



SPECIFICATION FOR  
PRE-TREATMENT PLANT

SPEC.NO.ROS:6323

Rev:0

BHARAT HEAVY ELECTRICALS LIMITED,  
RANIPET- 632 406.

TECHNICAL SPECIFICATION  
FOR  
PRE - TREATMENT PLANT

1X660 MW WBPDCI-SAGARDIGHI - TPS  
WEST BENGAL

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## **SECTION -1**

### **1.0 SCOPE OF INQUIRY/ INTENT OF SPECIFICATION**

- 1.1** The specification is intended to cover design, engineering, manufacture, fabrication, assembly, inspection and testing at vendor's & sub-vendor's works, painting, commissioning spares along with spares for erection and commissioning, startup and commissioning as required, forwarding, proper packing, shipment and delivery at site, unloading, handling & transportation at site , Erection & Commissioning, trial run, on FOR site basis, preparation & submission of "As Built" drawings, PG test at site and handing over of Pre - Treatment Plant as per the details in different sections / volumes of this specification for 1x660 MW WBPDCCL-SAGARDIGHI – TPS.
- 1.2** The contractor shall be responsible for providing all material, equipment & services, which are required to fulfill the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve them of the responsibility of providing such facilities to complete the supply, erection and commissioning of Pre - treatment plant.
- 1.3** It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to high standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material, which in his judgment is not in full accordance herewith.
- 1.4** The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items do not figure in the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items do not figure in the drawing.
- 1.5** The general terms and conditions, instructions to tenderer and other attachment referred to elsewhere in the specification are part of the tender specification. The equipment materials and works covered by this specification are subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for, and governed by all requirements stipulated herein.
- 1.6** While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed with this specification. In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of BHEL/ Customer shall prevail and shall be complied by the bidder

without any commercial implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by BHEL/ Customer as and when brought to their notice either by the bidder or by BHEL/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.

- 1.7** Deviations, if any, should be very clearly brought out clause by clause in the enclosed schedule; otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification.
- 1.8** In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.
- 1.9** Unless specified otherwise, all through the specification, the word contractor shall have same meaning as successful bidder / vendor and Customer /Purchaser / Employer will mean BHEL and / or Customer (WBPDCCL: West Bengal Power Distribution Corporation Ltd.) including their consultant as interpreted by BHEL in the relevant context.
- 1.10** The equipment covered under this specification shall not be dispatched unless the same have been finally inspected, accepted and dispatch release issued by BHEL / Customer.
- 1.11** BHEL's / Customer's representative shall be given full access to the shop in which the equipment is being manufactured or tested and all test records shall be made available to him.



## SECTION – 2

### 2.0 PROJECT INFORMATION

1	Name of the Project	Sagardighi Thermal Power Station (1x660 MW) Unit-5, phase-III.
2	Station Capacity	1x660 MW (Coal Based)
3	Owner	West Bengal Power Distribution Corporation Ltd. (WBPDCCL)
4	Site Location	Manigram village, Sagardighi, Raghunathganj sub-division, Murshidabad District, West Bengal.
5	Latitude	24° 22' 13.7" N
6	Longitude	88° 6' 15.8" E
7	Nearest Town	Ajimganj, Jangipur, Raghunathganj.
8	Nearest railway Station	Manigram railway station on Bandel-Barhawara branch line 1 km from site.
9	Nearest Airport	240 KM Kolkata
10	Site Conditions	
	Elevation above MSL	34 m
	Temperature –Minimum	10°C during Winter
	- Maximum	42°C during Summer
	- Design Ambient	50°C
	- Ambient (performance)	26.9°C
	Relative Humidity for design / efficiency	84 %
	Annual Rainfall - Average	1389 mm
	- Maximum	1043 mm
	- Lowest	343 mm
	Mean Wind Speed	47 m/sec
	Wind Pressure	As per the latest revision of IS 875/1987
	Siesmic Co-efficient	Zone –III, as per IS 1893 (Part-IV)
11	Source of water	The source of water for this project is the River Bhagirathi (5 km). The water from the River Bhagirathi will be transferred and stored in the five (5) nos. Plant Raw Water Reservoirs by augmentation of the Intake water transportation system.
12	Source of Coal	The Power plant shall receive coal from ECL mines. Coal is planned to be transported in rake loads through the existing Pakur- Tildanga-Dhulian-Monigram broad gauge line or through Pakur- Nalhati (proposed)–Takipara-Gosaingram-Poradanga-Monigram broad gauge line.

## SECTION – 3

### 3.0 SCOPE OF SUPPLY

This specification is intended to cover the Design, engineering, manufacture, assembly, inspection and testing at manufacturer's and/or his sub-contractors works, proper packing, delivery at site, transportation, unloading/handling at site, storage at site, site fabrication, site painting, erection including all civil design/ testing/ commissioning at site, trial run and performance testing of Pre-treatment plant for 1x660 MW SAGARDIGHI TPS including complete Electrical, C&I and Civil Works as specified and as necessary.

1. The Broad scope of supply shall be as per following.
  - a. Pre-treatment plant comprising of CT Blow down water from stage#2 and stage#3 will be fed directly to clarifier through a flow control station. CT Blow down water inlet piping to complete Control stations, stilling chamber, Parshall flumes, distribution chambers Clarifiers, bypass channels, outlet channel & pipes to Clarified water storage tank, Sludge sumps, sludge transfer pumps, periphery sludge pit, air blowers for sludge sump, dosing systems, safety showers & safety equipment, material handling arrangements, hangers & supports and all other equipment and accessories required for complete pre-treatment plant of Sagardighi 1x660 MW power plant.
  - b. All the Isolation gates and shutters as required, vents, sampling points, complete with all accessories so as to ensure physical completion and operability & maintainability of the system. The same shall have required / necessary instrumentation & Controls in line with the specification.
  - c. To the extent possible, vendor shall ensure to supply all foundation bolts & conduit pipe for power cable timely so as to facilitate placement of these bolts & pipe while casting the foundation and clarifier base.
  - d. All integral and interconnected pipe works, valves, sumps, gates, all types of pipe supports, pipe racks, pipe bridges etc. for the entire system.
  - e. All insert plates, rung ladder, nuts and bolts, and flanges and matching counter flanges wherever applicable.
  - f. All special tools necessary for proper maintenance or adjustment of the equipment packed in permanent box.
  - g. Operating platforms, permanent ladders (not rugs), supports and other structural works for each tanks, valves etc. to facilitate accessibility for operation and maintenance. All pipes, fittings etc. required for hand railing, platforms, and ladders shall be in the scope of bidder.
  - h. All necessary structural steel for pipe supporting structure, platforms, walkways / pathways and access stairs, mechanical plant and equipment, mechanical services and pipe work associated with Pre Treatment Plant. Finish paints for touch up painting of equipment after erection at site in sealed container.
  - i. All handrails shall be of 32 mm nominal bore MS pipes (medium class) as per IS: 1161 galvanised using 750 gm/sq. m of zinc. Hand railing shall be a two-rail system with the top rail 1000 mm above the walkway surface and the intermediate rail 450

mm below the top rail. Handrail post spacing shall be limited to 1500 mm as far as possible but can be proportioned to the length of the opening. In such a case spacing shall not exceed 1850 mm centre to centre of posts. Hand railing shall be shop fabricated for specific locations and field welded or bolted to the erected structural steel. Railings shall be provided with 100 mm wide and 8 mm thick MS strip at bottom as toe guard all along the length of railing in horizontal plane.

- j. Monitoring gadgets, instruments and equipment required for commissioning & maintenance (till PG test and plant handover).
- k. Permanent ladder (not rungs) for approaching the top of tanks, valves for All steel inserts with lugs, plates, bolts, nuts, sleeves, edge angles and all other embedding components etc. as required to grout in civil works and to support/hold the equipment being supplied under this specification for opening/maintenance purpose.
- l. Wherever pipe racks are not available, pipes shall run on pedestals or below ground. All auxiliary structure & fixing items such as U clamps, nuts, bolts, channels, insert plates etc. required to lay the pipes on pedestals shall be in bidder's scope of work. Wrapping, coating and protection of all the buried pipe is also in bidder's scope
- m. Wrapping, coating and protection of the entire buried pipe shall be as per IS 10221 or AWWA C 203-93.
- n. Any item/work either supply of equipment or erection material which have not been specifically mentioned in but are necessary to complete the works for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification and shall be in bidder's scope without any commercial, technical and delivery implication to BHEL.
- o. All required elbow, tee, pipe fittings etc. required for erection of the complete system including piping shall be in bidder's scope. Bidder to provide the detailed BOQ during detail engineering.
- p. Bidder shall perform the performance guarantee test as per specification requirement to the satisfaction of owner. The exact modalities of verifying guarantee for the parameters indicated in the specification shall be finally as agreed with the owner during detailed engineering & mutually agreed.
- q. All the first fill and one Year's topping requirements of consumable such as greases, oil, lubricants, servo fluids/control 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 of facilities shall be in bidder's scope. Suitable standard lubricants as available in India are desired. Efforts should be made to limit the variety of lubricants to minimum.
- r. All blank flanges/counter flanges, isolations valves, tees etc. to interconnect the pipes at all terminal points.
- s. All necessary structural steel for pipe supporting structure, platforms, walkways / pathways and access stairs for mechanical plant and equipment, mechanical services and pipe work associated with Pre Treatment Plant.
- t. All the tanks shall be provided with vent, overflow, drain and sample connections. Effective capacity for chemical tanks & water retaining structures/ tanks/ sumps means the capacity between the bottoms of the overflow nozzle to the top of the

outlet nozzle. Outlet nozzle centre line shall be kept at least 200 mm from the Invert Level of the chemical tanks/ water retaining structures/ tanks/ sumps. A minimum free board of 300 mm shall be provided in all the water retaining structures of PT Plant (such as Stilling chamber, all the channels, Clarifiers, Clarified water tank, Overhead filtered water tank, Sludge sump, Backwash water collection sump, Chemical tanks etc.) above the maximum water level/ overflow level as the case may be excluding the thickness of the slab / beam thickness if any

u. RCC pedestals design for all piping of PT plant except chemical house and Clarified water storage tank. However necessary civil inputs/mechanical GA to be furnished by bidder.

v. Piping:

All the piping as listed below shall be in bidder's scope. The below indicated pipes shall be designed, supplied, erected, laid and tested by the bidder. Elbows, tees, flanges Hangers and supports, embedment plates with lugs etc. required for the below given piping shall also be provided by the bidder.

- All piping within the Pre-Treatment Plant, Inlet and outlet pipes for sump, pits, pumps, other equipment, etc. with pipe connections to the respective sumps, pits, equipment as indicated in the P&ID of Pre-treatment plant.
  - a. Clarifier feed piping (including control station)
  - b. Clarifier by-pass piping
  - c. Sludge transfer piping
  - d. Air score piping in sludge sump
  - e. Chemical dosing piping
  - f. Chemical dilution water piping
  - g. Instrument air piping
  - h. Service water and potable water piping
- Sludge disposal piping: Bidder to terminate sludge disposal discharge line at a distance of 5 mtrs from the sludge sump further piping upto main PT plant sludge sump shall be in BHEL scope.
- Sampling of water shall be taken from the following points & sampling collection rack shall be provided nearby clarified water storage tank.
  - a. CWBD water inlet to pH Correction Chamber (before control station of clarifier)
  - b. Sludge water from clarifiers – Tapping will be provided at sludge transfer pump common discharge line
  - c. Clarified water from the launders
- Service water piping, instrument air piping, service air piping, potable water piping, etc. as applicable as per the Terminal Points.
- In addition, any additional piping and associated accessories required to complete the system shall be in bidder's scope.

## 2. Electrical

The Specification of Electrical items, scope & terminal Points shall be as per Electrical spec. ROS 4292.

### 3. Control & Instrumentation

Control & Instrumentation - Refer C& I portion of this specification

### 4. Scope of Services

- a. Design & engineering of entire Pre-treatment plant
- a. Complete civil design of Entire Pre-treatment plant except Chemical house and clarified water storage tank. However necessary civil inputs/mechanical GA to be furnished by bidder.
- b. Unloading, Storage, handling and transportation at site
- c. Minor Civil work including chipping of foundation, grouting below base plate for all structures, equipment, grouting of anchor bolts wherever these are not placed in the foundation during casting of foundation itself etc. To the extent possible, vendor shall ensure to supply all foundation bolts timely so as to facilitate placement of these bolts while casting the foundation. Wrapping, coating and protection of all the buried pipe shall be as per IS 10221
- d. Pre- Commissioning work such as flushing, hydraulic testing etc. Necessary consumables and instrumentation as required for inspection and testing at works as well as at site including pre-commissioning activities shall be arranged by the successful bidder at their own cost
- e. Erection, commissioning of all the equipment of Pre-treatment plant including but not limited to the above list which are required for completion of the pre-treatment plant shall be considered by Bidder.
- f. Supervision of all Civil works of entire Pre-treatment plant
- g. Arrangement of all lubricants, instruments, reagents for carrying out trial run, commissioning and PG test
- h. Monitoring gadgets, instruments and equipment required for maintenance (till PG test & Plant Hand over).
- i. All personnel required during commissioning, trial run and PG Test
- j. All tools & tackles required for the system shall be provided by Bidder.
- k. Trial run for requisite period
- l. Performance testing
- m. Painting of all equipment within scope of supply as per painting specification. Final touch up painting at site
- n. Preparation of civil assignment drawings i.e. pedestals details; insert plates / embedment's plates required for supporting pipes and equipment etc. and review of civil drawing prepared by BHEL based on civil assignment drawing of bidder. In case any modification is required in the civil work already done based on civil inputs given by vendor, rework shall be done at the cost and risk of the vendor.
- o. Preparation & submission of all drawings
- p. Preparation of drawings / document / P&ID's in 3D modelling software and providing soft copy of same to BHEL
- q. Training of plant Owner's personnel, O&M operators' personnel on plant operation and maintenance
- r. Any other service required for making the installation complete in all respect within battery limits and for satisfactory erection & commissioning of the system as well

as to meet any statutory requirement relevant to the package, unless specifically EXCLUDED from scope of services.

**5. Painting**

- a. Supply and application of shop painting and final painting at manufacturer's works and at site for the entire system as specified elsewhere in this Bid Document

**6. Consumables**

- a. All consumables (lubricating oil, inhibitor for oil, etc.) as applicable for operation of the PT Plant & sludge transfer pumps etc., required for pre commissioning, commissioning, trial run, PG test until taking over along with topping up required for six(6) months operation of the plant shall be in the scope of the Bidder. However, bidder to refer to relevant clauses in the entire tender document and the most stringent clause shall be considered.
- b. All spares required for erection and commissioning of complete system, new set of special tools and tackles, fixtures etc. required for regular operation and maintenance of the system as addressed elsewhere in the entire specification shall be considered by Bidder.

**7. Terminal points**

- a. The details regarding terminal points are provided in Design memorandum, Layout and P&ID drawings.
- b. Raw water (Cooling tower Blowdown water) to PT plant shall be provided by BHEL- The terminal points shall be as indicated in Equipment Layout 1-WT-025-01848.
- c. Clarified water from PT plant clarifiers shall be transferred by Bidder through channels and terminated at each compartment of Clarified water storage tank.
- d. Sludge from the clarifiers shall be collected in Sludge sump by Bidder. Necessary piping, isolation valves, manholes, etc. shall be provided by Bidder to ensure proper sludge collection in Sludge sump.
- e. Sludge disposal piping: Bidder to terminate sludge disposal discharge line at a distance of 5 mtrs from the sludge sump further piping upto main PT plant sludge sump shall be in BHEL scope.
- f. Service air supply (25NB connection) at 5 to 7 kg/cm<sup>2</sup> (g) – near Chemical house of Pre- treatment plant. Please refer to TP in Layout drawing for coordinates
- g. Service water connection (50NB connection) – near Chemical house of Pre-treatment plant. Please refer to TP in Layout drawing for coordinates.
- h. Potable water connection (50NB connection) – near Chemical house of Pre-treatment plant. Please refer to TP in Layout drawing for coordinates.
- i. Distribution and piping of Service air, Service water and Potable water inside Pre-treatment plant area shall be in bidder's scope.

**8. Exclusion**

- a. All civil work including foundation of equipment by BHEL. However, complete grouting for equipment, fixing and any concreting inside vessels, etc., shall be in the scope of bidder.
- b. Pedestals for pipe supports by BHEL. However, auxiliary structure, supports components for piping is in bidder's scope.
- c. Civil design of Chemical house and clarified water storage tank by BHEL. However, Bidder to provide necessary Civil assignment, input & Mech GA drawings for all

equipment inside chemical house & Clarified water storage tank including isolation gates, puddles flages,etc .

- d. Air conditioning, ventilation & fire fighting facilities.
- e. All chemicals (FeCl<sub>3</sub>, Lime & Poly electrolyte).
- f. Refer to E,C&I specification for exclusions

**9. Civil**

- a. Complete civil design & construction drawings of Entire Pre-treatment plant is in bidder scope except for Chemical house and clarified water storage tank. However necessary civil assignment inputs/mechanical GA to be furnished by bidder

**10. Material handling requirements**

- a. Two (2) numbers Electrically Operated Monorail Hoist of 1.0 Ton safe working capacity and complete with all accessories for handling of chemicals in Chemical house.
- b. Bidder to refer to Hoists specification for guidelines for selecting hoists.

**11. Other design & construction features**

- a. Stilling chamber/pH correction chamber: The CT blow down water shall be fed to the Stilling Chamber/pH correction chamber through control station. The stilling chamber shall be provided with a baffle wall so that water shall enter the chamber from the bottom and velocity of water rise through the stilling chamber shall be selected to avoid any turbulence of the incoming water. Draining arrangement with a valve shall be provided for the stilling chamber.
- b. Clarifiers: The type of clarifier shall be solid contact type with integral variable speed impeller/ turbine to internally recirculate water and sludge at adjustable rate to produce consistent water quality at varying hydraulic load and turbidity. Weir loading shall not exceed 300 m<sup>3</sup>/ m/ day. For uniform overflow over weirs, triangular notches (saw tooth weir) shall be provided as necessary. Clear width of the bridge shall not be less than 1000 mm.

Design of the sludge removal system should be such as to reduce loss of water during sludge blow off within 3% of rated flow. Inlet portion of the unit, (i.e. pumps, stilling chamber, inlet channel and clarifier) shall be designed to handle excess water to make good for water loss during sludge blow-off. The walkways shall be provided with handrail along with periphery access ladders (at least from two locations) with platforms and hand railing for the clarifiers for good approach. Permanent ladders shall also be provided (not rungs) for approaching the sludge pipeline valves for maintenance. (However the sludge valves shall be operatable from the top of the sludge chamber through head stock and extended spindle arrangement.

The clarifier units shall be circular, central feed type with concentric recirculation zone (rapid mixing) with sampling points at different elevation, reaction zone (slow mixing) and clarification zone in RCC construction. Bridge type rake arm and suitable equipment such as turbine/ impeller shall be provided for internal sludge

recirculation. The design of the turbine/ impeller shall be such as not to break the flocks during recirculation. Suitable mechanism for varying the recirculation rate shall also be provided such that the reactor clarifier shall be capable of operating at varying hydraulic load and turbidity with consistent effluent quality.

Clarifiers shall be provided with radial launders. The bottom of clarifier shall be sloped towards the center and mechanically driven sludge scraper and collector shall be used to remove the settled sludge down the sloping bottom to the central sludge area. Rubber squeezer pads shall be provided on sludge scraper and skimmer. Sludge removal system design shall consist of central sludge area with rotating pickets and back flush arrangement for proper control of sludge accumulation at the bottom.

Sludge blow off shall be effected by the static head of water in the clarifier unit. Sludge outlet pipes from the concentrated sludge hopper shall be branched into main disposal line and continuous sludge disposal line. Main sludge disposal line, which includes a blow-off valve, shall drain sludge to the sludge disposal pump sump. This is an intermittent operation. Continuous sludge disposal line consists of telescopic stand pipe, the top of which is maintained at a desired elevation to ensure trickle flow of water or sludge water mixture to the sludge sump. The de-sludging of clarifiers shall be done once in a shift. The de-sludging of Clarifiers shall not exceed one (1) hour. All equipment/ sump shall be designed accordingly.

Arrangement of clarifier sludge pit/ sump shall be as indicated in data sheet and schematic drawings. Minimum capacity of the pit shall be referred in the data sheets. Bidder shall supply all necessary piping, valves and other accessories as required. Each section of the pit shall be provided with agitation by recirculation systems and air agitation system.

Suitable sampling connections from the various levels and zones of clarifier and at the outlet shall be provided for performance monitoring.

The total detention time in the reaction zone shall not be less than 15 minutes.

Clarifier shall have the features for mixing, internal recirculation followed by clarification and collecting sludge in sludge pit and transferring the sludge upto the terminal point as marked in P&ID and Equipment layout.

Generally, clarifier shall be provided with a gate at the outlet for isolation and for by-pass & for maintenance.

- c. Chemical house: All dosing system shall be housed inside chemical house. In addition, dosing systems (BHEL scope of supply) pertaining to UF & RO system also shall be accommodated. UF&RO dosing system details are provided in tender equipment layout. Hoists shall be provided for movement of chemicals from chemical storage area of chemical house to respective chemical preparation tanks. Service water from terminal point shall be distributed by Bidder to each of the PT plant chemical preparation and dosing tanks.
- d. Suitable flushing(auto) water connections shall be provided for PT dosing system (Lime, FeCl<sub>3</sub> & Poly electrolyte) for flushing purpose. Flushing connections should be provided at regular interval



## SECTION-4

### 4.0 General requirements of specification

1. Approved Design memorandum (BHEL DOC NO.: 4-WT-220-01575; WBPDCCL NO.: RP-DC-445-WTP-A001) Rev 02
2. P& ID for PT System (BHEL DOC NO.: 1-WT-220-01882; WBPDCCL NO.: RP-DG-445-WTP-A002) Rev 02
3. PT plant Equipment Layout (BHEL DOC NO.: 1-WT-220-02076; WBPDCCL DOC NO.: RP-DG-445-WTP-A003) Rev 00
4. Qualification requirement shall be as per tender specification specified elsewhere.
5. Sub Vendor list shall be as per attached list (**Annexure-1**). However, Bidder shall submit the list for all the equipment during contract stage for approval by BHEL.
6. Quality plan shall be as per attached quality plan document (**Annexure-2**). However, Bidder shall submit Quality plan for all the equipment supplied, services & works during contract stage for approval by BHEL.
7. Minimum list of drawings shall be as per attached master drawing list (**Annexure-3**). However, bidder shall submit the list during contract stage for approval by BHEL.
8. Bidder shall submit the PG test procedure for Pre-treatment plant for approval and same shall be followed. Requirements are specified in (**Annexure-4**)
9. Design philosophy, PID, Equipment layout which are part of this tender are provided as **Annexure-5**.
10. Project schedule for Pre-treatment plant shall be submitted by Bidder for approval. However, bidder to ensure to match with the overall project schedule of the BOP packages.
11. Refer **Annexure-6** for Technical requirements for Hoist
12. Refer **Annexure-7** for Quality Assurance requirements
13. Refer **Annexure-8** for List of Drawings & Documents to be submitted along with bid and after award of contract.
14. Bidder to refer to Painting Specification **Annexure-9** for meeting the requirements of this package.
15. Bidder to also refer to the General conditions of contract (GCC) and Special conditions of contract (SCC).
16. Bidder to refer to Health Safety and Environment plan for Site Operation by Subcontractors in **Annexure-10**.
17. Refer **Annexure-11** for Additional General Technical requirements
18. Refer **Annexure-12** for Engineering services requirements
19. Refer **Annexure-13** for Project Management and site services
20. Refer **Annexure-14** for Spares, Tools, Tackles & Consumables
21. All civil as well as structural design, construction and architectural works as addressed in **Annexure-15** of the specification.
22. Refer **Annexure-A** Technical Deviation format
23. Refer **Annexure-B** for Compliance and confirmation schedule
24. Bidder to refer to relevant section of specification of Service air. Bidder to integrate with overall service air distribution piping and ensure distribution to required areas within this plant package. Bidder shall also consider necessary air receivers to meet system requirements.

25. Bidder to consider proper Packaging for shipping and storage at site and the procedure shall be duly submitted to Customer
26. Bidder shall furnish 3D model in editable format to ensure integration with overall 3D model of the Power plant
27. Customer approved Design Philosophy & P&ID attached with this specification is minimum requirement and to be complied by Bidder. Bidder to design the equipment/system for safe and trouble free operation of Plant to meet the performance duty required by systems.
28. The Pre-treatment plant complete with all accessories shall conform to this technical specification, Design memorandum & PID. The decision of BHEL shall be final in case of any discrepancy.
29. All the instruments shall be supplied along with necessary fittings, accessories, valve manifold, root valves, Canopy & Structural steel as required. Instrument Installation, along with hardware shall be in bidder scope
30. The make shall be as per approved vendor list. The model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable. In case of any conflict or repetition of clauses in the specification, the more stringent requirements among them are to be complied with.
31. Each valve/instrument shall be fitted with a stainless steel or aluminium nameplate indicating the valve/instrument service and reference number in accordance with the approved equipment coding system
32. All valves above 150NB shall be double flanged. All valves dimension standard shall be as per ASME B16.5 standards.
33. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system shall be supplied by bidder without any technical, commercial and delivery implication to BHEL
34. Uniformity of make and type of instruments and control components shall be followed throughout for rationalization of spares' inventory, except for certain proprietary items where this requirement cannot be met.

## 5.0 PUMPS & PIPING SELECTION CRITERIA

Sl. No.	Pipe Size	Velocity in m/sec		
		Below 50mm	50mm-150mm	200mm & above
1	Pump Suction for Water		1.2-1.5	1.2-1.8
2	Pump Discharge for Water	1.2-1.8	1.8-2.4	2.1-2.5
3	Header		1.5-2.4	2.1-2.4
4	Compressed Air Below 2Kg/cm2(g)	15-20	20-30	25-35
5	Compressed Air Above 2Kg/cm2(g)	20-30	25-40	35-45
6	Suction to compressor/Blowers		7-8	
7	Pump Suction for Chemical Solution	0.8-1.2	0.8-1.3	
8	Pump Discharge for chemical solution	1.2-1.4	1.3-1.5	

## 6.0 IMPORTANT POINTS TO BIDDERS

1. If the vendor has suggestions/requirements of any additional instruments/equipment over & above as shown in the P & ID drawing, the same shall be clearly indicated and suitably covered in the commercial bid also separately.
2. The specification for the instruments/equipment available in the main specification shall be taken for such additional requirements (or) Customer should be contacted.

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**BHARAT HEAVY ELECTRICALS LIMITED,  
RANIPET- 632 406.**


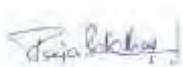

**TECHNICAL SPECIFICATION  
for  
Electrical, Control  
& Instrumentation**


**Of**

**CWBD-  
PRE TREATMENT PLANT**

**Project: 1 X 660 MW SAGARDHIGI TPS  
(PHASE-3, UNIT#5)**


**SPEC NO: ROS 4292, REV-00**

					
	12.11.2021	AJV	MEGA	VNS	Fresh issue
	Date	Prepared	Checked	Approved	Remarks

	<b>1 X 660MW, Sagardhigi (Unit #5)</b>	<b>BAP-RANIPET</b>
	Technical Specification for Pre-Treatment Plant (E, C & I Scope)	<b>Spec. No: ROS: 4292, Rev-00</b> <b>PART of ROS: 6323, Rev-00</b>

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## SECTION-A: INTRODUCTION

### 1. PROJECT INFORMATION

#### 1.1 THE PROJECT

Sagardighi Thermal Power Station, Phase-III, comprising of a single extension Unit of 660 MW capacity of Super Critical technology is being implemented by The West Bengal Power Development Corporation Limited in Murshidabad district, West Bengal, India. This Power Station will generate electricity and feed into the West Bengal Transmission Grid to meet the power demand in West Bengal.

#### 1.2 THE SITE


Sagardighi Thermal Power Station site is located at Manigram village, 13 KM north of Sagardighi town by the side of the SMGR (Sagardighi-Manigram-Gankar-Raghunathganj) Road at a distance 20 KM from National Highway 34 in Murshidabad District, West Bengal and around 240 KM from Kolkata, India. The nearest rail station is Manigram adjacent to the site on Bandel - Barhawara branch line and 6.5 KM from Sagardighi Railway Station on Sainthia - Azimgunj line of Eastern Railway.

