement	:	Length M

10.3.11 **3 D Type Acoustic Wave Level Transmitter**

Type	:	Acoustic Wave Level Transmitter (3D type)
Temperature compensation	:	Required for high temp applications
Operating Principle	:	Non – Intrusive acoustic wave transmission & Reflection
Frequency Range	:	3 – 10 KHz
Accuracy	:	±0.25 % for even surface & ± 0.5 % for uneven surface.
Resolution	:	1 MM
Output	:	4-20mA DC with HART

Local Display Unit:

Type	:	Head mounted LCD Display with Engg. Units
Location	:	Suitable location at bunker / Silo operating floor area
Protection Class	:	IP 65

Material of construction:

Housing	:	Polypropylene
Flange	:	Polypropylene

Sizes:

Flange Size	:	2” ANSI 300 # RF SS
Electrical connection size	:	1/2” NPT (F)
Accessories	:	i. Double compression type Nickel Plated Cable glands ii. Suitable Mating Flange, necessary gaskets iii. Local display unit & Suitable mounting brackets, necessary mounting hardware for Local display unit iv. Complete software as required to have 3 D view on monitors

10.3.12 **Level Switches (LS)**

Type/Construction :

a) External float cage type with magnetic switch actuator for tanks and vessels.

b) Displacer –Top mounted for all clean water sumps.

c) Conductivity type for high Pressure and high temperature enclosed vessel like drain pot, HP heaters etc.

Materials

- Body	:	Cast Carbon Steel suitable for specified pressure and temperature ratings
	:	For corrosive liquids suitable anti-corrosive coat/lining shall be provided.
- Float/Displacer	:	316 SS
-Wire rope	:	316 SS
Differential & Setting	:	± 12 mm minimum (Adjustable) Contacts
-Number	:	DPDT/2 SPDT
- Type	:	Snap action micro switch Auto reset with internal Adjustable
- Rating	:	5 Amp 240V AC, 0.5 Amp 220V DC
Connection – Process	:	One (1) inch Scrd NPT Female One (1) inch ANSI Flanged Four(4) inch ANSI Flange for sump services.
Electrical	:	Suitable for Plug in type. All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not terminated inside the switch. Cable ends are to be soldiered in connector and to be inserted for easy maintenance.
Enclosure protection	:	IP 65
Temperature/pressure rating:		As per service conditions
Accessories	:	Counter flanges, still pipe of requisite length with anticorrosive coating for sump services.

10.3.13 **Capacitance Type Level Switch**

Type	:	Capacitance type
Probe	:	a) Rod or suspended electrode
		b) Rope type probes may be used only where required probe length is greater than 3 meters.
Probe Mounting	:	Stainless steel 1-1/2 ANSI RF Flange / ¾“ NPT (M)
Material of construction	:	316 SS
Insulation	:	PTFE Part/Full as per service.
Enclosure	:	Powder/Epoxy coated Die cast Aluminum. With neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area)
Repeatability	:	± 0.5% of full range.

	Ambient temperature	:	0-60 ºC.
	Mounting	:	On top
	Supply voltage	:	240V AC, 50Hz / 24V DC
	Relay output	:	2SPDT
	Contact rating	:	5A min. at 240V AC on resistive load
	Response time	:	100 msec or better
	Cable connection	:	3/4" ET
	Accessories	:	Counter flange, Cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.

10.3.14 **RF Type Level Switch**

Electronic Controller

1.	Input Supply	:	240 V AC (+/-10%), 50 Hz (+/- 5%)
2.	Construction	:	Cast Aluminum Housing
3.	Relay Output	:	2 Nos. Relay Changeover Potential Free Contacts (2SPDT)
4.	Contact Rating	:	5A at 240 V AC & 0.5 at 220 V DC
5.	Class of Protection	:	IP-65
6.	Ambient Temperature	:	55 Deg. C(Max)
7.	Local Indication	:	Local LED Indications
	Green	:	Normal Level
	Red	:	Alarm Level
	Yellow	:	Probe Healthy
8.	Cable connection	:	3/4" ET(2 Nos.) for Supply and Output 5/8" ET(1 No.) for Probe Connection
9.	Repeatability	:	100%

B. Sensing Probe

1.	Type of Probe	:	Rigid
2.	Material	:	Stainless steel SS 316
3.	Probe Head Housing	:	Cast Aluminum
4.	Insulation (B/W Active & Shield And Shield & Ground)	:	PTFE
5.	Probe Head Protection	:	IP-66
6.	Mounting	:	Side Mounted

7.	Cable Connection	:	5/8" ET (1No.)
8.	Process Connection	:	40 NB BSP THREADED
C.	Signal Cable	:	Coaxial cable for Connection Between Sensing probe and electronic Controller (@ 10 Mtrs. Per Level Probe)
D.	Application	:	Silos

10.3.15 **Level Indicators (Gauge Glass) (LI)**

Type/Construction	:	a) Reflex b) Tubular (For tanks open to atmosphere only)
Material:		
a) Glass	:	Tempered toughened borosilicate resistant to thermal shock
b) Body material	:	Forged Carbon steel / SS 304
c) Integral cocks and	:	i) Forged carbon steel with drain valves stainless steel internals ii) Rubber lined corrosion resistant stainless steel 316 (for demineralized and Osmosis water service)
d) Fittings	:	i) Forged carbon steel ii) Rubber lined 316 steel/PVC for corrosive liquids Demineralized and Osmosis water service) iii) 304 Stainless Steel for non-corrosive liquids
e) Packing	:	Teflon
Dial size/scale	:	150 mm /1.4 Meters maximum length with shatter Proof glass
Scale details	:	Aluminum/SS316 scale Graduated in mmwc
Connection	:	25 Nb/40 Nb ANSI Flanged
Enclosure protection	:	IP 65
Accessories	:	a) Integral cocks b) Drain/vent valves 15 NB c) Bolts, nuts and gaskets for all KEL-F shield for transparent type d) Illuminating lamps as required e) Periscope as required
Tests	:	Tested at two hundred (200) percent of the maximum process pressure
Other details	:	For larger lengths, additional gauge glasses shall be provided with minimum of 50 mm overlap.

10.3.16 **Vortex Flow Meter**

Sensor

Type	:	Vortex

	Output Signal	:	Pulse.
	Material of Construction	:	AISI 316
	Sensor Seal	:	PTFE / higher based on temperature.
	Flow range	:	As required.
	Linearity	:	±0.25% or better.
	Repeatability	:	±0.02% or better.
	Ambient temperature	:	50 deg C
	Mounting	:	On-Line mounting with flanges of stainless steel.
	Enclosure	:	IP 65.
	Accessories	:	Nuts, bolts, gaskets etc.
	Transmitter		
	Electronics	:	Solid State.
	Power Supply	:	240V AC, 50Hz.
	Input	:	Input from Sensor.
	Display	:	4 1/2 digit LCD.
	Output	:	Isolated 4-20mA DC HART.
	Measuring Accuracy	:	±0.5% of full scale range.
	Totalized Value	:	Required.
	Housing	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
	Nameplate	:	Tag number, service engraved in stainless steel tag plate.
	Accessories	:	Clamping strip, bracket, prefab cable etc. Special tool kit for calibration / configuration.

10.3.17 **Flow Transmitter (Ultrasonic)**

	Type	:	ULTRA SONIC, 2-wired.
	Sensing element	:	Non-contact.
	Output	:	4-20mA with HART Protocol.
	Accuracy	:	± 0.1% FS.
	Supply	:	24 V DC.
	Enclosure class	:	IP-65.

Transmitter

Mounting	:	On Nozzle.
Mounting position	:	Top mounted.
Housing	:	Plastic.
Display	:	Head mounted LCD Display & remote display.
Accessories	:	As per process requirement.
Process connection	:	1/2" NPT.
Electrical connection	:	1/4" NPT.
Turn Down ratio	:	1:100.
Measuring range	:	Adjustable (as per process requirement).
Totaliser	:	Required.
Enclosure class	:	IP-65.

10.3.18 **Positive Displacement Flow Transmitter**

Positive displacement flow transmitters shall be offered. An electronic totalizer shall be provided for each flowmeter with IP 65 protection and the location of the totalizers shall be acceptable to the Owner. Air eliminators shall also be provided to ensure maximum accuracy.

10.3.19 **Electromagnetic Flow Meter**

Electromagnetic flow meters shall have separate transmitter having accuracy ±0.2% with zero stability feature, electrode material SS-316, liner material Teflon and enclosure IP65, local digital display, 4-20 mA output HART signal with zero and span field adjustable. Application – DM Water and for other application as decided by owner.

10.3.20 **Flow Gauges (FG)**

Type/Construction	:	a) On-line type rotameter for 50 Nb & below lines. b) Bypass type rotameter for above 50 Nb lines.
Material		
- For On-line type		
Metering tube	:	Borosilicate glass
Float	:	316 SS
Packing	:	Teflon
End fittings	:	304 SS
- For bypass type		

	Metering Tube	:	Borosilicate glass
	Float	:	316 SS
	Packing	:	Teflon
	End fittings	:	304 SS
	Orifice Plate	:	316 SS
	Carrier ring	:	304 SS
	Flanges & Mating flanges	:	Same as pipe material, 200 lbs ANSI – RF.
	Impulse pipe	:	Same as pipe material.
	Fittings	:	2000 ANSI, SW ends to match with pipe material.
	Dial size / Scale length	:	250mm.
	Scale Details	:	Direct reading type engraved on detachable aluminium scale.
	Accuracy	:	± Two (2) percent.
	Reproducibility	:	Half (1/2) percent.
	Connection	:	SCRD NPT
	Enclosure class	:	IP-65.
	Accessories	:	a) Isolating valves (for Bypass type only). b) Bolts, Nuts and Gaskets as required.
	Tests	:	Shall be tested at two hundred (200) percent of the maximum process pressure.

10.3.21 **Sight Flow Glass Indicators**

	Type/Construction	:	Rotary type/ Flapper type as per process requirement.
	Materials		
	Body	:	Carbon steel.
	Glass	:	Toughened Borosilicate
	Gaskets	:	Neoprene.
	Bolts & Nuts	:	SS
	Flappers / Rotating Wheel	:	316 SS
	Flappers / Rotating Wheel holder	:	304 SS
	Process Connection	:	SW

	Enclosure class	:	IP-65.
	Accessories	:	Bolts, Nuts, Cover plates and Gaskets as required.
	Tests	:	Tested at two hundred (200) percent of the maximum process pressure.

10.3.22 **Solid Flow Meter**

	Type	:	Online Impact type Microprocessor Based.
	Measuring Principle	:	The system measurement is basically pertains to the measurement of horizontal deflection using LVDT, created by the impact of solid flow upon online sensing plate. The horizontal deflection being proportional to the impact forces, LVDT convert this horizontal movement into electrical signal. The inbuilt integrator convert this signal into time based flow rate indication & provide totalized flow also.
	Sensing plate	:	316 SS
	Sensing head	:	Sensing mechanism shall be mounted outside the process flow line.
	Enclosure	:	316 SS
	Enclosure protection	:	IP 65
	Class		
	Accuracy	:	+/-1%
	Repeatability	:	+/- 0.2%
	Drift	:	Both zero & span $\pm$ 2% / month.
	Output	:	4-20mA DC isolated, load 600 ohm (min)
	Digital communication	:	yes, (HART) facility.
	Power Supply	:	240 V AC, 50Hz.
	Ambient condition	:	Temperature -60°C, RH-95%. Environment – Highly Dusty.
	Accessories	:	Shall be complete with all the accessories including digital display for flow rate, integral vents, baffles for air separation, etc., whichever required for satisfactory operation.

Note:-

1. The above on line flow meter shall not create any obstruction on flow.
2. User's list shall be submitted to support on proven satisfactory performance for similar Process application.

10.3.23 **Dew Point Meter**

Type	:	2 Wire Loop Powered Dew point transmitter
Overall Range	:	-60℃ to +20℃ Dew point
Accuracy	:	± 2℃ Dew point
Material	:	SS316 (wetted parts)
Features	:	i) Automatic calibration ii) Can be Configured for Linear 4-20mA signal in ℃ & ℉ Dew point, ppm(v), ppb(v), g/m3 iii) Temperature Compensation iv) Failure Diagnostics v) Long Term Stability vi) Fast Response vii) IP 65 / NEMA4X Protection viii) Supplied with Calibration Certificate Traceable to National & International Humidity Standards ix) Sensor protection with sintered filter x) Local LCD Display for Dew Point

10.3.24 **Analyser Instruments:**

Common requirements:

Output signals Analog	4-20 mA DC galvanically isolated. If analyser provides superimposed HART signal on 4-20 mA DC output, It shall have provision also to be connected to PC based station.
Binary	2 NO + 2 NC for high alarm
Zero & span Adjustment	To be provided with range selection facility.
Ambient temp.	50℃
Indication	Digital Alphanumeric Display. Display of reading in engineering units shall be provided.
Enclosure	Type/Material Weather & Dust proof (IP 65) Die cast Aluminium/SS.
Type of Electronics	Microprocessor based with self-diagnostic.
Digital Signal transmission	HART / RS 485 Port Modbus Protocol / Ethernet TCP/IP protocol for communication with plant control system.
Calibration	Auto & Manual (from Remote)
Power Supply	To be arranged by Bidder subject to Owner's approval

	Enclosure class	IP 65
	Others	All interconnection tubing and cabling between probe and analyzer / analyzer panel and cabling from analyzer/ analyzer panel to local junction box are to be provided All the calibration gases required for one year continuous operation shall be provided. The calibration gas container material shall not contaminate the calibration gas.

10.3.25 **SO2,NO2,CO2,CO Analyzer:**

Principle	UV Fluorescence
Measurement	**SO2,NO2,CO2,CO**
Display	LCD
Ranges	SO2: 0-500, 1000, 2000, 3000 ppm. NOx: 0-300 ppm CO2: 0-1000 ppm CO:0-200,0-1000 ppm
Minimum Detectable Limit	1 PPB
Noise Level	0.5 PPB or less
Zero Drift at Lowest Range	2% per month with automatic zero Compensation.
Span Drift at Lowest Range	2% per month of full scale
Response Time at Lowest Range	2 minutes or less
Linearity	+ 1% of full scale
Calibration	Built-in Calibration Facility
Consumables and spares	Recommended requirements of 3 years Continuous operation
Digital Signal Transmission	RS 232 link. Analyzer shall be capable to transfer all the data through RS 232 link to a PC based data logger.

10.3.26 **pH Analyser**

Type :	Cell - flow through
Accuracy :	< ± 1% of reading
Range :	0 - 14 pH freely programmable (For others)
No. of steams :	Single
Temp. compensation :	Automatic

10.3.27 **Oxygen Analyzer**

O_2 analyzers shall be direct insertion 'in-situ' type with accuracy of ±1% of reading or better with auto and manual calibration having zirconia probe as sensing element. Accessories like back purge system etc., shall be provided. Material for flue gas carrying parts shall be of SS 316. Protection tube shall be provided to prevent erosion of the probe. Maintenance requirement shall not be more than once a week. Local indicating meter for read out to be provided. Alarm on abnormalities and self-diagnosis features shall be provided.

1. Measurement Range : 0 to 25% oxygen programmable up to min 0.5% of O2
2. Accuracy : +/-1 % of Full Scale
3. Linearity : +/- 1% of F.S.
4. Repeatability : ≤ 0.5% of Span
5. Response time(up to 90% of full scale : ≤5secs
6. Zero Drift : <1% span week
7. Span Drift : < 1 % measured value/week
8. Operating Temperature Range : 0-450 deg.C
9. Filter : Suitable filter to be provided
10. Temperature : Automatic temperature control of heating circuit through thermostat.

l) Accessories

i) Electronic unit housed in a rugged sheet steel enclosure (IP65) houses transmitting system, probe heater control circuit etc. Electronic unit shall be separate from the probe and not be head mounted.

ii) Calibration gas cylinder & accessories, reference air set, rotameters

iii) Shield (316 SS), special cables, electronic control panel and Provision of SS 316 stainless steel diffuser assembly for the protection of Zirconia cell.

iv) Ownership certificate, pressure test certificate, explosion proof certificate for standard gas cylinders shall be given and these will be used for next filling up of standard gases.

vi) Moisture separator unit along with AFR for reference air shall be installed for long life of Zirconia cell.

vii) Any other accessories as required.

10.3.28 **Opacity Analyzer**

Accessories like back purge system etc., shall be provided. Material for flue gas carrying parts shall be of SS. Protection tube shall be provided to prevent erosion of the probe. Local indicating meter for read out to be provided. Alarm on abnormalities and self-diagnosis features shall be provided. The air purging systems shall keep the windows free from dust and deposits.

The measurement shall conform to EPA regulations. Bidder shall indicate the procedure for zero opacity setting at site for calibration purpose.

All cables for connecting the converter unit to the transceiver shall be furnished to integrate the system.

a) Type	:	In-Situ dry type visible light (through LED)
b) Principle of Measurement	:	Transmission and absorption
c) Measurement Range	:	o to *999mg/m2,* (Programmable)
d) Accuracy	:	2% of F.S.
e) Linearity	:	+/-1% of F.S.
f) Repeatability	:	≤ 1% of span
g) Response time(up to 90% of full scale):		≤ 5 secs
h) Temperature Drift	:	Automatic temp compensation
i) Zero Drif	:	<1% span week
j) Span Drift	:	< 1 % measured value/week
j) Operating Temperature Range	:	0-300 deg.C
k) Filter	:	To be provided
l) Accessories purging system	:	Purging system to be provided with heavy duty blowers and shutter mechanism for Automatic isolation of lens during purge air failure.
j) Temperature compensation/measurement		Yes.(Temperature measurement using thermocouple and transmitter with a 4-20ma flue gas temp signal to PLC in addition to Opacity monitor)
d) Process connection	:	ANSI flange
m) Accessories	:	i) Control unit complete with small setting up meter and miniaturized red and green indicating lamps. ii) Remote indicating and mounting unit for flush panel mount. iii) Ever clean windows iv) Projector transformer

v) Mounting flanges, bolts, hoses, clamps and alignment tools

vi) Special cable up to control room (if required)

vii) Trans-receiver and reflector assemblies with weatherproof housing

viii) Other accessories as required

10.3.29 **Junction Boxes**

Bidder shall note that the Analog and digital signals shall be wired to different junction boxes.

(i) No. of ways	12/24/36/48/64/72/96/128 with 20% spare terminals.
(ii) Material	4mm thick fibre glass reinforced polyester.
(iii) Type	Screwed at all four corners for door. Door handle shall be self-locking with common key. Door gasket shall be of synthetic rubber.
(iv) Mounting clamps and structures etc	Suitable for mounting on walls, columns,. accessories The brackets, bolts, nuts, screws, double compression glands and lugs required for erection shall be of brass, included in Bidders scope of supply. Race ways for routing of cables inside JBs shall be provided.
(v) Type of TB	Rail mounted maxi termi or cage-clamp type suitable for terminal conductor size upto 2.5 mm2. A M6 earthing stud shall be blocks provided.
(vi) Protection class	IP:65 minimum and Explosion/Flame Proof as per area classification.

10.3.30 **Interposing Relays (IPR)**

Electromagnetic type IPRs with modular design, plug-in type connections, suitable for channel/DIN rail mounting in cabinets; coil rating 24V D.C; 2 set of change over contacts rated for 0.5A 220 V DC / 5A 240 V AC. Freewheeling diode across relay coil and self-reset type status LED indicator flag (electronic) shall be provided. Manual forcing/override facility is required. The test voltage for relay shall not be less than 4 KV with operating temperature from –20 deg. C to 60 deg. C. The relay shall have the necessary approvals like V0 inflammability class in accordance with UL94", IEC60664/ IEC60664A/DIN VDE 0110.

10.3.31 **Digital Indicator**

Type	:	Programmable electronic digital indicator with floating point decimal.
Input	:	4-20 mA DC/1-5V DC/RTD/T/C.

Number of inputs	:	One
Range	:	As per requirement/adjustable by end user through key pad available on the indicator.
Number of digits	:	Four plus sign
Digit height	:	20 mm or larger
Display	:	Fluorescent red
Input over range/open	:	All digits to flash sensor (T/C)
Input hold time	:	0.7 seconds max.
Accuracy	:	±0.05% of span
Power supply	:	240V AC, 50Hz
Mounting	:	Flush panel, compatible for mounting on mosaic grid panel
Size	:	96x48 mm
Other Particular	:	Indicator receiving thermocouple Signal shall have automatic cold junction compensation. Retransmission Output 4-20 mA isolated required.
	:	24 V DC inbuilt power supply
	:	Alarm contact with 2 NO/NC contact (rating 5A/230 V AC)

10.3.32 **Receiver Indicators (Single/Dual Channel)**

Type	:	Analogue indicator
Input Signal	:	Universal input (T/C, RTD, 4-20 mA, Voltage)
Scale	:	Range fully configurable and programmable
Measurement Accuracy	:	± 0.2% of span + 1 count
Resolution	:	0.5% Span
Dead band	:	± 0.2% of span
Repeatability	:	0.2% of span
Full scale response time	:	Less than two (2)seconds
Power Supply	:	240V AC, 50 Hz
Connection	:	Plug in type
Accessories	:	Mounting Bracket for Bins
Other Particulars	:	Indicator receiving thermocouple Signal shall have automatic cold Junction compensation.

		:	Retransmission Output 4-20 mA Isolated required.

10.3.33 **Ammeters (AMM)**

Input	:	4-20 mA DC
Mounting	:	Flush panel, compatible for mounting on mosaic grid panel
Face Dimensions	:	96 x 96 mm
Scale/Type	:	Moving coil, circular, FSD 240
Zero adjustment	:	Screw on meter face
Accuracy	:	±1 percent (class 1)
Indication	:	Pointer with scale
Magnetic Shield	:	Shielded Case
Quantities	:	For all HT Motors & LT motor with rating ≥ 30 KW and other critical application motors/drives.

10.3.34 **Voltmeter**

Input	:	4 – 20 mA DC
Mounting	:	Flush Panel, compatible for mounting on mosaic grid panel
Face Dimension	:	96x96 mm
Range	:	As per requirement
Accuracy	:	± < 0.5 %
Indication	:	Digital type 4 1/2 digit
Magnetic Shield	:	Shielded Case
Connection	:	Plug in type
Quantities	:	For 240 V AC input power supply, UPS power supply, 24V DC interrogation voltage & 220 V DC.

10.3.35 **Push Buttons (PB)/ ILPBs for On/Off, Open/Close**

Type	:	Momentary / Miniaturised suitable for mosaic grid 24x48 Mm with 2 PB and 3 coloured LED.
Contact Configuration	:	2 NO + 2 NC
Contact Material	:	Hard Silver Alloy

	Contact Rating	:	500V / 10 A
	Insulation Voltage	:	2 KV for 1 minute between terminals and earth
	Lamp Rating	:	a) Voltage : 240 V AC b) Watt : 2 Watt (approx.)
	Colour	:	Red, Green, Amber, Yellow

10.3.36 **Push Button For Desk Release,**

Push button for desk release	:	Momentary mosaic grid mounted
Desk lamp test desk ack	:	24x48 mm size, single PB 18x40 mm

10.3.37 **Push Button for Sequence Start/Release**

Push Button for Sequence Start/Release	:	Momentary (Miniaturised) suitable for mosaic grid 24x48 mm 3 PB + 5 LED

10.3.38 **Push Button for Annunciation**

Contacts - Number & Type	:	As per requirement
- Breaking capacity	:	0.5 Amp, 220V DC 10 Amp, 600V AC Different colours for Accept/Ack – Green, reset Grey, test – Yellow & Audio Ack – Black.

10.4.0 Control Valves, Actuators & Accessories

10.4.1 **General Requirements**

The control valves and accessories equipment furnished by the Bidder shall be designed, constructed and tested in accordance with the latest applicable requirements of code for pressure piping ANSI B 31.1, the ASME Boiler & pressure vessel code, Indian Boiler Regulation (IBR), ISA, and other standards specified elsewhere as well as in accordance with all applicable requirements of the "Federal Occupational Safety and Health Standards, USA" or acceptable equal standards. All the Control Valves, their actuators and accessories to be furnished under this Subsection will be fully suitable and compatible with the modulating loops covered under the Specification. All the control valves and accessories offered by the Bidder shall be from reputed, experienced manufacturers of specified type and range of valves.

10.4.2 **Control Valve Sizing & Construction**

The design of all valve bodies shall meet the specification requirements and shall conform to the requirements of ANSI (USA) for dimensions, material thickness and material specification for their respective pressure classes.

Control valves for steam and water applications shall be designed to prevent cavitation, wire drawing, flashing on the downstream side of valve and downstream piping. Thus for cavitation/flashing service, only valve with anti-cavitation trim shall be provided. Detailed calculations to establish whether cavitation will occur or not for any given application shall be furnished.

Control valves shall have leakage rate as per leakage Class-IV.

The control valve induced noise shall be limited to 85 dBA at 1 meter from the valve surface under actual operating conditions. The noise abatement shall be achieved by valve body and trim design and not by use of silencers.

10.4.3 **Valve Construction**

All valves shall be of globe / Butterfly body design & straightaway pattern with single or double port, unless otherwise specified or recommended by the manufacturer to be of angle body type. Rotary valve may alternatively be offered when pressure and pressure drops permit.

Valves with high lift cage guided plugs & quick-change trims shall be supplied. Cast Iron valves are not acceptable.

Bonnet joints for all control valves shall be of the flanged and bolted type or other construction acceptable to the Owner. Bonnet joints of the internal threaded or union type will not be acceptable.

Plug shall be of one-piece construction cast, forged or machined from solid bar stock. Plug shall be screwed and pinned to valve stems or shall be integral with the valve stems.

All valves connected to vacuum on downstream side shall be provided with packing suitable for vacuum applications (e.g. double vee type chevron packing) Valve characteristic shall match with the process characteristics.

Extension bonnets shall be provided when the maximum temperature of flowing fluid is greater than 280 deg. C,

Flanged valves shall be rated at no less then ANSI press class of 300 lbs

10.4.4 **Valve Materials**

1) The exact body and trim materials shall be finalized during detailed engineering depending on the service applications.

Valve material shall be as specified in Supplier's approved Control Valve Specification sheets. The following table defines abbreviations used for valve materials:

S.No.	Abbreviations	Description
a)	BR	Bronze ASTM B 61
b)	CS	Carbon Steel Forged - ASTM A 105 Cast - ASTM A 216 Grade WCC
c)	1 - 1/4 CR	1-1/4 percent chromium alloy steel Forged - ASTM A182 Grade F11 Cast-ASTM A17 Grade WC6
d)	2 - 1/4 CR	2-1/4 percent chromium alloy Steel Forged - ASTM A 182 Grade F22

		Cast - ASTM A 217Grade WC9
e)	5CR	Five percent chromium alloy steel Forged - ASTM A 182Grade F5 Cast - ASTM A 217 Grade C5.
f)	SS	Stainless Steel AISI Type 316 ASTMA351 Grade CF8M

2) Body material shall be selected by the bidder to be compatible with the nature of the fluid, service conditions, and piping material to which it is welded and shall be subjected to Owner approval. In general, cast or forged carbon steel bodies shall be provided for non-corrosive process applications up to 275 Deg.C. Alloy Steel castings shall be provided when the media is non-corrosive and the temperature exceeds 275 Deg.C and is within 550 Deg.C. Stainless Steel of suitable grade shall be provided when media is corrosive and the temperature is below 300 Deg.C.

Sr. No.	Service	Body Material
1.	Non Corrosive, Non Flashing, and non cavitations service for process temp. up to 275 deg. C	Cast Carbon Steel ASTM A216 Gr. WCB/WCC
2.	Non Corrosive, Non Flashing, and non cavitations service for process temp. above 275 deg. C. and up to 550 deg. C.	Cast Alloy Steel ASTM A217 Gr. WC9
3.	Severe Flashing/ cavitations service	Cast Alloy Steel ASTM A217 Gr. WC9
4.	Low Flashing/ cavitations service below 275 deg. C.	Cast Alloy Steel ASTM A217 Gr. WC6
5.	DM Water Application	Cast type 316 Stainless Steel ASTM A351 Gr. CF8M

3) Unless otherwise specified, all control valves shall have stems, guide bushings, plugs, seat rings, stem lock pins, stuffing box parts, and other trim, all made of stainless steel. Valve guide posts and bushings shall be Stellite faced for valves where specified. Stellite faced guide posts and bushings shall be differential hardened. For applications involving high pressure drop as also for flashing and cavitation services, trim material shall be properly chosen to ensure required degree of hard facing (such as17-4 PH SS) so as to avoid erosion.

Sr. No.	Service	Trim Material
1.	Non Corrosive, Non Flashing, and non cavitations service for process temp. up to 275 deg. C.	SS316 Stellited
2.	Non Corrosive, Non Flashing, and non cavitations service for process temp. above 275 deg. C. and up to 550 deg. C.	SS316 Stellited
3.	Severe Flashing/ cavitations service	440 SS
4.	Low Flashing/ cavitations service	17-4 PH SS
5.	DM Water Application	17-4 PH SS

4) Where stellite facing is not specified, hardened stainless steel shall be furnished for all surfaces subject to wear.

5) Manufacturer recommended materials for cage guided valves may be substituted for materials specified provided they satisfy the specified service conditions. Also where substitutions are made, the manufacturer shall guarantee performance of

recommended materials to be equal to or better than the specified materials for conditions specified.

Bidder may offer valve with body and trim material better than the specified material and in such case, bidder shall furnish the comparisons of properties including cavitations resistance, corrosion resistance, temp. resistance, erosion resistance, hardness etc. of the offered material vis a vis specified material for owner approval.

10.4.5 **End Preparation**

1) Valve body ends shall be butt-welded type.

2) Flanged ends shall be of a pressure class equal or greater in pressure-temperature rating to the body design pressure and temperature indicated on the control valve. Unless otherwise specified, steel flanges shall be raised face type. Flanged ends for valves shall be in accordance with ANSI B 16.5.

3) Welded end for control valves where specified shall be socket-weld per ANSI B 16.11 for control valves of sizes 50 mm (2") and below and Butt welded connections per ANSI B16.25 for control valves 65 mm (2-1/2") and above. The end preparation for butt welded control valves shall be matched to the corresponding details for the piping on which the valve is installed.

4) All end preparations shall be as per Owners requirements indicated during Contract stage.

10.4.6 **Valve Actuators**

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

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

The travel time of the pneumatic actuators shall not exceed 10 seconds.

10.4.7 **Control Valve Accessory Devices**

All pneumatically actuated control valve accessories such as air locks, hand Wheels/hand-jacks, limit switches, Microprocessor based Positioner, diffusers, external volume chambers, position transmitters (capacitance or resistance type only), reversible pilot for Positioner, tubing and air sets, solenoid valves and junction boxes etc shall be provided as per the requirements.

1) Specifications for Microprocessor Based Positioners:

1	**Electrical**	a) Input signal	4-20 mA
		b) Power Supply	Loop powered from the output card of Control system.
		c) Hart Protocol	Compatibility for remote calibration & diagnostics (Super-imposed Hart signal on input signal (4-20 mA)
		d) Valve position	Non-contact type position sensing with 4-20 mA output signal

2	**Environment**	a) Operating temp	-30 to 80 Deg C
		b) Humidity	0-95 %
		c) Protection Class	IP-65 Minimum
3	**Test reports / Certificates**	Factory Valve Signature Tests reports (Pr vs valve travel and reports/ travel vs I/P signal) are to be provided.	
		Test certificates as per manufacture standard / relevant standard are to be submitted	
4	**Configuration / Calibration**	Remote calibration, auto & manual calibration shall be possible. Universal HART calibrator to be provided.	
5	**Operating**	Operating Range	Full range & split range signal.
6	**Modes**	Valve Action	Direct & Reverse valve action(selectable)
		Flow characterization	Possible to fit valve characteristic curve – Linear & Equal Percentage.
7	**Fail safe / Fail Freeze**	Fail safe/Fail freeze feature is to be provided. (In case, the fail freeze feature is not intrinsic to the positioner, Bidder shall achieve the same externally through solenoid valve connected in the pneumatic circuit).	
8	**Pneumatic**	Air capacity	Sufficient to handle the valves selected/ boosters to be supplied if required.
		Air supply pressure	To suit air supply pressure/quality available.
		Process connection	1/4 inch NPT
9	**Electrical cable entry**	1/2-NPT, side or bottom entry to avoid water ingress.	
10	**Performance**	Characteristic Deviation	<=0.5 % Of Span
		Ambient Temp Effect	<=0.01 % / Deg C Or Better
11	**EMC & CE Compliance**	Required to International Standard like EN/IEC.	En50081-2& En50082 Or Equivalent
12	**Accessories**	In-built operator panel	Display with push buttons for configuration and display on the positioner itself (password protected/hardware lock).
		Press gauge block	For supply & output pressure.
		Mounting assembly	On as required basis.

2) Limit Switches:

Valves shall be provided with limit switches. Switches shall have not less than two normally open and two normally closed contacts in both open and close directions. Electrical rating of the limit switch contacts shall be 240V AC, 5 amp or 220V DC, 0.5 amp, limit switches should be micro switch type or owner approved equal. The enclosures of the limit switches shall be as per NEMA-4 Standard. Limit switches shall be constructed to withstand the temperatures encountered in the actual service. Explosion proof construction shall be furnished where required by applicable code or these specifications. Limit switches shall be factory mounted on the valves with check limit s w i t c h operation prior to shipment.

Limit/micro switches can be offered as an integral part of Smart valve Positioner.

3) Solenoid Valves:

a) Solenoid valves shall be selected to incorporate body construction, trim materials and internal arrangements suitable to the application and shall be acceptable to the Owner. Solenoid enclosures shall be NEMA-4 / IP 65 unless otherwise

specified. Solenoid coils shall be Class-H High temperature construction and shall be suitable for continuous duty.

b) Each solenoid valve shall be furnished with form U internal valve arrangement, Class H high temperature coil, threaded conduit connection, and other electrical and mechanical requirements as specified. The complete data such as material of construction, coil ratings, connection sizes, body rating etc shall be furnished along with the proposal. These shall be subject to Owner approval during detailed engineering stage.

c) Solenoid valves shall be provided with pneumatic operated control valves/dampers hooked up with process interlock requirements and where direct tripping is involved. The number of ways for solenoid valve shall be provided as indicated below, however the no. of ways for solenoid valve shall be based on client approval during detail engineering and same has to be supplied by bidder without any commercial or price implication.

- Two (2) way solenoid valves shall be provided, where process line of less than 50mm with low pressure and temperature application.
- Three (3) way solenoid valve shall be provided commonly, where the pressure is admitted or exhausted from a diaphragm valve or single acting cylinder, e.g, Pneumatic operated spray water block valve.
- Four (4) way solenoid valve shall be provided for operating double acting cylinders, e.g, Pneumatically operated on-off type dampers.
- All solenoid shall be with varistor, LED indication, surge suppress diode and circuits and with plug in connector connection.

4) Air Filter Regulator (AFR)

Constant bleed type AFR with an accuracy of ± 1.0 % inlet pressure range of 5-8 kg/ cm2 and suitable spring ranges (AFR) for use with positioners in control valves, control damper, E/P convertors and shut off valves for phosphor bronze filter element; Filtering particles above five microns. Weather and water proof enclosure. Material of accessories will be SS316.

Air filter regulators shall be provided as follows:

(a) Air supply line to valve positioners / power cylinders
(b) Air supply line to electric to pneumatic converters.
(c) Air supply line to pneumatic interlocked block valves.
(d) For each instrument rack, field instruments enclosure for purging.

5) Power Cylinders (Pneumatic)

Mounting Type	:	a) Fixed position mounting (End mounting). b) Trunnion mounting
Control Signal	:	0.2 to 1 Kg/Sq. cm. from I/P converter for modulating purposes. 24V/48VDC operated solenoid valve operating on pneumatic line. The Pilot solenoid will have separate coils for open closing purpose.
Supply Air	:	0-7 Kg / Cm2.
Selection	:	Based upon thrust / torque, stroke length, angular movement, full-scale travel time,

		repeatability, space factor etc. Provision for air-to-open and air-to-close operation
Casing	:	IP-65.
Accessories (as required)	:	a) Air lock relay b) Hand wheel. c) Air filter regulator with gauge. d) Volume Booster. e) Limit Switches. f) Positioner with Input, Output and supply pressure gauges. g) Pilot Solenoid Valve (Double Coil type) h) Position Transmitter (4-20 mA DC linear output, LVDT or non-contact type)
Fail-safe operation	:	Stayput, open or close position on pneumatic / electrical power supply failure as per process safety criteria.
Repeatability	:	Better than 0.5% of full travel.
Hysteresis	:	Less than 1% of full travel.

10.5.0 Flow Elements

The equipment furnished to this specification shall conform exactly to the requirements herein, unless modified by the respective datasheet of the equipment.

a) Orifice Plate

Features	Essential/Minimum Requirements
Type	Concentric as per ASME PTC-19.5 (Part-II), ISA RP-3.2, 1960 or BS-1042
Material	316 SS ▪ Thickness 3 mm for pipe dia. upto 250 mm ▪ 6 mm for main pipe dia above 250 mm ▪ 10 mm for main pipe dia. 500 & above.
Material of branch pipe	Same as main pipe
Root valve type	Globe
Root valve material	316 SS
Root valve size	1 inch
Impulse pipe of same material up to root valve	Required
Tappings	Flanged weld neck. 3 pairs. of tapping.
Beta Ratio	0.34 to 0.7

Beta Ratio calculation to be submitted	Yes
Assembly drg. and flow Vs DP Curves	Yes
Accessories	Root valves, flanges, Vent/drain hole (As required)

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

b) Flow Nozzle

Features	**Essential/Minimum Requirements**
Type	Long radius, welded type as per ASME PTC-19.5 (Part-III) or BS-1042
Material	316 SS
Thickness	Suitable for intended application
Material of branch pipe	Same as main pipe
Root valve type	Globe
Root valve material	316 SS
Root valve size	1 inch
Impulse pipe of same material up to root valve	Required
Tapping	D and D/2 (3 Nos. of tappings)
Beta Ratio	Around 0.7
Beta Ratio calculation to be submitted	Yes
Assembly drg. and flow Vs DP Curves	Yes
Accessories	Root valves, vent and drain hole.

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

The design, material, construction features, manufacture, inspection and testing of flow elements shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards. .

ANNEXURE-XII

ELECTRICAL LOAD LIST FOR EQUIPMENTS / SYSTEMS / PACKAGES
PROJECT : BHUSAWAL 1X 660 MW – FGD system
(FOR INTERNAL USE ONLY)

A) ----------SYSTEM

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]			[11]		[12]			[13]		[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]
Sl. No.	Description of Load	Equipment Tag No.	Location of Load	Type of load (Motor / Non motor^) ^(Heater/Panel)	Voltage (V)	No. of wire (3Ph-3 Wire) (3Ph-4 Wire) (1Ph-2 Wire)	Type of Feeder (DOL/RDOL/SFU/SFC/VFD/Soft Starter)	Name Plate Rating (kW)	Type of Enclosure			Duty		Direction			No of Units		Rated BKW (Shaft Power)	PF	Efficiency	Load Factor (Ratio of BKW to Name Plate Rating)	Emergency Power required for GT Start-up	Emergency Load (Required during Black-Out)	Required for Emergency Shutdown	UPS (Yes/No)	Cable Box Orientation (From NDE-LEFT/RIGHT/TOP)	Cable Size	Rated Current	Starting Current	Switchgear & Panel no.	Control Location (LCS/DCS/ECS/ALL)	Rev Status of Load (P-Prelim.) (Rec-X Int) (F-Final)	Remarks
									WP	e	EX	C	I	U	BI		W	S																	
															IN	NI																		

IMP NOTE

	PROJECT : BHUSAWAL 1X 660 MW – FGD system						Checked By	Approved By	Sheet no.								Rev. No.	Document No.
		Name																
PE&SD System Engineering Group Hyderabad	**Electrical Load List**	Sign.							No. of sheets								Date	**PEMC-XXXX**
		Date																

MOC DETAILS OF THE VACCUM BELT FILTER COMPONENTS

Materials of Construction:

	Model Number	**Material**	**Thickness (mm)**	**Lining Material**	**Lining Thickness (mm)**
	Filter Cloth	PET	1.3	/	/
	Carrying Belt	SBR	25	/	/
	Sealing Belt	Rubber & plastic	8	/	/
	Gypsum Discharge Hopper	CS lining with plastic	/	/	/
		Carbon steel	3		
				Plastic	3

`	**Vacuum Box**	CS lining with rubber			
		Carbon steel	4		
				rubber	3
	Feed Box	CS lining with plastic			
		Carbon steel	5		
				plastic	3
	Frame	CS spray with paint	AS per MDL 6130-109-PVM-H-001		
	Rubber rollers	CS wrap with rubber			
		Carbon steel body	6		
				rubber	8
	Rubber pulleys	CS wrap with rubber			
		Carbon steel body	12		
				rubber	20
	Vacuum Receiver	CS lining with rubber			
		Carbon steel body	6		
				rubber	5
	Vacuum Pump	Surface is CS spray with painting	/	/	/
	Filtrate manifold	CS lining with plastic			
		Carbon steel body	6		
				Plastic	3
	Wash Piping (cake / Cloth / belt)	304ss		/	/

Piping & Valve Material Specification

PROJECT: BHUSAWAL 1X660MW

1. General
   This specification covers the basic requirements for the design and materials of process and utility piping for the Gypsum dewatering system of Flue Gas Desulfurization Plant.