#### 1.3 THE SPECIFICATION AND TENDER

The accompanying Tender Specification is for the Engineering, Supply, Delivery, Erection, Testing and Commissioning of the Cooling Water Gas Chlorination plant as specified. The Plant and materials offered must be of proven quality where reliability in service and ease of operation and maintenance are the foremost prerequisites. The completion time should be the shortest possible.


#### 1.4 SITE CONDITION

1	Elevation above MSL	34 m
2	Temperature –Minimum	10°C during Winter
	- Maximum	42°C during Summer
	- Design Ambient	50°C
	- Ambient (performance)	26.9°C
3	Average relative humidity	84 %
4	Annual Rainfall - Average	1389 mm
	- Maximum	1043 mm
	- Lowest	343 mm
5	Mean Wind Speed	47 m/sec
6	Wind Pressure	As per the latest revision of IS 875/1987
7	Siesmic Co-efficient	Zone –III, as per IS 1893 (Part-IV)

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## 2. GENERAL SPECIFICATION

1. Services and Equipment as per SECTION-E, "Scope Division between BHEL and CWBD-PT Vendor".
2. Bidder shall confirm total compliance to the specification without any deviation from the technical/ quality assurance requirements stipulated.
3. The make of all the items shall be from approved sub-vendor list. The make/ model of instruments/ items/ systems not specified in the Sub-vendor list shall be subject to approval of BHEL/ Customer during detailed engineering stage without any commercial and delivery implications to BHEL.
4. Uniformity of make and type of Electrical, instrument and control components shall be followed throughout for rationalization of spares' inventory, except for certain proprietary items where this requirement cannot be met.
5. Vendor representative shall be available at site at the time of commissioning of the system and Vendor to delegate/ depute their person /experts as per owner/ consultant requirements.
6. The scope in this specification is indicative. Any item/ work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The bidder shall supply the same without any technical, commercial and delivery implication to BHEL.
7. In case of any conflict or repetition of clauses in the specification, the more stringent requirements among them are to be complied with. BHEL decision will be taken as final.

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**SECTION: B**

**GENERAL TECHNICAL REQUIRMENTS (ELECTRICAL):**

The equipment and services to be provided by bidder under this specification shall be as detailed here below, but not to be limited to the following:

1. Electrical load requirement for CWBD Pre-treatment Plant shall be furnished as per the format in Annexure-G.2.
2. All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information (SECTION-A).
3. Motors shall meet minimum requirement of Electric motor specification (Section: F.2)
4. Various drawings including GA drawing, Data sheet as per required format, quality plans, Calculations, test reports, test certificates, operation and maintenance manuals, characteristic curves, wiring diagrams/schemes etc. shall be furnished as specified at contract stage. All documents shall be subject to customer / BHEL approval without any commercial implications to BHEL.
5. Vendor shall clearly indicate equipment locations and local routing lengths in their cable listing as per the format in Annexure-G.3.




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**SECTION: C**

**GENERAL TECHNICAL REQUIREMENTS (C&I):**

1. Bidder to include all the instruments required for the package along with necessary fittings, remote chemical seal diaphragm accessories and valve manifolds etc.
2. The motor operated valves shall have limit switches for open/ close feedback. Motor operated valves for valve sizes less than 50 NB shall be rated for 240 V single phase AC only. For other higher sizes, the motor operated valves shall be rated for 415 V three phase only.
3. Panel dimensions shall be chosen liberally such that double door opening is available at front /rear or both at front & rear which shall be finalized during detailed engineering by BHEL to accommodate the panels within plant layout. Maximum single (half door) width acceptable is 600mm.
4. The design, manufacture, inspection, testing, site calibration and installation of all C&I equipment and systems covered under this specification shall conform to the latest editions of applicable codes and standards eg. ANSI, ASME, IEEE, ISO, IEC, IGCI, AWS, NFPA, AISC, IGS, SAMA, UBC, UL, NESC, NEMA, ISA, DIN, VDE, IS etc.
5. For instrument & control cable scope of supply refer 'SECTION-E'.
6. Instrument installation drawings are to be provided by bidder.
7. Every panel- mounted instrument, requiring power supply, shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.

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#### SECTION-D: DOCUMENTATION

Documents of Electrical, C&I System shall be submitted to end user/ owner for approval during detail engineering. Changes, if any required, shall be accommodated by the bidder without any price and/ or time implication.

Following documents to be furnished by the bidder along with the bid:


- Duly stamped and signed copy of Quality Plan.
- Requirement of electronic earthing, if any.
- Electrical power requirement in prescribed format duly signed and stamped.
- SDDR of Enquiry documents.

Editable & PDF copy of Drawings/ Documents and data to be furnished within two months after award of the contract:

1. C&I System Design Basis Report incorporating Control philosophy.
2. Control & operational write-up for the system
3. GA & wiring diagram of local control panel and its Power Requirement.
4. Local control panel and field instruments quality plan. Local control panel & instruments data sheet.
5. Filled up Electrical Load data as per Attached Formats (Annexure-G.2)
6. Cable schedule, cable interconnection drawing as per Attached Formats (Annexure-G.3)
7. Instrument schedule indicating range, operating pressure, flow etc., along with selected make & model.
8. Instrument hook-up diagram.
9. Electronic Earthing schemes
10. Filled up Motor datasheets as per Attached Formats (Annexure-G.4)
11. Logic diagrams with system description / functional write-up.
12. DCS IO List
13. Motors: Detailed catalogue, part number and subassembly/assembly drawings with manufacturer's cross reference for each spare part.
  - 1) OGA drawing with terminal boxes, earthing etc.
  - 2) Arrangement drawing of terminal boxes.
  - 3) Characteristic curves:
    - i. Current vs. time at rated voltage.
    - ii. Speed vs. time at rated voltage.
    - iii. Torque vs. speed at rated voltage and minimum voltage.  
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
    - iv. Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.
    - v. Load performance curves.


#### **NOTE:**

1. Documents mentioned in other sections of this specification is included.
2. Any other document decided during detailed engineering to be submitted.


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#### E: SCOPE DIVISION BETWEEN BHEL AND CWBD-PT VENDOR


S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	1. 415 V AC (3 Phase, 3 Wire) supply to motors, 415 V AC (3 Phase, 4 Wire) supply to other equipment etc. shall be provided by BHEL based on load data provided by vendor at contract stage for the equipment supplied by vendor as part of contract. 2. Any other voltage level (AC/DC) required will be derived by the vendor.
2	DCS System	BHEL	BHEL	
3	Local Push Button Station (LPBS) for motors	BHEL	BHEL	Located near the motor.
4	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage. All motors shall be 415V, 3 Phase only.
5	Instruments & Fittings	Vendor	Vendor	Complete instrumentation supply, erection, commissioning including site calibration of Instrument until Handover to end customer is in Vendor's scope
6	Junction box for control & instrumentation cable	BHEL	BHEL	

	<b>1 X 660MW, Sagardhigi (Unit #5)</b>	<b>BAP-RANIPET</b>
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7	Electric Operated Hoist with isolating switch	Vendor	Vendor	<p>BHEL will provide only one number 415 V (3ph) supply feeder and Input Power Cable from MCC supply feeder to isolating switch. Isolation switch supply is in vendor's scope to be placed at 1.2 mtr above ground. Any other voltage level (AC/DC) required will be derived by the vendor. Motor starter shall be part of crane control panel.</p> <p>Flexible Power cables (festoon cable)/ shrouded DSL from isolator to hoist &amp; upto motor shall be supplied by vendor. Earthing arrangement shall be part of hoist cable by vendor.</p>
	<b>Cable, Tray &amp; Accessories</b>			
8	Power cables, control cables and screened instrument cables for <ul style="list-style-type: none"> <li>a. both end equipment in BHEL's scope</li> <li>b. both end equipment in vendor's scope</li> <li>c. one end equipment in vendor's scope</li> </ul>	BHEL BHEL BHEL	BHEL Vendor BHEL	<ol style="list-style-type: none"> <li>1. For b) &amp; c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes will be done by BHEL.</li> <li>2. Termination at BHEL equipment terminals by BHEL.</li> <li>3. Termination at Vendor equipment terminals by Vendor. Vendor shall provide lugs &amp; glands in his scope.</li> </ol>
9	Any special type of cable like compensating, co-axial, prefab, MICC, OFC etc.	Vendor	Vendor	Any special cable required for equipment, instrument etc., supplied by Vendor.
10	<ul style="list-style-type: none"> <li>a. Cable trays, accessories &amp; cable trays supporting system</li> <li>b. 100/ 50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling</li> </ul>	BHEL Vendor	BHEL Vendor	Local cabling i.e., branching from nearby main route cable tray (BHEL scope) to equipment (vendor's supply) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs.
11	Conduit and conduit accessories for cabling of	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537.

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	equipment supplied by vendor			
12	Cable glands, lugs and cable tag for equipment supplied by Vendor	Vendor	Vendor	<ol style="list-style-type: none"> <li>1. Double compression Ni-Cr plated brass cable glands</li> <li>2. Solder less crimping type Aluminium lugs for Aluminium power cables and heavy duty tinned copper lugs for copper power cables</li> <li>3. Solder less crimping type heavy duty copper lugs for control and instrumentation cables.</li> </ol>
	<b>Lighting &amp; Earthing</b>			
13	Lighting	BHEL	BHEL	
14	Equipment grounding & lightning protection	BHEL	BHEL	There shall be provision for connecting earthing cable/ flat on equipment supplied by vendor.
15	Below grade grounding	BHEL	BHEL	
	<b>Drawing/ Document</b>			
16	For Control & Instrument Cables a. Cable schedules b. Cable interconnection/ Loop diagram	Vendor Vendor	- -	Cable listing for Control and Instrumentation Cable (excluding power cables) in enclosed excel format shall be submitted by vendor during detailed engineering stage.
17	Electrical cable tray layout drawing	Vendor	-	For ensuring proper cabling, vendor shall furnish cable tray layout drawings (both in print & AUTOCAD form) of complete plant indicating location and identification of all equipment that require cabling. Cabling arrangement (cable trays, ducts, conduits etc.) shall be decided during Engineering stage.
18	Electrical Equipment GA drawing	Vendor	-	For necessary interface review. Electrical equipment layout & cable tray layout drawing shall be

	<b>1 X 660MW, Sagardhigi (Unit #5)</b>	<b>BAP-RANIPET</b>
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				subjected to BHEL/ customer approval without any commercial implications to BHEL.
19	Any other equipment/ material/ service required for completeness of system but not specified above (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	

**NOTES:**

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/ customer after award of contract.
2. All QAPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mismatch due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit (if required) in their Civil assignment drawing.

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## **SECTION-F: Customer Specific Technical Requirement**

### **F.1 Specification for TURBIDITY ANALYZER**

1. Type: Nephelometric (Light reflection principle)
2. Range: 0.001-100 NTU
3. Body: Corrosion resistant polystyrene
4. Enclosure: IP-65 or better
5. Output: 4-20 mA DC isolated to a load of 600 Ohms (minimum)
6. Readout: LCD Display
7. Accuracy: Better than  $\pm 2\%$  of full scale
8. Repeatability:  $\pm 1\%$  of reading or  $\pm 0.002$  NTU (whichever is greater)
9. Accessories: Phenolic nameplate, Special cable upto transmitter with flexible conduit,  $\frac{1}{2}$ " NPT Cable Glands, 2" pipe mounting bracket, Calibration kit & standard solution etc.

#### **F.1.1 Manual Valve with LIMIT SWITCH**

Limit Switch shall be provided in all applicable manual valves as per enquiry. One for Open & one for Close position for each valve with 2 NO+2NC potential free contacts in each limit switch. Contact rating shall be 5A,240V AC, 0.5A, 220 V DC. Enclosure shall be weather proof IP 55. Limit Switch terminals shall be brought out to a Terminal.

Limit switches should be National Acme Co., or Honeywell micro switch type or equivalent.

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1 X 660 MW, SAGARDHIGI TPP (Phase-3, Unit-5)

BAP-RANIPET

SPECIFICATION FOR LT MOTOR

No: ROS:4286, REV: 0

**BHARAT HEAVY ELECTRICALS LIMITED,  
RANIPET- 632 406.**

**TECHNICAL SPECIFICATION  
FOR  
LT MOTOR**

**(Applicable for Sagardhigi Project)**

00	11.12.2021	AJV	MEGA	VNS	Fresh issue
<b>Rev. No</b>	<b>Date</b>	<b>Prepared</b>	<b>Checked</b>	<b>Approved</b>	<b>Remarks</b>



## 1. INTENT OF SPECIFICATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer's work and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station. All motors shall be chosen for non-hazardous SAFE area application.

## 2. SUPPLY OF LT MOTORS

All equipments, system and service covered under this specification shall comply with the requirements of the latest statutes regulations and safety codes as applicable in the locality where the equipments/systems will be installed. The Bidder shall fully acquaint himself with these requirements and shall ensure compliance with them. The equipments, systems and services furnished as per this specification shall conform to the codes and standards elsewhere in the specification. However, in the event of any conflict between the requirements of two standards or between the requirements of any standard and this specification, the more stringent requirements shall apply unless confirmed otherwise by the Owner in writing. The decision of the Owner shall be final and binding in all such cases.

### 2.1. CODES AND STANDARDS

All motors shall conform to the latest editions including all applicable amendment of relevant IS, IEC standards/Publications and all other applicable ANSI, ASME, IEEE, NEC, NEMA, ISA, DIN, VDE, NFPA, IEC, EIA, TIA standards. In case any other standard is followed that ensures equal or better quality, may be accepted. However, the English version of the Standard adopted shall be submitted. Bidder to note that in no case, OEM/manufacturers own standards shall be accepted.

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards. Any other applicable Indian standards for any component part even if not covered in the list shall also be followed.

- 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 60079 Explosive atmospheres
- n) IS/IEC 60529 Degrees of protection provided by enclosures (IP code)
- o) IEC 60034 Rotating electrical machines.
- p) IS 3177 Code of practice for Design, Manufacture, Erection and testing of Cranes and Hoists

### 2.2. SYSTEM PARAMETERS

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors. Maximum rating of the LV motor shall be 160 KW.



**1 X 660 MW, SAGARDHIGI TPP (Phase-3, Unit-5)**

**BAP-RANIPET**

**SPECIFICATION FOR LT MOTOR**

**No: ROS:4286, REV: 0**

S.No	Description	LT System
1	Motor Voltage level	240 V, 1 $\phi$ : Motor kW $\leq$ 0.2 kW 415 V, 3 $\phi$ : 0.2 kW < Motor kW $\leq$ 160 kW
2	System Earthing	415 V system solidly grounded.
3	Space heater supply (Applicable for motor rated $\geq$ 30KW)	230V+/-10%, 1 $\phi$ , 50Hz+/-5%, 10% (Absolute sum)
4	Fault withstand rating of motor terminal box. (Applicable for motor rated > 90KW i.e., Breaker operated motor)	415 V system: 50/65 kA for 0.2 second

### 2.3. DESIGN REQUIREMENTS

#### 2.3.1 Duty

1. For the purpose of design of equipment /systems, an ambient temperature of 50 °C and relative humidity of 95% shall be considered. The equipment shall operate in hot, humid and a highly polluted (coal and fly ash) environment.
2. AC motors shall be squirrel cage three phase/single phase induction motors. All the motor shall be designed for bi-directional rotation.
3. Motors shall be continuously rated (S1 duty).
4. Motors shall be suitable for direct on-line starting with any type of breaker on full load.
5. LV motors shall be compulsorily of Energy efficient level IE2 or better as per IS 12615.

#### 2.3.2 Design Margin

1. The motor rating shall be arrived at considering 15% margin over the duty point input or 10% over the maximum demand of the driven equipment, whichever is higher, considering highest system frequency.
2. Whenever the basis for motor ratings are not specified in the corresponding mechanical specification sub-sections, maximum continuous motor ratings shall be at least 10% above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations. 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.
3. Service shall be considered as 1.0 only.

### 2.4. STARTING REQUIREMENTS

1. Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.
2. Starting Voltage requirement motors :80 % of rated voltage for all motors. Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.
3. Motors shall be capable of restarting under full load after a momentary loss of voltage with the possibility of 150 % nominal voltage during fast bus transfer.
4. The motor shall be designed for direct on line starting at full voltage. Starting current shall not exceed 6 times full load current for all auxiliaries, subject to IS tolerance.
5. The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.
6. Transient voltage dip on starting of the largest motor with DOL shall be limited to 20% of the nominal system voltage at the voltage terminals.

### 2.5. TORQUE REQUIREMENTS

1. Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.



2. Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.
3. 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.

**2.6. The following frequency of starts shall apply**

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

1. No. of consecutive hot starts shall be 2 (with initial temperature of the motor at full load operating level).
2. No. of consecutive cold starts shall be 3 (with initial temperature of the motor at ambient temperature).

**2.7. RUNNING REQUIREMENTS**

1. Minimum voltage required for starting the motors shall be 85% of rated voltage
2. Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.
3. Motor shall not stall due to voltage dip in the system causing momentary drop in voltage up to 70% of the rated voltage for duration of 2 secs.

**2.8. STRESS DURING BUS TRANSFER**

1. All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.
2. The motors shall be suitable for bus transfer schemes provided on the 11 kV, 3.3 kV/415V systems without any injurious effect on its life.
3. Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.
4. Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.
5. The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

**2.9. LOCKED ROTOR WITHSTAND TIME**

1. Locked rotor current of the LV motor shall not exceed 600% of full load current inclusive of IS tolerance.
2. The locked rotor withstand time under hot condition at 110% rated voltage shall be more than motor starting time at minimum permissible voltage of 80% rated voltage by at least 3 seconds or 15% of the accelerating time whichever is greater. Provision of speed switch shall be avoided to the extent possible.
3. For the LT motors having starting time up to 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.
4. 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.
5. 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.
6. Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.
7. When a speed switch is mounted on the motor shaft, the same shall remain closed for speeds lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% over speed in either direction of rotation.



8. Hot thermal withstand curve shall have a margin of at least 10% over the full load current of the motor to permit relay setting utilising motor rated capacity.

**2.10. CONSTRUCTIONAL FEATURES**

1. Canopy shall be provided for outdoor or semi-outdoor area motors.
2. Bidder shall provide fully compatible electrical system, equipment, accessories and services.
3. **Bearings**
  - a. 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.
  - b. Sleeve bearings shall be split type, ring oiled with permanently aligned, close running shaft sleeves. The sleeve bearing housing shall be preferably in end shield itself. Grease lubricated bearings shall be pre-lubricated and shall have provisions for in-service positive lubrication with grease nipple and relief holes.
  - c. 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.
  - d. All motors below 15 kW shall be provided with sealed ZZ bearings.
4. Motors shall be designed to easy access for drilling holes through motor feed of mounting flange for installation of dowel pins after assembly of the motor and driven equipment.
5. Degree of Protection for Motors is IP 55
6. Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362. Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled
7. Motors shall be designed with cooling fans suitable for both directions of rotation.
8. Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.
9. Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.
10. In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10 deg C.
11. Winding and insulation
  - a. 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.
  - b. All insulated winding shall be of copper.
12. Noise and vibration
  - a. The peak amplitude of the vibration shall be within IS:12075 / IEC 60034-14. specified limits.
  - b. Noise level shall not exceed 85 db and shall follow IS: 12065 standard
  - c. vibration shall be within the limits prescribed in IS: 12075 respectively.
  - d. Motors shall withstand vibrations produced by driven equipment.
13. Grounding  
Motor body shall be grounded at two earthing points on opposite sides with two separate and distinct grounding pads complete with tapped holes, GI bolts and washers.





14. The cable terminal box shall have a separate grounding pad, Terminals and Terminal Boxes.
  - a. Degree of protection for terminal boxes shall be IP 55 as per IS 4691.
  - b. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.
  - c. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degrees for LV motors.
  - d. Suitable Double Compression type Cable glands and cable lugs shall be provided. The cable sizes will be informed during detail engineering.
  - e. Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size suitable for solidly grounded system shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.
19. Painting: Motor including fan Painting shall be carried out by an approved process. Pre-treatment 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. Finish shade shall be RAL 7032.
- 20 Lifting Provisions: Motor weighing 25 kg or more shall be provided with eye bolt or other adequate provision for shifting.

**2.11. GENERAL**

1. Motors provided for similar drives shall be interchangeable.
2. Suitable foundation bolts are to be supplied along with the motors.
3. Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956
4. Name Plate: 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.
5. Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.

**2.12. INSPECTION AND TESTING**

1. All materials, components and equipment covered under this specification shall be procured, manufactured, as per the Approved quality plan.
2. LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.
3. All motors shall be subjected to routine tests as per IS: 325. Noise level measurement and vibration test as per standards shall be conducted on all motors.
4. Inspection: for Motors Upto 55KW –Inspection by BHEL.

**2.13. DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT**

- 1) OGA drawing showing the position of terminal boxes, earthing connections etc.
- 2) Arrangement drawing of terminal boxes.
- 3) Characteristic curves:
  - i. Current vs. time at rated voltage.
  - ii. Speed vs. time at rated voltage.
  - iii. Torque vs. speed at rated voltage and minimum voltage.  
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
  - iv. Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.
  - v. Load performance curves.

**2.14. DATA SHEET****LT MOTORS (A.C.)**

1. Application : Indoor/ Outdoor/ Semi-outdoor
2. Type : Energy Efficient (IE2) or better
3. Frame size :
4. Manufacturer :
5. Rated output in KW :
6. Duty cycle : Continuous, S1
7. Rated voltage, no. of phases and frequency : 415 V, 3  $\phi$ , 50 Hz
8. Allowed voltage variation :  $\pm 10\%$ .
9. Allowed frequency variation :  $\pm 5\%$
10. Combined voltage and Frequency Variation : 10 % (Absolute sum)
11. At rated Voltage and frequency
  - a. Full load current (Amps) :
  - b. Rated speed :
  - c. Full load efficiency :
  - d. Full load power factor :
  - e. Starting torque in % of FLT :
12. Method of starting : DOL
13. Degree of protection : IP55
14. Method of ventilation :
15. Class of insulation : "F" (temp. rise limited to class B)
16. Stator winding connection (For continuous run) (Delta / Star) :
17. Full load torque :
18. Breakdown torque in % of FLT :
19. Pull up torque in % of FLT :
20. Locked rotor current in Amps (600% with tolerance of 20%) :
21. Motor efficiency and P.F.AT :
  - a. 100 % load
  - b. 75% load
  - c. 50% load
  - d. 25% load
22. Locked rotor withstand time under hot/cold condition at 110 % Voltage :
23. Maximum permissible starting time :
24. No load current in Amps. :
25. Starting time in seconds with driven equipment coupled at
  - a. rated voltage :
  - b. Min. Voltage :
  - c. Max. Voltage :
26. Actual temperature rise over an ambient of 50°C when motor is delivering rated output
  - a. By thermometer method :
  - b. By resistance method : (70°C for air cooled motors)
27. Number of successive starts with driven equipment coupled and motor initially at rated load temperature :
28. Minimum voltage required by the motor to bring the driven equipment to rated speed: To be 80% of RV.
29. Resistance per phase in ohms at 20 degrees :
30. Direction of rotation from driving end :



31. Make, type and size of bearing
  - a. At drive end :
  - b. At Non drive end :
32. Type of mounting and shaft Orientation :
33. Location of terminal box viewed from driving end :
34. Type and number of terminals brought out :
35. Motor Canopy : Applicable / Not-Applicable
36. Cable gland entry side :
37. Tropical & fungicidal treatment :
38. GD<sup>2</sup> of the motor :
39. Weight of the motor :
40. Space heater Rating & other details (for 30KW and above motors) :
41. Cable Gland
  - a. Size :
  - b. Quantity :
42. Cable Lugs
  - a. Size :
  - b. Quantity :

**3. PACKING AND DISPATCH**

Equipment shall be packed with suitable desiccants sealed in water-proof, vapour-proof wrapping, and packed in lumber or plywood enclosures, suitably braced tied and skidded. Lumber enclosures shall be solid, not slatted.

**4. MOTOR OEM LIST**

1	KIRLOSKAR ELECTRIC CO LTD	BENGALURU/CHENNAI
2	NGEF (HUBLI) LTD	BENGALURU
3	SIEMENS INDIA LTD	JOKA
4	BHARAT BIJILEE LTD	MUMBAI
5	CROMPTON GREAVES LIMITED	CHENNAI
6	JYOTI LIMITED	VADODARA
7	ABB LIMITED	CHENNAI
8	MARATHON ELECTRICAL MOTORS INDIA LIMITED	CHENNAI

**Note: This Motor OEM list is subject to customer approval**



1 X 660 MW, SAGARDHIGI TPP (Phase-3, Unit-5)

BAP-RANIPET

SPECIFICATION FOR ELECTRICAL ACTUATORS

No: ROS: 4289, REV: 00

**BHARAT HEAVY ELECTRICALS LIMITED,  
RANIPET- 632 406.**

**TECHNICAL SPECIFICATION  
FOR  
ELECTRICAL ACTUATORS  
(INCHING DUTY)**

00	12.11.2021	AJV	MEGA	VNS	Fresh issue
<b>Rev.No</b>	<b>Date</b>	<b>Prepared</b>	<b>Checked</b>	<b>Approved</b>	<b>Remarks</b>



### 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

3.1.0 Electric actuators shall be provided as specified in Mechanical and C&I section. It shall be equipped with 3 phase induction motor, rated for S2-15 minutes' duty for ON/OFF valve and intermittent duty for inching duty.

**For open-close service, the actuator shall be rated for three successive open-close operation of the valve/damper or 15 minutes, whichever is longer. Number of starts in no case less than 60 starts per hour. For inching service, the actuator shall be suitably time-rated for the duty cycle involved with necessary number of starts per hour, but in no case less than 150 starts per hour.**

3.2.0 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 used for high pressure and high temperature valves. Canopy shall be provided for outdoor service.

3.3.0 Motor shall be surface cooled designed for enclosure protection class of IP 67. Motor shall be suitable for starting direct on-line, with starting current limited to 6 times full-load current.

3.4.0 The actuator is placed in non-hazardous area.

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

3.6.0 Maximum continuous motor rating shall be at least 10% above the maximum load derived of the driven equipment under entire operating range including voltage & frequency variation.

3.7.0 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)

3.8.0 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.



- 3.9.0 Electrical Actuators of Inching type position transmitters of non-contact type shall be interfaced to DCS.
- 3.10.0 Actuators shall be of totally enclosed weather proof and dust proof construction with NEMA-6/IP 65 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.
- 3.11.0 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.
- 3.12.0 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. The maximum hand wheel force of 500N must not be exceeded. For limiting hand wheel forces, for control and operation purposes it may be necessary to install appropriate gears.
- 3.13.0 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.
- 3.14.0 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.
- 3.15.0 Each actuator shall have a space heater in the limit switch compartment suitable for 240V AC, 50 Hz single phase supply. Earthing terminals shall be provided on either side of the motor. All terminals must be suitable for 2.5 sq.mm wires.
- 3.16.0 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.
- 3.17.0 Actuators shall be supplied with integral starter which shall have sophisticated electronic controls with field programming feature. It shall be designed for remote control from



DCS/Respective control system. Required interposing relays for receiving open/close/stop command from DCS/Respective control system shall be provided. Potential free contacts and transducers shall be provided to provide status indication at remote DCS/Respective control system. The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.

The actuator shall have:

- One (1) built-in local position indicator for 0-100% travel.
- One (1) position transmitter, 4-20 mA current signals as position feedback to DCS.

In addition, all actuators for valves are to be fitted with socket and plug of well-established make to IEC 60309 or equivalent for the power cable connection. For the control cable connection separate socket and plug shall be provided.

3.18.0 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.

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

The following controls to be provided as a part of the Electric actuated valves- Inching duty.

1. Commands for Open, Close, Stop
2. Limit switch Feedbacks for Open, Close at any position within 0-100%, OTS, CTS
3. 4-20 mA current signals as position feedback

3.20.0 The following individual Status annunciation LED's and fault annunciation LED's 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

3.21.0 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)



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

3.23.0 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.

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

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

3.26.0 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 overload relay trip

#### **4.0 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. Copies of certified reports of all tests carried out at the works shall be furnished.

The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out.

- Measurement of insulation resistance.
- Measurement of full load current.
- Test running of the motors.