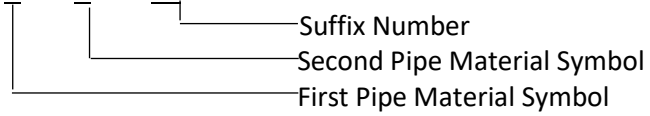
2. Material Selection
   1) Basically, rubber lined pipes are selected to prevent the corrosion and erosion for process service, namely slurry line.
   2) Class AA60 is applied according to process line conditions.
   3) For utility services, other classes are applied.
   4) In principle, piping material will conform to ASTM, but ASTM equivalent material specified by other authorized code may be applied.
   5) Non-asbestos type shall be used for Packing and Gasket.

3. Design of Piping Component
   1) In principle, each component of all piping will be selected from ANSI ASME or international standard in the dimensions and other requirements.
   2) Metric series are applied to the bolt thread.
   3) Nozzle weld tees or extruded tees are used as branch connection in lined piping, in general.
   4) Short radius elbow may be used for 550mm or larger size piping.
   5) Fittings for 50 and smaller galvanized piping shall be of screwed type.

4. Piping Material
   1) Symbols of Piping Service Class

      Piping service class name is composed of the following symbols.

      Example: A A 60

      Note:

First Pipe Material Symbol	
A: Lining	AA: Rubber Lining
B : Stainless Steel/G.I	BA: 304 Stainless steel/G.I
C: Carbon Steel	CA: A53 Gr.B Welded
	CC: A53 Gr.B or AI06 Gr.B/C
	CG: Galvanized

2) Class No. and Fluid Designation

CLASS NO.	FLUID NAME	SYMBOL	
AA60	Gypsum Slurry Filtrate Slurry Waste Water Duct Drain Belt filter Vent Gas	GS FS WW DD VBG	
BA01	Instrument Air Lube Oil (Low Pressure)	AI* LOL	*Inst. Air piping can be GI Pipe also.
CC01	Process Water Raw Water Cooling Water Supply Cooling Water Return Vacuum Pump Vent Antifoam Agent	WP WR WCS WCR VG AA	Note 1

Note I
Class AA60 shall also be applied for process water service line in contact with corrosive and abrasive media.

3) Abbreviations

Abbreviations used throughout this specification are as follows:

BB	:	Bolted Bonnet
BC	:	Bolted Cover
BE	:	Bevel End
BW	:	Butt Weld
CAL	:	Calculation
CR	:	Chloroprene Rubber
E	:	Electric Resistance Weld
EPDM	:	Ethylene Propylene Diene Methylene Rubber
Eq	:	Equal
FE	:	Flange End
FF	:	Flat Face
G. OP	:	Gear Operation
Gal.	:	Galvanized

HEX.	:	Hexagon
IIR	:	Isobutyl Isoprene Rubber
ISRS	:	Inside Screw Rising Stem
La	:	Larger
L.OP	:	Lever Operation
NB	:	Nominal Bore
NW	:	Nozzle Weld
OS&Y	:	Outside Screw & York
PE	:	Plane End
PP	:	Poly Propylene
PTFE	:	Poly Tetra Fluoro Ethylene
RF	:	Raised Face
R/L	:	Rubber lined or rubber seated
S	:	Seamless
SB	:	Screw Bonnet
SC	:	Screw Cover
SCH	:	Schedule No.
SCR'D	:	Screwed
Sm	:	Smaller
SO	:	Slip On
St.	:	Stellite
SW	:	Socket Weld
W	:	Weld
WN	:	Welding Neck
W/LINING	:	With Lining
V#	:	Valve No.
13 CR	:	13% CHROMIUM

CLASS	Max.Press. (MPaG)		1.0		C.A. mm
AA60 (1/1)	Max.Temp. (degC)		70		
FLUID	GYPSUM SLURRY				
ITEM	Size	Thickness	Specification		
PIPING	DN25 - DN50	Heavy	IS 1239 SML PE (I:R/L)		
	DN65 - DN150	Heavy	IS 1239 E.R.W BE (I:R/L)		
	DN200 - DN300	SCH20	IS 3589 Gr.410 E.R.W BE (I:R/L)		
	DN350 - DN400	SCH10	IS 3589 Gr.410 E.R.W BE (I:R/L)		
	DN450 - DN500	SCH10	IS 3589 Gr.410 E.R.W BE (I:R/L)		
	DN550 -DN1000	7.9T	IS 3589 Gr.410 E.R.W BE (I:R/L)		
	DN1100-DN1200	9.5T	IS 3589 Gr.410 E.R.W BE (I:R/L)		
FITTING	DN25 - DN50	Suit to PIPE	SA234 WPB (I:R/L) ASME-B16.9		
	DN65 - DN150	Suit to PIPE	SA234 WPB (I:R/L) ASME-B16.9		
	DN200 - DN300	Suit to PIPE	SA234 WPB (I:R/L) ASME-B16.9		
	DN350 - DN500	Suit to PIPE	SA234 WPB (I:R/L) ASME-B16.9		
	DN550 -DN1000	Suit to PIPE	IS 2062 Gr.B (Plate formed) (I:R/L) ASME-B16.9		
	DN1100-DN1200	Suit to PIPE	IS 2062 Gr.B (Plate formed) (I:R/L) ASME-B16.9		
FLANGE	DN25 - DN600		SO IS2062 Gr.B(Plate) FF (I:R/L) ASME-B16.5 Cl.150		
	DN650 -DN1800		SO IS2062 Gr.B(Plate) FF (I:R/L) AWWA-C207 Cl.B		
PINCH VALVE	DN25 - DN150		PN 16 BODY-A126-B TRIM-13CR SLEEVE-CR LINING-IIR FF HAND WHEEL		
GASKET	DN25 - DN600		V-2000 RUBBER RUBBER OR EQ. ASME150 4.0 mm T FLAT RING		
	DN650 -DN1800		V-2000 RUBBER RUBBER OR EQ. AWWA CL.B 4.0 mm T FLAT RING		
BOLT & NUT	ALL SIZE		STUD U HEAVY NUT A307-GR.B/A563-GR.A FINISHED		

Note: I: R/L - Replaceable Wear Resistant Isobutyl Isoprene rubber lining of minimum 4mm thickness

CLASS	Max.Press. (MPaG)		1		C.A. mm
BA01 (1/1)	Max.Temp. (degC)		45		
FLUID	INSTRUMENT AIR				
ITEM	Size	Thickness	Specification		
PIPING	DN6- DN150	Heavy	IS1239-I (Galv.) SML Screwed		
FITTING	DN6 - DN150	Suit to PIPE	IS1239-II (Galv.) Screwed		
FLANGE	DN6 - DN150		SO IS2062 Gr.B (Galv.) Screwed		
GATE VALVE	DN6 - DN50		API-602 PN 16 Body:A182-F304 Disc:AISI304 Stem:13%CR SW/NPT Thread for Inst Air BB,OS&Y HAND WHEEL		
	DN65 - DN250		ASME-B16.34 PN 16 Body:A351-CF8 Disc:AISI304 Stem:13%CR RF/BW BB,OS&Y HAND WHEEL		
GASKET	DN6 - DN150		V-6500 NON-ASBESTOS OR EQ. ASME150 4.0 mm T FLAT RING		
	DN200- DN250		V-6500 NON-ASBESTOS OR EQ. ASME150 4.0 mm T FLAT RING		
BOLT & NUT	ALL SIZE		STUD U HEAVY NUT A307-GR.B/A563-GR.A FINISHED		

CLASS	Max.Press. (MPaG)		0.11for VG	0.85 for Water	C.A. mm
CC01 (1/1)	Max.Temp. (degC)		155 for VG	45 for Water	
FLUID	WATER, VENT GAS				
ITEM	Size	Thickness	Specification		
PIPING	DN6 - DN50	Heavy	IS1239-I SML Screwed		
	DN65 - DN150	Heavy	IS1239 E.R.W BE		
	DN200 - DN300	SCH20	IS3589 Gr.410 E.R.W BE		
FITTING	DN6 - DN150	Suit to PIPE	BW IS1239-II		
	DN200 - DN300		BW SA234-WPB ASME-B16.9		
FLANGE	DN6 - DN300		SO IS2062 Gr.B(Plate) RF ASME-B16.5 Cl.150		
GATE VALVE	DN6 - DN50		API-602 PN16 Body:A105 Disc& stem:13CR SEAT STELLITE STL SW BB,OS&Y HAND WHEEL		
	DN65 - DN300		ASME-B16.34 PN16 Body:A395/A216WCB Disc& Stem:13CR RF/BW BB,OS&Y HAND WHEEL		
GLOBE VALVE	DN6 - DN50		API-602 PN16 Body:A105 Disc& stem:13CR SEAT STELLITE STL SW BB,OS&Y HAND WHEEL		
	DN65 - DN300		ASME-B16.34 PN16 Body:A395/A216WCB Disc& Stem:13CR RF/BW BB,OS&Y HAND WHEEL		
CHECK VALVE	DN6 - DN50		API-602 PN16 Body:A182 Gr 304 Trim:SS304 SEAT STELLITE STL SW BC,LIFT		
	DN65 - DN300		ASME-B16.34 PN16 A395 13CR RF BC,SWING		
BALL VALVE	DN6 - DN100		ASME-B16.34 PN16 Body:A105 Ball & Stem: AISI304 Seat:PTFE RF BALL LEVER.FULL BORE		
BUTTERFLY VALVE	DN50 - DN150		ASME-B16.34 PN16 Body: A216-WCB Trim:13CR Lining: EPDM Seals: Viton RF WAFER LEVER.		
	DN50 - DN150		ASME-B16.34 PN16 Body: A216-WCB Trim:13CR Lining: EPDM Seals: Viton RF WAFER AIR CYLINDER W/L.SWITCH		
	DN50 - DN150		ASME-B16.34 PN16 Body: A216-WCB Trim:13CR Lining: EPDM Seals: Viton RF WAFER ELECTRIC MOTOR W/L.SWITCH		
	DN200 - DN300		ASME-B16.34 PN16 Body: A216-WCB Trim:13CR Lining: EPDM Seals: Viton RF WAFER WHEEL WITH GEAR		
	DN200 - DN300		ASME-B16.34 PN16 Body: A216-WCB Trim:13CR Lining: EPDM Seals: Viton RF WAFER AIR CYLINDER W/L.SWITCH		
	DN200 - DN300		ASME-B16.34 PN16 Body: A216-WCB Trim:13CR Lining: EPDM Seals: Viton RF WAFER ELECTRIC MOTOR W/L.SWITCH		
GASKET	DN6 - DN150		V-6500 NON-ASBESTOS OR EQ. ASME150 4.0 mm T FLAT RING		
	DN200 - DN300		V-6500 NON-ASBESTOS OR EQ. ASME150 4.0 mm T FLAT RING		
BOLT & NUT	ALL SIZE		STUD U HEAVY NUT A307-GR.B/A563-GR.A FINISHED		

Annexure-XI	MAHAGENCO.	
	BHUSAWAL 1X 660 MW – FGD SYSTEM DATA SHEET – A1 HT/LT MOTORS	SHEET 1 OF 6

Sl. No.	Description	Unit	Specification Requirement	Bidder Details
I	**AC Motors**			
1.0	Application		*	
2.0	Designation & Frame size		*	
3.0	Number of units		As required	
4.0	Manufacturer		*	
5.0	Type of motors		Squirrel cage Induction Motor	
6.0	Supply system fault level			
6.1	HT Motors	kA	44 RMS (112kA Peak)	
6.2	LT Motors	kA	50 RMS (100kA Peak)	
7.0	Rating			
7.1	Rated voltage	kV	3.3 KV for HT 0.415kV for LT	
7.2	Output	kW	*	
7.3	Load factor		*	
7.4	Number of phases and frequency			
7.4.1	HT		3-phase, 3-wire, 50Hz	
7.4.2	LT		3-phase, 3-wire, 50 Hz	
8.0	Speed	rpm	*	
9.0	Duty		Continues	
10.0	Type of duty		S1	
11.0	Reference ambient temperature	Deg. C	50	
12.0	Installation			

REV. NO.						CLIENT:
DATE						M/s MAHAGENCO
REV. BY						PROJECT: BHUSAWAL 1X 660 MW – FGD SYSTEM

Sl. No.	Description	Unit	Specification Requirement	Bidder Details
12.1	Location		Indoor	
12.2	Atmosphere		Salty	
13	Allowable variations in supply Conditions			
13.1	Voltage	%	± 10	
13.2	Frequency	%	± 5	
13.3	Combined	%	10	
14.0	Efficiency	%	*	
15.0	Rated power factor		*	
16.0	Power factor during starting		*	
17.0	Current			
17.1	Full load	Amps	*	
17.2	Starting	% FL	*	
18.0	Method of starting		DOL	
19.0	Insulation			
19.1	Class of insulation		Class F	
19.2	Temperature rise by Resistance method	Deg. C	As per technical spec	
20.0	Type of cooling		As per IS6362	
20.1	HT Motors		CACA/TETV/TEFC	
20.2	LT Motors		TEFC	
21.0	Hazardous area division		As per specification	
22.0	Earthing conductors			
22.1	Material		GS	
22.2	Size	mm	*	
23.0	Miscellaneous			

Sl. No.	Description	Unit	Specification Requirement	Bidder Details
23.1	Shaft orientation & Mounting symbol		*	
24.0	Bearings			
24.1	Make		*	
24.2	Type of Bearing			
24.2.1	Drive end		*	
24.2.2	Non drive end		*	
24.3	Permissible temperature rise for bearings	Dec C	*	
25.0	Permissible vibration limits	Mm/sec	As per IS 325	
26.0	Whether CTs required for differential protection		*	
27.0	CT particulars			
27.1	CT ratio			
27.2	Class		PS/X	
27.3	Knee point voltage (K.P.V)		*	
27.4	Max. Rct, secondary winding resistance	ohm	*	
27.5	Maximum exciting current at ½ (K.P.V)	A	*	
27.6	Class of Insulation		Class B or Better	
28.0	Degree of protection			
28.1	Indoor		IP-54	
28.2	Outdoor		IP-55	
29.0	Terminal Box			
29.1	Degree of protection		IP-55	
29.2	Short time			
	a) Current	kA (RMS)	50/44	

Sl. No.	Description	Unit	Specification Requirement	Bidder Details
	b) Time	secs	0.25	
29.4	Dynamic	kA (peak)	105/112	
30.0	External cable details			
30.1	Type		Al. conductor, XLPE insulated	
30.2	Size		*	
30.3	Number of Cores		3 Cores	
31.0	Normal winding connection	Star / Delta	*	
32.0	Permissible no. of starts		As per spec.	
33.0	Hot thermal withstand time at 110% of the rated voltage.	Sec	As per spec.	
34.0	Starting time at 80% of the rated voltage.	Sec	As per spec.	
35.0	Thermal characteristics, starting characteristics and negative sequence characteristics to be furnished		*	
36.0	Motor reactance		*	
36.1	Sub-transient reactance	PU	*	
36.2	Transient reactance	PU	*	
36.3	Steady state reactance	PU	*	
37.0	Guaranteed losses		*	
37.1	Iron loss	kW	*	
37.2	Copper loss	kW	*	
37.3	Friction, Windage & Stray losses.	kW	*	
38.0	Weights and Dimensions		*	

Sl. No.	Description	Unit	Specification Requirement	Bidder Details
39.0	Paint Shade		RAL 7032 EPOXY BASED	
40.0	Dimensioned drawing enclosed		*	
41.0	Max. value of induced shaft voltage	mV	*	
II	**Motors for Hazardous Area Application**			
42.0	Type of construction		Flame proof type	
43.0	Degree of protection		IP - 55	
	Note: All items indicated above under AC motors are applicable here also.			
III	**Valve Actuator & its Motor**			
44	Application		Valves as per requirement	
45	Degree of protection		IP 68	
46	Indoor / Outdoor / Explosion proof		As per requirement at the location where it is installed	
47	Power supply		*	
48	Actuator type		Integral type	
49	Type of duty & duty designation for motor		Intermittent duty & S2	
50	Class of insulation for motor		Class F but Temperature rise limited to class B	
51	Interposing relays for receiving remote command signal		Required	

Sl. No.	Description	Unit	Specification Requirement	Bidder Details
52	Terminal box		Separate terminal box shall be provided for power and control wiring.	
52.1	Gaskets		Neoprene	
52.2	Terminals for motors		Stud type with plain washers, spring washers and check nuts	

'*' Indicated above shall be filled by the Bidder and submitted along with the Bid**.**

Piping & Valve Material Specification

PROJECT: BHUSAWAL 1X660MW

1. General
   This specification covers the basic requirements for the design and materials of process and utility piping for the Gypsum dewatering system of Flue Gas Desulfurization Plant.

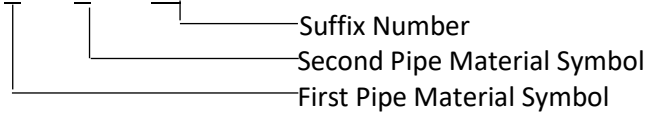
2. Material Selection
   1) Basically, rubber lined pipes are selected to prevent the corrosion and erosion for process service, namely slurry line.
   2) Class AA60 is applied according to process line conditions.
   3) For utility services, other classes are applied.
   4) In principle, piping material will conform to ASTM, but ASTM equivalent material specified by other authorized code may be applied.
   5) Non-asbestos type shall be used for Packing and Gasket.

3. Design of Piping Component
   1) In principle, each component of all piping will be selected from ANSI ASME or international standard in the dimensions and other requirements.
   2) Metric series are applied to the bolt thread.
   3) Nozzle weld tees or extruded tees are used as branch connection in lined piping, in general.
   4) Short radius elbow may be used for 550mm or larger size piping.
   5) Fittings for 50 and smaller galvanized piping shall be of screwed type.

4. Piping Material
   1) Symbols of Piping Service Class

      Piping service class name is composed of the following symbols.

      Example: A A 60

      Note:

First Pipe Material Symbol	
A: Lining	AA: Rubber Lining
B : Stainless Steel/G.I	BA: 304 Stainless steel/G.I
C: Carbon Steel	CA: A53 Gr.B Welded
	CC: A53 Gr.B or AI06 Gr.B/C
	CG: Galvanized

2) Class No. and Fluid Designation

CLASS NO.	FLUID NAME	SYMBOL	
AA60	Gypsum Slurry Filtrate Slurry Waste Water Duct Drain Belt filter Vent Gas	GS FS WW DD VBG	
BA01	Instrument Air Lube Oil (Low Pressure)	AI* LOL	*Inst. Air piping can be GI Pipe also.
CC01	Process Water Raw Water Cooling Water Supply Cooling Water Return Vacuum Pump Vent Antifoam Agent	WP WR WCS WCR VG AA	Note 1

Note I
Class AA60 shall also be applied for process water service line in contact with corrosive and abrasive media.