#### **5.0.0 DRAWINGS & DOCUMENTS**

The following drawings and documents shall be submitted for approval during detail engineering stage.

- Integral starter details
- Technical particulars of actuator
- Wiring diagram
- General arrangement drawings
- Test reports





**WBPDCL**

**EPC Bid Document  
Sagardighi Thermal Power Project  
1x660 MW Unit No. 5, Phase - III**

**SECTION-VI  
TECHNICAL SPECIFICATION  
CONTROL AND INSTRUMENTATION SYSTEMS**



**Development Consultants Pvt. Ltd.**

**Volume : II-E  
Section : VI  
Control & Instrumentation Systems**



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## SECTION-VI

### TECHNICAL SPECIFICATION

#### CONTROL AND INSTRUMENTATION SYSTEMS

##### 1.00.00 FIELD INSTRUMENTS

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

- i) HART management system shall be integral feature of the DDCMIS and shall be provided for centralised configuration, maintenance, diagnostics & record-keeping for all electronic transmitters.
- ii) Bidder shall provide following facilities as a minimum through software:
  - a) Constant scanning to monitor faults of changes to instrument configuration.
  - b) Owner-defined and standard calibration and configuration procedures for all transmitters.
  - c) Constant signal data collection facilities to maintain continuously updated records.
  - d) Automatic tracking of configuration changes made in the field, such as may be introduced by hand-held communicator. All configuration function associated with hand-held communicators shall be available in the system.
  - e) Event and log reports on screen as well as on printer.
  - f) Any addition/deletion of transmitter will be reported on printer and logged in hard disk.

##### 1.01.00 PRESSURE TRANSMITTER

01. Type : Microprocessor based Smart, HART protocol compatible
02. Transmission : 2 - Wire





03. Output Signal : Simultaneous transmission of digital and 4-20 mA DC signal.
04. Signal Processing : Silicon solid state electronic circuitry
05. Sensor type : Capsule / Diaphragm
06. Element material : AISI-316 or better
07. Static Pressure : 150 % of maximum span continuously, without affecting the calibration.
08. Turn-down ratio : 10 : 1 for vacuum/very low pressure application ; 30 : 1 minimum for other applications.
09. Span and Zero : Locally adjustable non-interacting. Facility for elevation and suppression by 100% of span
10. Enclosure Class : Weather proof as per IP-65 with durable corrosion resistant epoxy coating (Explosion proof for NEC Class-1, Division 1 area wherever required)
11. Output Indicator : Backlit LCD type
12. Nameplate : Tag number, service engraved in stainless steel tag plate
13. Body : Forged Carbon Steel (SS for DM Water & corrosive service).
14. Power supply : 16 - 48 Volts D.C.
15. Load : 500 Ohms (min.) at 24 Volts D.C.
16. Ambient Temperature : 0 - 50°C
17. Performance :
  - i) Accuracy :  $\pm 0.075\%$  of Span or better
  - ii) Repeatability :  $\pm 0.05\%$  of Span or better
  - iii) Response time : 100 msec or better
  - iv) Stability :  $\pm 0.1\%$  of Calibrated Span for 6 months up to 70 Kg/cm<sup>2</sup> and  $\pm 0.25\%$  of Calibrated Span for more than 70 Kg/cm<sup>2</sup>
  - v) Zero and span drift :  $\pm 0.015\%$  per deg. C at max span and 0.11% per deg. C at min span
18. Sealing/Isolation : Extended diaphragm with 5 meters SS armored capillary for corrosive, viscous and dirty fluid applications. Material for separator





diaphragm shall be as per application. 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

- 19. Diagnostics : Self indicating feature
- 20. Accessories :
  - a) Universal mounting bracket suitable for 2" pipe mounting.
  - b) High tensile carbon steel U- bolts.
  - c) Installation accessories as per relevant installation drawing.
  - d) Syphons for steam and hot water services.
  - e) ½" NPT 2-valve stainless steel manifold for pressure transmitters constructed from SS316 bar stock. In case it becomes necessary to use a DP transmitter for gauge pressure measurement then a 2-valve manifold should be used in place of 5-valve manifold.
  - f) Companion flange with nuts, bolts and gaskets.
  - g) Hand held configurator kit for calibration of Smart Transmitter.

1.02.00 Differential Pressure Transmitter

- 01. Type : Microprocessor based Smart, HART protocol compatible
- 02. Transmission : 2-Wire
- 03. Output signal : Simultaneous transmission of digital and 4-20 mA DC signal.
- 04. Signal Processing Unit : Silicon solid-state electronic circuitry
- 05. Sensor type : Capsule/Diaphragm
- 06. Element material : AISI-316 (Stainless Steel) or better
- 07. Static Pressure/





- Overload Pressure : Maximum line (or static) pressure on either side without permanent deformation or loss of accuracy
- 08. Turn-down ratio : 10 :1for vacuum/very low pressure application; 30 : 1 minimum for other applications.
- 09. Span and Zero : Locally adjustable, non-interacting
- 10. Enclosure class : Weather proof as per IP-65 with durable corrosion resistant epoxy coating (Explosion proof for NEC Class-1, Division 1 area wherever required))
- 11. Zero suppression / elevation : At least 100% of Span
- 12. Output Indicator : Backlit LCD type
- 13. Nameplate : Tag number and Service engraved in stainless steel tag plate
- 14. Body : Forged Carbon Steel (SS for DM Water)
- 15. Ambient temperature : 0 - 50° C
- 16. Power supply : 16 - 48 Volts DC
- 17. Load : 500 Ohms (min.) at 24 Volts DC
- 18. Performance :-
  - i) Accuracy :  $\pm 0.2$  % of span or better
  - ii) Repeatability :  $\pm 0.05$  % of span or better
  - iii) Response time : 100 msec or better
  - iv) Stability :  $\pm 0.1\%$  of Calibrated Span for 6 months up to 70 Kg/cm<sup>2</sup>
  - v) Zero and span drift :  $\pm 0.015\%$  per deg. C at max span and 0.11% per deg. C at min span
- 19. Sealing/Isolation : Extended diaphragm with 5 meters. SS armored capillary for corrosive, viscous and dirty fluid applications. Material for separator diaphragm, depending on application.
- 20. Diagnostics : Self indicating feature
- 21. Accessories : a) Universal mounting bracket suitable for 2" pipe mounting.



- b) High tensile carbon steel U-bolts.
- c) Installation accessories as per relevant installation drawing.
- d) Syphons for steam and hot water services.
- e) 1/2" NPT 5-valve stainless steel manifold, constructed from SS316 bar stock.
- f) Companion flange with nuts, bolts and gaskets.
- g) Hand held configurator kit for calibration of Smart Transmitter.

1.02.00 DISPLACER TYPE LEVEL TRANSMITTERS

- 01. Type : SMART
- 02. Stages of operation : Continuous
- 03. Material -
  - i) Displacer : AISI 316 SS
  - ii) Suspension wire : AISI 316 SS
  - iii) Torque tube housing : Carbon steel or SS as per application
  - iv) Torque tube : Inconel
  - v) Displacer chamber : Carbon steel or SS as per process application
  - vi) Transmitter Housing : Die cast aluminium or better
- 04. Power supply : 16-48 Volts D.C.
- 05. Transmission : 2-wire
- 06. Output Signal : Simultaneous transmission of digital and 4-20 mA DC signal. Standard HART protocol.
- 07. Signal processing : Solid-state electronic circuitry
- 08. Static / overload pressure : Maximum static pressure without permanent deformation or loss of accuracy.
- 09. Turn-down ratio : 10 : 1 or better





- 10. Zero & Span : Easily accessible (local zero & span adjustment and non-interactive type)
- 11. Enclosure Class : IP-65 (Explosion proof for NEC Class-1, Division 1 area)
- 12. Output Indicator : Yes, Backlit LCD type
- 13. Nameplate : Tag number and Service engraved in stainless steel tag plate
- 14. Ambient Temperature : 0 - 50°C
- 15. Load Impedance : 500 Ohms at 24 Volts (minimum)
- 16. Process Connection : 2" Companion flange with nuts, bolts and gaskets
- 17. Performance -
  - Accuracy : ± 0.2% of span or better
- 18. Accessories :
  - a) Counter Flange, nuts, bolts, gaskets etc.
  - b) Weights for 5 point calibration of instruments.
  - c) Vent and drain plugs
  - d) Special calibration tool/configurator, if any.
- 19. Preferred Features :
  - a) Test plug connection and cutout terminals physically separated from other electronics.
  - b) Electronic Damping facility (adjustable).

1.03.00 MASS FLOW METER

A. Sensor

- 01. Measuring Principle : Coriolis Mass flow.
- 02. Primary Element : Flow Tube of 316SS or better
- 03. Temperature Control : To be provided for heavy fuel oil application. Heating arrangement shall be integral. For Heating
- 04. Process Connection : Flanged and rating as per process requirement.
- 05. Drain : Self-draining facility







- 06. Enclosure : Stainless steel
- 07. Accessories : Counter flanges, Mounting nuts, bolts, gaskets etc.
- B. Transmitter
  - 01. Measured quantities : Mass Flow rate, Total Mass Flow, Density, Temperature as minimum.
  - 02. Input Signal Processing : Digital Processing.
  - 03. Display : Digital Display (LCD).
  - 04. Output : 2 Nos. isolated output of 4-20mA DC with HART protocol, selectable from four measured quantities & field bus output for softlink with DCS
  - 05. Load : < 750 ohms.
  - 06. Power supply : "UPS", (if the external power supply is 230V AC, 50 HZ).
  - 07. Turn Down : 100:1
  - 08. Accuracy :  $\pm 0.2\%$  of measured value
  - 09. Housing : IP 65 (Explosion proof for NEC Class-1, Division 1 area).
  - 10. Hazardous duty Version : FM Standards.
  - 11. Nameplate : Tag number, service engraved in stainless steel tag plate
  - 12. Accessories :
    - a) As required for field mounting
    - b) Handheld configurator
    - c) Mounting U-bolts, nuts, bolts, prfab cable etc.

1.04.00 Turbine Flow meter

- A. Sensor
  - 01. Type : Turbine (in line full-bore, based on magnetic pick up pulses)





- 02. Output Signal : Pulse
- 03. Material of Construction :
  - a) Body : AISI 316
  - b) Rotor: AISI 431 or 410
  - c) Bearings: Tungsten Carbide / Stellite Sleeve
- 04. Flow rate range : As required.
- 05. Linearity :  $\pm 0.25\%$  or better.
- 06. Repeatability :  $\pm 0.02\%$  or better.
- 07. Ambient temperature :  $50^{\circ}\text{C}$
- 08. Mounting : On-Line, flanged
- 09. Enclosure : IP 65
- B. Transmitter
  - 01. Electronics : Solid State
  - 02. Power Supply : "UPS", if the external power supply is 230V AC, 50 HZ.
  - 03. Input : Input from Sensor
  - 04. Display : Backlit LCD
  - 05. Output : Isolated 4-20mA DC with HART protocol.
  - 06. Measuring Accuracy :  $\pm 0.5\%$  of full scale range
  - 07. Totalized Value : Required
  - 08. Housing : IP-65 (Explosion proof for NEC Class-1, Division 1 area)
  - 09. Nameplate : Tag number, service engraved in stainless steel tag plate
  - 10. Accessories :
    - a) Clamping strip, bracket, prefab cable etc.
    - b) Calibration or cofigurator kit.

1.05.00 Vortex Flow meter

- A. Sensor
  - 01. Type : Vortex





- 02. Output Signal : Pulse
- 03. Material of Construction : AISI 316
- 04. Sensor Seal : PTFE / higher based on temperature
- 05. Flow range : As required.
- 06. Linearity :  $\pm 1\%$  or better.
- 07. Repeatability :  $\pm 0.2\%$  or better.
- 08. Ambient temperature :  $50^{\circ}\text{C}$
- 09. Mounting : On-Line, flanged.
- 10. Enclosure : IP 65
- 11. Accessories : Nuts, bolts, gaskets etc.
- B. Transmitter
  - 01. Electronics : Solid State-remote mounting
  - 02. Power Supply : 24 V DC.
  - 03. Input : Input from Sensor
  - 04. Display : Backlit LCD
  - 05. Output : Isolated 4-20mA DC.
  - 06. Protocol : HART
  - 07. Totalized Value : Required
  - 08. Housing : IP-65 (Explosion proof for NEC Class-1, Division 1 area)
  - 09. Nameplate : Tag number, service engraved in stainless steel tag plate
  - 10. Accessories : a) Clamping strip, bracket, prefab cable etc.  
b) Special tool kit for calibration/ configuration .



1.06.00

**Rotameter**

01. Type : Online upto 2" and Bypass above 2" line size"
02. Metering tube : Borosilicate glass
03. Float : AISI 316-SS unless the process fluid demands some other material.
04. Body MOC : SS as per fluid condition.
05. Scale : Aluminium Graduated - Engraved black on white background.
06. Process connection : Flanged to line size or threaded for connection size ½" or less.
07. Accuracy : ± 2% of full scale detection or better for on-line type and ±4% of full-scale detection or better for by-pass type.
08. Nameplate : Tag number, service engraved in stainless steel tag plate
09. Accessories : Slip-on orifice plate of 316-SS and taps of / SS as per application. Applicable SS Isolation valves and SS Range Orifice - for bypass type rotameters.
10. Housing protection class : IP- 65.

1.07.00

**Pressure Gauge and Differential Pressure Gauge**

01. Type : Bourdon/Bellows/Diaphragm
02. MOC Sensing & Socket : AISI-316 SS
03. Movement Material : AISI-304 SS
04. Case Material : Stainless steel..
05. Bezel Material : SS 304.
06. Socket Material : SS 316
07. Enclosure : IP-65.
08. Dial Size : 150 mm





- 09. Scale : Black lettering on white background in 270 Deg. arc.
- 10. Window : Shatterproof glass
- 11. Range Selection : Normal process pressure – 50 ~ 70 % of range (approximately).
- 12. Over-range Protection : 125% of maximum range by internal stop. External stop at zero
- 13. Adjustment : Micrometer screw for zero adjustment. Internal micrometer screw for range adjustment.  
  
External zero adjustment for glycerine filled gauges.
- 14. Element Connection : Argon welding
- 15. Process Connection : 1/2" NPT(M) Bottom connection for local mounting, back connection for panel mounting.
- 16. Performance : Accuracy of  $\pm 1.0$  % of span or better.
- 17. Operating ambient temperature : 0 - 50°C
- 18. Safety Feature : Blow out disc./diaphragm at the back
- 19. Accessories :
  - a) Snubbers and Glycerin filled for pulsating fluid applications and at pump discharge.
  - b) Stainless steel Diaphragm chemical seals for corrosive, viscous and solid-bearing or slurry type process fluids. diaphragm chemical seal shall be provided with the following:
    - 1) Top chamber : SS 304
    - 2) Bottom Chamber: SS 316
    - 3) Sealing fluid: Silicon DC 200
    - 4) Diaphragm: SS 316
  - c) 3-way SS gauge cock/ 2-Valve SS-316 barstock manifold for pressure gauges with 1/2" NPT process connection..





- d) 5-valve SS316 manifold constructed from barstock for differential pressure gauge. Process connection 1/2" NPT.
- e) Union, nut & tail piece and other Installation accessories as required.
- f) Syphons for steam and hot water services.

- 20. Applicable standard : IS-3624 / 1996 , EN-837-1
- 21. Nameplate : Tag number, service engraved in stainless steel tag plate

1.08.00 Temperature Gauge

- 01. Type : Inert gas filled remote mounting system.
- 02. Sensing Element Material : Bourdon - AISI-316 SS
- 03. Capillary Armoring : Stainless steel flexible
- 04. Movement Material : AISI 304 SS
- 05. Bulb / Stem Diameter : 12 mm
- 06. Bulb / Stem Material : AISI 316
- 07. Capillary : Stainless Steel
- 08. Thermometer connection to well : 1/2" NPT
- 09. Case Material : Stainless steel
- 10. Dial Size : 150 mm in general (100 mm for SWAS gauges)
- 11. Scale : Black lettering on white background in 270 Deg. arc.
- 12. Mounting : Surface/Panel
- 13. Over range Protection : 125 % of range or more
- 14. Instrument connection : Bottom connection for local mounting and back connection for panel mounting.





- 15. Range : Normal temperature – 50 ~ 70% of range approximately.
- 16. Zero adjuster : Micrometer screw adjustable from front.
- 17. Window : Shatterproof glass.
- 18. Accuracy : ± 1 % or better
- 19. Enclosure Class : IP-65
- 20. Capillary : 5 meters (local)/15.0 meters (local panel) - armoured stainless steel
- 21. Compensation : Capillary and Case Compensation
- 22. Accessories : a) Forged/barstock SS316 thermowell screwed as per ASME PTC code. Process connection M 33X2 (M). Material of construction of thermowell:
  - 1) SS 316: in general
  - 2) Inconel: For flue gas application
  - 3) Tungsten carbide: For coal mill applicationb) Installation accessories as required.
- 23. Nameplate : Tag number, service engraved in stainless steel tag plate

1.09.00 Thermocouples

- 01. Type : a) Type-K (Chromel Alumel) / Type-R (Pt.-Rhodium Pt.) / Type-E (Chromel Constantan) [As per application]  
b) Duplex (Triplex incase of turbine/Generator/excitor bearing temperature may be used)  
c) Ungrounded
- 02. Wire gauge : 16 AWG for Type-K, 24 AWG for Type-R
- 03. Standard : ANSI-MC 96.1.
- 04. Protecting Tube :-
  - i) O.D. : 8 mm
  - ii) Material : 316-SS Seamless
  - iii) Filling : Magnesium Oxide (Purity above 99.4%)





05. Response time with Thermowell : a) Less than 20 seconds for measurement.  
b) Less than 10 seconds for control.
06. Accuracy :  $\pm 1.1^{\circ}\text{C}$  upto  $300^{\circ}\text{C}$  & 0.4% of measured temperature range above  $300^{\circ}\text{C}$ .
07. Head :
- i) Type : IP-65 universal screwed type. (Explosion proof for NEC Class-1, Division 1 area)
  - ii) Material : Die cast aluminum or better
  - iii) Terminal blocks : Nickel plated Brass - screw type / silver plated
  - iv) Instrument connection :  $\frac{1}{2}$ " NPT to well
  - iv) Cable connection :  $\frac{1}{2}$ " NPT gland and grommet.
  - v) Others : Terminal head cover with SS chain and suitable gasket. All thermowells in the high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safe size and design of thermowells"
08. Accessories : a) Adjustable nipple-union-nipple [ $\frac{1}{2}$ " Sch 80 X  $\frac{1}{2}$ " NPT (M)] with thermowell connection  
b) Compression fittings/unions  
c) Flanges etc. (for flanged connections only)  
d) Barstock thermowell of stepless tapered design as per ASME PTC19.3 code.  
Process connection M33x2 (M) in general or  $1\frac{1}{2}$ " flanged for flue gas/Furnace/air etc. application.  
Material of construction of thermowell:  
1) SS 316: in general  
2) Inconel: For flue gas application  
3) Tungsten carbide: For coal mill application.





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

1.10.00 Passing condition of various drain valves shall be monitored by measuring drain pipe metal temperature at the downstream of the drain valves. Also Drum, SH, RH metal temperature measurement shall be provided. Necessary thermocouples shall be provided as per the following specification.

- 01. Measuring medium : Metal temperature
- 02. Metal of thermocouple element : Chromel-Alumel Type-K
- 03. Type of thermocouple : Duplex with separate hot junctions, ungrounded type.
- 04. Insulation : Mineral insulation Magnesium Oxide
- 05. Thermocouple wire gauge : 16 AWG
- 06. Protective Sheath : SS 321
- 07. Protective Sheath Dia : 8 mm O.D.
- 08. Characteristics of thermocouple : Special limits of error as in ANSI MC 96.01.1975
- 09. Mounting Accessories : 1/2" BSP SS sliding end connector, weld pad, weld on clamps of heat resistant steel SS 310.
- 10. Cold end sealing : SS pot seal with colour coded PTFE headed sleeve insulated flexible tails. Sealing compound - Epoxy resin
- 11. Minimum Bending Radius : 30 mm
- 12. Length of T/C : 30 mtrs. (minimum)

1.11.00 Resistance Temperature Detector

- 01. Type : Platinum (Duplex), Ungrounded
- 02. Resistance : 100 ohm at 0°C
- 03. Base : Wound on ceramic (anti-inductive)
- 04. Wiring : 3/4 Wire





05. Protecting Tube :-
- i) O.D. : 8 mm
  - ii) Material : SS-316, Seamless
  - iii) Filling : Magnesium oxide (Purity above 99.4%).
06. Response time : a) < 20 seconds for measurement.  
b) < 10 seconds for control.
07. Calibration : DIN 43760
08. Accuracy : ± 0.5% of range
09. Head :
- i) Type : IP-65 universal screwed type. (Explosion proof for NEC Class-1, Division 1 area)
  - ii) Material : Die cast aluminum or better
  - iii) Terminal blocks : Nickel plated Brass-screw type / silver plated
  - iv) Cable connection : ½” NPT gland and grommet.
  - v) Others : Terminal head cover with SS chain and suitable gasket. All thermowells in the high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safe size and design of thermowells"
10. Accessories : a) Adjustable nipple-union-nipple [1/2” Sch 80 X ½” NPT (M)] with thermowell connection
- b) Compression fittings/unions
  - c) Flanges etc. (for flanged connections only)
  - d) Barstock thermowell of stepless tapered design as per ASME PTC19.3 code.
- Process connection M33x2 (M) in general or 1 1/2" flanged for flue gas/Furnace/air etc. application.
- Material of construction of thermowell:
- 1) SS 316: in general
  - 2) Inconel: For flue gas application



3) Tungsten carbide: For coal mill application.

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

1.12.00 Pressure Switch

01. Type : i) Piston for high pressure application (above 40 bar)

ii) Bellow /Diaphragm for low pressure application (below 40 bar)

02. Sensing element material : AISI SS-316. All other wetted part SS316.

03. Case Material : Die-cast aluminum alloy with neoprene gasket.

04. Setter Scale : Black graduation on white linear scale. Graduation 0-100% with red pointer for set points.

05. Over range : 150 % of maximum pressure

06. Adjustments : a) Internal Set Point  
b) Differential adjustment

07. End Connection : 1/2" NPT (M) bottom connected

08. Switch configuration : Two SPDT

09. Switch Rating : 240V, 5A AC/220V, 0.5A DC

10. Switch Type : Snap acting, shock & vibration proof

11. Terminal Block : Suitable for full ring lugs for cable connection.

12. Elect connection : Plug in socket

13. Enclosure Class : IP-65 weather and dust proof (Explosion proof for NEC Class-1, Division 1 area).

14. Performance : a) Repeatability  $\pm 0.5\%$  of full range  
b) Accuracy of Setting Indication of  $\pm 1.5\%$

15. Ambient temperature : 0 – 50°C





- 16. Nameplate : Tag number, service engraved in stainless steel tag plate
- 17. Accessories :
  - a) Remote diaphragm seal with SS-316 capillary for viscous & corrosive application. MOC of seal material shall be as per process fluid requirement.
  - b) Snubbers for pulsating fluid application.
  - c) Syphons for steam and hot water services.
  - d) Retention ring and screws for surface mounting.
  - e) 1/2" NPT 2 Valve SS-316 manifold constructed from barstock
  - f) Brass cable gland

1.13.00 Differential Pressure Switch

- 01. Type : Bellows / Diaphragm / Piston actuated
- 02. Sensing element material : AISI SS-316. For all other wetted part SS 316
- 03. Case Material : Die-cast aluminum alloy with neoprene gasket.
- 04. Setter Scale : Black graduation on white scale with 0-100% graduation and provided with red pointer for set point adjustment
- 05. Over range : Static pressure on any one side, the other side being open to atmosphere.
- 06. Adjustments :
  - a) Internal set point adjustment
  - b) Differential adjustment
- 07. Process Connection : 1/2" NPT (M) bottom connected / back connected.
- 08. Switch configuration : Two SPDT
- 09. Switch rating : 240V, 5A AC/220V, 0.5A DC.
- 10. Switch type : Snap acting type contacts, shock and vibration proof.





- 11. Terminal Blocks : Suitable for full ring lugs for cable connection.
- 12. Elect connection : Plug in socket
- 13. Performance : a) Repeatability  $\pm 0.5\%$  of full range  
b) Accuracy of set point Indication:  $\pm 1.5\%$
- 14. Operating Ambient Temperature : 0 - 50°C
- 15. Enclosure : IP-65 (Explosion proof for NEC Class-1, Division 1 area).
- 16. Accessories : a) Snubbers for pulsating fluid application.  
b) Syphons for steam and hot water services.  
c) Retention ring and screws for surface mounting.  
d) 1/2" NPT 3-Valve SS-316 manifold constructed from barstock
- 17. Nameplate : Tag number, service engraved in stainless steel tag plate
- 18. Remote Seal type for special application : a) Silicone oil / fluorolube filled remote diaphragm seal for dirty / viscous / corrosive fluid.  
b) SS armoured capillary at least 3 meters each.  
c) Adapter flanges with nuts, bolts and gaskets for instrument and process side.

1.14.00 Temperature Switch

- 01. Type : Inert gas filled-in
- 02. Sensing Element Material : Bellow / Bourdon AISI SS-316
- 03. Bulb Material : AISI SS-316
- 04. Capillary : Stainless steel armoured
- 05. Movement Material : AISI SS-304
- 06. Case material : Epoxy coated steel plate or die-cast aluminum alloy with neoprene gasket and





clear glass where applicable cover conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).

- 07. Scale : Black lettering on white background
- 08. Over range Protection : 120 %
- 09. Instrument connection : Bottom
- 10. Switch configuration : Two SPDT
- 11. Switch rating : 240V, 5A AC/220V, 0.5A DC
- 12. Switch type : Snap acting, shock and vibration-proof.
- 13. Adjustability : Internal Set point adjustable over span range
- 14. Elect connection : Plug in socket
- 15. Compensation :
  - a) Capillary compensation with invar wire throughout the capillary length.
  - b) Case compensation
- 16. Performance :
  - i) Scale Accuracy :  $\pm 1.0$  % of full scale
  - ii) Repeatability :  $< 0.5$  % of full range
  - iii) Response time : Less than 40 seconds with thermowell
- 17. Capillary length : 5 meters (minimum) for local mounting/15 meters for local panel mounting.
- 18. Nameplate : Tag number, service engraved in stainless steel tag plate
- 19. Accessories : Thermowell from SS barstock, Mounting accessories, 1/2" NPT cable gland.

1.15.00 Level Switch

- 01. Type : External cage float operated. Magnetically coupled.
- 02. Float Material : AISI-316 stainless steel or better
- 03. Other wetted parts : AISI-316 stainless steel or better
- 04. External Cage : Carbon steel / Stainless steel or better as per process requirements, welded type / flanged





construction. Cage pressure rating shall equal or exceed the rating of the main vessel.

- 05. External cage mounting : Side-Side.
- 06. External cage connection : 25 NB socket welded.
- 07. Switch housing : Epoxy coated die-cast aluminum alloy with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
- 08. Type of switch configuration : 2 SPDT (two nos.)
- 09. Contact rating : 5A, 240V/AC, 0.25A, 220V DC
- 10. Accessories :
  - a) Counter flange, nuts & bolts, suitable gasket etc.
  - b) Steel globe type drain valve.
  - c) ½"NPT cable gland
  - d) Stainless steel alpha-numeric engraved for service and tag.
  - e) Globe drain valve
- 11. Preferred feature : Switch operating point marked on cage
- 12. Mounting : On standpipe

1.16.00 Conductivity Type Level Switch

- 01. Type : Conductivity discrimination.
- 02. Application : Drain pots viz. on CRH line
- 03. Mounting : Flanged – on external cage.
- 04. Probe MOC : Stainless steel with high purity ceramic.
- 05. Probe rating : > Maximum design pressure of vessel.
- 06. Input : Four independent channel with selectable switching threshold for water conductivity.
- 07. Relay Output : Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo.





08. Contact type & rating : 2SPDT or 1 DPDT @ 5A 30V DC.
09. Local Display : Coloured LEDs for Hi, Lo, Hi-Hi, Lo-Lo, Power & fault.
10. Power supply : Dual 240V AC, 50 Hz, 1Ph UPS supply.
11. Enclosure : IP-65, corrosion resistant & wall mounting type (Explosion proof for NEC Class-1, Division-1 area).
12. Accessories :
  - a) PTFE cable from probe to electronics
  - b) Mounting accessories
  - c) External cage
  - d) Washer & gasket
13. Test pressure : Two times rated pressure
14. Elect connection : Plug in socket

**1.17.00 Capacitance Type Level Switch**

01. Type : Capacitance type
02. Probe :
  - a) Rod or suspended electrode
  - b) Rope type probes may be used only where required probe length is greater than 1.5 meters.
  - c) Reference rod for non grounded tank.
03. Probe Mounting : 1-1/2" Flanged
04. Material of construction : 316 SS and to suit fluid type
05. Insulation : PTFE/PP/Kynar Part/Full as required
06. Enclosure : Powder coated Die cast aluminium. with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
07. Ambient temperature : 0-60°C.
08. Mounting : Top Mounting
09. Supply voltage : 240V AC, 50 Hz, 1Ph UPS supply/ 24V DC







- 10. Relay output : 2 SPDT
- 11. Contact rating : 5A min. at 240V AC on resistive load
- 12. Response time : 100 msec or better
- 13. Elect connection : Plug in socket
- 14. Accessories : Counter flange, cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.

1.18.00 RF Type Level Switch

- Sensing Probe :
- 01. Type : Rigid
- 02. Material : SS-316
- 03. Mounting : Threaded
- 04. Probe Head Housing : Cast Aluminium
- 05. Protection : IP-66
- Electronic Controller :
- 01. Supply Voltage : 240V AC (UPS)
- 02. Relay Output : 2 nos. SPDT
- 03. Contact Rating : 240V AC,5A/ 220V DC, 0.25A
- 04. Housing Material : Cast Aluminium
- 05. Protection : IP-65
- 06. Local LED Indication : Power On, Alarm Level, Probe Healthy
- 07. Switching Repeatability :  $\pm 0.5\%$
- 08. Accessories : Coaxial cable probe connection to controller  
1/2"NPT Cable Gland

1.19.00 Ultrasonic Level Switch

- 01. Principle of operation : Ultrasonic contact level technology
- 02. Input Power : 24V DC/ 240V AC





- 03. Output Contact : 2 SPDT (240V AC, 5A/ 220V DC, 0.25A)
- 04. Switch Mounting : Integral
- 05. Sensor Material : SS-316
- 06. Enclosure : Cast Aluminium (IP-65)
- 07. Process Connection : 2" Flanged
- 08. Repeatability : 2 mm
- 09. Power supply : 240V AC, 50 Hz, 1Ph UPS supply/ 24V DC
- 10. Cable connection : ½" NPT with cable gland
- 11. Accessories : Cable gland, cable, companion flange, bolts & nuts, gaskets etc. along with all mounting hardware

**1.20.00 Ultrasonic Level Transmitter**

- 01. Principle of operation : Detection of reflected ultrasonic pulse
- 02. Signal processing : Microprocessor Controlled Signal Processing
- 03. Type : Smart
- 04. Display : Large alpha-numeric back lit LCD/LED
- 05. Calibration & configuration : Accessible from front of panel
- 06. Diagnostic : On-line
- 07. Status : For power, Hi / Lo / V. Hi / V. Lo-level indication, fault etc.
- 08. Construction : Plug-on board
- 09. Power supply : 240V AC, 50 Hz, 1Ph UPS supply/ 24V DC
- 10. Signal Output : 4-20 mA DC (isolated) - 500 Ohm load with HART protocol.
- 11. Hysteresis : Fully adjustable preferred
- 12. Output contacts : 2SPDT Potential free changeover contacts @ 5A 230V AC.





13. Accuracy & Repeatability : 0.25% of span or better
14. Resolution : 0.1% of span
15. Operating temp. : Transmitter- 0 to 50° C and Sensor 0 to 80° C
16. MOC Sensor : SS 316 in general / PTFE, PP for corrosive application.
17. Humidity : 1% to 95% non condensing.
18. Enclosure : IP-65 powder coated die cast aluminium
19. Cable connection : ½” NPT with cable gland
20. Mounting : 2” flanged for sensor and Transmitter on panel / surface.
21. Accessories : Cable gland, prefab cable, mounting accessories.

**1.21.00 Conductivity Type E lectronic Level Indicator**

01. Type : Conductivity discrimination.
02. Application : Separator drum Level .
03. No. of Probes : As per manufacturer standard.
04. Probe Mounting : Flanged – on standpipe.
05. Probe MOC : Stainless steel with high purity ceramic.
06. Probe rating : > Maximum design pressure of vessel.
07. Input : Independent channel with selectable switching threshold for water conductivity.
08. Relay Output : Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo.
09. Contact type & rating : 2 SPDT or 1 DPDT @ 5A 30V DC.
10. Current output : Isolated 4-20 mA DC
11. Local Display : a) Coloured (Red & Green) LEDs for level.  
b) Flashing LEDs for fault.
12. Remote Display : Red, Green & flashing yellow LEDs for steam, Water & Fault indication respectively.



13. Power supply : Dual 240V AC, 50 Hz, 1Ph UPS supply.
14. Enclosure : a) IP-65, corrosion resistant & wall mounting type for local electronics.  
b) IP-42 for remote indicator
15. Accessories : a) PTFE cable from probe to electronics  
b) Mounting accessories.  
c) Standpipe  
d) Washer & gaskets  
e) Double isolation valves on each connection, double drain valves & double vent valves with mechanical lock.  
f) ½" NPT cable gland
16. Test pressure : Two times design pressure

**1.22.00****Air Filter Regulator**

01. Filter Element : Sintered Bronze
02. Filter Size : 5 microns
03. Input Air : 10.0 Kg/Sq. cm (maximum)
04. Output : Adjustable from 0-2.0 Kg / Sq. cm or 0-7.0 Kg / Sq. cm (continuous) as applicable.
05. Effect of Supply : Maximum 0.02 Kg/Sq. cm for a change pressure variation in supply pressure of 4 Kg/Sq. cm
06. Bowl Material : Metallic.
07. Accessories : 2" dial size output pressure gauge
08. Feature : No perceptible drop of pressure on opening the drain port.

**1.23.00****SOLENOID VALVE**

01. Operating Principle : Electromagnetic (noiseless)
02. Coil voltage rating : 24V DC (in general) other 220V DC /240V AC /110V AC as required





- 03. Ways : 3 ways in general other depending on requirement
- 04. Port size : 1/4" NPT all ports
- 05. Body : SS Bar Stock
- 06. Trim : AISI SS-316
- 07. Manual Operator : In built
- 08. Duty : Suitable for continuous energization
- 09. Sealing : Airtight and leak proofing with nitrile (NBR) and polyurethane (PUR) material
- 10. Ambient Temperature : 0 - 50° C
- 11. Fluid Temperature : 0-150° C (approx.)
- 12. Coil Enclosure : Stainless Steel
- 13. Insulation : Class-H
- 14. Coil Casing : IP-65 (Explosion proof for NEC Class-1, Division-1 area)
- 15. Response time : 4-7msec
- 16. Mounting : On pipe or on panel
- 17. Cable Connection : ½" NPT cable gland
- 18. Accessories : Mounting brackets, nuts and bolts
- 19. Special feature : (i) LED indication for power  
(ii) Double coil type for open & close operation of valve / damper.  
(iii) Solenoid valve directly integral to actuator body shall have NAMOOR interface for uniformity

1.24.00 ORIFICE PLATE

- 01. Application : Low fluid velocity flow measurement
- 02. Design Standard : Concentric as per ASME PTC-19.5 (Part –II), ISA RP-3.2 or BS-1042, Part-I
- 03. Number of Tapings : As required plus one additional pair of taps
- 04. Diameter Ratio : Between 0.34 to 0.7





- 05. Thickness : 3mm for main pipe of diameter upto 250mm, 6mm for main pipe of diameter above 250mm and 10mm for diameter above 500 mm
- 06. Document : Beta ratio calculation, assembly drawing and Flow vs. DP curve.
- 07. Meter run pipe : Same as pipe material
- 08. Accessories : Flanges, gaskets, nuts & bolts, root valves (1" 316 SS globe) jack screw, meter run pipe, Drain & vent hole as per application etc.

NOTE: One flow element of each type shall be calibrated in the test laboratory for validation of computed flow calculations.

**1.25.00 FLOW NOZZLE**

- 01. Application : High fluid velocity flow measurement
- 02. Design Standard : ASME PTC 19.5
- 03. Tapings : D and D/2 ( Numbers as required plus one additional pair of taps)
- 04. Diameter Ratio : Between 0.4 and 0.7
- 05. Material : 316 SS (321 SS for high temperature)
- 05. Document : Beta ratio calculation, assembly drawing and Flow vs. DP curve.
- 06. Meter run pipe : Same as pipe material
- 07. Accessories : Meter run pipe, nipples and root valves (1" 316 SS globe).(Inspection port assembly for nozzles used in plant performance purpose)

NOTE: One flow element of each type shall be calibrated in the test laboratory for validation of computed flow calculations.

**1.26.00 GAUGE GLASS**

- 01. Type : Reflex
- 02. Glass : Toughened borosilicate. Resistant to mechanical and thermal shocks.
- 03. Body material : Carbon steel / stainless steel- As per process requirements (Flanged Connection)
- 04. Pressure rating : Twice the maximum working pressure





- 05. Temperature rating : 300<sup>o</sup> C
- 06. Bolts and nuts : Rust proof alloy steel
- 07. Accessories : Suitable ball check valves of SS-304/316 body, gaskets, companion flange etc.

**1.27.00 LEVEL GAUGE (FLOAT & BOARD)**

- 01. Type : Float and Board
- 02. Float & Tape MOC : AISI 316
- 03. Pulley and Pulley Housing material : SS 304
- 04. Guide wire : SS 316 Stainless steel
- 05. Accuracy : +/- 2 mm
- 06. Indication : Vertical dial
- 07. Rating : Twice the design pressure
- 08. Spring tension assembly : SS 304
- 09. Anchor plate : SS304
- 10. Calibrated scale board: Aluminium with black graduation

Note: The measuring rope/tape shall be passed through conduits

**1.28.00 POWER CYLINDERS (PNEUMATIC)**

- 01. Mounting Type : a) Fixed position mounting (End mounting).  
: b) Trunnion mounting
- 02. Control Signal : 4-20 mA DC to smart positioner with HART protocol for modulating purposes. 24V/48VDC operated solenoid valve operating on pneumatic line for open & closing purpose of on & off drive.
- 03. Supply Air : 0-7 Kg / Cm<sup>2</sup>.
- 04. Selection : Based upon thrust / torque, stroke length, angular movement, full-scale travel time, repeatability, space factor etc. Provision for air-to-open and air-to-close operation.
- 05. Casing : IP-65.





- 06. Accessories (as required) :
  - a) Air lock relay
  - b) Hand wheel.
  - c) Air filter regulator with gauge.
  - d) Volume Booster.
  - e) Limit Switches.
  - f) Smart Positioner with integral I-P convertor, feedback position Transmitter (4-20 mA DC output), Input & Output pressure gauges, local keypad & display.
  - g) Solenoid Valve
  - h) Junction box with cable gland
- 07. Fail-safe operation : Stay put for regulating duty.
- 08. Repeatability : Better than 0.5% of full travel.
- 09. Hysterisis : Less than  $\pm 1\%$  of full travel
- 10. Operating Temp. limit : 80° C (min.)

1.29.00

SIGHT GLASS

- 01. Type : Flap-type
- 02. End connection : Screwed / Flanged
- 03. Material :
  - a) Body : SS-304
  - b) Cover Plate : SS-304
  - c) Indicator : SS-316
- 04. Sight Glass : Toughened Borosilicate
- 05. Gasket : Neoprene
- 06. Bolts & Nuts : High tensile steel
- 07. Hydraulic Test
  - Pressure : 1.5 times maximum working pressure
- 08. Accessories : As required

1.30.00

SMOKE DENSITY ANALYZER

- 01. Type : Insitu dry visible light (through LED)
- 02. Principle of







- Measurement : Transmission & absorption (Dual beam type)
03. Sensor type : Luminiscence
04. Display : Back Lit LCD
05. Measurement range : 0-999 mg/m<sup>3</sup>, 0-999 mg/Nm<sup>3</sup>, 0-100% opacity
06. Measurement averaging : Selectable 10 sec to 60 minutes
07. Accuracy : 0.2% of F.S
08. Resolution : 0.1% of F.S / 1mg/m<sup>3</sup> whichever is better
09. Linearity : 1.0% of F.S
10. Repeatability : < 0.5% of Span
11. Response time (upto 90% of full scale) : 5 sec
12. Flue gas temperature : 90<sup>o</sup>C (When FGD in op[eration)  
135<sup>o</sup>C (When FGD not in operation)  
Max 600<sup>o</sup>C (at APH outlet)
13. Ambient temperature : 0 - 60<sup>o</sup>C
14. Operating temperature : Transmitter & receiver- 0-90<sup>o</sup>C, Electronic unit – 0-70<sup>o</sup>C
15. Mounting : Transceiver on opposite side of the duct
16. Analog output : 4-20mA DC (in 500 ohm resistance) to DCS
17. Alarm output : 2 SPCO potential free rated at 230 VAC, 5A
18. Power Supply : 240V AC, 50 Hz, 1 Phase UPS
19. Automatic misalignment detection : Required
20. Automatic compensation of lens contamination : Required
21. Purge air Failure : Purge air to be provided from Blower unit and to be monitored for failure.
22. Span and Zero Check : Automatic periodic with manual override



- 23. Housing : Corrosion resistant painted aluminium rated at IP-65
- 24. Fail safe shutter : Automatic fail safe shutter against power and air failure
- 25. Input normalisation : Correction for temperature, pressure, oxygen and water vapour to be provided.
- 26. Preferred Features : "Power Supply On" LED visible from front
- 27. Accessories :
  - a) Mounting pads suitable for mounting projector and receiver units on duct, flanges, etc.
  - b) Blower unit (Purging System) with purge fail alarm at CCR
  - c) Enclosure for electronic units & indicators
- 28. Application : At chimney  
At each ESP outlet

1.31.00

SO<sub>x</sub> & NO<sub>x</sub> ANALYZER

As per Protocol for Real time (Emission & Effluent) Data Management from Insudtries Version-1.2 (10.06.2015); Instruments/Analysers/Equipments (each model) individually certified from Institutions like TUV, MCERTs, USEPA etc. as notified by CPCB.

- 01. Type : Insitu Probe/ Cross duct type analyser
- 02. Gases to be measured : SO<sub>x</sub>, NO<sub>x</sub>
- 03. Principle of measurement : Infrared absorption/ UV Spectroscopy
- 04. Flue gas Temperature : As per process requirement
- 05. Mounting/Application : Flanged/ On chimney
- 06. Measurement range : Fully selectable as per process requirement
- 07. Units of measurement : PPM, mg / Nm<sup>3</sup> and %
- 08. Power Supply : 240V, 50 Hz, 1 Phase UPS
- 09. Local Display : Back lit LCD / LED
- 11. Accuracy : 2% of measured value





- 12. Repeatability : 1% of full scale
- 13. zero & Span drift : 2% per month
- 14. Calibration : Zero and Span calibration in manual and automatic mode. Automatic calibration interval shall be fully selectable. Remote Calibration and configuration facility from the remote location shall be possible. (i.e, the hardware and software required for Remote Calibration and configuration from Remote location to be provided).
- 15. Analog output : 4-20 mA DC (in 500 ohm resistor) to DCS for each channel
- 16. Alarm output : (1NO + 1NC) for each measured parameter and self diagnostic failure. All contacts rated at 230V AC, 5A
- 17. Input normalisation : Required-online with pressure and temperature sensor and also provision for key pad entry of inputs
- 18. Probe material : Stainless Steel 316L
- 19. Enclosure : Corrosion resistant epoxy painted aluminium housing & enclosure rated to IP-65.
- 20. Accessories :
  - a) Compressor/Blower unit, tubes & fittings for calibration and purging, purge fail alarm in CCR
  - b) Calibration gas cylinders for SO<sub>2</sub>, Nox & N<sub>2</sub> (for Zero Calibration) filled in 10 Ltrs. of WC carbon cylinder with necessary SS regulators with pressure & flow gauges, solenoid valve & SS tubings and SS fittings etc. as required.
  - c) Mounting flanges, gasket etc.
  - d) control unit for interface with PC based data logger to be provided.

1.32.00 OXYGEN ANALYZER

- 01. Type : In-situ, Zirconium sensor, micro-processor-based transmitter,
- 02. Range : 0.1-10% / 0.25-25% by volume
- 03. Output : 4-20 mA DC linear





- 04. Probe Length /  
Material : 1800 mm (approximate depending on duct size) / SS 316
- 05. Process Temperature : As per Process Requirement.
- 06. Measurement  
Reference : Instrument Air
- 07. Accuracy :  $\pm 1\%$  of F.S.
- 08. Response Time : Less than 5 (five) sec for 90% of full scale
- 09. Amplifier Housing : IP-65
- 10. Calibration : Manual or Automatic periodic-operator selectable
- 11. Power Supply : 240V, 50 Hz, 1 Phase UPS
- 12. Material for Gas Carrying Components : Stainless Steel
- 13. Read Out : Backlit LED/LCD
- 14. Protection : Automatic cell protection against reducing atmosphere
- 15. Alarm Facility : 1 HI and 1 LO independently adjustable over span. Contact rating 500 mA at 220 V DC (minimum).
- 16. Preferred Features :
  - a) HI and LO alarm LED visible from front.
  - b) Power Supply On/Failure LED visible from front
- 17. Accessories :
  - a) Mounting flanges, adaptor plate and protection shield (protection/abrasive shield shall be SS 316)
  - b) Gasket, nuts and bolts
  - c) Cable with conduit from cell to amplifier (as required) and other special cables (if any)
  - d) Automatic calibration kit (complete with all accessories and standard Gas Cylinders)





- 18. Application : e) Solenoid valve, Pressure regulator with Filter and Flow indicator  
a) At economizer outlet  
b) At each air preheater inlet and outlet
- 1.33.00 H2 + CO2 + AIR ANALYZER
- 01. Type : Thermal Conductivity
  - 02. Range Selection : 3 ranges.
  - 03. Range : As required
  - 04. Output : 4-20mA DC (Isolated)
  - 05. Operating ambient temp. : 10<sup>o</sup> C to 50<sup>o</sup> C
  - 06. Power Supply : 240V AC, 50Hz UPS
  - 07. Sample gas flow control : Required
  - 08. Reference gas flow : Required
  - 09. Reference gas pressure regulator : Required
  - 10. Cell response : 95% of change in 30 Sec.(Appox.)
  - 11. Accuracy : 2% of full scale
  - 12. Repeatability : 1% of full scale
  - 13. Local Indicator : Indicating meter of 1% accuracy Backlit LCD/LED display
  - 14. Alarm facility : Dual (High & Low) independently adjustable.
  - 15. Contact rating : 0.5A at 220 V AC
  - 16. Enclosure : Flame Proof
  - 17. Accessories : Calibration gas, mounting accessories and others as required to be provided
  - 18. Application : Generator Gas Purity.
- 1.34.00 CO ANALYZER
- 01. Operating Principle : NDIR



- 02. Type : In-situ, microprocessor based probe type at economiser. In-situ, microprocessor based Cross duct/Probe type at chimney
- 03. Range : As per process requirement
- 04. Accuracy : 1% Full Scale
- 05. Linearity : ±1% of Full Scale
- 06. Repeatability : <1% of span\
- 07. Calibration : Automatic & Manual (Zero & Span)
- 08. Power Supply : 240V AC
- 09. Output Signal : 4~20 mA DC
- 10. Alarm annunciation : Four relay contacts, dual alarm set points (240V AC, 5A)
- 11. Enclosure : Cast Aluminium (IP-65)
- 15. Indication : LCD Display
- 16. Op. Temperature Range : At Economiser (350 Deg C) and at Chimney (100 Deg C)
- 17. Accessories : Interconnection cable (as required) in flexible conduits  
Tube / fittings, mounting brackets/ pads as required  
Purge system for cleaning  
Surge Arrester
- 18. Location : At Economizer and Chimney
- 19. Additional Feature : Remote Calibration and configuration facility from the remote location shall be possible. (i.e, the hardware and software required for Remote Calibration and configuration from Remote location to be provided).

1.35.00 MERCURY ANALYZER

- 01. Operating Principle : Atomic absorption spectroscopy
- 02. Range : 0-100 µg/Nm3
- 03. Measuring Parameters : Total gaseous mercury
- 04. Output : 4~20 mA DC





- 05. Alarm/ Annunciation : Four Relay contacts, dual alarm set points (240V AC, 5A)
- 06. Indication : LCD Display
- 07. Sampling System : Extractive
- 08. Enclosure : IP-65
- 09. Power Supply : 240V AC (UPS)
- 10. Location : On Chimney
- 10. Accessories : a) Inbuilt calibration facility through calibrator. Inbuilt cell for Zero & Span calibration to be provided. Handling of Liquid Mercury to be avoided.  
b) Remote calibration facility to be provided.  
c) The Mercury analyser cabinet to be placed inside an enclosed AC environment.

1.36.00 DEW POINT METER

- 01. Type : Direct mounting capacitance type with change in output proportional to moisture present
- 02. Sensing Element : Ceramic/ Aluminium Oxide sensor
- 03. Service : Dry Air
- 04. Range : -90 Deg.C to 10 Deg.C Dew point temperature
- 05. Sensor Accuracy :  $\pm 2$  Deg.C Dew point
- 06. Repeatability : 0.5 Deg.C Dew point
- 07. Op.Ambient Temperature : -40 Deg.C to 50 Deg.C
- 08. Op. Pressure : 0-10 Kg/cm<sup>2</sup>
- 09. Display : Combined enclosure with 5 digit seven segments LED display
- 10. Element Filter : 80 micron sintered stainless steel
- 11. Output : 4~20 mA DC loop powered
- 12. Power Supply : 24V DC nominal





- 13. Enclosure Class : IP-65
- 14. Interchangeability : Fully Interchangeable Transmitters
- 15. Accessories : Sampling System, cables, sensor holder, dessicant chambers, souble compression fittings, 3/4" cable gland, mounting fixture etc.

1.37.00

DENSITY METER

- 01. Operating Principle : Vibration Density measurement
- 02. Wetted Part Material : SS-316L
- 03. Case Material : Cast Aluminium
- 04. Output : 4~20 mA DC
- 05. Electrical connection : 1/2" NPT
- 06. Enclosure Class : IP-65
- 07. Local Display : Digital 5 digit, density display with temp. compensation
- 08. Accuracy : ±1.0 %
- 09. Power Supply : 240V AC (UPS)
- 10. Location : At the discharge of Gypsum bleed pump in FGD system.

1.38.00

RADAR TYPE LEVEL MEASUREMENT

- 01. Type : Radar based on Time Domain Reflectometry
- 02. Antena : Co axial / single rod type guided wave or Horn type as required for the application
- 03. Communication : Two wire 4-20mA DC, HART protocol
- 04. Environmental temperature : 0 – 50°C
- 05. Enclosure : Explosion proof /IP 65 as per application
- 06. Cable Entry : 1/2" NPT
- 07. Calibration : a) Self calibration with internal reference  
b) Zero & Span calibration
- 08. Programming : Handheld programmer & Local key pad
- 09. Process Connection : Flanged /screwed







- 10 Transmitter Beam
  - Angle : 10 degree or less
- 11 Blocking distance : less than 300 mm
- 12. Electronic Housing : Epoxy painted Die-Cast aluminium alloy
- 13. Antenna / Flange assembly : 316 SS or Hestalloy (as required)
- 14. Output Indicator : Digital Integral Display (Backlit LCD/LED)
- 15. Accuracy : 5 mm or 0.1% of probe length
- 16. Accessories : a) Programming tool kit  
b) Gasket

1.39.00 CHLORINE LEAK DETECTOR

- 01. Type : Electrochemical
- 02. Resolution : 0.1 ppm
- 03. Display Type : Digital Indicating Meter
- 04. Operating Temperature : 0~45°C
- 05. Alarm Contacts : Dual Alarm setpoints (240V AC, 5A)
- 06. Enclosure Class : IP-65
- 07. Mounting : Wall mounting
- 08. Power Supply : 240V AC
- 09. Output : 4~20 mA DC (600 Ω load)

1.40.00 RESIDUAL CHLORINE ANALYZER

- 01. Type : Amperometric
- 02. Electrode : Platinum/ Gold and copper electrode shall be provided with cell cleaning system
- 03. Display Type : LCD in Analyzer Panel
- 04. Range : 0 to 20.0 mg/L (ppm)
- 05. Accuracy : 2% or better . The measurement accuracy shall not be affected by presence of treatment chemicals as chromates.





phosphates, de-former highly polluted water, change in temperature etc.

- 06. Sensitivity : 0.01 mg/L
- 07. Alarm Contacts : Dual Alarm setpoints (240V AC, 5A)
- 08. Enclosure Class : IP-65
- 09. Power Supply : 240V AC
- 10. Output : 4~20 mA DC (600 Ω load)
- 11. Calibration : Zero & Span adjustment. Final calibration adjustments of the analyzer to be done at site and duly verified bt titration. Temperature compensation range 0-50°C.
- 12. Mounting : Field mounting conform to IP-65
- 13. Accessories : Chemical reagents, sample drain, pumping system (if required) etc.

1.41.00 ELECTRIC TO PNEUMATIC (E/P) CONVERTERS

- 01. Air Supply : 1.5 kg/cm2
- 02. Max. supply Pressure : 7 kg/cm2
- 03. Input Signal : 4-20 mA DC (as required by the design of control system).
- 04. Output Signal : 0.2 to 1.0 kg/cm2
- 05. Control Action : Air to Close, Air to Open and Fail freeze-field selevelable
- 06. Response Time : 5 seconds for 0 to 90% output pressure
- 07. Repeatability : +/- 0.1% span typical
- 08. Accuracy : +/- 0.25% span typical
- 09. Linearity : 0.5% of span or better
- 10. Hysteresis : 0.1% of span or better
- 11. Ambient Temp. effect : Less than 0.02% of span per °C between





-20 °C to +60 °C

- 12. Supply pressure effect: less than 1%
- 13. Span and zero adjustment : screw
- 14. Mounting : Close to Actuator (but not on the actuator)
- 15. Output Capacity : To suit the actuator
- 16. Protection Class : IP 65
- 17. Allowable Drift Rate : ± 2% of set point / hour maximum

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

1.42.00 SMART POSITIONER

- 01. Type : Universal design (linear or rotary application)
- 02. Input Signal : 4-20mA DC , 2 wire loop with 24V DC.
- 03. Output Signal (position F/B) : i) 4-20mA  
ii) Configurable end position switch
- 04. Supply Pressure : Single acting 1.2 to 7.0 bar  
Double acting 1.2 to 10.5 bar
- 05. Air Delivery : Single acting 10.0 SCFM at 2.1 bar supply  
Double acting 7.2 SCFM at 2.1 bar supply
- 06. Housing : IP 65
- 07. Repeatability : +/- 0.3% of span or better
- 08. Accuracy : +/- 0.1% of span or better
- 09. Communication : Hart protocol
- 10. Power-up with position : < 150 ms or better control
- 11. Power interruption without reset : <100ms or better
- 12. Body Material : Aluminium
- 13. Response Time : Less than 10 sec





- 14. Features :
  - i) Noncontact position feedback sensor
  - ii) Integral Electro-Pneumatic convertor
  - ii) Self calibration with tunable response time
  - iii) Online diagnostics
  - iv) Pressure guages to be provided on positioner (I/P & O/P pressure)

1.43.00 MAGNETIC LEVEL INDICATOR

- 01. TYPE : Magnetically coupled level indicator
- 02. Display : Coloured flags
- 03. Chamber material : Stainless steel
- 04. Wetted part material : Stainless steel
- 05. Process connection : Side Side Flanged
- 06. Drain & Vent : Flanged
- 07. Scale : Standard, Stainless steel
- 08. Accessories : Counter flange, gaskets

1.44.00 FLOW SWITCH

- 01. Type : Paddle /Piston/Disk
- 02. Wetted part material : Stainless steel or Hastelloy for acidic application
- 03. End connection Tee :
  - i) Threaded upto 1" line size with integral
  - ii) Flanged for line size > 1 1/2"
- 04. Enclosure material : Die cast aluminium
- 05. Enclosure class : IP 65
- 06. Switch configuration : 2 SPDT
- 07. Contact rating : 240V AC 15A
- 08. Repeatability : 2%
- 09. Cable connection : 1/2"NPTF





10. Accessories : Tee, counter flange

1.45.00 ULTRA SONIC TYPE FLOW METER

- a) Ultrasonic Flow meter shall be dual path transit time clamp-on type.
- b) The flow meters shall be of proven reliability, accuracy and repeatability requiring a minimum of maintenance. They shall comply with relevant international standards and shall be subject to approval.
- c) CW flow shall be measured by redundant Ultrasonic Flow meter.
- d) All accessories required for mounting/erection of these instruments shall be furnished, erected and installed as necessary for completeness of the system though not specifically asked for. Also the equipment shall include necessary cables, flexible conduits, junction boxes required for the purpose.
- e) Flow meters shall be provided with suitable environment protection devices / structures such that they shall be suitable for continuous operation in the operating environment of a coal fired utility station without any loss of function or departure from the specification requirements.

f) Technical Requirements

- 01. Type : Transit time Clamp On Ultrasonic meter
- 02. Mounting Style : Dual path with two sets of transducers on the same pipe
- 03. Flow measurement : Instantaneous Flow rate as well as totalized flow
- 04. Power supply : 240V AC, 50Hz with built –in battery back up.
- 05. Analog Outputs : Isolated 4-20mA linear outputs for each path
- 06. Binary Output : Contact relay outputs, 2 NO + 2 NC for alarm
- 07. Communication ports : RS 232 C digital  
Hand held terminal port
- 08. Display/Indication : Flow meter with LCD screen backlight based local display and keypad. If required, transmitter shall be suitably located away from the sensor for better access and visibility.