3) Abbreviations

Abbreviations used throughout this specification are as follows:

BB	:	Bolted Bonnet
BC	:	Bolted Cover
BE	:	Bevel End
BW	:	Butt Weld
CAL	:	Calculation
CR	:	Chloroprene Rubber
E	:	Electric Resistance Weld
EPDM	:	Ethylene Propylene Diene Methylene Rubber
Eq	:	Equal
FE	:	Flange End
FF	:	Flat Face
G. OP	:	Gear Operation
Gal.	:	Galvanized

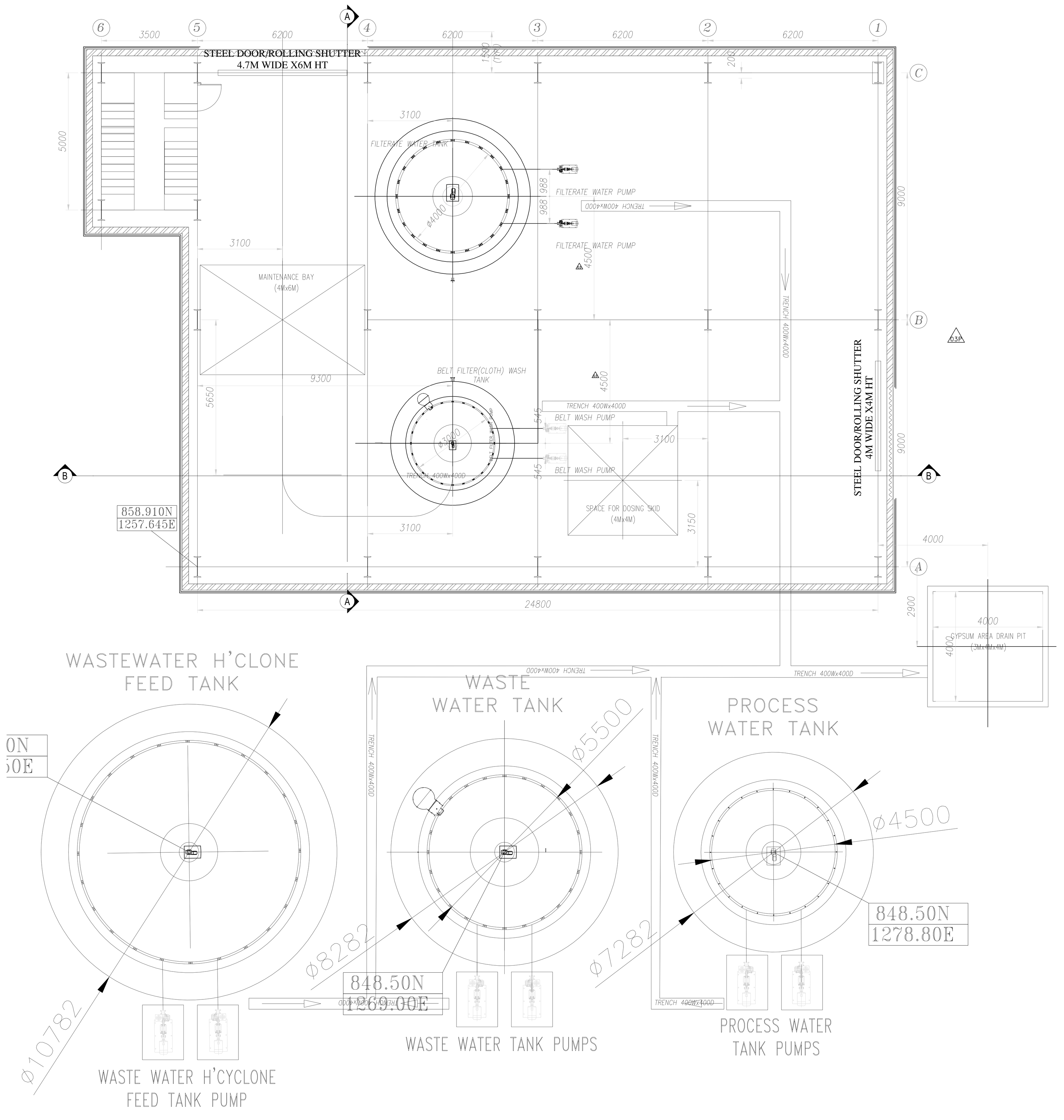
HEX.	:	Hexagon
IIR	:	Isobutyl Isoprene Rubber
ISRS	:	Inside Screw Rising Stem
La	:	Larger
L.OP	:	Lever Operation
NB	:	Nominal Bore
NW	:	Nozzle Weld
OS&Y	:	Outside Screw & York
PE	:	Plane End
PP	:	Poly Propylene
PTFE	:	Poly Tetra Fluoro Ethylene
RF	:	Raised Face
R/L	:	Rubber lined or rubber seated
S	:	Seamless
SB	:	Screw Bonnet
SC	:	Screw Cover
SCH	:	Schedule No.
SCR'D	:	Screwed
Sm	:	Smaller
SO	:	Slip On
St.	:	Stellite
SW	:	Socket Weld
W	:	Weld
WN	:	Welding Neck
W/LINING	:	With Lining
V#	:	Valve No.
13 CR	:	13% CHROMIUM

CLASS	Max.Press. (MPaG)		1.0		C.A. mm
AA60 (1/1)	Max.Temp. (degC)		70		
FLUID	GYPSUM SLURRY				
ITEM	Size	Thickness	Specification		
PIPING	DN25 - DN50	Heavy	IS 1239 SML PE (I:R/L)		
	DN65 - DN150	Heavy	IS 1239 E.R.W BE (I:R/L)		
	DN200 - DN300	SCH20	IS 3589 Gr.410 E.R.W BE (I:R/L)		
	DN350 - DN400	SCH10	IS 3589 Gr.410 E.R.W BE (I:R/L)		
	DN450 - DN500	SCH10	IS 3589 Gr.410 E.R.W BE (I:R/L)		
	DN550 -DN1000	7.9T	IS 3589 Gr.410 E.R.W BE (I:R/L)		
	DN1100-DN1200	9.5T	IS 3589 Gr.410 E.R.W BE (I:R/L)		
FITTING	DN25 - DN50	Suit to PIPE	SA234 WPB (I:R/L) ASME-B16.9		
	DN65 - DN150	Suit to PIPE	SA234 WPB (I:R/L) ASME-B16.9		
	DN200 - DN300	Suit to PIPE	SA234 WPB (I:R/L) ASME-B16.9		
	DN350 - DN500	Suit to PIPE	SA234 WPB (I:R/L) ASME-B16.9		
	DN550 -DN1000	Suit to PIPE	IS 2062 Gr.B (Plate formed) (I:R/L) ASME-B16.9		
	DN1100-DN1200	Suit to PIPE	IS 2062 Gr.B (Plate formed) (I:R/L) ASME-B16.9		
FLANGE	DN25 - DN600		SO IS2062 Gr.B(Plate) FF (I:R/L) ASME-B16.5 Cl.150		
	DN650 -DN1800		SO IS2062 Gr.B(Plate) FF (I:R/L) AWWA-C207 Cl.B		
PINCH VALVE	DN25 - DN150		PN 16 BODY-A126-B TRIM-13CR SLEEVE-CR LINING-IIR FF HAND WHEEL		
GASKET	DN25 - DN600		V-2000 RUBBER RUBBER OR EQ. ASME150 4.0 mm T FLAT RING		
	DN650 -DN1800		V-2000 RUBBER RUBBER OR EQ. AWWA CL.B 4.0 mm T FLAT RING		
BOLT & NUT	ALL SIZE		STUD U HEAVY NUT A307-GR.B/A563-GR.A FINISHED		

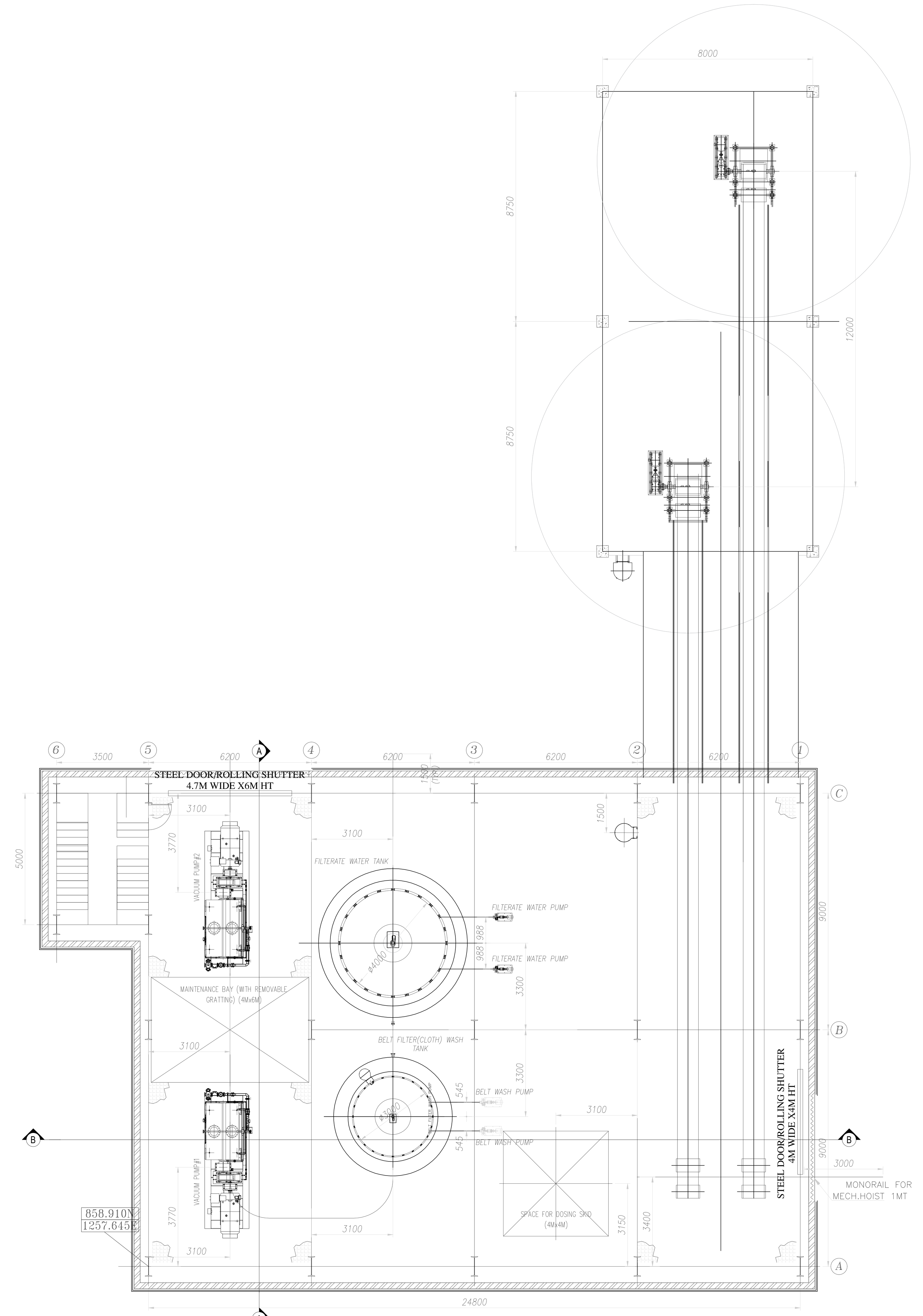
Note: I: R/L - Replaceable Wear Resistant Isobutyl Isoprene rubber lining of minimum 4mm thickness

CLASS	Max.Press. (MPaG)		1		C.A. mm
BA01 (1/1)	Max.Temp. (degC)		45		
FLUID	INSTRUMENT AIR				
ITEM	Size	Thickness	Specification		
PIPING	DN6- DN150	Heavy	IS1239-I (Galv.) SML Screwed		
FITTING	DN6 - DN150	Suit to PIPE	IS1239-II (Galv.) Screwed		
FLANGE	DN6 - DN150		SO IS2062 Gr.B (Galv.) Screwed		
GATE VALVE	DN6 - DN50		API-602 PN 16 Body:A182-F304 Disc:AISI304 Stem:13%CR SW/NPT Thread for Inst Air BB,OS&Y HAND WHEEL		
	DN65 - DN250		ASME-B16.34 PN 16 Body:A351-CF8 Disc:AISI304 Stem:13%CR RF/BW BB,OS&Y HAND WHEEL		
GASKET	DN6 - DN150		V-6500 NON-ASBESTOS OR EQ. ASME150 4.0 mm T FLAT RING		
	DN200- DN250		V-6500 NON-ASBESTOS OR EQ. ASME150 4.0 mm T FLAT RING		
BOLT & NUT	ALL SIZE		STUD U HEAVY NUT A307-GR.B/A563-GR.A FINISHED		

CLASS	Max.Press. (MPaG)		0.11for VG	0.85 for Water	C.A. mm
CC01 (1/1)	Max.Temp. (degC)		155 for VG	45 for Water	
FLUID	WATER, VENT GAS				
ITEM	Size	Thickness	Specification		
PIPING	DN6 - DN50	Heavy	IS1239-I SML Screwed		
	DN65 - DN150	Heavy	IS1239 E.R.W BE		
	DN200 - DN300	SCH20	IS3589 Gr.410 E.R.W BE		
FITTING	DN6 - DN150	Suit to PIPE	BW IS1239-II		
	DN200 - DN300		BW SA234-WPB ASME-B16.9		
FLANGE	DN6 - DN300		SO IS2062 Gr.B(Plate) RF ASME-B16.5 Cl.150		
GATE VALVE	DN6 - DN50		API-602 PN16 Body:A105 Disc& stem:13CR SEAT STELLITE STL SW BB,OS&Y HAND WHEEL		
	DN65 - DN300		ASME-B16.34 PN16 Body:A395/A216WCB Disc& Stem:13CR RF/BW BB,OS&Y HAND WHEEL		
GLOBE VALVE	DN6 - DN50		API-602 PN16 Body:A105 Disc& stem:13CR SEAT STELLITE STL SW BB,OS&Y HAND WHEEL		
	DN65 - DN300		ASME-B16.34 PN16 Body:A395/A216WCB Disc& Stem:13CR RF/BW BB,OS&Y HAND WHEEL		
CHECK VALVE	DN6 - DN50		API-602 PN16 Body:A182 Gr 304 Trim:SS304 SEAT STELLITE STL SW BC,LIFT		
	DN65 - DN300		ASME-B16.34 PN16 A395 13CR RF BC,SWING		
BALL VALVE	DN6 - DN100		ASME-B16.34 PN16 Body:A105 Ball & Stem: AISI304 Seat:PTFE RF BALL LEVER.FULL BORE		
BUTTERFLY VALVE	DN50 - DN150		ASME-B16.34 PN16 Body: A216-WCB Trim:13CR Lining: EPDM Seals: Viton RF WAFER LEVER.		
	DN50 - DN150		ASME-B16.34 PN16 Body: A216-WCB Trim:13CR Lining: EPDM Seals: Viton RF WAFER AIR CYLINDER W/L.SWITCH		
	DN50 - DN150		ASME-B16.34 PN16 Body: A216-WCB Trim:13CR Lining: EPDM Seals: Viton RF WAFER ELECTRIC MOTOR W/L.SWITCH		
	DN200 - DN300		ASME-B16.34 PN16 Body: A216-WCB Trim:13CR Lining: EPDM Seals: Viton RF WAFER WHEEL WITH GEAR		
	DN200 - DN300		ASME-B16.34 PN16 Body: A216-WCB Trim:13CR Lining: EPDM Seals: Viton RF WAFER AIR CYLINDER W/L.SWITCH		
	DN200 - DN300		ASME-B16.34 PN16 Body: A216-WCB Trim:13CR Lining: EPDM Seals: Viton RF WAFER ELECTRIC MOTOR W/L.SWITCH		
GASKET	DN6 - DN150		V-6500 NON-ASBESTOS OR EQ. ASME150 4.0 mm T FLAT RING		
	DN200 - DN300		V-6500 NON-ASBESTOS OR EQ. ASME150 4.0 mm T FLAT RING		
BOLT & NUT	ALL SIZE		STUD U HEAVY NUT A307-GR.B/A563-GR.A FINISHED		



PLAN @ EL (-) 0.5m



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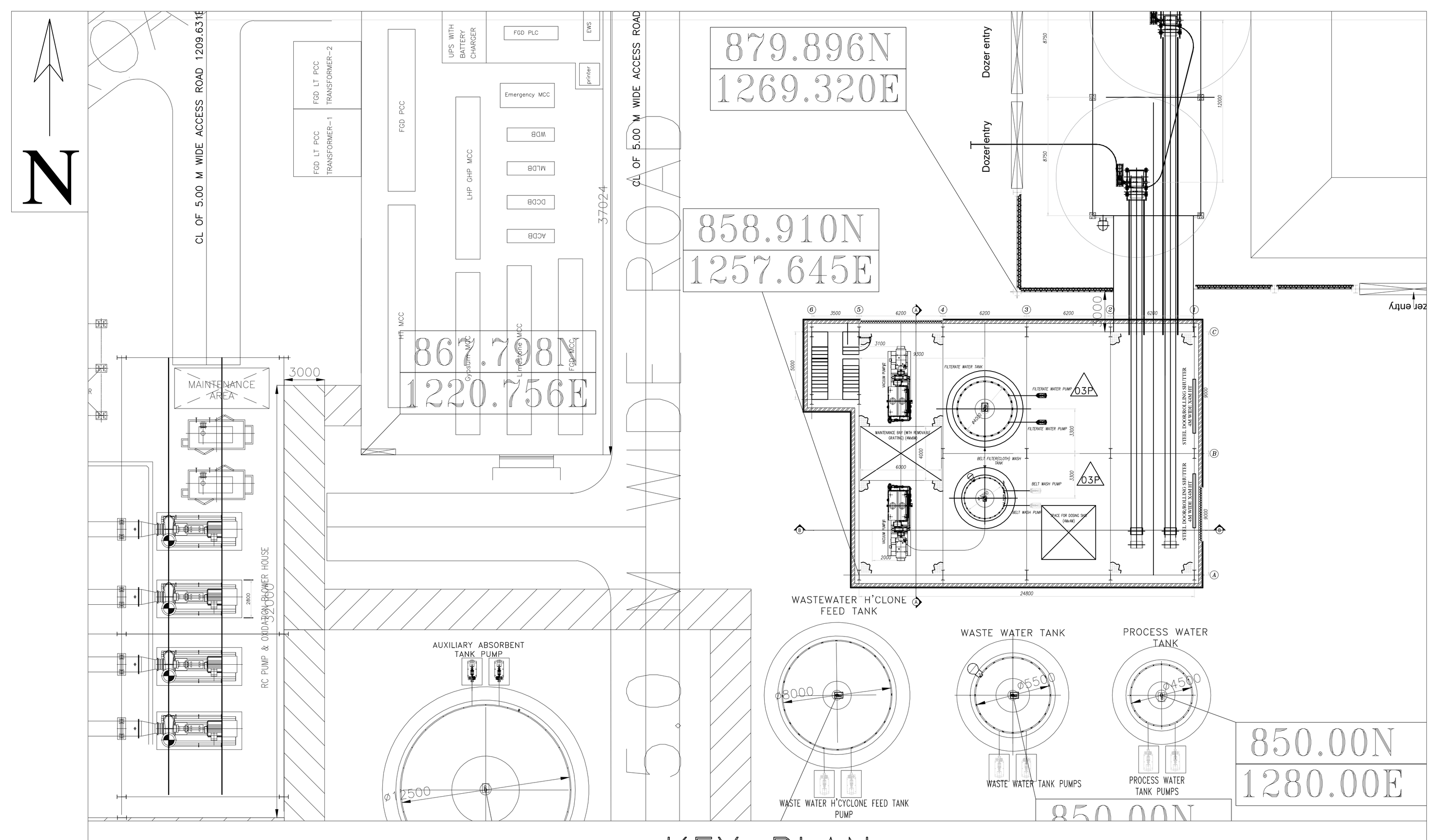