09. Recording / Totalizing /





- Logging Facilities : Yes. Should be able to compute cumulative flow over intervals selectable by Owner i.e., daily, weekly, monthly etc. The data shall be stored in the memory of flow computer for access in future.
- 10. Software features : Compensation for any cross path errors Programming, configuration, shall be possible from front panel.
- 11. Diagnostics : False signal tolerance , power supply failure etc.
- 12. Protection Class : IP-65 or better, Weather protection against direct sunlight, rain etc for Flow meter and suitable for Cooling water for Transducer.
- 13. Accuracy : ± 1%
- 14. Electrical connection : Plug and socket
- 15. Accessories : All mounting hardware required like clamping fixtures, mechanism to remove the transducers online, interconnecting cables etc.  
  
All weather canopy for protection from direct sunlight and direct rain. Material of all fittings shall be SS 316
- g) 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.

**2.00.00 NOT USED**

**3.00.00 CONTROL PANEL/DESK MOUNTED INSTRUMENTS AND ELECTRICAL SYSTEM ACCESSORIES.**

(For electrical System's Meter and for synchronisation, bidder shall refer to Electrical volume of specification)

**3.01.00 Digital Indicator (If required)**

- 01. Type : Five and half digit LED seven-segment display with sign.
- 02. Display Character : 13.8 mm, RED (LED)
- 03. Accuracy : 0.1% of reading, ±2 digit





- 04. Input : 4-20mA DC/1-5 V DC/ pulse (as applicable)
- 05. Mounting : Flush Panel
- 06. Power Supply : 240V  $\pm$ 10%, 50  $\pm$ 2.5 Hz

**3.02.00 PUSH BUTTON**

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

**3.03.00 ILLUMINATED PUSH BUTTON**

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





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

**3.04.00****SELECTOR SWITCH**

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







12. Enclosure Class : IP-52

3.05.00 INDICATING LAMP

- 01. Type : LED with built-in resistor
- 02. Face Dimension : 32 x 32 mm (maximum)
- 03. Voltage : 240 V AC
- 04. Watt : 2.5 Watt (approximate)
- 05. Lamp and Lens Replacement : From front
- 06. Construction : Transparent Plastic lens
- 07. Color : Red, Green, Amber, Yellow etc.
- 08. Connection : Screw terminals
- 09. Legend : Engraving

3.06.00 INDICATING METERS (A.C)

- 01. Type : Rectifier type taut band
- 02. Face Dimension : 96 x 96 mm
- 03. Scale : Radial arc of 240 Deg.
- 04. Accuracy : 1.5% of full scale.  
±0.5 Hz for frequency meter
- 05. Input : 0-1/0-5A for current measurement, 0-240V for voltage measurement, 50 ± 2.5 Hz for Frequency measurement
- 06. Zero Adjustment : Screw on meter face
- 07. Enclosure : Shielded Case IP-52
- 08. Mounting : Flush Panel
- 09. End Scale  
Suppression : 6 times the measuring range only for motor ammeters

3.06.01 INDICATING METERS (D.C)

- 01. Type : Taut band moving coil
- 02. Face Dimension : 96 x 96 mm





- 03. Scale : Radial arc of 240 Deg.
- 04. Accuracy : 1.5% of full scale
- 05. Input : 0-75 mA for current measurement. Direct reading for voltage measurement.
- 06. Zero Adjustment : Screw on meter face
- 07. Enclosure : Shielded case IP-52
- 08. Mounting : Flush Panel
- 09. End Scale
- Suppression : 2 times the measuring range only for motor ammeters.

**3.07.00 AUXILIARY RELAY**

- 01. Type : Plug-in type with base/DIN rail Mounted
- 02. Coil voltage : 240 V AC/24V DC / 220V DC
- 03. Contact Configuration : 2 NO & 2 NC (Minimum), additional contacts as per requirement
- 04. Contact rating : 250V/5A (A.C/D.C.)
- 05. Operating range : 80 to 110% of rated voltage
- 06. Insulation : 2 KV for 1 minute between terminals & earth.
- 07. Mechanical life : 20 million operations
- 08. Enclosure : Transparent cover
- 09. Connection : Screw terminals.
- 10. Mounting : Projection mounting inside panel /DIN rail Mounting

Note : Coil protection: diode/surge suppressor shall be provided

**3.08.00 COUPLING RELAY**

- 01. Type : Miniature plug-in type/ DIN rail Mounting
- 02. Coil voltage : 24 V D.C. / 48 V DC or others as required.
- 03. Contact : 2 NO & 2 NC (Minimum)-Additional contact as per requirement





- 04. Contact rating : 250 V/10A (A.C)/220V/2A (D.C)
- 05. Operating range : 70 to 110% of rated voltage.
- 06. Insulation : 2 KV for 1 minutes between terminal & earth.
- 07. Mechanical life : 20 million operations
- 08. Coil protection : Diode
- 09. Indication : Coil on LED
- 10. Enclosure : Transparent cover
- 11. Connection : Screw terminals.
- 12. Mounting : Projection mounting inside panel / DIN rail mounting

3.09.00 UNINTERRUPTED POWER SUPPLY (FOR CONTROL EQUIPMENT ROOM, UNIT CONTROL ROOM AND OFFSITE PLCs)

UPS with 2x100% configuration shall be provided for the equipments / devices located in the Control Equipment (DCS) room and Unit Control room. Normally both of the redundant UPS will run in parallel mode sharing 50% load. On failure of any UPS, its load shall automatically get transferred to the other healthy UPS. For detail specification of UPS refer volume IIF/2 section X-A1 & X-A2.

3.11.00 Push Button Station ( Emergency Stop)

- 01. Function : Hardware communication between P/B Station & DCS
- 02. Type : Mechanical keys Shrouded
- 03. Size : 48 mm
- 04. Mounting : On Auxiliary Console
- 05. Signal Level : 24V DC Binary
- 06. Ambient temperature : 0-50 ° C
- 07. Ambient Humidity : 0-95% RH (max.)



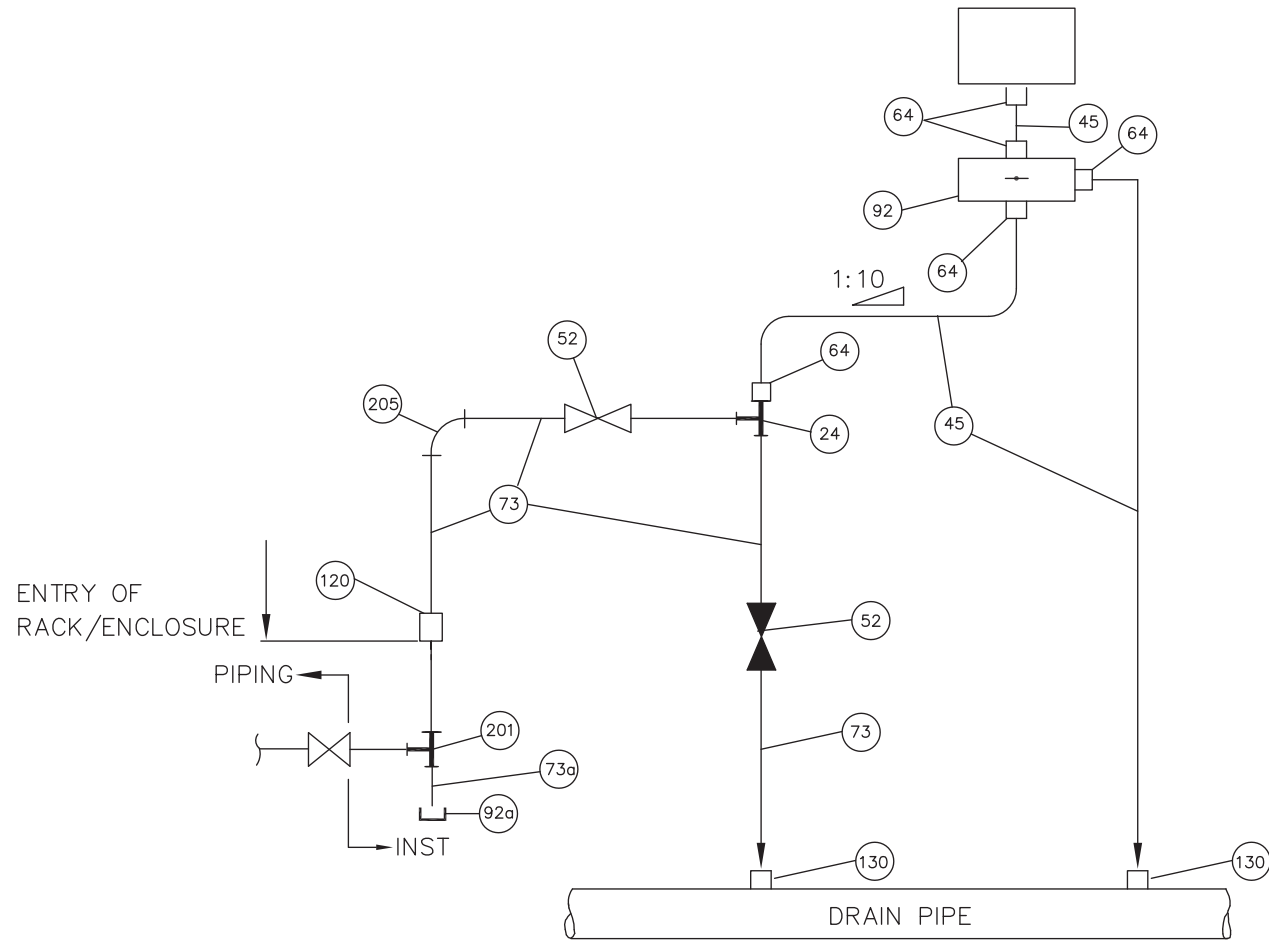






PRESSURE TRANSMITTER/PRESSURE SWITCH  
MOUNTED ABOVE SOURCE POINT

PRESSURE TRANSMITTER/  
SWITCH



BILL OF MATERIAL		
ITEM NO.	QTY./INST.	DESCRIPTION
24	1	UNEQUAL TEE, 1/2" SW X 1/2" NPT (F)
45	3 M	TUBE, 1/2" OD
52	2	GLOBE VALVE, 1/2" SW
64	5	MALE CONNECTOR 1/2" NPT(M) X 1/2" OD
73	15	IMPULSE PIPE, 15 NB
73a	1	NIPPLE, 1/2" SW X 1/2" NPT (F), 150 MM
92	1	2-VALVE MANIFOLD, 1/2" NPT (F)
92a	1	DRAIN PLUG, 1/2" NPT (M)
120	1	BULK HEAD UNION/COUPLING, 1/2" SW
130	2	HALF COUPLING, 1/2" SW
201	1	EQUAL TEE, 1/2" SW
205	2	90° ELBOW, 1/2" SW

SERVICE : CONDENSER PRESSURE ETC.

FOR TENDER PURPOSE ONLY

TYPICAL INSTRUMENT INSTALLATION DIAGRAM

THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD.

KOLKATA, INDIA

SAGARDIGHI THERMAL POWER STATION  
1 x 660 MW, PHASE-III  
EXTN. UNITS # 5



DEVELOPMENT CONSULTANTS PVT. LTD  
CONSULTING ENGINEERS

JOB NO. DCL- 12A05 SCALE : NIL

DWG. NO. 12A05-DWG-I-0022 REV. 0

REVIEWED	APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE
	A.T.	S.B.	A.K.P.	S.K.	FIRST ISSUE	-	0	22.06.2017

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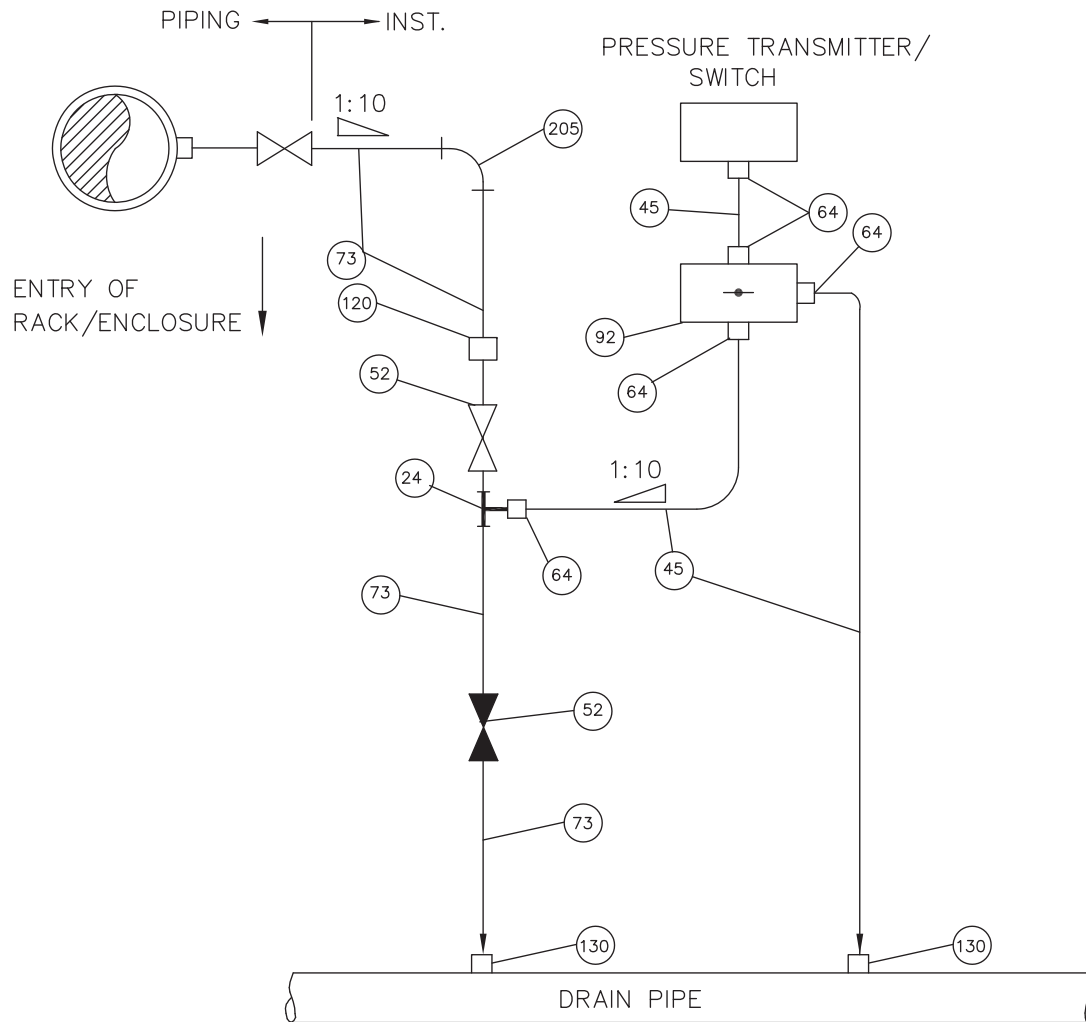
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**PRESSURE TRANSMITTER/PRESSURE SWITCH  
MOUNTED BELOW SOURCE POINT**



BILL OF MATERIAL		
ITEM NO.	QTY./INST	DESCRIPTION
24	1	UNEQUAL TEE, 1/2" SW X 1/2" NPT (F)
45	3 M	TUBE, 1/2" OD
52	2	GLOBE VALVES, 1/2" SW
64	8	MALE CONNECTOR, 1/2" NPT (M) X 1/2" OD
73	15 M	IMPULSE PIPE, 15 NB
92	1	2 VALVE MANIFOLD, 1/2" NPT (F)
120	1	BULK-HEAD UNION, 1/2" SW
130	2	HALF COUPLING, 1/2" SW
205	1	90° ELBOW, 1/2" SW

SERVICE : CONDENSATE, FEED WATER ETC.

**FOR TENDER PURPOSE ONLY**

TYPICAL INSTRUMENT INSTALLATION DIAGRAM

THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD.

KOLKATA, INDIA

SAGARDIGHI THERMAL POWER STATION  
1 x 660 MW, PHASE-III  
EXTN. UNITS # 5



DEVELOPMENT CONSULTANTS PVT. LTD  
CONSULTING ENGINEERS

JOB NO. DCL- 12A05 SCALE : NIL

DWG. NO. 12A05-DWG-I-0022 REV. 0

REVIEWED	APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE
	A.T.	S.B.	A.K.P.	S.K.	FIRST ISSUE	-	0	22.06.2017

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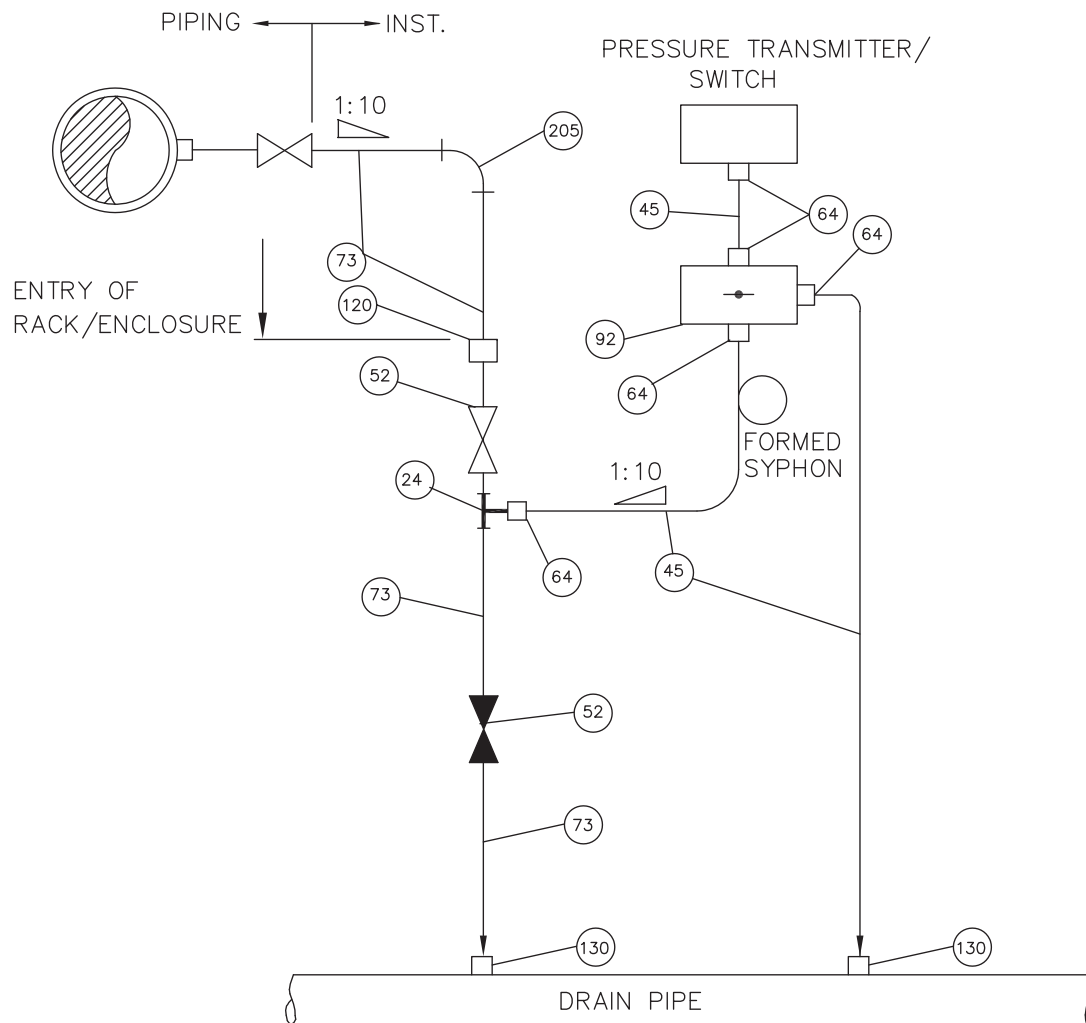
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**PRESSURE TRANSMITTER/PRESSURE SWITCH  
MOUNTED BELOW SOURCE POINT(WITH SYPHON)**



BILL OF MATERIAL		
ITEM NO.	QTY./INST	DESCRIPTION
24	1	UNEQUAL TEE, 1/2" SW X 1/2" NPT (F)
45	3 M	TUBE, 1/2" OD
52	2	GLOBE VALVES, 1/2" SW
64	8	MALE CONNECTOR, 1/2" NPT (M) X 1/2" OD
73	15 M	IMPULSE PIPE, 15 NB
92	1	2 VALVE MANIFOLD, 1/2" NPT (F)
120	1	BULK-HEAD UNION, 1/2" SW
130	2	HALF COUPLING, 1/2" SW
205	1	90° ELBOW, 1/2" SW

SERVICE : LOW PRESSURE STEAM

FOR TENDER PURPOSE ONLY

TYPICAL INSTRUMENT INSTALLATION DIAGRAM

THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD.

KOLKATA, INDIA

SAGARDIGHI THERMAL POWER STATION

1 x 660 MW, PHASE-III  
EXTN. UNITS # 5



DEVELOPMENT CONSULTANTS PVT. LTD  
CONSULTING ENGINEERS

JOB NO. DCL- 12A05 SCALE : NIL

DWG. NO. 12A05-DWG-I-0022 REV. 0

REVIEWED	APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE
	A.T.	S.B.	A.K.P.	S.K.	FIRST ISSUE	-	0	22.06.2017

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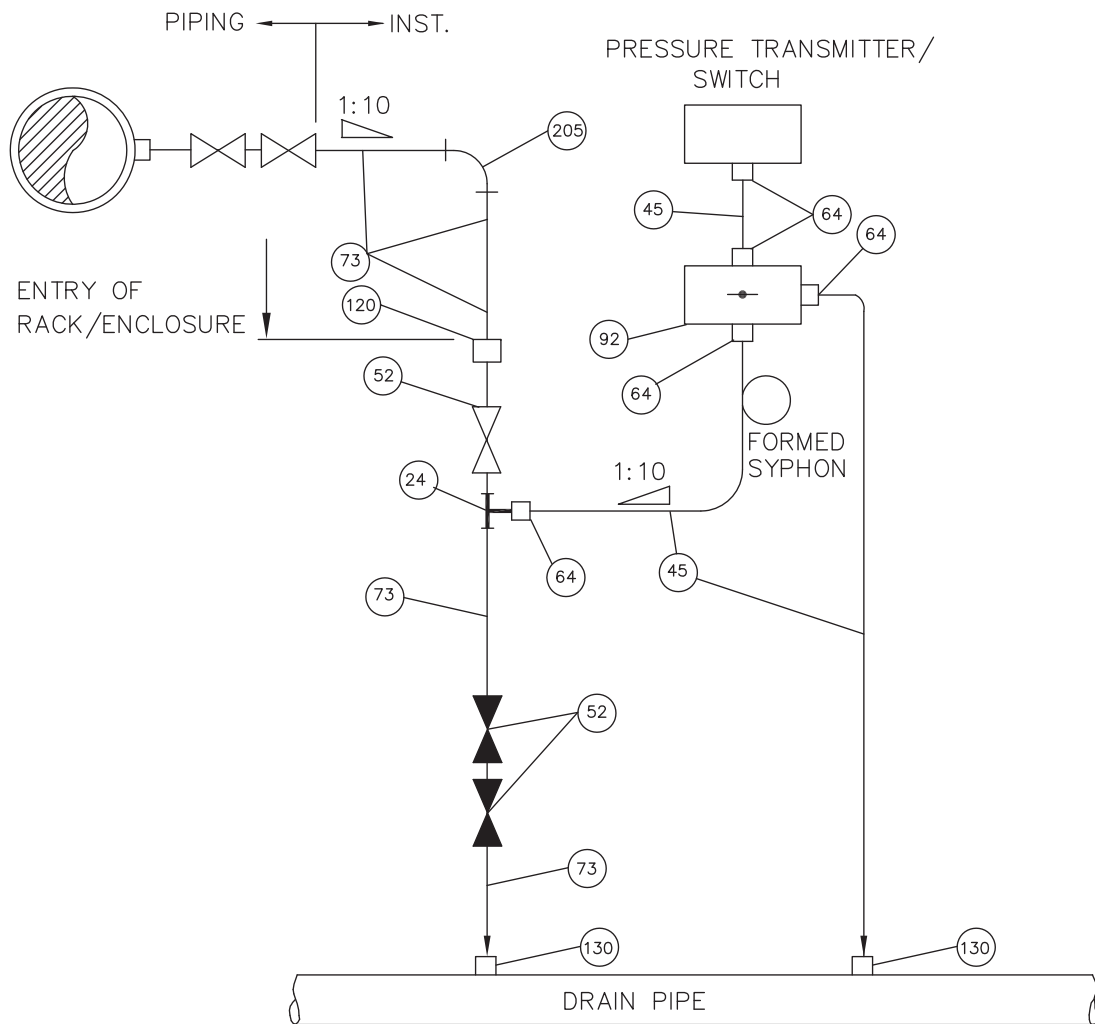
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**PRESSURE TRANSMITTER/PRESSURE SWITCH  
MOUNTED BELOW SOURCE POINT(WITH SYPHON)**



BILL OF MATERIAL		
ITEM NO.	QTY./INST	DESCRIPTION
24	1	UNEQUAL TEE, 1/2" SW X 1/2" NPT (F)
45	3 M	TUBE, 1/2" OD
52	3	GLOBE VALVES, 1/2" SW
64	8	MALE CONNECTOR, 1/2" NPT (M) X 1/2" OD
73	15 M	IMPULSE PIPE, 15 NB
92	1	2 VALVE MANIFOLD, 1/2" NPT (F)
120	1	BULK-HEAD UNION, 1/2" SW
130	2	HALF COUPLING, 1/2" SW
205	1	90° ELBOW, 1/2" SW

SERVICE : SERVICE : MEDIUM & HIGH PRESSURE STEAM

**FOR TENDER PURPOSE ONLY**

TYPICAL INSTRUMENT INSTALLATION DIAGRAM

THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD.

KOLKATA, INDIA

SAGARDIGHI THERMAL POWER STATION  
1 x 660 MW, PHASE-III  
EXTN. UNITS # 5



DEVELOPMENT CONSULTANTS PVT. LTD  
CONSULTING ENGINEERS

JOB NO. DCL- 12A05 SCALE : NIL

DWG. NO. 12A05-DWG-I-0022 REV. 0

REVIEWED	APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE
	A.T.	S.B.	A.K.P.	S.K.	FIRST ISSUE	-	0	22.06.2017

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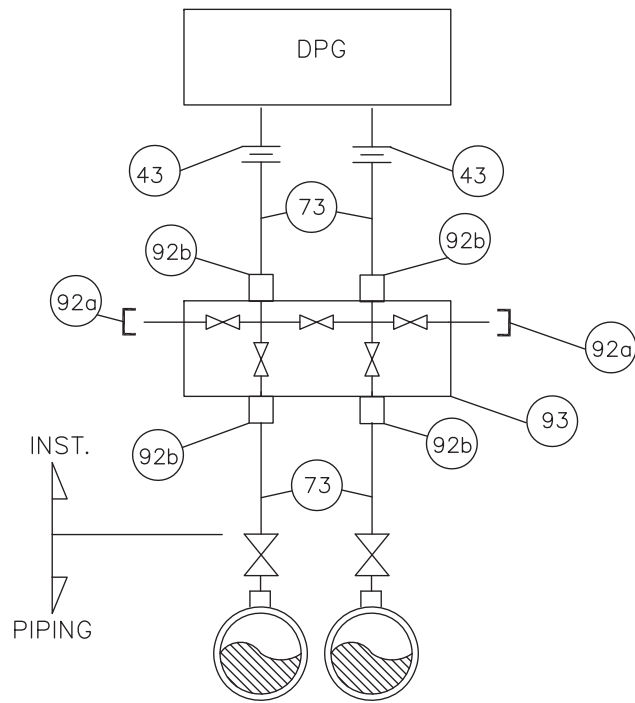








DIFFERENTIAL PRESSURE GAUGE



BILL OF MATERIAL		
ITEM NO.	QTY./INST	DESCRIPTION
43	2	THREE PIECE UNION, 1/2" SW X 1/2" NPT (F)
52	2	GLOBE VALVE, 1/2" SW
73	30 M	IMPULSE PIPE 15 NB
93	1	5 VALVE MANIFOLD, 1/2" NPT (F)
92a	2	VENT PLUG, 1/2" NPT (M)
92b	4	ADAPTOR, 1/2" SW X 1/2" NPT (M)

SERVICE : WATER, STEAM, AIR ETC.

FOR TENDER PURPOSE ONLY

TYPICAL INSTRUMENT INSTALLATION DIAGRAM



DEVELOPMENT CONSULTANTS PVT. LTD  
CONSULTING ENGINEERS

THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD.  
KOLKATA, INDIA

JOB NO. DCL- 12A05 SCALE : NIL

SAGARDIGHI THERMAL POWER STATION  
1 x 660 MW, PHASE-III  
EXTN. UNITS # 5

DWG. NO. 12A05-DWG-I-0022 REV. 0

REVIEWED	APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE
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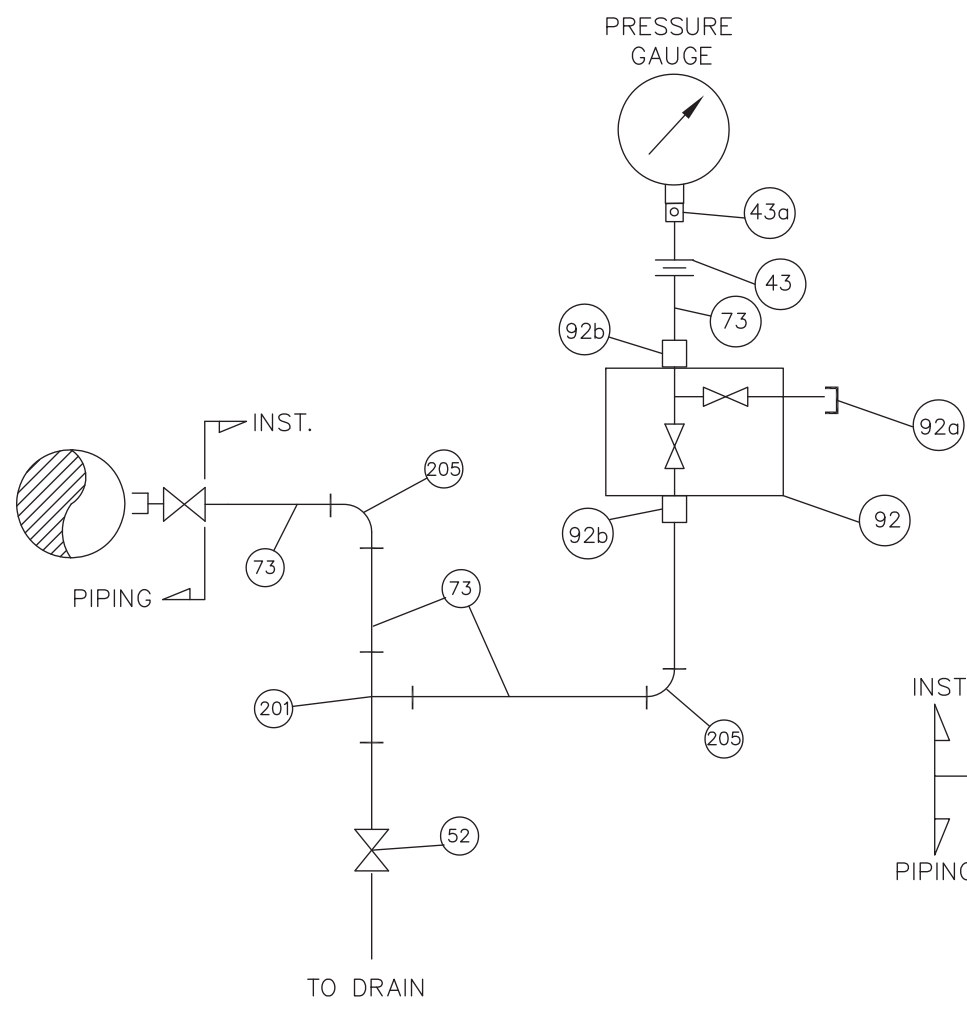
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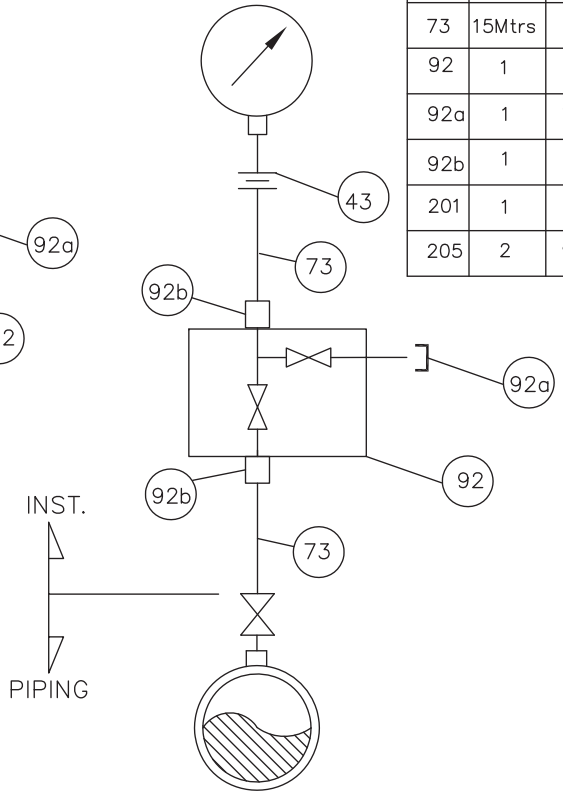
A  
B  
C  
D

PRESSURE GAUGE



REMOTE MOUNTING

PRESSURE GAUGE



ON TAP MOUNTING

BILL OF MATERIAL		
ITEM NO.	QTY./INST	DESCRIPTION
43	1	THREE PIECE UNION, 1/2" SW X 1/2" NPT (F)
43a	1	SNUBBER, 1/2" NPT (M) X 1/2" NPT (F) (AT PUMP DISCHARGE)
52	1	GLOBE VALVE, 1/2" SW
73	15Mtrs	IMPULSE PIPE 15 NB
92	1	2 VALVE MANIFOLD, 1/2" NPT (F)
92a	1	VENT PLUG, 1/2" NPT (M)
92b	1	ADAPTOR, 1/2" SW X 1/2" NPT (M)
201	1	EQUAL TEE 1/2" SW
205	2	90° ELBOW 1/2" SW

SERVICE : WATER, CONDENSATE ETC.

**FOR TENDER PURPOSE ONLY**

REVIEWED	APPROVED	S.B.	A.K.P.	S.K.	DESCRIPTION	RELEASE STATUS	REV.	DATE
					FIRST ISSUE	-	0	22.06.2017

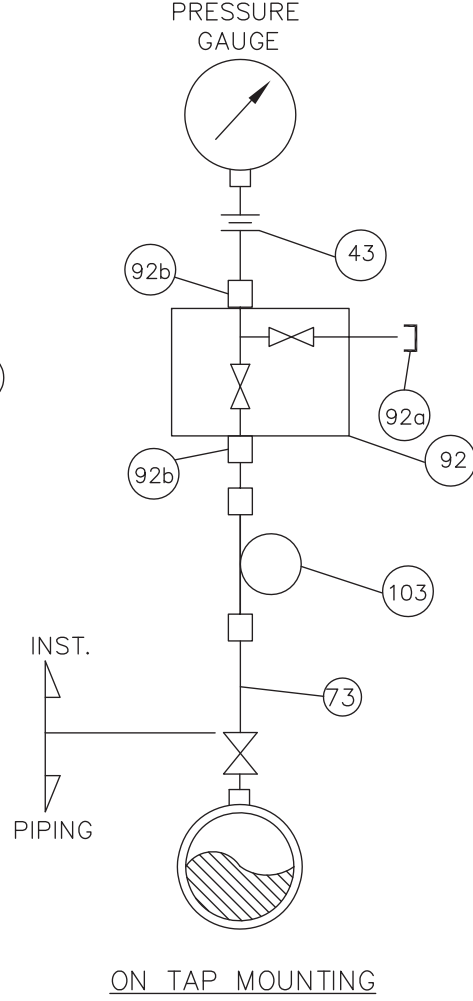
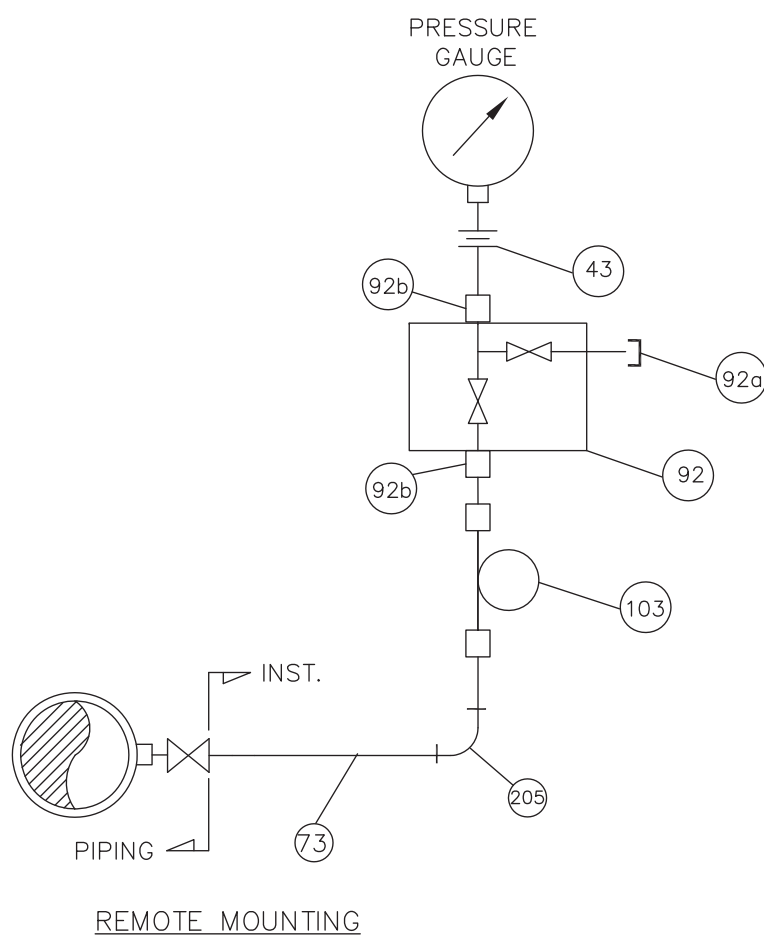
<b>TYPICAL INSTRUMENT INSTALLATION DIAGRAM</b> THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD. KOLKATA, INDIA		DEVELOPMENT CONSULTANTS PVT. LTD CONSULTING ENGINEERS	
SAGARDIGHI THERMAL POWER STATION 1 x 660 MW, PHASE-III EXTN. UNITS # 5		JOB NO. DCL- 12A05	SCALE : NIL
DWG. NO. 12A05-DWG-I-0022		REV. 0	

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A3 (9-96) [420x297]

D 12A05-DWG-I-0022-R-0-SHT-15 OF 27 C 22.06.2017

PRESSURE GAUGE



BILL OF MATERIAL		
ITEM NO.	QTY./INST.	DESCRIPTION
43	1	THREE PIECE UNION, 1/2" SW X 1/2" NPT (F)
73	15Mtrs	IMPULSE PIPE 15 NB
92	1	2 VALVE MANIFOLD, 1/2" NPT (F)
92a	1	VENT PLUG, 1/2" NPT (M)
92b	1	ADAPTOR, 1/2" SW X 1/2" NPT (M)
103	1	SYPHON 1/2" SW
205	1	90° ELBOW 1/2" SW

SERVICE : STEAM, FEED WATER

FOR TENDER PURPOSE ONLY

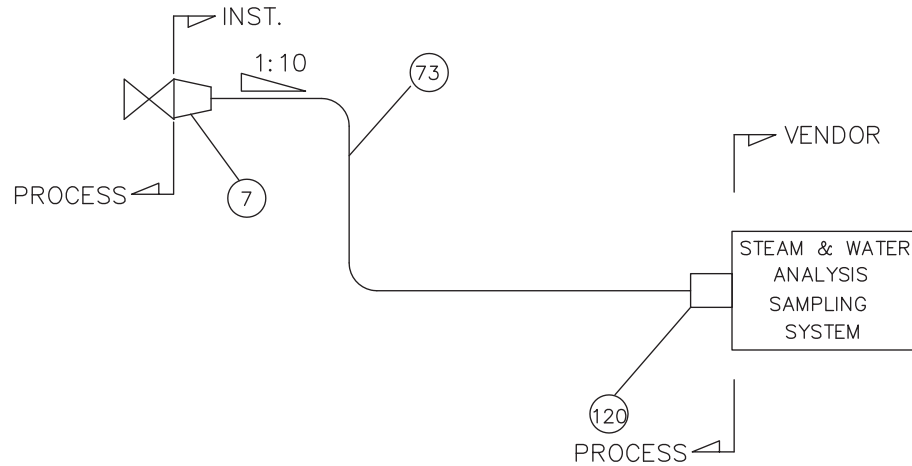
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		A.T.	S.B.	A.K.P.	S.K.	FIRST ISSUE	-	0	22.06.2017		
		APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE		
	1		2			3			4		5

TYPICAL INSTRUMENT INSTALLATION DIAGRAM		DEVELOPMENT CONSULTANTS PVT. LTD CONSULTING ENGINEERS	
THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD. KOLKATA, INDIA		JOB NO. DCL- 12A05	SCALE : NIL
SAGARDIGHI THERMAL POWER STATION 1 x 660 MW, PHASE-III EXTN. UNITS # 5		DWG. NO. 12A05-DWG-I-0022	REV. 0
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A3 (9-96) [420x297]

D 12A05-DWG-I-0022-R-0-SHT-16 OF 27 C 22.06.2017

SWAS SYSTEM TAPPING POINT



BILL OF MATERIAL		
ITEM NO.	QTY./INST.	DESCRIPTION
7	1	REDUCER, 1" SW X 1/2" SW
73	A/R	IMPULSE PIPE, 15 NB
120	1	BULK HEAD UNION, 1/2" SW

FOR TENDER PURPOSE ONLY

TYPICAL INSTRUMENT INSTALLATION DIAGRAM



DEVELOPMENT CONSULTANTS PVT. LTD  
CONSULTING ENGINEERS

THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD.

KOLKATA, INDIA

JOB NO. DCL- 12A05 SCALE : NIL

SAGARDIGHI THERMAL POWER STATION  
1 x 660 MW, PHASE-III  
EXTN. UNITS # 5

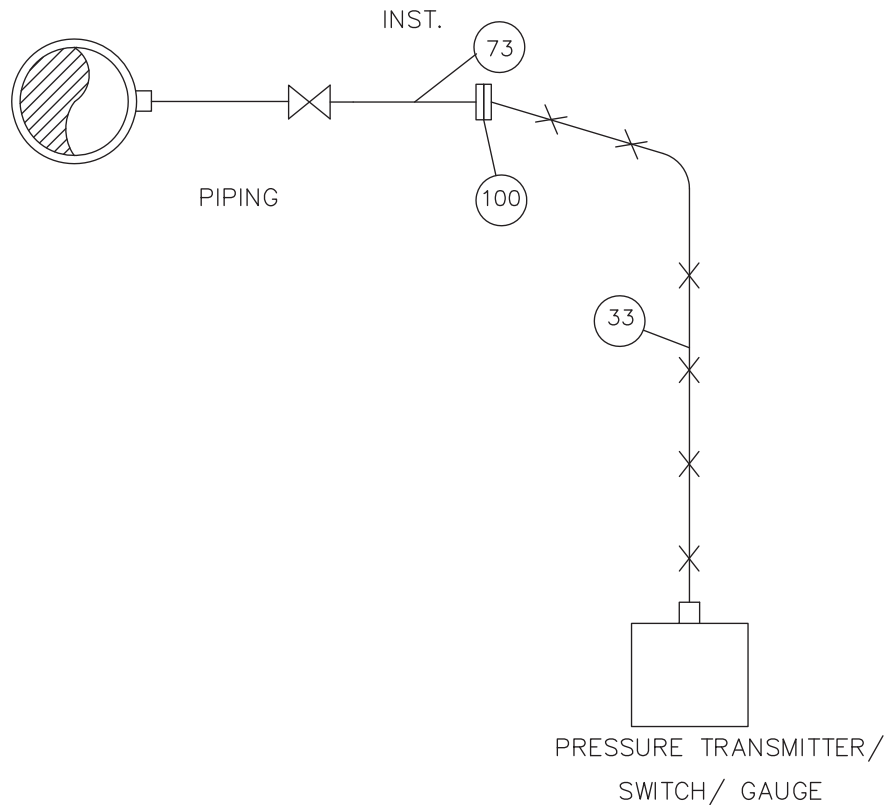
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	A.T.	S.B.	A.K.P.	S.K.	FIRST ISSUE	-	0	22.06.2017



PRESSURE TRANSMITTER/PRESSURE SWITCH  
WITH REMOTE DIAPHRAGM SEAL

BILL OF MATERIAL		
ITEM NO.	QTY./INST.	DESCRIPTION
33	A/R	SS ARMoured CAPILLARY TUBE
73	1 M	IMPULSE PIPE, 15 NB
100	1	FLANGE ASSEMBLY TO SUIT 1/2" PIPE



SERVICE: CORROSIVE/ VISCIOUS/SOLID BEARING OR SLURRY SERVICE

FOR TENDER PURPOSE ONLY

TYPICAL INSTRUMENT INSTALLATION DIAGRAM

THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD.

KOLKATA, INDIA

SAGARDIGHI THERMAL POWER STATION

1 x 660 MW, PHASE-III  
EXTN. UNITS # 5



DEVELOPMENT CONSULTANTS PVT. LTD  
CONSULTING ENGINEERS

JOB NO. DCL- 12A05

SCALE : NIL

DWG. NO. 12A05-DWG-I-0022

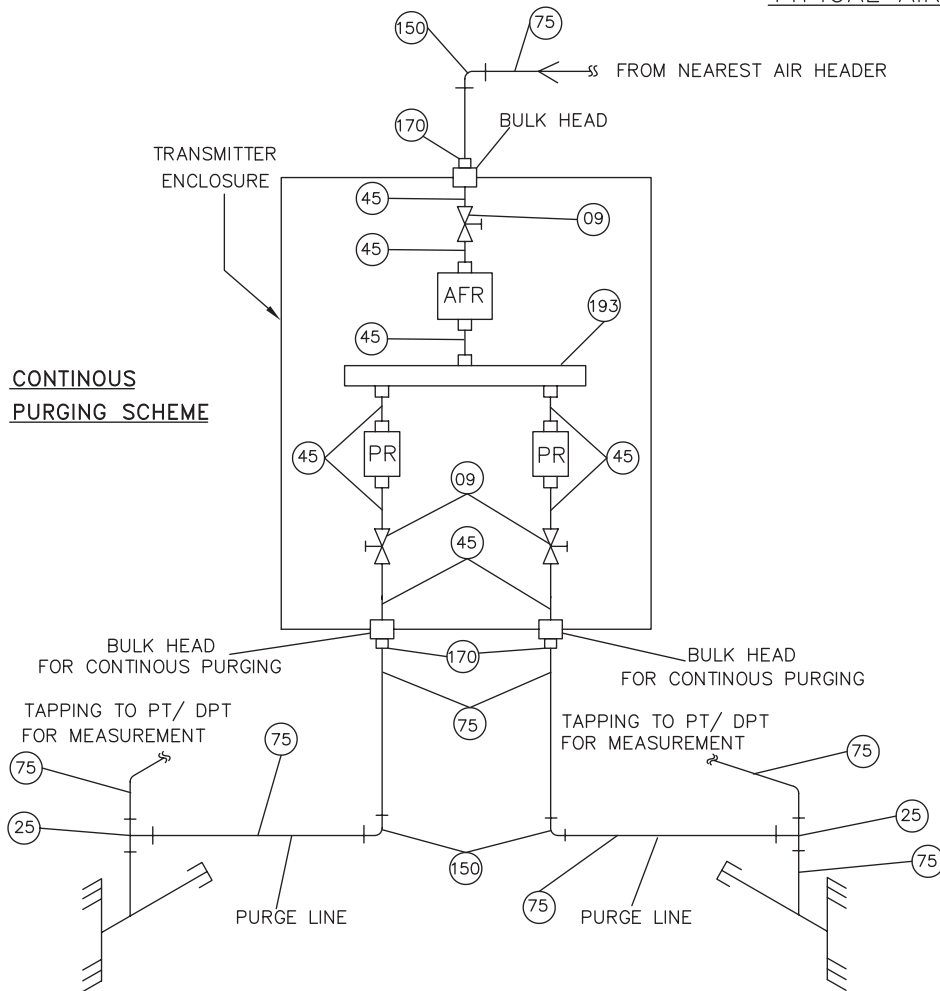
REV. 0

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	A.T.	S.B.	A.K.P.	S.K.	FIRST ISSUE	-	0	22.06.2017

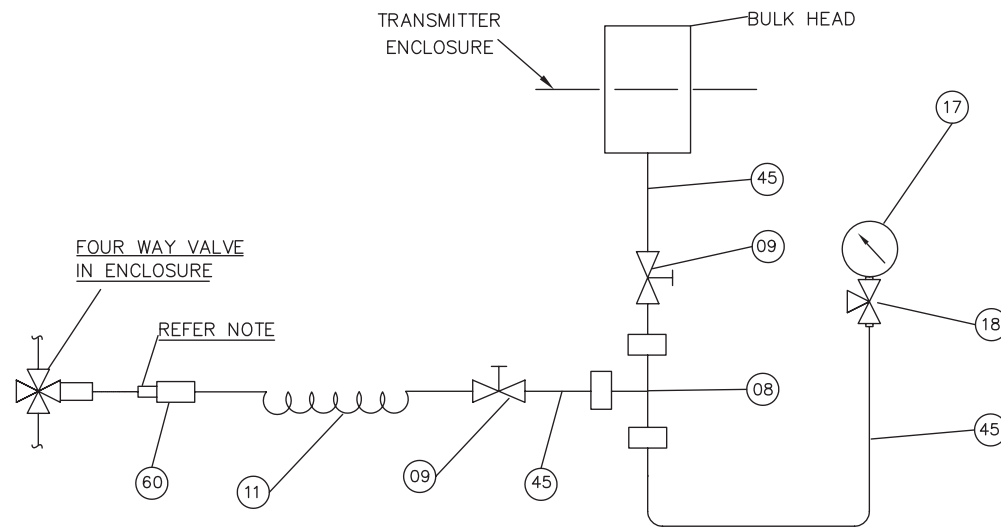


# TYPICAL AIR PURGING SCHEMES

## CONTINUOUS PURGING SCHEME



## INTERMITTENT PURGING SCHEME



### NOTE:

QUICK DISCONNECTING FITTING IS CONNECTED TO FOUR WAY VALVE WHERE INTERMITTENT PURGING IS CALLED IN SCHEME.

### ABBREVIATION:

AFR: AIR FILTER REGULATOR  
PR: PURGE ROTAMETER

CONTINUE TO SHT. NO. 22/27

FOR TENDER PURPOSE ONLY

TYPICAL INSTRUMENT INSTALLATION DIAGRAM



DEVELOPMENT CONSULTANTS PVT. LTD  
CONSULTING ENGINEERS

THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD.