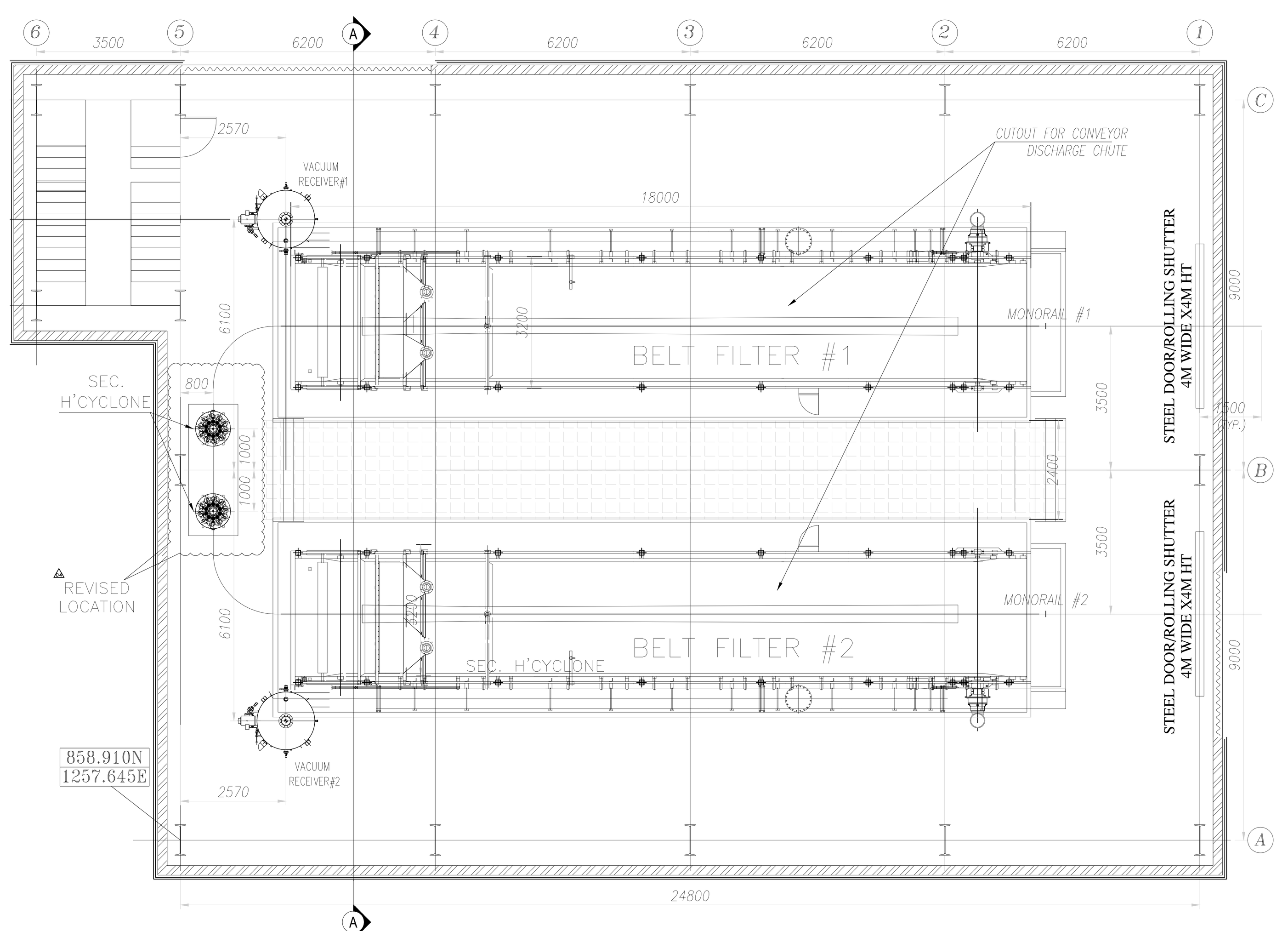
KEY PLAN

EQUIPMENT LIST:

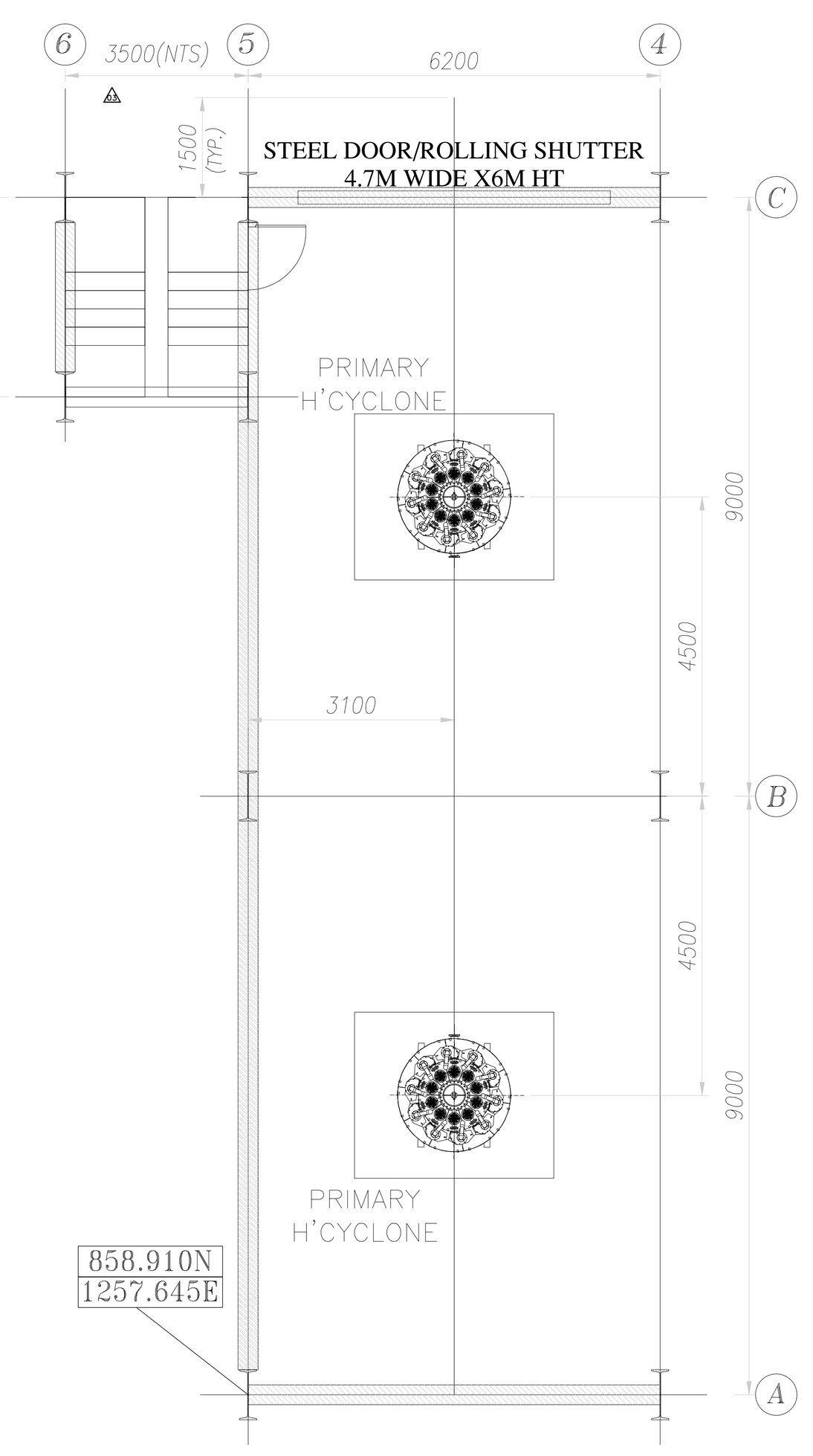
Sl No.	Equipment Description	Not to exceed loads (kg.)
1.	Primary Hydrocyclone	2000
2.	Belt Filter Washing Tank Pump	2000
3.	Belt Filter Washing Tank	10000
4.	Vacuum Belt Filter	80000
5.	Vacuum Receiver	2000
6.	Vacuum Pump	8000
7.	Belt Support Fan A/B	2000
8.	Filtrate water Pump	Later
9.	Filtrate water Tank	Later
10.	Secondary Hydrocyclone	2000

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



PLAN @ EL(+)13.00M



PLAN @ EL(+)21.0M

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS IN METRES.
2. EL (±)0.00M IS FFL OF POWER HOUSE BUILDING WHICH CORRESPONDS TO RL (+)209.00M
3. FGL IN GYPSUM DEWATERING BUILDING AREA IS RL (+)208.00M
4. 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.
5. FLOOR OPENINGS, PIPE CROSSINGS SHALL BE CONFIRMED DURING DETAIL ENGINEERING.
6. DETAILS OF STAIRCASE, SUITABLE DOORS, WINDOWS, VENTILATORS SHALL BE CONSIDERED BY CIVIL DESIGNER FOR GYPSUM DEWATERING BUILDING.

REF. DWGS

1. 0-FW-000-00785 : PLANT LAYOUT OF FGD SYSTEM
2. 3-FW-000-00857 : P&ID OF GDWS

REV	DATE	DRN / CHD & APPD	DESCRIPTION
04	05.04.2022	DRN: RAVI; CHD & APPD: UDAY KUMAR V	GENERALLY REVISED AS PER THE LATEST INPUT
03	13.03.2021	DRN: RAVI; CHD & APPD: UDAY KUMAR V	GENERALLY REVISED AS PER THE LATEST INPUT
02	27.04.2020	DRN: RAVI; CHD & APPD: UDAY KUMAR V	REVISED AS PER CUSTOMER COMMENT
01	10.04.2020	DRN: RAVI; CHD & APPD: UDAY KUMAR V	REVISED AS PER CUSTOMER COMMENT

CUSTOMER NOS: R4U8

CUSTOMER: MAHARASTRA STATE POWER GENERATION CORPORATION.LTD

PROJECT: BHUSAWAL 1x800MW FGD SYSTEM PACKAGE

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

DEPT CODE		NAME	SIGN	DATE
M	DRN	RAVI	-sd-	04.04.20
	CHD	MOQEET M	-sd-	04.04.20
	APPD	UDAY KUMAR V	-sd-	04.04.20

TITLE: ELEVATION/PLAN DETAILS OF GYPSUM DEWATERING BUILDING (SHEET-01)

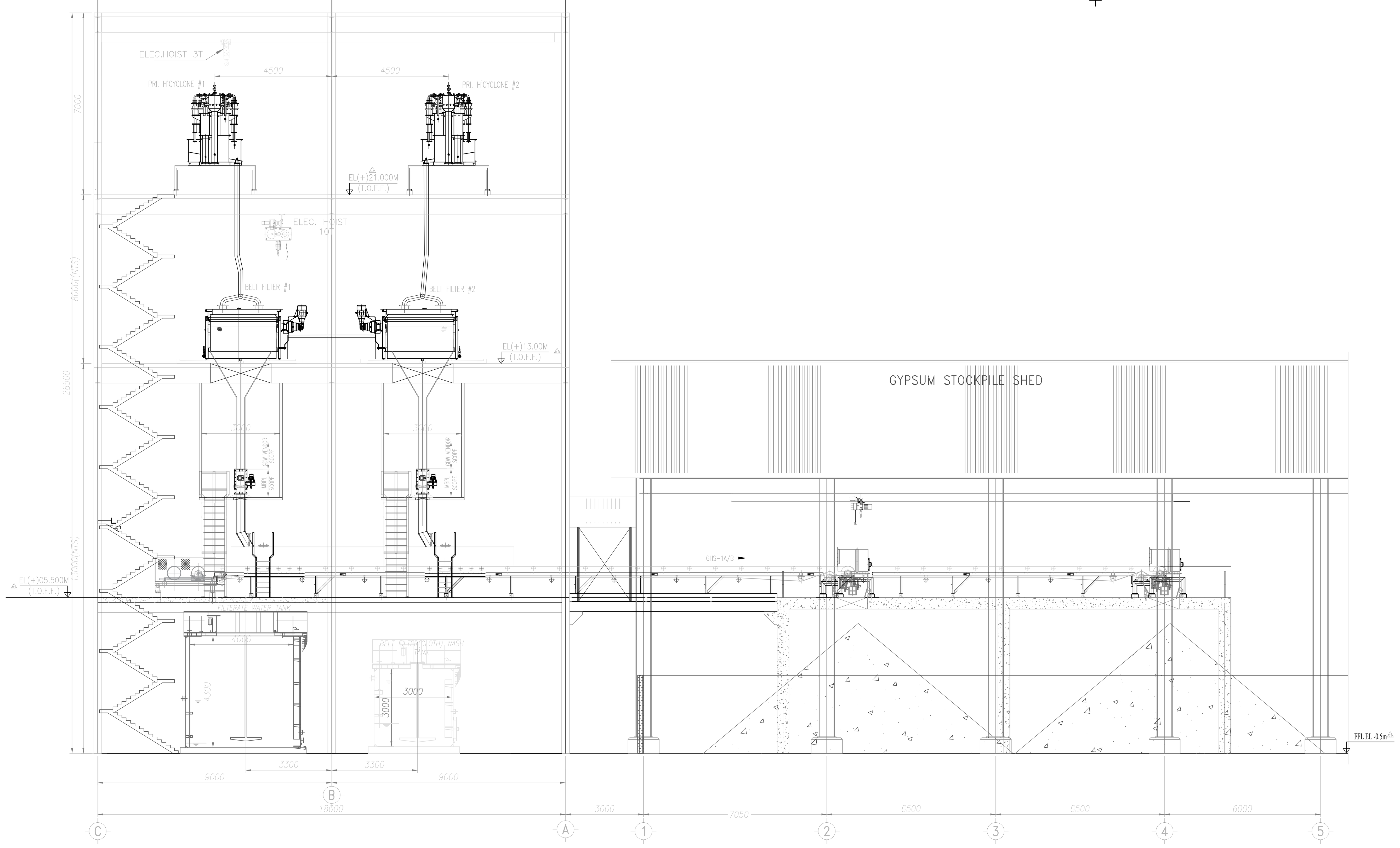
SCALE : 1:100

DRAWING NO. 0-FW-000-00787

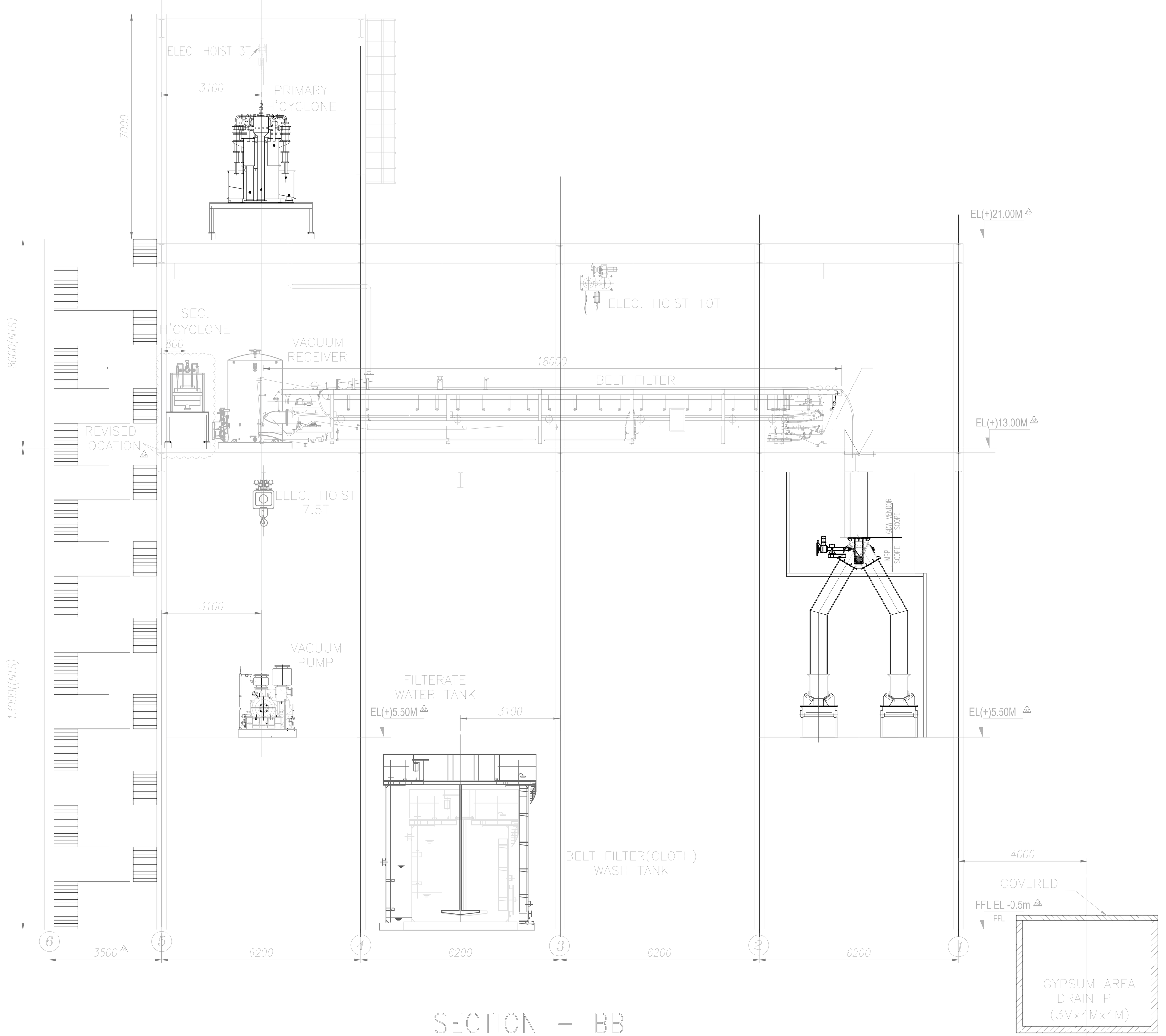
REV. 04

Size A0

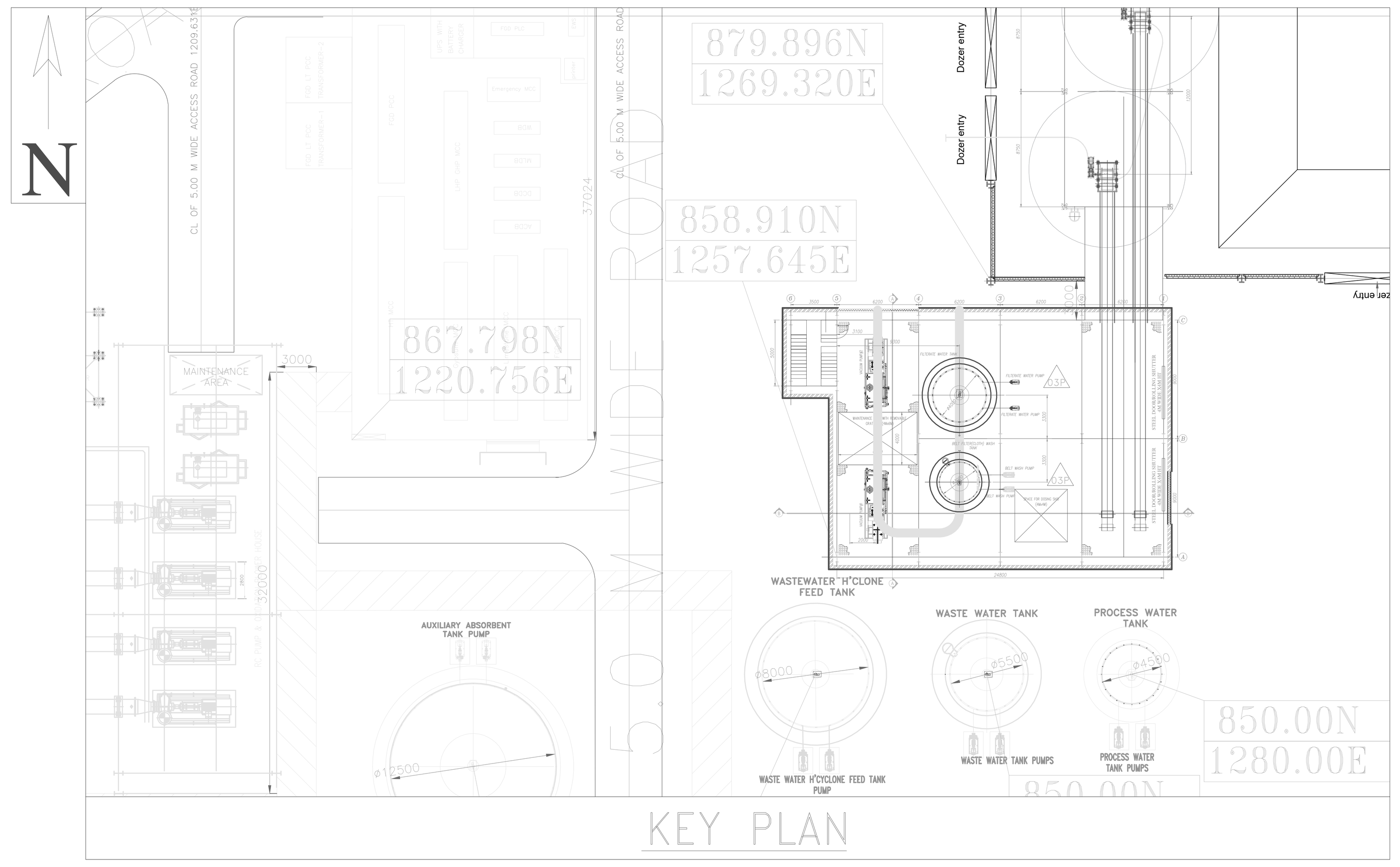
0-FW-000-00787



SECTION - AA
(REF. SHEET-01)



SECTION - BB
(REF. SHEET-01)



KEY PLAN

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3.	Belt Filter Washing Tank	10000
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5.	Vacuum Receiver	2000
6.	Vacuum Pump	8000
7.	Belt Support Fan A/B	2000
8.	Filtrate water Pump	Later
9.	Filtrate water Tank	Later
10.	Secondary Hydrocyclone	2000

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

NOTES:

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2. EL (±)0.00M IS FFL OF POWER HOUSE BUILDING WHICH CORRESPONDS TO RL (+)209.00M
3. FGL IN GYPSUM DEWATERING BUILDING AREA IS RL (+)208.00M
4. 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.
5. FLOOR OPENINGS, PIPE CROSSINGS SHALL BE CONFIRMED DURING DETAIL ENGINEERING.
6. DETAILS OF STAIRCASE, SUITABLE DOORS, WINDOWS, VENTILATORS SHALL BE CONSIDERED BY CIVIL DESIGNER FOR GYPSUM DEWATERING BUILDING.

REF. DWGS

1. 0-FW-000-00785 : PLANT LAYOUT OF FGD SYSTEM
2. 3-FW-000-00857 : P&ID OF GDWS

CUSTOMER NOS: R4U8

CUSTOMER: MAHARASTRA STATE POWER GENERATION CORPORATION.LTD

PROJECT: BHUSAWAL 1x800MW
FGD SYSTEM PACKAGE

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

DEPT CODE		NAME	SIGN	DATE
M	DRN	RAVI	-sd-	10.04.20
	CHD	MOQEET M	-sd-	10.04.20
	APPD	UDAY KUMAR V	-sd-	10.04.20

TITLE: ELEVATION/PLAN DETAILS OF GYPSUM DEWATERING BUILDING (SHEET-02)

SCALE : 1:90

DRAWING NO. 0-FW-000-00787

REV. 04

Size A0

BHUSAWAL TPS (1X660MW) FGD PACKAGE

PAINTING SCHEME FOR FGD SYSTEM

CUST ORDER REF: 48/PPMM/SE-IV/Panki Extn.dt. 31.03.2018

BHEL RANIPET Customer No(s).: R4U8& R673 (for GAD)

Prepared By	Reviewed & Approved By
	
Rajamanickam M **Dy. Mgr/QA**	**K.C. Gandhi Parimalam** **DGM/QA**

Sl No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	

RECORD OF REVISION

REV NO	DATE	DETAILS OF REVISION
00	25.04.2019	Original Issue - First Submission
01	08.05.2019	Revised Issue- Changes as per the comments incorporated in the document
02	19.10.2019	Revised Issue- New PGMAs added under FGD system and Engg has deleted some PGMAs too as they have been amalgamated , hence addition & deletion of new PGMAs done under Sl nos: 3,5,13, 15, 17, 19, 20, 22, 23, 24, 26, 27, 29, 31, 36, 37, 40, 41, 45, 46& 48 under FGD and resubmitted for your kind approval. There is no change in the painting scheme, only the PGMAs are added/deleted under the above mentioned Sl nos. We request you to kindly review and approve our painting scheme.

Sl No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	

1. FGD SYSTEM

1	Slurry recirculation pump System	FW 212	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140
2	Absorber system internals (Structural items)	FW 213	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140
3	Mist eliminator & Accessories, Absorber baffle support, Mist eliminator support& Spray pipe support (Structural Items)	FW 215 FW 216 FW 217 FW 218	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140
4	Absorber System- Base (Structural CS surfaces)	FW 219	Blast Cleaning to Sa 2.5 Near White metal with surface roughness profile to 40-60 µm	**Primer**: One coat of Inorganic Zinc silicate primer to IS 14946, (Solid by volume- 60% (min)), DFT = 75 µm per coat; DFT- 75µm **Intermediate:** One coat of Polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min)) DFT = 100 µm per coat	75 100	**Finish:** One coat of Polyamide cured Epoxy based finish coat (solid by volume- 40% (min)) DFT = 40 µm per coat **Shade: Grey white RAL9002**	40	215
5	Absorber system structures & Absorber shear plate	FW 220 FW 231	Blast Cleaning to Sa 2.5 Near White metal with surface	**Primer**: One coat of Inorganic Zinc silicate primer to IS 14946, (Solid by volume- 60% (min)), DFT = 75 µm per coat; DFT- 75µm	75 100	**Finish:** One coat of Polyamide cured Epoxy based finish coat (solid by volume- 40% (min)) DFT = 40 µm per coat **Shade: Grey white RAL9002**	40	250

Sl No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
			roughness profile to 40-60 µm	**Intermediate:** One coat of Polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min)) DFT = 100 µm per coat		**Finish coat at site:** One coat of Two pack Aliphatic Acrylic PU finish Paint to IS 13213 (solid by volume- 40% (min)), DFT = 35 µm per coat; DFT- 35 µm **Shade: Grey white (RAL 9002)**	35	
6	Absorber system casing bottom (Outside surfaces)	FW 221	Blast Cleaning to Sa 2.5 Near White metal with surface roughness profile to 40-60 µm	**Primer**: One coat of Inorganic Zinc silicate primer to IS 14946, (Solid by volume- 60% (min)), DFT = 75 µm per coat; DFT- 75µm **Intermediate:** One coat of Polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min)) DFT = 100 µm per coat	75 100	**Finish:** One coat of Polyamide cured Epoxy based finish coat (solid by volume- 40% (min)) DFT = 40 µm per coat **Shade: Grey white RAL9002**	40	215
7	Absorber system casing top (Outside surfaces)	FW 222	Blast Cleaning to Sa 2.5 Near White metal with surface roughness profile to 40-60 µm	**Primer**: One coat of Inorganic Zinc silicate primer to IS 14946, (Solid by volume- 60% (min)), DFT = 75 µm per coat; DFT- 75µm **Intermediate:** One coat of Polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min)) DFT = 100 µm per coat	75 100	**Finish:** One coat of Polyamide cured Epoxy based finish coat (solid by volume- 40% (min)) DFT = 40 µm per coat **Shade: Grey white RAL9002**	40	215
8	Absorber system accessories Temp<90°C	FW 223	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140

Sl No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
9	Emergency Quench water tank- Outside surfaces	FW 226	Blast Cleaning to Sa 2.5 Near White metal with surface roughness profile to 40-60 µm	**Primer**: One coat of Inorganic Zinc silicate primer to IS 14946, (Solid by volume- 60% (min)), DFT = 75 µm per coat; DFT- 75µm **Intermediate:** One coat of Polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min)) DFT = 100 µm per coat	75 100	**Finish:** One coat of Polyamide cured Epoxy based finish coat (solid by volume- 40% (min)) DFT = 40 µm per coat **Shade: Grey white RAL9002**	40	215
10	Emergency Quench water tank- Inside surfaces	FW 226	Blast cleaning to Sa 2½ (Near white metal) with surface profile 35-50µm	**Primer Coat:** Two coats of Red Oxide Zinc phosphate primer to IS 12744 DFT- 60µm (min)				
11	Emergency quench system	FW 227	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140
12	Absorber- W/D interface (Structural items)	FW 228	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140
13	W/D Wash system, Air oxidation system Temp<90°C	FW 229 FW 230	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140
14	Duct supports between Bypass & Absorber	FW 232	Blast Cleaning to Sa 2.5 Near White metal with surface roughness profile to 40-60 µm	**Primer**: One coat of Inorganic Zinc silicate primer to IS 14946, (Solid by volume- 60% (min)), DFT = 75 µm per coat; DFT- 75µm **Intermediate:** One coat of Polyamide cured Epoxy based MIO pigmented Intermediate coat (solid	75 100	**Finish:** One coat of Polyamide cured Epoxy based finish coat (solid by volume- 40% (min)) DFT = 40 µm per coat **Shade: Grey white RAL9002**	40	215

Sl No	SURFACE LOCATION		PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
					PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
					by volume- 80% (min)) DFT = 100 µm per coat				
15	Duct support between Absorber & Stack		FW 234	Blast Cleaning to Sa 2.5 Near White metal with surface roughness profile to 40-60 µm	**Primer**: One coat of Inorganic Zinc silicate primer to IS 14946, (Solid by volume- 60% (min)), DFT = 75 µm per coat; DFT- 75µm **Intermediate:** One coat of Polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min)) DFT = 100 µm per coat	75 100	**Finish:** One coat of Polyamide cured Epoxy based finish coat (solid by volume- 40% (min)) DFT = 40 µm per coat **Shade: Grey white RAL9002**	40	215
16	Structures for RC Pump house		FW 236	Blast Cleaning to Sa 2.5 Near White metal with surface roughness profile to 40-60 µm	**Primer**: One coat of Inorganic Zinc silicate primer to IS 14946, (Solid by volume- 60% (min)), DFT = 75 µm per coat; DFT- 75µm **Intermediate:** One coat of Polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min)) DFT = 100 µm per coat	75 100	**Finish:** One coat of Polyamide cured Epoxy based finish coat (solid by volume- 40% (min)) DFT = 40 µm per coat **Shade: Grey white RAL9002**	40	215
17	Slurry distribution & Oxidation Air distribution system, Viewing ports& Handling equipment Temp<90°C		FW 239 FW 243 FW 244 FW 249	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140
18	Expansion joint between bypass Temp-150°C	Flue gas swept surface (Inside)	FW 251	Power Tool Cleaning to St3 (SSPC-SP3)	Red Oxide Zinc Phosphate Primer to IS: 12744 (two coats)	70	NIL	--	70
		Insulated surfaces		Power Tool Cleaning to St3 (SSPC-SP3)	HR Aluminium paint to IS 13183 Gr.II (upto 400 deg C) (Two coats)	40	NIL	--	40

Sl No	SURFACE LOCATION		PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
					PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
19	Expansion joint between absorber (Structural portion) Temp-60°C	Flue gas swept surface (Inside)	FW 252	Power Tool Cleaning to St3 (SSPC-SP3)	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two coats)	70	NIL	--	70
		Insulated surfaces		Power Tool Cleaning to St3 (SSPC-SP3)	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140
20	Ducts between Bypass& Absorber Temp-120°C	Flue gas swept surface (Inside)	FW 255	Power Tool Cleaning to St3 (SSPC-SP3)	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two coats)	70	NIL	--	70
		Insulated surfaces		Power Tool Cleaning to St3 (SSPC-SP3)	HR Aluminium paint to IS 13183 Gr.II (upto 400 deg C) (Two coats)	40	NIL	--	40
21	Ducts between Absorber& Stack Temp-55°C to 60°C	Flue gas swept surface (Inside)	FW 257	Power Tool Cleaning to St3 (SSPC-SP3)	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two coats)	70	NIL	--	70
		Insulated surfaces		Power Tool Cleaning to St3 (SSPC-SP3)	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140
22	Duct structure between bypass & Absorber, Absorber & Stack		FW 260 FW 262	Blast Cleaning to Sa 2.5 Near White metal with surface roughness profile to 40-60 µm	**Primer**: One coat of Inorganic Zinc silicate primer to IS 14946, (Solid by volume- 60% (min)), DFT = 75 µm per coat; DFT- 75µm **Intermediate:** One coat of Polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min)) DFT = 100 µm per coat	75 100	**Finish:** One coat of Polyamide cured Epoxy based finish coat (solid by volume- 40% (min)) DFT = 40 µm per coat **Shade: Grey white RAL9002** **Finish coat at site:** One coat of Two pack Aliphatic Acrylic PU finish Paint to IS 13213 (solid by volume- 40% (min)), DFT = 35 µm per coat; DFT- 35 µm **Shade: Grey white (RAL 9002)**	40 35	250

Sl No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
23	Foundation material for duct structures, Absorber, Elevators, RC pump shed & Staircase, Tanks, Pipe racks, Silo Structure	FW 280 FW 281 FW 282 FW 283 FW 740 FW 760 FW 762 FW 763	Temporary rust preventive fluid application as per PRQA 523 DFT- 20µ All Threaded and other surfaces of foundation bolt and its materials shall be coated with temporary rust preventive fluid. During execution of civil works the dried film of coating will be removed using Organic Solvents.					
24	Supporting structure for Emergency Quench water tank &Structures for Elevator	FW 285 FW 292	Blast Cleaning to Sa 2.5 Near White metal with surface roughness profile to 40-60 µm	**Primer**: One coat of Inorganic Zinc silicate primer to IS 14946, (Solid by volume- 60% (min)), DFT = 75 µm per coat; DFT- 75µm **Intermediate:** One coat of Polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min)) DFT = 100 µm per coat	75 100	**Finish:** One coat of Polyamide cured Epoxy based finish coat (solid by volume- 40% (min)) DFT = 40 µm per coat **Shade: Grey white RAL9002** **Finish coat at site:** One coat of Two pack Aliphatic Acrylic PU finish Paint to IS 13213 (solid by volume- 40% (min)), DFT = 35 µm per coat; DFT- 35 µm **Shade: Grey white (RAL 9002)**	40 35	250
25	Elevator and accessories	FW 293	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140

Sl No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
26	Galleries and railings for Staircase & Elevator, Absorber, Tank, Ducts, Platform for Pipe rack& Sub pipe rack, Limestone silo approach platform	FW 237 FW 610 FW 613 FW 722 FW 733 FW 766 FW 767	Gratings & Step treads- Blast cleaning to Sa 2½ / Acid pickling to SSPC-SP8	Hand rails, Gratings- Hot dip galvanizing to 610gms/sq.m (minimum) and to a coating thickness of 80µm (minimum)				
27	Galleries and railings for Staircase & Elevator, Absorber, Tank, Ducts, Platform for Pipe rack& Sub pipe rack, Limestone silo approach platform– Structures other than the above	FW 237 FW 610 FW 613 FW 722 FW 733 FW 766 FW 767	Blast Cleaning to Sa 2.5 Near White metal with surface roughness profile to 40-60 µm	**Primer**: One coat of Inorganic Zinc silicate primer to IS 14946, (Solid by volume- 60% (min)), DFT = 75 µm per coat; DFT- 75µm **Intermediate:** One coat of Polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min)) DFT = 100 µm per coat	75 100	**Finish:** One coat of Polyamide cured Epoxy based finish coat (solid by volume- 40% (min)) DFT = 40 µm per coat **Shade: Grey white RAL9002**	40	215
28	Slurry pumps & accessories.	FW 701	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140
29	Process Water pumps & accessories	FW 702	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140
30	Monorail for hoist & cranes	FW 710	Blast Cleaning to Sa 2.5 Near White metal with surface roughness profile to 40-60 µm	**Primer**: One coat of Inorganic Zinc silicate primer to IS 14946, (Solid by volume- 60% (min)), DFT = 75 µm per coat; DFT- 75µm **Intermediate:** One coat of Polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min)) DFT = 100 µm per coat	75 100	**Finish:** One coat of Polyamide cured Epoxy based finish coat (solid by volume- 40% (min)) DFT = 40 µm per coat **Shade: Grey white RAL9002**	40	215

Sl No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
31	Handling Equipment in FGD- Chain pulleys, Hoists& Manhole door, Air cannon silo, Bag filter& fan assy, Nozzles and Flanges	FW 713 FW 714 FW 717 FW 723 FW 724 FW 725	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140
32	Agitator support	FW 721	Blast Cleaning to Sa 2.5 Near White metal with surface roughness profile to 40-60 µm	**Primer**: One coat of Inorganic Zinc silicate primer to IS 14946, (Solid by volume- 60% (min)), DFT = 75 µm per coat; DFT- 75µm **Intermediate:** One coat of Polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min)) DFT = 100 µm per coat	75 100	**Finish:** One coat of Polyamide cured Epoxy based finish coat (solid by volume- 40% (min)) DFT = 40 µm per coat **Shade: Grey white RAL9002**	40	215
33	Limestone silo structures	FW 730	Blast Cleaning to Sa 2.5 Near White metal with surface roughness profile to 40-60 µm	**Primer**: One coat of Inorganic Zinc silicate primer to IS 14946, (Solid by volume- 60% (min)), DFT = 75 µm per coat; DFT- 75µm **Intermediate:** One coat of Polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min)) DFT = 100 µm per coat	75 100	**Finish:** One coat of Polyamide cured Epoxy based finish coat (solid by volume- 40% (min)) DFT = 40 µm per coat **Shade: Grey white RAL9002** **Finish coat at site:** One coat of Two pack Aliphatic Acrylic PU finish Paint to IS 13213 (solid by volume- 40% (min)), DFT = 35 µm per coat; DFT- 35 µm **Shade: Grey white (RAL 9002)**	40 35	250
34	Limestone Silo- Outside surfaces	FW 731	Blast Cleaning to Sa 2.5 Near White metal with surface roughness profile to 40- 60µm	**Primer**: One coat of Inorganic Zinc silicate primer to IS 14946, (Solid by volume- 60% (min)), DFT = 75 µm per coat; DFT- 75µm **Intermediate:** One coat of Polyamide cured Epoxy based MIO pigmented	75 100	**Finish:** One coat of Polyamide cured Epoxy based finish coat (solid by volume- 40% (min)) DFT = 40 µm per coat **Shade: Grey white RAL9002**	40	215

Sl No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
				Intermediate coat (solid by volume- 80% (min)) DFT = 100 µm per coat				
35	Lime stone Silo- Inside surfaces	FW 731	Blast cleaning to Sa 2½ (Near white metal) with surface profile 35-50µm	**Primer Coat:** Two coats of Red Oxide Zinc phosphate primer to IS 12744 DFT- 70µm (min) (SS lining is inside the Limestone silo, hence primer is only envisaged)	70	NIL	--	70
36	Lime stone Mill- Outside surfaces & Accessories	FW 735	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140
37	Lime stone Mill- Inside surfaces	FW 735	Power Tool Cleaning to St3 (SSPC-SP3)	Primer: Two coats of Red Oxide Zinc phosphate primer to IS: 12744	70	--	--	70
38	Gypsum belt filter and accessories- Structural Mechanical items	FW 738	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140
39	Lime stone slurry storage tank, Auxiliary absorber tank, Filtrate tank, Wastage water tank, Secondary Hydro cyclone feed tank, Process Water tank, Belt filter washing tank, Clarified water tank Neutralization Tank Outside surfaces	FW 742 FW 743 FW 744 FW 745 FW 747 FW 748 FW 785 FW 800 FW 802	Blast Cleaning to Sa 2.5 Near White metal with surface roughness profile to 40-60 µm	**Primer**: One coat of Inorganic Zinc silicate primer to IS 14946, (Solid by volume- 60% (min)), DFT = 75 µm per coat; DFT- 75µm **Intermediate:** One coat of Polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min)) DFT = 100 µm per coat	75 100	**Finish:** One coat of Polyamide cured Epoxy based finish coat (solid by volume- 40% (min)) DFT = 40 µm per coat **Shade: Grey white RAL9002**	40	215

Sl No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
40	Lime stone slurry storage tank, Auxiliary absorber tank, Filtrate tank, Wastage water tank, Secondary Hydro cyclone feed tank, Process Water tank, Belt filter washing tank, Clarified water tank Neutralization Tank& Internal structures Inside surfaces	FW 742 FW 743 FW 744 FW 745 FW 747 FW 748 FW 749 FW 785 FW 800 FW 802	Blast cleaning to Sa 2½ (Near white metal) with surface profile 35-50µm	**Primer:** Two coats of Red oxide Zinc phosphate primer to IS 12744 DFT- 70µm (min) (Liner is given in the inside surfaces of tank)	70	--	--	70
41	Process water pipe accessories& cooling water pipe accessories (Temp<90°C)	FW 751 FW 752	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140
42	Slurry pipe accessories (Temp<90°C)	FW 753	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140
43	Service Air pipe accessories (Temp<90°C)	FW 754	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140
44	Instrument air pipe accessories (Temp<90°C)	FW 755	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140