KOLKATA, INDIA

SAGARDIGHI THERMAL POWER STATION  
1 x 660 MW, PHASE-III  
EXTN. UNITS # 5

JOB NO. DCL- 12A05 SCALE : NIL

DWG. NO. 12A05-DWG-I-0022

REV. 0

REVIEWED	APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE
	A.T.	S.B.	A.K.P.	S.K.	FIRST ISSUE	-	0	22.06.2017

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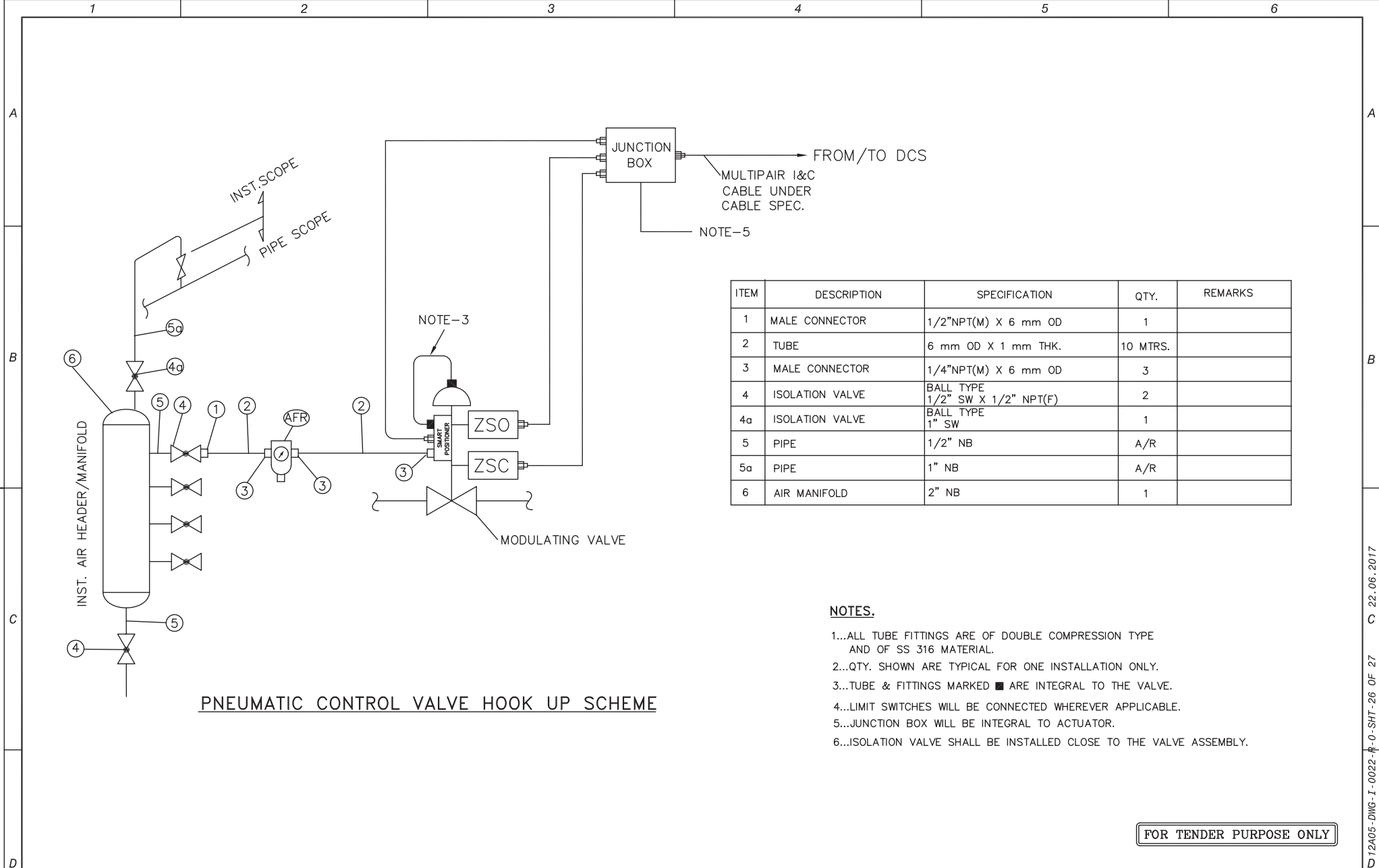












ITEM	DESCRIPTION	SPECIFICATION	QTY.	REMARKS
1	MALE CONNECTOR	1/2"NPT(M) X 6 mm OD	1	
2	TUBE	6 mm OD X 1 mm THK.	10 MTRS.	
3	MALE CONNECTOR	1/4"NPT(M) X 6 mm OD	3	
4	ISOLATION VALVE	BALL TYPE 1/2" SW X 1/2" NPT(F)	2	
4a	ISOLATION VALVE	BALL TYPE 1" SW	1	
5	PIPE	1/2" NB	A/R	
5a	PIPE	1" NB	A/R	
6	AIR MANIFOLD	2" NB	1	

PNEUMATIC CONTROL VALVE HOOK UP SCHEME

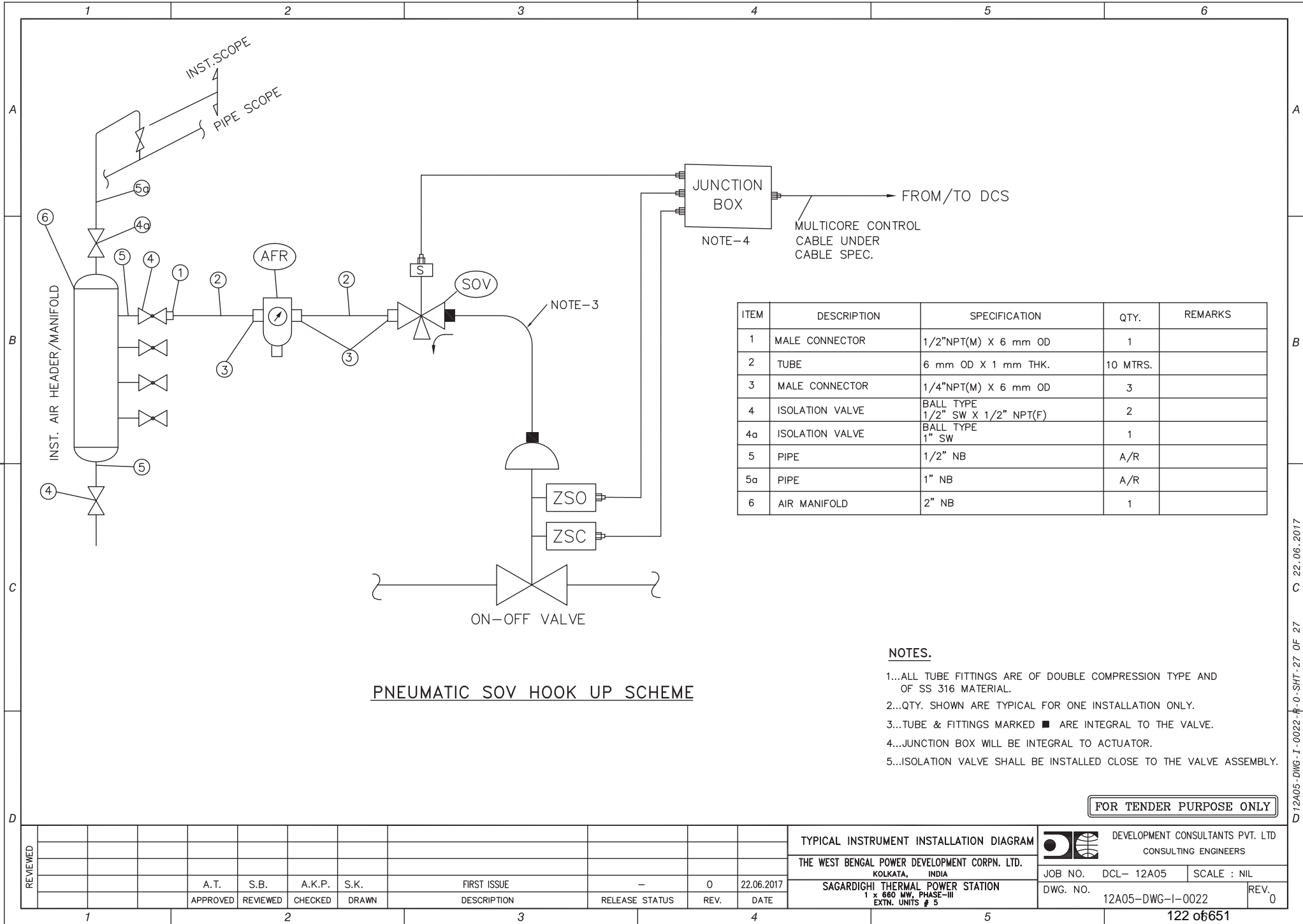
- NOTES.**
- 1...ALL TUBE FITTINGS ARE OF DOUBLE COMPRESSION TYPE AND OF SS 316 MATERIAL.
  - 2...QTY. SHOWN ARE TYPICAL FOR ONE INSTALLATION ONLY.
  - 3...TUBE & FITTINGS MARKED ■ ARE INTEGRAL TO THE VALVE.
  - 4...LIMIT SWITCHES WILL BE CONNECTED WHEREVER APPLICABLE.
  - 5...JUNCTION BOX WILL BE INTEGRAL TO ACTUATOR.
  - 6...ISOLATION VALVE SHALL BE INSTALLED CLOSE TO THE VALVE ASSEMBLY.

FOR TENDER PURPOSE ONLY

REVIEWED	DATE	DESCRIPTION	RELEASE STATUS	REV.	DATE	TYPICAL INSTRUMENT INSTALLATION DIAGRAM		DEVELOPMENT CONSULTANTS PVT. LTD CONSULTING ENGINEERS	
						THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD. KOLKATA, INDIA		JOB NO. DCL- 12A05 SCALE : NIL	
						SAGARDIGHI THERMAL POWER STATION 1 x 660 MW, PHASE-III EXTN. UNITS # 5		DWG. NO. 12A05-DWG-I-0022 REV. 0	
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A3 (9-96) [420x297]

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ITEM	DESCRIPTION	SPECIFICATION	QTY.	REMARKS
1	MALE CONNECTOR	1/2"NPT(M) X 6 mm OD	1	
2	TUBE	6 mm OD X 1 mm THK.	10 MTRS.	
3	MALE CONNECTOR	1/4"NPT(M) X 6 mm OD	3	
4	ISOLATION VALVE	BALL TYPE 1/2" SW X 1/2" NPT(F)	2	
4a	ISOLATION VALVE	BALL TYPE 1" SW	1	
5	PIPE	1/2" NB	A/R	
5a	PIPE	1" NB	A/R	
6	AIR MANIFOLD	2" NB	1	

**NOTES.**

- 1...ALL TUBE FITTINGS ARE OF DOUBLE COMPRESSION TYPE AND OF SS 316 MATERIAL.
- 2...QTY. SHOWN ARE TYPICAL FOR ONE INSTALLATION ONLY.
- 3...TUBE & FITTINGS MARKED ■ ARE INTEGRAL TO THE VALVE.
- 4...JUNCTION BOX WILL BE INTEGRAL TO ACTUATOR.
- 5...ISOLATION VALVE SHALL BE INSTALLED CLOSE TO THE VALVE ASSEMBLY.

**FOR TENDER PURPOSE ONLY**

TYPICAL INSTRUMENT INSTALLATION DIAGRAM		DEVELOPMENT CONSULTANTS PVT. LTD CONSULTING ENGINEERS	
THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD. KOLKATA, INDIA		JOB NO. DCL- 12A05	SCALE : NIL
SAGARDIGHI THERMAL POWER STATION 1 x 660 MW, PHASE-III EXTN. UNITS # 5		DWG. NO. 12A05-DWG-I-0022	REV. 0

REVIEWED	APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	RELEASE STATUS	REV.	DATE
	A.T.	S.B.	A.K.P.	S.K.	FIRST ISSUE	-	0	22.06.2017

A3 (9-96) [420x297]

D 12A05-DWG-I-0022-R-0-SHT-27 OF 27 C 22.06.2017

# 1X660MW SAGARDIGHI THERMAL POWER EXTENSION PROJECT PHASE III (UNIT #5)

## DRIVE CONTROL PHILOSOPHY (STATION C&I)

REV.	DATE	ALTD	CHD	APPD	DH-APP
04	20.04.21	AR	SCS	SCS	DP

1. REVISED AS PER CUSTOMER'S COMMENTS DTD 26.02.21 & BHEL'S REPLY DTD 20.04.21

REV.	DATE	ALTD	CHD	APPD	DH-APP	REV.	DATE	ALTD	CHD	APPD	DH-APP
03	04.02.21	AR	SCS	SCS	DP	02	21.12.20	AR	SCS	SCS	DP

1. REVISED AS PER CUSTOMER'S COMMENTS DTD 11.01.21 & BHEL'S REPLY DTD 04.02.21

1. REVISED AS PER CUSTOMER'S COMMENTS DTD 22.09.20 & BHEL'S REPLY DTD 21.12.2020



**THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD. (WBPDCCL)**  
1X660 MW SAGARDIGHI THERMAL POWER EXTENSION PROJECT (UNIT #5)



**DEVELOPMENT CONSULTANTS PRIVATE LIMITED**  
KOLKATA



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

JOB NO. 445

STATUS CONTRACT

DISTRIBUTION

TO	NO.	REV.	DATE	ALTD	CHD	APPD	DH-APP
		01	8.9.20	AR	SCS	SCS	DP

1. REVISED AS PER CUSTOMER'S COMMENTS DTD 11.11.19 & BHEL'S REPLY DTD 08.09.2020

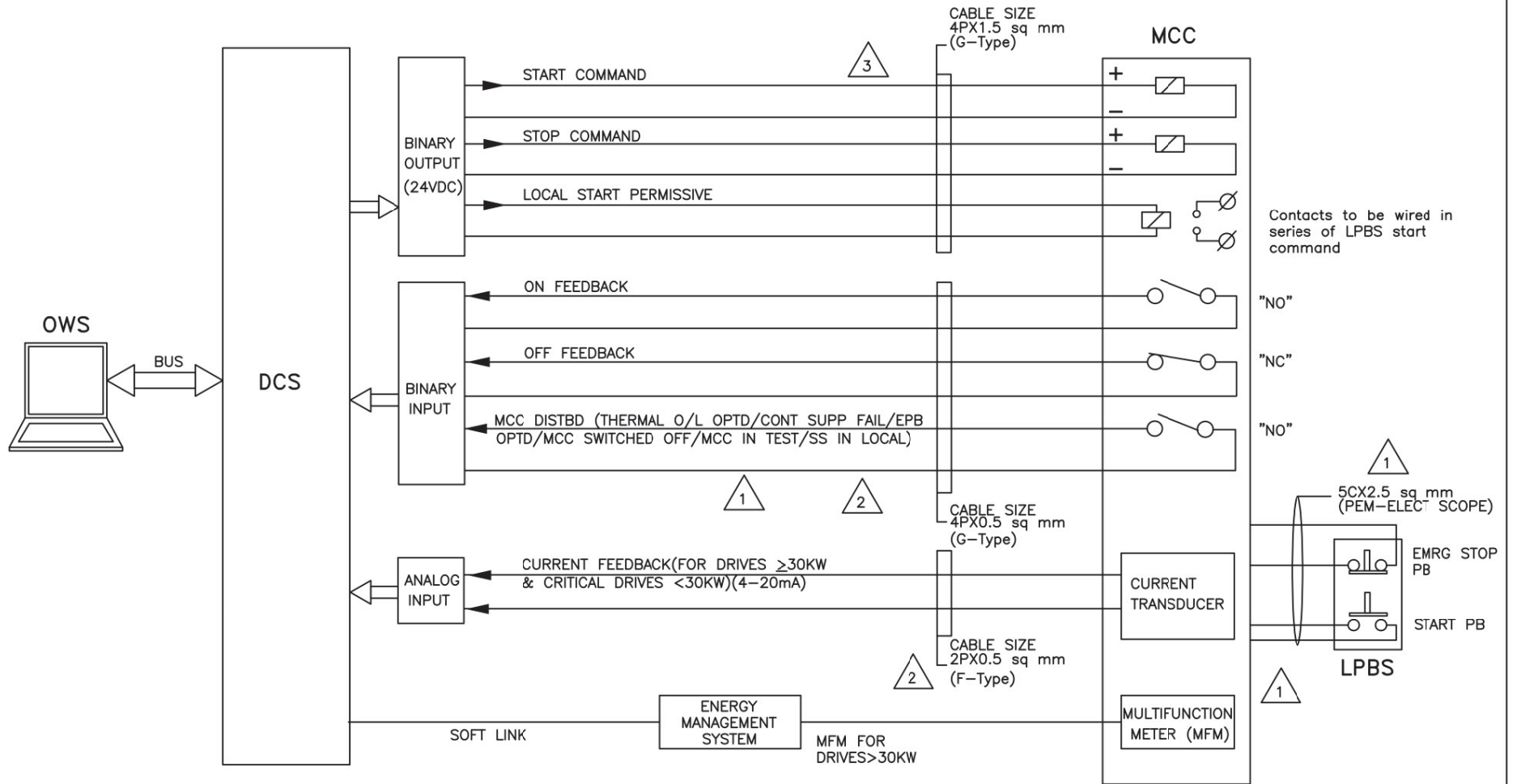
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DEPT CODE	NAME	SIGN	DATE
I	DSGN	AR	-sd- 24.05.19
	CHD	VKV	-sd- 24.05.19
	APPD	SCS	-sd- 24.05.19
	DH-APP	SM	-sd- 24.05.19

TITLE **DRIVE CONTROL PHILOSOPHY (STATION C&I)**

						DEPT.	SCALE	DRAWING NO.
						SIGN		PE-DM-445-145-1002
						DATE		SHEET 1 OF 11 128 of 684

# DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE (CONTACTOR OPERATED) △ 1



**NOTES:**

REDUNDANCY IN OUTPUT SHALL BE PROVIDED FOR ALL CRITICAL LT DRIVES △ 2



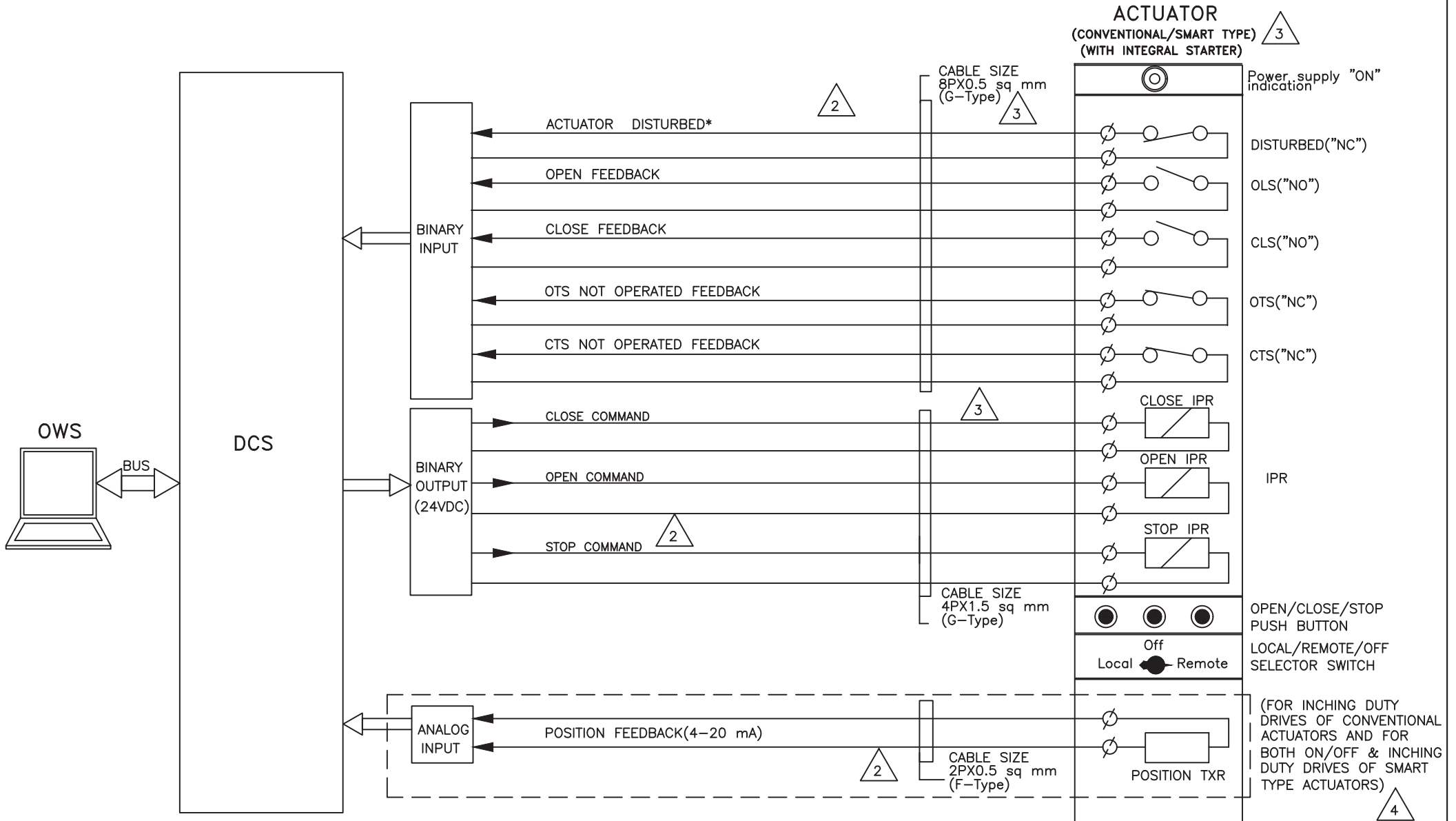
**PROJECT:** 1X660MW SAGARDIGHI THERMAL POWER EXTENSION PROJECT (UNIT #5)

**TITLE:** DDCMIS INTERFACE FOR UNIDIRECTIONAL LT DRIVE (CONTACTOR OPERATED)

DRG.NO.	PE-DM-445-145-I002
DATE	20.04.2021
REV.NO.	04
SHT	



# DCS INTERFACE FOR BIDIRECTIONAL DRIVE(WITH INTEGRAL STARTER)



**NOTE:**

\* DISTURBED= Loss of Power supply (1 Phase/3 Phase)/  
Loss of control supply/ Motor thermostat trip/  
Thermal over load/ Local/Off/Remote Sel.  
switch in local or off mode/ Stop PB optd/  
Torque open/close cutoff/ Valve jammed



**PROJECT:** 1X660MW SAGARDIGHI THERMAL POWER  
EXTENSION PROJECT (UNIT #5)

**TITLE** DDCMIS INTERFACE FOR  
BIDIRECTIONAL DRIVE

DRG.NO.	PE-DM-445-145-1002
DATE	20.04.2021
REV.NO.	04
SHT	125 of 651





**Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.**

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.
2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT\_CAB\_SCH\_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.
3. The field properties shall be as under:
  - a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
  - b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
  - c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
  - d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
  - e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
  - f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
  - g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.
4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).
5. The cables shall be described as per the scheme listed below:

A	NN	A	NNN
Cable	No. of cores	Cable code	Cable size
Voltage	(e.g. 01,03,3H, 07)	(See C below)	(e.g. 035,185,2.5, 0.5)
Code (see B below)			

- (A) SYSTEM VOLTAGE CODES:  
 (ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V  
 (dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

- (B) CABLE VOLTAGE CODES:  
 A = 11KV (Power cables)

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

- B = 6.6KV (Power cables)
- C = 3.3KV (Power cables)
- D = 1.1KV (LV & DC system power & control cables)
- E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

- A = Armoured FRLS
- B = Armoured Non-FRLS
- C = unarmoured FRLS
- D = Unarmoured Non-FRLS

PVC Aluminium

- E = Armoured FRLS
- F = Armoured Non-FRLS
- G = unarmoured FRLS
- H = Unarmoured Non-FRLS


XLPE Copper

- J = Armoured FRLS
- K = Armoured Non-FRLS
- L = unarmoured FRLS
- M = Unarmoured Non-FRLS

XLPE Aluminium

- N = Armoured FRLS
- P = Armoured Non-FRLS
- Q = unarmoured FRLS
- R = Unarmoured Non-FRLS

- S = FIRE SURVIVAL CABLES
- T = TOUGH RUBBER SHEATH
- U = OVERALL SCREENED
- V = PAIRED OVERALL SCREENED
- W = PAIRED INDIVIDUAL SCREENED
- Y = COMPENSATING CABLES
- I = PRE-FABRICATED CABLES
- Z = JELLY FILLED CABLES

	TITLE	SPECIFICATION NO.	
	<p style="text-align: center;"><b>MOTOR</b></p> <p style="text-align: center;"><b>DATA SHEET - C</b></p>	VOLUME	II B
		SECTION	D
		REV NO. 00	DATE 08/09/2010
		SHEET	1 OF 7


**LT MOTORS****A. GENERAL**

1. Manufacturer & Country of origin.  
(Shall be as per approved QA make)
2. Equipment driven by motor
3. Motor type
4. Quantity

**B. DESIGN AND PERFORMANCE DATA**


1. Frame size
2. Type of duty
3. Type of enclosure /Method of cooling/Degree of protection
4. Applicable standard to which motor generally conforms
5. Efficiency class as per IS 12615
6. (a) Whether motor is flame proof Yes/No  
(b) If yes, the gas group to which it conforms as per IS:2148
7. Type of mounting
8. Direction of rotation as viewed from DE END\_\_
9. Standard continuous rating at 40 deg.C. ambient temp. as per Indian Standard (KW)
10. Derated rating for specified normal condition i.e. 50 deg. C ambient temperature (KW)
11. Maximum continuous load demand of driven equipment in KW
12. Rated Voltage (volts)
13. Permissible variation of :

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

	TITLE	SPECIFICATION NO.	
	<p style="text-align: center;"><b>MOTOR</b></p> <p style="text-align: center;"><b>DATA SHEET - C</b></p>	VOLUME	II B
		SECTION	D
		REV NO. 00	DATE 08/09/2010
		SHEET	2 OF 7

- a. Voltage (Volts)
  - b. Frequency (Hz)
  - c. Combined voltage and frequency
14. Rated speed at rated voltage and frequency(RPM)
15. At rated Voltage and frequency:
- a. Full load current
  - b. No load current
16. Power Factor at
- a. 100% load
  - b. NO load
  - c. Starting.
17. Efficiency at rated voltage and frequency,
- a. 100% load
  - b. 75% load
  - c. 50% load
18. Starting current (amps) at
- a. 100 % voltage
  - b. 85% voltage
  - c. 80% voltage
19. Minimum permissible starting Voltage (Volts)
20. Starting time with minimum permissible voltage
- a. Without driven equipment coupled
  - b. With driven equipment coupled

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

	TITLE	SPECIFICATION NO.	
	<b>MOTOR DATA SHEET - C</b>	VOLUME	II B
		SECTION	D
		REV NO. 00	DATE 08/09/2010
		SHEET 3	OF 7


21. Safe stall time with 100% and 110% of rated voltage
  - a. From hot condition
  - b. From cold condition
22. Torques :
  - a. Starting torque at min. permissible voltage(kg-mtr.)
  - b. Pull up torque at rated voltage.
  - c. Pull out torque
  - d. Min accelerating torque (kg.m) available
  - e. Rated torque (kg.m)
23. Stator winding resistance per phase (ohms at 20 Deg.C.)
24. GD<sup>2</sup> value of motors
25. No of permissible successive starts when motor is in hot condition
26. Locked Rotor KVA Input
27. Locked Rotor KVA/KW
28. Vibration limit :Velocity (mm/s)
29. Noise level limit (dBA)

**C. CONSTRUCTIONAL FEATURES**

1. Stator winding insulation
  - a. Class & Type
  - b. Winding Insulation Process
  - c. Tropicalised (Yes/No)


NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			



	TITLE	SPECIFICATION NO.	
	<b>MOTOR DATA SHEET - C</b>	VOLUME	II B
		SECTION	D
		REV NO. 00	DATE 08/09/2010
		SHEET	4 OF 7

- d. Temperature rise over specified maximum ambient temperature of 50 deg C
  - e. Method of temperature measurement
  - f. Stator winding connection
2. Main Terminal Box
- a. Type
  - b. Location (viewed from NDE side)
  - c. Entry of cables(bottom/side)
  - d. Recommended cable size (To be matched with cable size envisaged by owner)
  - e. Fault level (MVA), Fault level duration (sec)
  - f. Cable glands & lugs details (shall be suitable for power cable)
3. Type of DE/NDE Bearing
4. Motor Paint shade
5. Weight of
- a. Motor stator (KG)
  - b. Motor Rotor (KG)
  - c. Total weight (KG)
- D. List of accessories.**
- 1. Space Heaters (Applicable for 30 KW & above motor) (Nos./Power in watts/supply voltage)
  - 2. Terminal Box for Space Heater (Yes/No)
  - 3. Speed switch (Yes/No) No of contacts and contact ratings of speed switch

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

	TITLE	SPECIFICATION NO.	
	<b>MOTOR DATA SHEET - C</b>	VOLUME	II B
		SECTION	D
		REV NO. 00	DATE 08/09/2010
		SHEET	5 OF 7

4. Insulation of bearing (Yes/No)

5. Noise reducer(Yes/No)

6. Grounding pads

i) No and size on motor body

ii) Nos on terminal Box

7. Vibration pads

i) Nos and size

ii) Location

8. Any other fitments

**E. List of curves.**

1. Torque speed characteristic of the motor

2. Thermal withstand characteristic

3. Starting. current Vs. Time

4. Starting. current Vs speed

5. P.F. and Effi. Vs Load

**F. Additional Data to be filled for each rating of DC Motor**

1. Rated armature voltage (Volt)

2. Rated field excitation (Amp)

3. Permissible % variation in voltage


4. Minimum Permissible Starting voltage (volt)

5. At rated voltage

i) Full load Armature current.(Amp)


ii) Full load Field current (Amp)

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

	TITLE	SPECIFICATION NO.	
	<b>MOTOR</b>  <b>DATA SHEET - C</b>	VOLUME	II B
		SECTION	D
		REV NO. 00	DATE 08/09/2010
		SHEET	6 OF 7

- iii) No load Armature current (Amp)
- 6. Full load Field current (Amp)
- 7. No load Armature current (Amp)
- 8. Minimum permissible field current(Amp) to avoid overspeeding at
  - i) Maximum permissible voltage
  - ii) Rated voltage
  - iii) Minimum Permissible Voltage
- 9. Resistance (indicative Values) in ohm
  - i) Armature winding (Arm + IP + Series) at 25 deg.C
  - ii) Field Winding at 25 deg. C
- 10. Inductance (indicative values)
  - i) Armature winding
  - ii) Field winding
- 11. Value of trimmer resistance (ohm) to be connected in series with the shunt field to obtain rated speed at
  - i) 220 V DC
  - ii) 250 V DC
  - iii) 187 V DC
- 12. Value of the external resistance (ohm) required to be connected in series with armature during starting only
- 13. Technical data sheet for external resistance box
- 14. GA drawing of motor
- 15. Starting time calculation

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

	<b>TITLE</b>  <b>MOTOR</b>  <b>DATA SHEET - C</b>	<b>SPECIFICATION NO.</b>	
		<b>VOLUME</b>	<b>II B</b>
		<b>SECTION D</b>	
		<b>REV NO. 00 DATE 08/09/2010</b>	
		<b>SHEET</b>	<b>7 OF 7</b>