Sl No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
45	All Valves and fittings (Temp <95°C)	FW 815 to FW 851	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140
46	Structure for Pipe racks, Sub pipe racks Trestle for pipe racks	FW 761 FW 765 FW 768 FW 769	Blast Cleaning to Sa 2.5 Near White metal with surface roughness profile to 40-60 µm	**Primer**: One coat of Inorganic Zinc silicate primer to IS 14946, (Solid by volume- 60% (min)), DFT = 75 µm per coat; DFT- 75µm **Intermediate:** One coat of Polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min)) DFT = 100 µm per coat	75 100	**Finish:** One coat of Polyamide cured Epoxy based finish coat (solid by volume- 40% (min)) DFT = 40 µm per coat **Shade: Grey white RAL9002** **Finish coat at site:** One coat of Two pack Aliphatic Acrylic PU finish Paint to IS 13213 (solid by volume- 40% (min)), DFT = 35 µm per coat; DFT- 35 µm **Shade: Grey white (RAL 9002)**	40 35	250
47	Structures inside Gypsum Dewatering Building & Ball Mill Building	FW 787	Blast Cleaning to Sa 2.5 Near White metal with surface roughness profile to 40-60 µm	**Primer**: One coat of Inorganic Zinc silicate primer to IS 14946, (Solid by volume- 60% (min)), DFT = 75 µm per coat; DFT- 75µm **Intermediate:** One coat of Polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min)) DFT = 100 µm per coat	75 100	**Finish:** One coat of Polyamide cured Epoxy based finish coat (solid by volume- 40% (min)) DFT = 40 µm per coat **Shade: Grey white RAL9002**	40	215
48	Tools, Air receivers, commissioning spares, Mandatory spares	FW 798 FW 988 FW 996	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140

Sl No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	

2. GATES & DAMPERS (Released under R673 WO)

01	Gates & Dampers > 95° C Insulated Surfaces	57 363 57 413 57 560 57 570 57 583 57 603 57 613	Power tool cleaning to St3 (SSPC-SP3)	HR Aluminium paint to IS 13183 Gr. II	40	--	--	40
02	Ladder, Cage for Ladder, Toe Guard Plate Floor Grill, Hand Rails, Hand Rail Post,	57 566 57 666	Hot Dip Galvanizing to 610 gm per Sq. Meter (minimum) and to a coating thickness of 87 µm (minimum)					
03	Other Structural Items – other than sl.no. 3 of above.	57 566 57 666	Power tool cleaning to St3(SSPC-SP3	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two Coats)	70	Synthetic enamel to IS 2932 grey shade 692 of IS 5 (Two coats)	70	140
04	Ducts Commissioning Spares	57 988	As per respective items mentioned in this Painting Scheme					

Sl No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	

3. PAINTING OF DAMAGED AREAS

Areas where paint has deteriorated badly by erosion and areas where the paint film has lost its adhesion property and where the steel has got rusted appreciably - these areas are to be repainted as per the following procedure:

SL NO	SURFACE LOCATION	SURFACE PREPARATION	PRIMER, INTERMEDIATE & FINISH
1	Paint damaged Components falling under FGD Sl nos. 4,5,6,7, 9,14,15,16,22,24,27,30,32,33,34, 39, 46& 47	Hand/ Power Tool cleaning to Bare metal to minimum 6 inches peripheral area adjoining to damaged area	Primer: Epoxy Zinc rich primer to IS 14589, DFT-70µ (If Metal surface exposed) followed by intermediate & finish coat as per respective scheme If primer is intact- Intermediate & finish as per respective scheme
2	Paint damaged components failing under other Sl nos of FGD& GAD	Power Tool Cleaning to Bare metal	Primer and Finish : As given in respective scheme

Sl No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	

GENERAL NOTES

1. No painting is required for Galvanized, non-ferrous & stainless steel items, except as indicated above.
2. Machined items are to be applied with coat of temporary rust preventive oil
3. PGMAs covered in sub-supplier (ie., Purchased) items viz., Agitator and other sub-delivery components etc., are not indicated in the above list. However, the Painting Schedule for all items supplied by all sub-suppliers and BOI under the scope of BHEL shall be same as for main equipment covered in this document.
4. In sub-assy, wherever plates / sheets of thickness less than or equal to 5mm and rods are used, very minor items like clamps, small items etc - Power Tool or Hand Tool Cleaning to SSPC - SP 3 / SP 2 shall be followed and painting under Sl no:01 of FGD shall be followed.
5. Ground shade/colour of finish paints and identification tag/band for equipments, piping, pipe services, supporting structures and other components is followed as per the color coding practice at site.
6. All components covered under different PGMAs are to be painted. In case any component is left out, the same shall deemed to be included under the relevant section.
7. All threaded and other surfaces of foundation bolts and its materials, insulation pins, Anchor channels, Sleeves shall be coated with temporary rust preventive fluid and during execution of civil works; the dried film of coating shall be removed using organic solvents.
8. All steel structures shall be provided with painting as given in the specification. Further, painting system shall also meet the requirements of corrosivity category C3 (durability high) as per ISO 12944.
9. Finish coat to be applied after an interval of min 10 hrs and within 6 months (after completion of intermediate coat).
10. Bottom of base plate including below zero level portion marked in Supporting Columns of structures which will be embedded in concrete, those surfaces shall be prepared by manual cleaning to ST3 and provided with primer coat of chlorinated rubber based zinc phosphate primer of min. 50 µm DFT.

Sl No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	

PAINTING SCHEME- DETAILS OF PROCUREMENT & APPLICATION PROCESSES

SL NO	TYPE OF PAINT	SPECIFICATION OF PAINT	NO OF PACK	VOLUME OF SOLIDS (% Min)	MODE OF APPLICATION	MIN. OVER COATING INTERVAL (hours)	SHADE
01	Inorganic Zinc silicate primer	IS 14946	2	60	Airless Spray only	24	
02	Epoxy High solid-Polyamide cured Epoxy based MIO pigmented **intermediate coat**	--	2	62	Airless Spray only	16	Brown
03	Aliphatic isocyanate acrylic polyurethane paint	IS 13213	2	40	Spray	16	Corresponding shade no
04	Epoxy based polyamide cured finish paint	IS 14209	2	40	Brush/Spray	24	Corresponding shade no
05	Heat resistant aluminium paint	IS 13183 Grade II	1	--	Brush/ Spray	24	--
06	Long oil alkyd Synthetic enamel finish paint	IS 2932	1	35	Brush/ Spray	12	Corresponding shade no
07	Red oxide Zinc phosphate primer	IS 12744	1	--	Brush/ spray	12	--

4.0 LIST OF APPROVED VENDORS – CONTROL & INSTRUMENTATION

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
1.0	**FIELD / PRIMARY INSTRUMENTS:**		
1.1	RTD & THERMOCOUPLES	(a)	PYRO ELECTRIC INSTRUMENTS GOA PVT. LTD.
		(b)	GENERAL INSTRUMENTS CONSORTIUM, MUMBAI
		(c)	DETRIVE, MUMBAI
		(d)	TEMSENS INSTRUMENTS(I) PVT. LTD, UDAIPU
1.2	SMART ELECTRONIC TRANSMITTERS (PRESSURE, DIFF. PRESSURE)	(a)	EMERSON PROCESS MANAGEMENT (I) LTD
		(b)	FUJI, JAPAN
		(c)	YOKOGAWA, JAPAN/ YOKOGAWA INDIA
		(d)	ABB, GERMANY / FARIDABAD
		(e)	HONEYWELL, USA / PUNE
1.3	DISPLACER TYPE LEVEL TRANSMITTER	(a)	CHEMTROL MIL
		(b)	DRESSER, COIMBTORE
		(c)	V-AUTOMAT, DELHI
		(d)	ECKARDT, GERMANY
1.4	LEVEL TRANSMITTERS (DISPLACEMENT TYPE)	(a)	DRESSER MASONIELAN, FRANCE (DRESSER VALVES INDIA LTD. COIMBATORE)
		(b)	CHEMTROLS, MUMBAI (ECKARDT, GERMANY)
		(c)	ECKARDT, GERMANY

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
1.5	LEVEL TRANSMITTERS (ULTRASONIC TYPE)	(d)	ENDRESS+HAUSER, GERMANY/INDIA
		(e)	KROHNE, FRANCE
		(f)	PEPPERL+FUCHS, GERMANY/INDIA
		(g)	VEGA, GERMANY
		(h)	KAB INSTRUMENTS LTD.
1.6	RADAR TYPE LEVEL TRANSMITTERS	(a)	SIEMENS MILLTRONICS
		(b)	ENDRESS & HAUSER
		(c)	SBEM
		(d)	EMERSON
		(e)	AMETEKEDREXELBRROK (CHEMTROLS)
1.7	TEMPERATURE TRANSMITTERS	(a)	EMERSON PROCESS (FORMERLY FISHER ROSEMOUNT), USA/DAMAN
		(b)	ABB, GERMANY / FARIDABAD
		(c)	FUJI, JAPAN
		(d)	HONEYWELL, USA / PUNE
		(e)	YOKOGAWA, JAPAN/ YOKOGAWA INDIA
		(f)	MOORE, USA
1.8	MAGNETIC LEVEL SWITCHES	(a)	LEVCON INSTRUMENTS PVT. LTD., KOLKATA
		(b)	V.AUTOMAT, NEW DELHI
		(c)	ASIAN INDUSTRIAL VALVES, CHENNAI
1.9	LEVEL SWITCHES CONDUCTIVITY TYPE	(a)	BHARAT HEAVY ELECTRICALS LTD.
		(b)	YARWAY, USA

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
		(c)	LEVELSTATE, UK
		(d)	SOLARTON, UK (PRESENTLY CALLED AS MOBREY)
		(e)	CHEMTROL
		(f)	LEVEL STATE (HITECH SYSTEMS)
		(g)	MOBREY
1.10	FLOW SWITCHES	(a)	SWITZER, CHENNAI
		(b)	KRONHE MARSHALL
		(c)	GENERAL INSTRUMENTS MUMBAI
		(d)	CHEMTROL
1.11	BYPASS ROTAMETER	(a)	IEPL, HYDERABAD
		(b)	PLACKA INSTRUMENTS INDIA PVT. LTD., CHENNAI
		(c)	TRAC, HYDERABAD
		(d)	EUREKA, PUNE
1.12	ROTAMETER	(a)	INSTRUMENTATION ENGINEERS PVT. LTD.
		(b)	SIGMA INSTRUMENTS CO.
		(c)	EUREKA INDUSTRIAL EQPT. PVT. LTD.
		(d)	TELACE EQUIPMENT PVT. LTD.
1.13	FLOW INTEGRATOR (ELECTRONIC TYPE)	(a)	ABB, GERMANY / FARIDABAD
		(b)	MASIBUS, GANDHINAGAR
		(c)	YOKOGAWA, JAPAN/ YOKOGAWA INDIA
		(d)	LEKKTROTEK, PUNE
		(e)	EMERSON

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
		(f)	ENDRESS & HAUSER
		(g)	FORBES MARSHALL
1.14	GAUGES (PRESSURE, DIFF. PRESSURE)	(a)	A N INSTRUMENTS PVT. LTD., KOLKATA
		(b)	GENERAL INSTRUMENTS CONSORTIUM, GOA/ MUMBAI
		(c)	GOA THERMOSTATIC INSTRUMENTS, GOA
		(d)	FORBES MARSHALL LTD., HYDERABAD
		(e)	WAAREE INDUSTRIES, MUMBAI
		(f)	H.GURU INSTRUMENTS (SOUTH INDIA), BANGALORE
		(g)	WIKA INSTRUMENTS INDIA PVT. LTD., PUNE
		(h)	GOA INSTRUMENTS PVT. LTD.,
		(i)	MONOMETER, MUMBAI
		(j)	BELLS CONTROLS LTD., KOLKATA
		(k)	SWITZER INSTRUMENTS LTD., CHENNAI
		(l)	WIKA ALEXANDER WIEGAND GMBH&CO., GERMANY
		(m)	BUDENBURG GUAGE CO. LTD
		(n)	INSTRUMENTATION PVT. LTD., BANGALORE
		(o)	INDOSONIC INSTRUMENT, MUMBAI
		(p)	PRECISION
		(q)	ASHCROFT

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
1.15	TEMPERATURE GAUGE	(a)	GOA THERMOSTATIC INSTRUMENTS, GOA
		(b)	GENERAL INSTRUMENTS CONSORTIUM,
		(c)	A.N. INSTRUMENTS PVT. LTD., KOLKATA
		(d)	H. GURU INSTRUMENTS (SOUTH INDIA), BANGALORE
		(e)	FORBES MARSHALL, HYDERABAD
		(f)	WIKA INSTRUMENTS INDIA PVT. LTD., PUNE
		(g)	WAREE, DADRA GOA INSTRUMENTS PVT. LTD.,
		(h)	BELLS CONTROLS LTD., KOLKATA
		(i)	SWITZER INSTRUMENTS LTD., CHENNAI
		(j)	WIKA ALEXANDER WIEGAND GMBH&CO., GERMANY
		(k)	BUDENBURG GUAGE CO. LTD.
		(l)	INDOSONIC INSTRUMENT, MUMBAI
1.16	SWITCHES (PRESSURE, DIFF. PRESSURE)	(a)	INDFOSS INDUSTRIES LTD., GHAZIABAD
		(b)	SWITZER INSTRUMENTS COMPANY, CHENNAI
		(c)	SOR INC., USA
		(d)	PYROELECTRIC, GOA
		(e)	DRESSER INDUSTRIES INC, USA
		(f)	REGULATEURS GEORGIN, FRANCE

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
		(g)	DELTA CONTROLS LTD., U.K.
		(h)	KDG INSTRUMENTS LTD. U.K.
		(i)	ASHCROFT
		(j)	DWAYER, USA
		(k)	GENERAL INSTRUMENTS CONSORTIUM
1.17	TEMPERATURE SWITCH	(a)	INDFOSS INDUSTRIES LTD., GHAZIABAD
		(b)	SWITZER INSTRUMENTS COMPANY, CHENNAI
		(c)	GENERAL INSTRUMENTS CONSORTIUM, MUMBAI
		(d)	SOR INC., USA
		(e)	PYROELECTRIC, GOA DRESSER INDUSTRIES INC, USA
		(f)	REGULATEURS GEORGIN, FRANCE
		(g)	DELTA CONTROLS LTD., U.K.
		(h)	KDG INSTRUMENTS LTD. U.K.
1.18	AIR FILTER REGULATOR	(a)	PLACKA, CHENNAI
		(b)	SHAVO NORGREN, INDIA
1.19	MASS FLOW METER (CORROLIOUS PRINCIPLE)	(a)	EMERSON PROCESS MANAGEMENT (I) LTD
		(b)	ABB
		(c)	YOKOGAWA
		(d)	ENDRESS+ HAUESER
		(e)	GE SENSING & INSPECTION TECHNOLOGIES
		(f)	FORBES MARSHALL

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
1.20	I/P CONVERTER	(a)	ECKHARDT, GERMANY
		(b)	MTL, CHENNAI
		(c)	ABB
		(d)	WATSON SMITH (PRESENTLY NORGREN)
		(e)	EMERSON PROCESS MGMT ASIA PACIFIC LTD.
		(f)	MOORE CONTROLS
1.21	FLOW ELEMENTS	(a)	INSTRUMENTATION LTD.
		(b)	MICRO PRECISION PRODUCTS
		(c)	ENGINEERING SPECIALITIES PVT. LTD.
		(d)	GENERAL INSTRUMENTS
1.22	LEVEL GAUGES (FLOAT TYPE)	(a)	SB ELECTRO
		(b)	SIGMA
		(c)	V AUTOMAT
		(d)	LEVCON
		(e)	CHEMTROLS
		(f)	ASIAN INDUSTRIAL VALVES
1.23	ORP TRANSMITTERS	(a)	FORBES MARSHALL
1.24	DENSITY METER (NUCLEONIC TYPE)	(a)	ENDRESS + HAUSER
		(b)	THERMO MEASURE TECH.
		(c)	CHEMTROL (THERMO FISHER)
1.25	DENSITY METER (NON-NUCLEONIC TYPE)	(a)	ENDRESS + HAUSER
		(b)	THERMO MEASURE TECH.
		(c)	CHEMTROL (THERMO FISHER)

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
1.26	SOLID MASS FLOW METER	(a)	SIEMENS MILLTRONICS
		(b)	CHEMTROL (THERMO FISHER)
		(c)	SIEMENS INSTRUMENTS, CANADA
1.27	PULL CORD SWITCH	(a)	JAYASHREE ELECTRODEVICES PVT. LTD.
		(b)	A.G. SYSTEM CONTROLS, MUMBAI
1.28	BELT SWAY SWITCH	(a)	JAYASHREE ELECTRODEVICES PVT. LTD.
		(b)	A.G. SYSTEM CONTROLS, MUMBAI
1.29	ZERO SPEED SWITCH	(a)	A.G. ELECTRONICS
		(b)	JAYASHREE ELECTRODEVICES PVT. LTD.
1.30	PROXIMITY SWITCH	(a)	AW
		(b)	JAYASHREE ELECTRODEVICES PVT. LTD.
1.31	LEVEL SWITCH (RF TYPE)	(a)	EIP ENVIRO LEVEL CONTROLS
2.0	**DCS, HMI, MONITORING AND PLC SYSTEMS:**		
2.1	DDCMIS	(a)	ABB.
		(b)	YOKOGAWA
		(c)	SIEMENS.
		(d)	BHEL
		(e)	EMERSON PROCESS MANAGEMENT
		(f)	MHI
2.2	PLC	(a)	ALLEN BRADLEY.
		(b)	SCHNEIDER
		(c)	ROCKWELL

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
		(d)	GE FANUC
2.3	MASTER SLAVE CLOCK	(a)	SYMMETRICOM INC., USA
		(b)	HOPF, GERMANY
		(c)	HATHWAY, USA
		(d)	SERTEL ELECTRONICS, CHENNAI
		(e)	ADVANCE MICRONIC
2.4	DOT MATRIX PRINTER	(a)	HP / EPSON / WIPRO / TVS / SAMSUNG
2.5	LASER & COLOUR INKJET PRINTERS	(b)	HP / EPSON / CANON / IBM / XEROX / SAMSUNG
2.6	COMPUTERS FOR OPERATOR / ENGINEER / HISTORY STATION, SHIFT SUPERVISOR, STORIAN, SOFT LINK STATION FOR INTERFACING WITH OTHER SYSTEMS, PERFORMANCE CALCULATION AND SER STATION	(a)	IBM
		(b)	DELL
		(c)	HP/COMPAQ
2.7	TFT MONITOR	(a)	LG / SAMSUNG / HP / COMPAQ / IBM / DELL
2.8	VIBRATION MONITORING SYSTEM & TURBO-SUPERVISORY INSTRUMENTS	(a)	ROCKWELL AUTOMATION, USA
		(b)	BENTLEY NEVADA, USA / INDIA
		(c)	SHINKAWA, JAPAN / FORBES MARSHALL,
		(d)	VIBROMETER, SWITZERLAND
2.9	LARGE VIDEO SCREENS	(a)	BARCO BELGIUM / BARCO, INDIA
		(b)	PLANAR, USA / PYROTECH, INDIA
		(c)	CHRISTIE, USA / CHRISTIE, INDIA

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
		(d)	SYNELEC
		(e)	DELTA, THAILAND / DELTA POWER SYSTEMS, INDIA
2.10	HART COMMUNICATOR	(a)	HONEYWELL, USA/PUNE
		(b)	EMERSON PROCESS (FORMERLY FISHER ROSEMOUNT), USA / DAMAN
		(c)	YOKOGAWA, JAPAN / YOKOGAWA, INDIA
		(d)	MERIAM, USA / CHEMTROLS, MUMBAI
		(e)	ABB, GERMANY / INDIA
		(f)	FUJI, JAPAN
2.11	HART MANAGEMENT SYSTEM	(a)	PEPPERL+FUCKS, GERMANY / INDIA
		(b)	MTL, UK / INDIA
		(c)	EMERSON PROCESS, USA / DAMAN
2.12	ALARM ANNUNCIATION SYSTEM	(a)	PROCON, CHENNAI
		(b)	I I C, HYDERABAD
		(c)	MINILEC, PUNE
		(d)	IIC, MUMBAI
		(e)	PIRIE, MUMBAI
		(f)	PECON, VADODARA
		(g)	POSITRONICS
2.13	RMCMS (ROTATING MACHINE CONDITION MONITORING SYSTEM)	(a)	VIBROTECH (M/S MEGITT INDIA PVT. LTD.)
		(b)	M/S SKF INDIA LTD.
2.14	ACOUSTIC PYROMETER	(a)	BONNENBERG + DRESCHER GMBH, GERMANY

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
2.15	ACOUSTIC STEAM LEAK DETECTION SYSTEM (ASLD)	(a)	HI-TECH SYSTEM & SERVICES LTD, NEW DELHI (AMI MAKE)
		(b)	SARTECH INTL, CHENNAI (INSTROTECH MAKE INSPECTA FFT
2.16	EPABX SYSTEM	(a)	SIEMENS
		(b)	BPL
2.17	FURNACE TV CAMERA SYSTEM	(c)	HITECH SYSTEM & SERVICES LTD. (M/S LENOX INSTRUMENT COMPANY INC., USA
3.0	**ELECTRICAL & SECONDARY INSTRUMENTS:**		
3.1	DIGITAL INDICATOR	(a)	ABB, GERMANY / FARIDABAD
		(b)	MASSIBUS, GANDHINAGAR PYROTECH, UDAIPUR
		(c)	LEKTROTEK, PUNE
		(d)	GOSSEN / CAMILLE BAUER / METRAWATT YOKOGAWA, JAPAN / INDIA
		(e)	SIEMENS
3.2	BARGRAPH INDICATORS	(a)	ABB, GERMANY / FARIDABAD
		(b)	MASSIBUS, GANDHINAGAR
		(c)	PYROTECH, UDAIPUR
		(d)	LEKTROTEK, PUNE
		(e)	GOSSEN / CAMILLE BAUER / METRAWATT
		(f)	M-SYSTEM, JAPAN (CHINO LAXSONS DAMAN)
		(g)	SIEMENS

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
3.3	PEN, POINT AND CHARTLESS RECORDERS	(a)	EUROTHERM, UK
		(b)	TATA HONEYWELL
		(c)	YOKOGAWA, JAPAN (YOKOGAWA, INDIA)
		(d)	CHINO (LAXSON), JAPAN
		(e)	ABB, UK / GERMANY
		(f)	FUJI ELECTRIC, JAPAN
3.4	TRANSDUCERS	(a)	SEIMENS
		(b)	AUTOMATIC ELECTRIC LTD., MUMBAI
		(c)	PYROTECH, UDAIPUR
		(d)	SOUTHERN TRANSDUCERS, CHENNAI
		(e)	ACCORD, PUNE MECO, MUMBAI
		(f)	ABB
		(g)	SITU, MUMBAI
		(h)	RISHABH
		(i)	ADEPT, PUNE
3.5	ELECTRICAL ANALOG (PANEL) METERS	(a)	AUTOMATIC ELECTRIC LTD., MUMBAI
		(b)	MECO, MUMBAI
		(c)	RISHAB, NASIK
3.6	SELECTOR SWITCHES AND CONTROL SWITCHES	(a)	KAYCEE
		(b)	ALSTOM
		(c)	L & T
		(d)	SIEMENS

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
3.7	MOSAIC ANALOG (MOVING COIL) INDICATORS	(a)	GOSSEN, GERMANY
		(b)	WEIGEL, GERMANY
3.8	MOSAIC DIGITAL INDICATORS	(a)	GOSSEN, GERMANY
		(b)	WEIGEL, GERMANY
3.9	INTERPOSING RELAYS FOR COMMAND OUTPUT TO MCC	(a)	JYOTI
		(b)	H&B
		(c)	ALSTOM
		(d)	ELASTA
		(e)	OEN SIEMENS
		(f)	ABB
3.10	RELAYS / AUX. CONTACTORS	(a)	TELEMECANIQUE & CTRLS
		(b)	ABB
		(c)	SIEMENS
		(d)	GEC – ALSTOM
		(e)	L & T
3.11	LIMIT SWITCHES	(a)	BHARTIYA CUTLER & HAMMER, FARIDABAD
3.12	MINIATURIZED PUSH BUTTONS / ILPB (24X48MM) MOSAIC GRID COMPATIBLE	(a)	SIEMENS
		(b)	TEW, GERMANY (OLD NAME SUBKLEW)
4.0	**CONTROL DESKS & PANELS:**		
4.1	UNIT CONTROL PANELS (UCP)/ ELECTRICAL CONTROL PANEL (ECP)/ CONTROL DESK (MOSAIC GRID BASED)	(a)	BHEL EDN
		(b)	PYRO TECH, UDAIPUR
		(c)	INSTRUMENTATION LTD. KOTA
		(d)	KHODAY CONTROL SYSTEMS, BANGALORE

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
		(e)	CHEMIN CONTROLS, PONDICHERRY
4.2	CRT DESK / OPERATOR DESK	(a)	PYRO TECH, UDAIPUR
		(b)	INSTRUMENTATION LTD. KOTA
		(c)	KHODAY CONTROL SYSTEMS, BANGALORE
		(d)	CHEMIN CONTROLS, PONDICHERRY
4.3	MOSAIC GRID/ MOSAIC TILES & OTHER MOSAIC ITEMS	(a)	SYMO, SWITZERLAND
		(b)	TEW, GERMANY (OLD NAME SUBKLEW)
		(c)	PYROTECH
4.4	LOCAL PANELS / DISTRIBUTION BOARDS	(a)	CONTROL & SCHEMATICS
		(b)	PYROTECH
		(c)	RITTAL
		(d)	L&T
4.5	TERMINAL BLOCKS	(e)	ELMEX
		(f)	PHOENIX
		(g)	WAGO
5.0	**ANALYSERS:**		
5.1	SWAS ANALYSERS	(a)	POLYMETRON / ZELLWEGGER – ANALYTICALS
		(b)	ABB
		(c)	ORION, USA
		(d)	ROSEMOUNT ANALYTICAL-CHEMPURE,
		(e)	HACH ULTRA FRANCE,
		(f)	HACH USA

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
		(g)	YOKOGAWA
		(h)	AMETECH
		(i)	FORBES MARSHALL
		(j)	EMERSON
5.2	SWAS (STEAM AND WATER ANALYSIS SYSTEM) PANELS	(a)	ABB KENT, U.K.
		(b)	ABB LTD. FARIDABAD
		(c)	FORBES MARSHAL
		(d)	EMERSON PROCESS MANAGEMENT INSTRUMENTATION LTD., KOTA
		(e)	YOKOGAWA
5.3	CO ANALYSER (IN SITU TYPE)	(a)	AMETEK, USA / SINGAPORE
		(b)	CODEL INTERNATIONAL LTD. UK
		(c)	LAND COMBUSTION UK
5.4	OXYGEN IN FLUE GAS ANALYSER (ZIRCONIA PROBE TYPE)	(a)	AMETEK, USA / SINGAPORE
		(b)	LAND INSTRUMENTS, UK
		(c)	EMERSON PROCESS MANAGEMENT (I) LTD
		(d)	YOKOGAWA, JAPAN
		(e)	ENOTECH, GERMANY
		(f)	ABB, UK
		(g)	TELEDYNE, USA
		(h)	FUJI (AIC)
5.5	SMOKE DENSITY ANALYSER / PARTICULATE EMISSION ANALYSER / OPACITY ANALYSER	(a)	DURAG, GERMANY
		(b)	CODEL, UK
		(c)	LAND COMBUSTION UK

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
		(d)	EMERSON
		(e)	ABB
		(f)	FUJI (AIC)
5.6	NOX / SO2 ANALYSER (IN SITU)	(a)	CODEL, UK
		(b)	FORBES MARSHALL
		(c)	LAND COMBUSTION, UK
5.7	OZONE ANALYSER	(a)	BMT MESSTECHNIK, GMBH
5.8	RESIDUAL OZONE ANALYSER	(a)	ECO SENSORS / KAUFFMANN UMWITTECHNIK .EK
5.9	OZONE LEAK DETECTOR	(a)	OTTPL
6.0	**CONTROL VALVES / ACTUATORS / SOLENOID VALVES:**		
6.1	ELECTRICAL ACTUATORS FOR REGULATING & OPEN / CLOSE VALVES	(a)	ROTORK CONTROL (INDIA) LTD.,
		(b)	AUMA (INDIA) LTD.,
		(c)	LIMITORQUE INDIA LTD.
6.2	PNEUMATIC ACTUATORS-REGULATING & OPEN / CLOSE	(d)	INSTRUMENTATION LTD., PALGHAT
		(e)	KELTRON CONTROLS, KERALA
6.3	SH/RH SPRAY CONTROL VALVES SH/RH SPRAY BLOCK VALVES FEED CONTROL VALVES	(a)	MIL CONTROLS LTD.
		(b)	INSTRUMENTATION LTD. PALGHAT
		(c)	FISHER SANMAR LTD.
		(d)	CONTROL COMPONENT INC., USA
		(e)	HORA (HOLTER REGELARMATUREN GMBH & CO.)
6.4	LFO/HFO CONTROL, AND TRIP VALVES, FLOW CONTROL, PRESSURE	(a)	MIL CONTROLS LTD.
		(b)	INSTRUMENTATION LTD. PALGHAT

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
	CONTROL, TEMP. CONTROL, AND BURNER TRIP VALVES, BALL VALVES	(c)	FOURESS ENGG (I) LTD, BANGALORE
		(d)	SAMSON CONTROLS , PUNE
6.5	SOOT BLOWER PRESSURE REDUCING VALVE	(a)	MIL CONTROLS LTD.
		(b)	INSTRUMENTATION LTD., PALGHAT
		(c)	FISHER SANMAR LTD.
		(d)	CONTROL COMPONENT INC., USA
		(e)	HORA (HOLTER REGELARMATUREN GMBH & CO.)
6.6	APRDS CONTROL VALVES	(a)	INSTRUMENTATION LTD.
		(b)	CONTROL COMPONENT INC., USA
		(c)	HORA (HOLTER REGELARMATUREN GMBH & CO.)
6.7	CONTROL VALVES- NON CRITICAL	(a)	DEZURIK COPES VULCAN LTD., U.K.
		(b)	CONTROL COMPONENT INC., USA
		(c)	FISHER SANMAR LIMITED
		(d)	INSTRUMENTATION LTD
		(e)	MIL CONTROL LTD.
		(f)	FISHER XOMOS SANMAR LTD.
		(g)	HORA (HOLTER REGELARMATUREN GMBH & CO.)
6.8	SOLENOID VALVE	(a)	ASCO, CHENNAI
		(b)	ROTEX AUTOMATION LTD., GUJRAT
		(c)	AVCON CONTROLS, MUMBAI
6.9	HP/LP BYPASS VALVES	(a)	BOPP & REUTHER SR GMBH CONTROL COMPONENTS INC (CCI)

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
6.10	ELECTRO-HYDRAULIC ACTUATOR	(a)	LEONARDO AUTOMATION (INDIA) PVT. LTD.
7.0	**ERECTION HARDWARES:**		
7.1	LOCAL INSTRUMENT RACK (LIR) AND LOCAL INSTRUMENT ENCLOSURES (LIE)	(a)	PYROTECH, UDAIPUR
		(b)	INSTRUMENTATION LTD., KOTA
		(c)	ELECTRONICS CORPORATION OF INDIA LTD., HYDERABAD
		(d)	CHEMIN CONTROLS, PONDICHERRY
		(e)	PRAMMEN INDUSTRIES
7.2	INSTRUMENT VALVES	(a)	EXCEL HYDRO PNEUMATICS PVT. LTD., MUMBAI
		(b)	BHEL
		(c)	METPRESS ENGINEERING WORKS, KOLKATA
		(d)	BALDOTA VALVE & FITTING CO. PVT. LTD., MUMBAI
		(e)	AURA INC., NEW DELHI
		(f)	INSTRUMENTATION LTD. PALGHAT
		(g)	PRECISSION ENGG. INDUSTRIES, MUMBAI
		(h)	VIKAS INDUSTRIAL PRODUCTS, NEW DELHI
7.3	VALVE MANIFOLDS	(a)	EXCEL HYDRO PNEUMATICS PVT. LTD., MUMBAI
		(b)	METPRESS ENGINEERING WORKS, KOLKATA

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
		(c)	BALDOTA VALVE & FITTING CO. PVT. LTD., MUMBAI
		(d)	AURA INC., NEW DELHI
		(e)	PRECISSION ENGG. INDUSTRIES, MUMBAI
		(f)	HP VALVES AND FITTINGS, CHENNAI
7.4	COMPRESSION FITTINGS / SOCKET WELD FITTINGS	(a)	SWAGELOCK, USA
		(b)	ASTEC VALVES & FITTINGS PVT. LTD.
		(c)	MET-LOK HYDRO PNEUMATICS PVT. LTD.
7.5	CONDENSATE POTS	(a)	EXCEL HYDRO-PNEUMATICS PVT. LTD., MUMBAI
		(b)	MICROPRECISION, FARIDABAD
		(c)	INSTRUMENTATION LTD. PALGHAT
		(d)	METPRESS ENGINEERING WORKS, KOLKATA
		(e)	BALDOTA VALVES & FITTINGS CO. PVT. LTD., MUMBAI
		(f)	PRECISSION ENGG. INDUSTRIES, MUMBAI
7.6	IMPULSE & SAMPLE PIPINGS	(a)	TPS TECHNITUBE ROHREN WERKE GMBH, GERMANY
		(b)	MAHARASHTRA SEAMLESS LTD.
		(c)	BHEL
		(d)	CHOKSI TUBE COMPANY LTD., INDIA
		(e)	INDIAN SEAMLESS METAL TUBES LTD., INDIA
		(f)	MANNESMANN AG, GERMANY

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
		(g)	TOUVAY AND CAUVIN GULF EC, DUBAI
		(h)	JINDAL SAW PIPES LTD., INDIA
		(i)	SUMITOMO CORPORATION, JAPAN / KAWASAKI
		(j)	RATNAMANI METALS & TUBES LTD., AHMEDABAD
7.7	JUNCTION BOX (FRP)	(a)	DEVI POLYMERS, CHENNAI
		(b)	SUCHITRA INDUSTRIES, BANGALORE
		(c)	RITTAL
		(d)	PYROTECH
		(e)	L&T
		(f)	HENSEL ELECTRIC INDIA PVT. LTD., SRIPERUMBUDUR
7.8	AIR CYLINDER	(a)	VELJAN HYDRAIR, HYDERABAD
		(b)	NUCON INDUSTRIES, HYDERABAD
		(c)	PRECISION ENGG. (PREAC), BANAGALORE
		(d)	ASCO, CHENNAI
8.0	**CABLES:**		
8.1	CONTROL CABLES	(a)	DELTON CABLES, FARIDABAD
		(b)	UNIVERSAL CABLES, SATNA
		(c)	NICCO CABLE, KOLKATA
		(d)	POLYCAB, DAMAN
		(e)	GAYOLENE, MUMBAI
		(f)	RELIANCE ENGRS, BANGALORE
		(g)	CORDS CABLES, RAJASTHAN

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
		(h)	PARAMOUNT CABLES, ALWAR
		(i)	THERMOCABLES, BANGALORE,
		(j)	KEI INDUSTRIES LTD., CHENNAI
8.2	INSTRUMENTATION CABLE	(a)	DELTON CABLES, FARIDABAD
		(b)	UNIVERSAL CABLES, SATNA
		(c)	NICCO CABLE, KOLKATA
		(d)	POLYCAB, DAMAN
		(e)	GAYOLENE, MUMBAI
		(f)	RELIANCE ENGRS, BANGALORE
		(g)	CORDS CABLES, RAJASTHAN
		(h)	PARAMOUNT CABLES, ALWAR
		(i)	THERMOCABLES, BANGALORE / HYDERABAD
		(j)	KEI INDUSTRIES LTD., CHENNAI
		(k)	CABLE CORPRN OF (I) LTD., CHENNAI
		(l)	RPG CABLES LTD., CHENNAI
		(m)	FORT GLOSTER INDUSTRIES LTD. KOLKATA
		(n)	DECO CABLES, DELHI
		(o)	KRISHNA CABLES, GWALIOR
		(p)	THERMAPADS (P) LTD
		(q)	ELKAY TELELINKS LTD.
		(r)	INCAB INDUSTRIES LTD
		(s)	TORRENT CABLE LTD.
8.3	COMPENSATING CABLES	(a)	DELTON CABLE

SR. NO.	NAME OF EQUIPMENT / ITEM		APPROVED VENDORS
		(b)	TOSHNIWAL, MUMBAI RELIANCE, BANGALORE
		(c)	LAPP INDIA, MUMBAI/ BANGALORE
		(d)	CORDS CABLES, RAJASTHAN
		(e)	PARAMOUNT CABLE
8.4	SPECIAL CABLES (PTFE /FEP INSULATED CABLES)	(a)	TOSHNIWAL CABLE
		(b)	RELIANCE CABLES
		(c)	LAPP INDIA, MUMBAI
		(d)	PARAMOUNT CABLES
		(e)	FINOLEX, PUNE
8.5	POWER CABLES (LT)	(a)	DELTON CABLES, FARIDABAD
		(b)	UNIVERSAL CABLES, SATNA
		(c)	NICCO CABLE, KOLKATA
		(d)	CORDS CABLES, RAJASTHAN
		(e)	FORTGLASTER INDUSTRIES
		(f)	INCAB, PUNE
		(g)	CCIL, BANGALORE
		(h)	KEI INDUSTRIES LTD., CHENNAI
		(i)	POLYCAB, DAMAN PARAMOUNT CABLES, ALWAR
9.0	**UPS / DC SYSTEM:**		
9.1	UPS WITH ACDB	(a)	HI-REL ELECTRONICS
		(b)	EMERSON NETWORK (FORMERLY TATA LIEBERT)
		(c)	DB POWER ELECTRONICS
9.2	24 VDC BATTERY CHARGER	(a)	CALDYNE, KOLKATA

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

PROJECT ENGINEERING & SYSTEMS DIVISION

PRICE FORMAT FOR GYPSUM DEWATERING EQUIPMENT (Sub -Assembly of FGD Equipment)

BHUSAWAL 1 X 660 MW STG TPS FGD

	Bidder's Name : <Bidder to indicate>	
	Bidder's Offer No. & Dt. : <Bidder to indicate>	
	Bidder's Ref No. & Dt. :<Bidder to indicate>	
	BHEL Enq. No. & date :<Bidder to indicate>	

I	**MAIN OFFER [Prices for individual items to be quoted as indicated in the price bid format]**				
SL NO	**ITEM DESCRIPTION**	**QTY**	**UNIT**	**TOTAL PRICE (Rs.)**	**PRICE WEIGHTAGE IN PERCENTAGE**
A	**MATERIAL SUPPLY**				
A.1	Gypsum Dewatering Equipment complete with all Accessories as per the Technical Specification PY52324 including Commissioning Spares. (Commissioning spares as per manufacturer's recommendation. List to be enclosed.)	1	Set	not to be quoted separately	**95%** **(FOR TOTAL A.1 AND 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	**SUPERVISION CHARGES FOR ERECTION & COMMISSIONING AT SITE**				
B.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	Lump sum	not to be quoted separately	**5%** **(FOR B.1)**
	TOTAL LUMPSUM PRICE				**A + B**

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). 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.)**
C	**SUPERVISION CHARGES FOR ERECTION & COMMISSIONING AT SITE**			
C.1	Per day supervision charges of an Engineer including all other expenses like boarding, lodging, local travel, insurance etc.	1	Day	
C.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	
D	**3 YEARS RECOMMENDED SPARES**			
D.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.

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.

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

PROJECT ENGINEERING & SYSTEMS DIVISION

PRICE FORMAT FOR GYPSUM DEWATERING EQUIPMENT (Sub -Assembly of FGD Equipment)

BHUSAWAL 1 X 660 MW STG TPS FGD

4) The Lumpsum Price quoted by the bidders for items under main offer : Sl. No. I [A to B] 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 (PY52324) & 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) will be issued by BHEL-PE&SD Hyderabad.
b) The Purchase Order for Supervision of E&C (I-B) 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.