- 16. Starter resistance design calculation
- 17. Electrical connection diagram of motor

<b>NAME OF VENDOR</b>			<b>SEAL</b>	<b>REV.</b>		
<b>NAME</b>	<b>SIGNATURE</b>	<b>DATE</b>				

## **SPECIAL CONDITIONS OF CONTRACT (SCC)**

## Project Information

	Project Name	Sagardighi Thermal Power Station (1x660 MW) Unit-5, phase-III.
	Ultimate Customer	West Bengal Power Distribution Corporation Ltd. (WBPDCCL)
	Location of Plant	<p>Location: Manigram village, Sagardighi, Raghunathganj sub-division, Murshidabad District, West Bengal.</p> <p>Access by:            Nearest Railway station: Manigram railway station on Bandel-Barhawara branch line 1 km from site.            Latitude: 24<sup>0</sup> 22' 13.7" N            Longitude: 88<sup>0</sup> 6' 15.8" E</p>
	Consignee Address (Ship to)	Sagardighi Thermal Power Station (1x660 MW) Unit-5, phase-III. Manigram village, Sagardighi, Raghunathganj sub-division, Murshidabad District, West Bengal
	Mode of Dispatch	By Road / Rail / Sea on Door Delivery and Freight Pre Paid Basis.
	Unloading at site	By Vendor
	Storage at site	By Vendor, preferably in a container with lock & key for items like small valves, instruments, panels etc.
	Movement of Material within Site	By Vendor

	Provision of facilities at Site	<p>Construction Power: Construction Power (3 phase AC 415V) shall be provided free of cost within the plant premises.</p> <p>Construction Water: Construction water shall be provided free of cost within the plant premises.</p> <p>Land for Temporary store (open and closed store): Limited area of land within the plant premises as allotted by M/s.WBPDCL shall be provided free of cost, subject to availability.</p> <p>Land for Labour colony: Land for construction of temporary accommodation may be available free of cost, subject to availability. However, all other infrastructure/facilities as per prevailing statutory norms shall be provided by the bidder at his cost.</p>
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		<p>All facilities like open area development temp. Illumination, temp roads and drains, securities, fire safety equipment etc. shall be in the scope of bidder at his cost. No tree felling should be done without prior approval of WBPDCL.</p> <p>Establishment of Quality control lab for construction works is to be arranged by the bidder at his cost.</p>
	Inspection Agency (Domestic supplies)	<p>Vendor shall give inspection call in line with approved QAP / Customer Hold Points to Regional BHEL-CQS center / Third Party Inspection Agency (TPIA) (as informed by BHEL) on "BHEL CQS Website"; with a copy of inspection call to BHEL (respective units) for arranging Customer/Third Party participation (wherever applicable), with an advance notice of 15 days for participation in inspection/ Joint inspection on the proposed date. The MDCC shall be issued by customer based on the BHEL-CQS/TPIA report OR Joint inspection report of BHEL CQS/TPIA &amp; Customer (wherever applicable).</p>

	Inspection Agency (Imported supplies)	In case of Imported Supplies advance notice of 30 days for participation in inspection (if applicable, in line with approved QAP / Customer Hold Points) to be given. The Test Certificates & Inspection reports duly accepted by the Foreign Vendor Inspection agency/BHEL/WBPDCL in line with approved QAP/Customer Hold Points shall be submitted to BHEL. The above Inspection reports & Test certificates shall be reviewed by BHEL in line with the Technical Specifications & Approved Data sheets and then sent to customer for their clearance. The customer dispatch clearance (MDCC) will be given to the Foreign Vendor or their representative in India through BHEL after acceptance/clearance of above test certificates by Customer.
	Material Receipt Certificate (MRC)	For Packages wherever E&C is in the scope of Vendor, The vendor shall arrange Material Receipt Certificate from the project site, duly signed by Customer and BHEL-Site after receipt & physical verification of the material at site.
	Packing, Identification & marking	<ul style="list-style-type: none"> <li>• The supplier shall include and provide for securely protecting and packing the materials so as to avoid loss or damage during handling &amp; transport by air, sea, rail and road.</li> <li>• All packing shall allow for easy removal and</li> </ul>



		<p>Checking at site. Special precaution shall be taken to prevent rusting of steel and iron parts during transit by sea. Gas seals or other materials shall be adopted by the Contractor for protection against moisture during transit.</p> <ul style="list-style-type: none"><li>• The number of each package in a shipment shall be shown in fraction, numerator showing number of the package and the denominator showing total number of packages in a lot / consignment. The packages number shall be generally prepared in the sequence in which they will be required for erection.</li><li>• Each package delivered under the Contract shall be marked by and at the expense of the supplier and such marking must be distinct and in English language (all previous irrelevant markings being carefully obliterated). Such marking shall show the description and quantity of contents, the name and address of consignee, the gross weight and net weight of the package, the name of the Contractor with a distinctive number of mark sufficient for purposes of identification. All markings shall be carried out with such materials as to ensure quickness of drying, fastness and indelibility. Each equipment or parts of equipment shall, when shipped or railed or otherwise dispatched be tagged with reference to the assembly drawings and corresponding part numbers. Each bale or package shall contain a packing note quoting specifically the name of the Contractor, the number and date of contract and the name of the office placing the contract, nomenclature of the stores and include a schedule of parts for each complete equipment giving the part numbers with reference to the assembly drawing and the quantity of each part, drawings nos. and tag numbers.</li><li>• Rotor bearings should not be used as a support while packing</li><li>• Besides wherever necessary, packing shall bear a special marking "TOP", "BOTTOM", "DO NOT TURN OVER", "KEEP DRY", "HANDLE WITH CARE" etc.</li></ul>
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		<ul style="list-style-type: none"> <li>• All packing cases, containers (excluding marine container), packing and other similar materials shall be new.</li> <li>• Notwithstanding anything stated in this clause, the Contractor shall be entirely responsible for loss, damage or depreciation or deterioration to the materials &amp; supplies due to faulty and/or insecure packing.</li> <li>• One copy of respective standard manufacturer's erection instruction/operation instruction manual shall be kept in each package/container for immediate reference.</li>   <li>• Each and every package box shall be marked with the following, as a minimum: <ul style="list-style-type: none"> <li>(i). Name and address of Consignee:</li> <li>(ii). Project reference:</li> <li>(iii). Contract No.:</li> <li>(iv). Packing No.: (1/10, 2/10, 3/10 ..... when there are 10 packages for one consignment)</li> <li>(v). Net Weight/Gross Weight:</li> <li>(vi). Port of Loading:</li> <li>(vii). Destination Port:</li> <li>(viii). Packing Mark: [symbols indicating "TOP", "BOTTOM", "DO NOT TURN OVER", "KEEP DRY", "HANDLE WITH CARE" etc.</li> <li>(ix). Type of Equipment: <ul style="list-style-type: none"> <li>"E" (for Equipment supply)</li> <li>"T" (for Tools &amp; Tackles)</li> <li>"S" (for Mandatory Spares)</li> </ul> </li> </ul> </li>   <li>• Two copies of packing list should be kept in case/package No. 1 of each consignment of the goods and four copies in each case (three inside the box and one copy in a special packet at the outer side of the Box).</li> </ul>
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	Commissioning spares	The commissioning spares shall be properly packed separately in separate box and each spare shall be properly tagged giving details (to match the description given in the packing slip) to facilitate their proper identification. Three copies of packing list is to be kept inside the box and one copy in a special packet at the outer side of the Box.
	Mandatory Spares	The Mandatory spares shall be properly packed separately in separate box indicating Mandatory Spares in bold letters and each spare shall be properly tagged giving details i.e. item number of the equipment in line with the Ultimate Customer Contract & Number per item (to match the description given in the packing slip) to facilitate their proper identification by ultimate customer M/s WBPDCCL. Three copies of packing list along with Manufacturing drawing no. Reference, Catalogue reference etc. is to be kept inside the box and one copy in a special packet at the outer side of the Box
	Submission of	As per Technical specification/ Kick off meeting.
	Final Drawing / Documents along with O&M Manual, Type Test Certificates (if any)	
	"item-rate" items	The quantity indicated in the BOQ / Price bid is approximate only and is liable for variation. The quantity of each item may vary to any extent as per requirement. Payment will be as per actual quantity executed as certified by BHEL Engineer. Contractor shall not be eligible for any compensation on this account.

Surplus materials	Ownership of any plant and equipment in excess (i.e, surplus material including scrap and commissioning spares) of the requirements for the facilities shall lie with the bidder, upon completion of trial operation or at such earlier time when BHEL and bidder agree that the surplus material / scrap in question are no longer required for the completion of facilities. WBPDCCL / BHEL will issue necessary gatepass for taking back the surplus materials / scrap after such agreement.
Demurrage charges	No demurrage charges shall be payable
Penalty for Guaranteed power consumption and performance	As per the Technical specification
HSE guidelines	As per <b>Annexure-10</b>
Warranty	Warranty for water system packages shall be 12 months from the date of handing over of packages to customer.
Vendor/Sub vendor approval	WBPDCCL informed that in view of their previous experience, Chinese vendors to be avoided. Vendor list subject to Customer Approval.

1. Bidder shall follow the attached approved Sub-Vendor list. The Sub Vendor list provided is compiled list of all BHEL units and sufficient Sub-Vendors have been already approved by WBPDCCL. No additional Vendors will be entertained for the equipment already available in the Sub-Vendor list.
2. In case any equipment is not specified in the list, Bidder shall submit the credentials of the Sub Vendors during contract stage for Approval.
3. Credentials shall consist of the following as minimum
  - a. List of references for similar application
  - b. Minimum 2nos. of Purchase Orders of similar references
  - c. Minimum 2nos. of Performance certificates/ Inspection clearance reports
  - d. Sub Vendor Catalogues
4. Finalized list of Sub Vendors shall be submitted to WBPDCCL for intimation/ approval/ clearance.



# The West Bengal Power Development Corporation Limited

(A Government of West Bengal Enterprise)

Corporate Identity No.: U40104WB1985SGC039154

Registered & Corporate Office: Bidyut Unnyan Bhavan,

Plot - 3/C, LA - Block, Salt Lake City, Sector - III, Kolkata - 700 098

Phone: 033-2335-0445/2335-0571/2339-3100

Fax: 033-2339-3286/2335-0516

website: [www.wbpdcl.co.in](http://www.wbpdcl.co.in). E-mail: [wbpdcl@wbpdcl.co.in](mailto:wbpdcl@wbpdcl.co.in)

Ref. No. WBPDC/Corp./SGMP03/AV/8/047

Date: 16.06.2020

To,  
Shri A.K. Singhal, GM  
PS- MKTG. BHEL House,  
Siri Fort, New Delhi 110 049

Sub : Vendor List of Sagardighi Thermal Power Extension Project Unit No.5 (1X660MW)

Ref : E-mail from BHEL PS-MKTG dtd. 29<sup>th</sup> August, 2019

Dear Sir,

Please find the reviewed Vendor List for the captioned Project.

BHEL may note that some Vendors have been identified under 'DR' category for which BHEL is requested to provide detail credentials of the Vendor in line with the tender requirements for Approval consideration from WBPDC.


The entire Vendor List is divided under the following sub heads-

- |    |                           |   |            |
|----|---------------------------|---|------------|
| a) | Mechanical Aux.Packages   | : | Annexure-A |
| b) | Mechanical Equipment List | : | Annexure-B |
| c) | FGD Plant Equipment List  | : | Annexure-C |
| d) | CHP Equipment List        | : | Annexure-D |
| e) | AHP Equipment List        | : | Annexure-E |
| f) | Electrical Equipment List | : | Annexure-F |
| g) | C&I Equipment List        | : | Annexure-G |
| h) | FPA Equipment List        | : | Annexure-H |
| i) | HVAC System               | : | Annexure-I |
| j) | PSER Erection Vendors     | : | Annexure-J |

This is for your information and further necessary action from your end.

Thanking you,

Yours faithfully

  
16.6.2020  
Kalyanbrata Chakrabarty  
GM (Projects)

<b>Bandel Thermal Power Station</b> GM-26846369,DGM(O) 26846447, DGM(M) 26846403, Senior Manager(P&A)-26845086 Senior Manager-26845083 Guest House-26845201 Fax : 2684 6151	<b>Santalidih Thermal Power Station</b> GM-260227 Senior Manager(P&A)260226 Senior Manager(F&A)260341 Electrical Control Room-260228 Guest House260342/260203 Fax:260217 STD Code-3251	<b>Kolaghat Thermal Power Station Ph:</b> GM 231110,DGM(O)231254 DGM(M)231261 DGM(U)231255 DGM(Accts.)231290 STD Code-03228 E mail: <a href="mailto:ktpsdc1@cal.vsnl.net.in">ktpsdc1@cal.vsnl.net.in</a>	<b>Bakreswar Thermal Power Project</b> GM- 220201DGM(Const.)-220210 Senior Manager(P&A)/(F&A)-220202 Guest House(Abdarpur)225475,225346 PBX:220694, Fax-220214 Email: <a href="mailto:bktp@cal2.vsnl.net.in">bktp@cal2.vsnl.net.in</a> STD Code:03462
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**SAGARDIGHI THERMAL Power EXTENSION PROJECT  
PHASE-III, UNIT#5 (1 x660 MW)**

SL. NO.	Item Description	Vendor Name	Remarks
1	OXYGEN DOSING SYSTEM	ENPRO INDUSTRIES PVT.LTD. MARKAL KHED,PUNE	Approved
		POWER PIPING COMPANY ,Mandaiyur	DR
		PSI ENGINEERING SYSTEMS (P) LTD., Chennai	Approved
		Positive Metering Pumps (I) Pvt. Ltd.,Nasik	DR
		V.K PUMP INDUSTRIES PVT LTD, Nasik	Approved
2	CHEMICAL DOSING SYSTEM	ENPRO INDUSTRIES PVT.LTD., MARKAL KHED,PUNE	Approved
		PSI ENGINEERING SYSTEMS (P) LTD., Chennai	Approved
		SWELORE ENGG. PVT. LTD, AHMEDABAD	Approved
		TECHNO CONSULTANTS , GHATKOPAR (W) MUMBAI	Approved
		MILTON ROY INDIA (P) LTD.	Approved
V.K PUMP INDUSTRIES PVT LTD, Nasik	Approved		
3	CONDENSATE POLISHING UNIT	BGR ENERGY SYSTEMS LIMITED.,	Approved
		DRIPLEX WATER ENGINEERING INTERNATIONAL PRIVATE LIMITED, Hardwar	Approved
		ION EXCHANGE (INDIA) LTD	Approved
		THERMAX LTD. PUNE	Approved
		VA TECH WABAG LTD	Approved
4	MILL REJECT SYSTEM (PNEUMATIC TYPE)	MECAWBEE BEEKAY PVT LTD., GREATER NOIDA	Approved
		UNITED CONVEYOR CORPORATION (INDIA) PVT.LTD.,KOLKATA	Approved
5	COLTCS	GEA BGR ENERGY SYSTEM INDIA LTD., Nellore	Approved
		TAPROGGE GmBH, Noida	Approved
		TECHNOS, FRANCE	Approved
		EIMCO WATER TECHNOLOGIES ,LLC, USA	Approved
		KLUMP & KOLLER GmbH	Approved
		FILTRATION ENGINEERS LTD.	Approved
MULTITEX FILTRATION ENGINEERS LIMITED,	Approved		
7	CHLORINATION PLANT (Items to be procured from the approved Vendor	PERFECT CHLORO SYSTEMS	Approved
		METITO POLLUTION CONTROL INDIA LTD	Approved



**SAGARDIGHI THERMAL Power EXTENSION PROJECT  
PHASE-III, UNIT#5 (1 x660 MW)**

Sl. No.	Item Description	Vendor Name	Remarks
1	VIBRATION ISOLATION	GERB	Approved
2.	STEEL GATE / GLOBE / NR VALVES  'BHEL' Make Valves are approved for only for 1500 CLASS or below.	WEIR B.D.K VALVES INDIA PVT. LTD.	Approved
		KIRLOSKAR BROTHERS LTD.	Approved
		LEADER VALVES LTD.	Approved
		KSB VALVES	Approved
		FOURESS ENGG.INDIA LTD.	Approved
		VAG VALVES	DR
		AUDCO INDIA	Approved
		DEWARANCE	DR
		Hawa Valves (India) Pvt. Ltd.	Approved
		HAWA ENGINEERS LTD.	Approved
		INTERVALVE POONAWALLA LTD.	Approved
MICON VALVES (INDIA) PVT. LTD.	DR		
3.	BALL VALVES	FLOW CHEM INDUSTRIES	Approved
		FISHER SANMAR LIMITED	Approved
		KIRLOSKAR BROS. LTD.	Approved
		LEADER VALVES LTD.	Approved
		KSB VALVES	Approved
		WEIR B.D.K VALVES INDIA PVT. LTD.	Approved
		VAG VALVES	Approved
		A.V. VALVES LTD	Approved
		Hawa Valves (India) Pvt. Ltd.	Approved
INTERVALVE POONAWALLA LTD.	Approved		
4.	CAST IRON GATE /GLOBE/ NR/ SAFETY RELIEF VALVES	H.SARKER & COMPANY	Approved
		G.M.DALUI & SONS PVT.LTD.	Approved
		KIRLOSKAR BROS. LTD.	Approved
		LEADER VALVES LTD.	Approved
		VENUS PUMP & ENGG. WORKS	Approved
5.	SAFETY RELIEF VALVE (TUBE SIDE AND SHELL SIDE)	BHEL-HPBP TRICHY	Approved for Class 1500 or below
6.	Safety Valve, Safety relief Valve & ERV  'BHEL' Make Valves are approved for only for 1500 CLASS or below.	SEMPELL GmbH./Germany	Approved
		DRESSER CONSOLIDATED,/USA	Approved
		DRESSER CONSOLIDATED,/United Kingdom	Approved
		TYCO VALVES & CONTROLS,/USA	Approved
		MEIWA CORPORATION,/Japan	Approved
		BOPP&REUTHER,SICHERHEITS-UND/Germany	Approved
		REINEKE MESS-UND REGELTECHNIL GMBH/Germany	Approved
		VALVTECHNOLOGIES,/USA	Approved
		BOPP&REUTHER,SICHERHEITS-UND/Germany	Approved
		VALVTECHNOLOGIES,/USA	Approved
7	GUN METAL VALVES	A.V.VALVES LTD,	Approved
		LEADER VALVES LTD.,	Approved
		VALTECH INDUSTRIES	Approved



**SAGARDIGHI THERMAL Power EXTENSION PROJECT  
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Sl. No.	Item Description	Vendor Name	Remarks
8	BUTTER FLY VALVES (STEAM SERVICE)	FOURESS ENGG.INDIA LTD.	Approved
		INSTRUMENTATION LTD.	Approved
		BDK PROCESS CONTL. HUBLI	Approved
9.	BUTTER FLY VALVES (WATER SERVICE)	WEIR B.D.K VALVES INDIA PVT. LTD.	Approved
		FOURESS ENGG.INDIA LTD.	Approved
		INSTRUMENTATION LTD.	Approved
		LARSEN & TOUBRO LTD.	Approved
		KIRLOSKAR BROS. LTD.	Approved
		TYCO VALVES & CONTROLS INDIA PVT.LTD.	Approved
10.	SPRING LOADED BYPASS VALVES/ PLUG VALVES/ ANGLE DRAIN VALVES	WEIR VALVES & CONTROLS M.E.	Approved
		WEIR B.D.K VALVES INDIA PVT. LTD.	Approved
		FISHER SANMAR LIMITED	Approved
		LARSEN & TOUBRO LTD	Approved
		LEADER VALVES LTD.	Approved
		REINEKE MEB-UND REGELTECHNIK GMBH	Approved
		SEMPELL AG, GERMANY	Approved
		VELAN INC.,CANADA	Approved
11.	AIR RELEASE VALVES	H.SARKER & COMPANY	Approved
		LEADER VALVES LTD.	Approved
		VENUS PUMP & ENGG. WORKS	Approved
		G.M.DALUI & SONS PVT.LTD.	Approved
		A.V. VALVES LTD	Approved
12.	DUAL PLATE CHECK VALVES	VENUS PUMP & ENGG. WORKS	Approved
		FLUIDLINEVALVES COMPANY PRIVATE LTD.	Approved
13.	FLOAT VALVES	H.SARKER & COMPANY	Approved
		G.M.DALUI & SONS PVT.LTD.	Approved
		LEADER VALVES LTD.	Approved
14	CONDENSATE PUMP-LP	SAM TURBO INDUSTRY PVT LIMITED	Approved
		SULZER PUMPS INDIA PVT LTD	Approved
		KIRLOSKAR BROTHERS LTD	Approved
		CLYDE PUMPS INDIA PVT LTD,	Approved
15.	FUEL OIL PUMPS (POSITIVE DISPLACEMENT PUMPS)	TUSHACO PUMPS PVT. LTD.,	Approved
		ALEKTON ENGG.INDUSTRIES PVT.LTD.	Approved
		U.T.PUMPS & SYSTEMS (P) LTD.	DF
		ALLWEILER INDIA PVT.LTD.,	Approved
16.	PGB SPECIAL OIL-ISO VG 320	INDIAN OIL CORPN.LTD.,	Approved
		HINDUSTAN PETROLEUM CORPN. LTD.	Approved
		CASTROL INDIA LIMITED	Approved
		EXXONMOBIL LUBRICANTS PVT LTD	Approved
		SHELL INDIA MARKETS PRIVATE LIMITED	Approved
17.	JACKING OIL PUMPS WITH MOTOR (SCREW TYPE) FOR MAIN TURBINE	TUSHACO PUMPS LIMITED	Approved
		ALLWEILER AG ,GERMANY	Approved



**SAGARDIGHI THERMAL Power EXTENSION PROJECT  
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Sl. No.	Item Description	Vendor Name	Remarks
19.	AUX. OIL PUMP (AOP) & EMERGENCY OIL PUMP WITH MOTOR (EOP) FOR MAIN TURBINE	KSB PUMPS LIMITED	Approved
		MATHER & PLATT PUMPS	Approved
		KBL	Approved
20.	VACUUM PUMPS	EDWARDS LIMITED, UK	Approved
		NI-TECH INC. USA	DR
		NASH ELOM INDUSTRIES, GERMANY	Approved
21	LUB OIL TRANSFER PUMPS	MATZ PUMPS PVT.LTD.	DR
		TUSHACO PUMPS PVT.LT	Approved
		IDEX INDIA PVT LTD	DR
		DELTA P D PUMPS PVT LTD	Approved
		ALLWEILER INDIA PRIVATE LIMITED	Approved
22	CONCRETE VOLUTE PUMP	KIRLOSKAR BROS. LTD.	Approved
		CLYDE UNION PUMPS	Approved
		FLOWSERVE CORPORATION	Approved
		BHEL HYD BASED ON MHI COLLABORATION	DR
23.	MISC.PUMPS (VERTICAL)	KIRLOSKAR BROS. LTD.	Approved
		KSB PUMPS LTD.	Approved
		SULZER PUMPS INDIA LTD.	Approved
		WEIR,UK	Approved
		WPIL LIMITED	Approved
		FLOWMORE	Approved
		BHARAT PUMPS & COMPRESSORS LTD	Approved
WILO MATHER & PLATT PUMPS PVT. LTD.	Approved		
24.	BOILER WATER RECIRCULATION PUMP	TORISHIMA PUMP MFG CO.LTD, Japan	Approved
		KSB AKTIENGESELLSCHAFT, Germany	DR
25.	PUMPS (HORIZONTAL) Type-I (FLOW<300 CMH)	KIRLOSKAR BROS. LTD.	Approved
		MATHER & PLATT PUMPS LTD.	Approved
		KSB PUMPS LTD.	Approved
		SULZER PUMPS INDIA LTD.	Approved
		WEIR,UK	Approved
26.	PUMPS (HORIZONTAL) Type- II (FLOW>300 CMH)	FLOWMORE LTD.	Approved
		WPIL LIMITED	Approved
27.	SUMP PUMPS / SUBMERSIBLE PUMPS/ SLUDGE PUMP	KISHOR PUMPS PVT.LTD	Approved
		KIRLOSKAR BROS. LTD.	Approved
		KSB PUMPS LTD.	Approved
		FLOWMORE LTD.	Approved
		JASCO PUMP PVT. LTD.	Approved
		SAM TURBO	Approved
28.	OIL MODULE AND ACCESSORIES	HYDAC (INDIA) PVT. LTD.	Approved
		ALLWEILER INDIA PRIVATE	Approved
		AEL APPARATEBAU GMBH LEISNIG	Approved
		VDL DELMAS GMBH	Approved



**SAGARDIGHI THERMAL Power EXTENSION PROJECT  
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Sl. No.	Item Description	Vendor Name	Remarks
		FLENCO FLUID SYSTEM S.R.L (FOR KELAG AG	Approved Approved
29.	LUBE OIL PUMPS (CENTRIFUGAL)FOR TDBFP	KSB PUMPS LTD. KIRLOSKAR EBARA, KIRLOSKARWADI SULZER, MUMBAI. FLOWSERVE SANMAR LTD.,	Approved Approved Approved Approved
30.	LUBE OIL PUMPS (SCREW TYPE) FOR TDBFP	ALLWEILER, GERMANY IMO PUMP, USA TUSHACO, DAMAN LEISTRITZ (EMPIRE), GERMANY	Approved Approved Approved Approved
31.	JACKING OIL PUMP TDBFP	HAGULLAND DENSION TUSHACO PUMPS PVT. LTD., DELTA P D PUMPS PVT LTD	Approved Approved Approved
32.	EHA FOR TURBINE VALVES	BOSCH REXROTH AG HORST THIELE MASCHINENBAU HYDRAULISCHE GERATE GMBH, GERMANY	Approved Approved
33.	HPSU FOR TURBINE VALVES	HYDAC (INDIA) PVT LTD REINEKE MESS-UND REGELTECHNIK GMBH BOSCH REXROTH (INDIA) PRIVATE LIMITED; HYDAC SYSTEM GMBH KEICHER ENGINEERING AG	Approved Approved Approved Approved Approved
34.	OIL ACCUMALATOR	BOLENZ & SCHAFFER MASCHINENFABRIK, Germany HYDAC INDIA PVT LTD, Navi Mumbai PARKER HANNIFIN CORPORATION, USA	Approved Approved Approved
35.	VACUUM BREAKER VALVE ASSY	MULLER CO-AX AG INSTRUMENTATION LIMITED CRANE PROCESS FLOW	Approved Approved DF
36.	SCANNER AIR FAN	C.DOCTOR & CO.PVT.LTD. PATELS AIRFLOW LTD. AIR CONTROL & CHEMICAL ENGG. CO.LTD.	Approved Approved Approved
37.	OIL PURIFICATION UNIT (OIL CENTRIFUGE)/PORTABLE OIL PURIFIERS	ALFA LAVAL LIMITED, INDIA SERVIZE INDUSTRIAL, ITALY ALFA-LAVALSEPARATION AB - SWEDEN	Approved DF Approved
38.	ELECTRICAL HOIST	REVA INDUSTRIES LTD CONSOLIDATED HOIST PVT LTD TUOBRO FURGUSON(INDIA)PVT.LTD HERCULES HOISTS LTD. UNIVERSAL HOIST - O- FABRIK BRADY & MORRIS ENGINEERING CO. LTD. TRACTEL TIRFOR INDIA PVT. LTD.	Approved Approved Approved Approved Approved Approved Approved
		UNIVERSAL HOIS -O-FABRIK HERCULES HOISTS LTD. TUOBRO FURGUSON(INDIA)PVT.LTD	Approved Approved Approved



**SAGARDIGHI THERMAL Power EXTENSION PROJECT  
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Sl. No.	Item Description	Vendor Name	Remarks
39	CHAIN PULLEY BLOCK	BRADY & MORRIS ENGINEERING CO. LTD.	Approved
		TRACTEL TIRFOR INDIA PVT. LTD.	Approved
		UNIVERSAL HOIS -O-FABRIK	Approved
		HERCULES HOISTS LTD.	Approved
		TUOBRO FURGUSON(INDIA)PVT.LTD	Approved
40	DOUBLE GIRDER EOT CRANES UPTO 50T	UNIQUE INDUSTRIAL HANDLERS PVT.LTD	Approved
		MUKAND LIMITED,	Approved
		REVA INDUSTRIES LTD.	Approved
		HEAVY ENGG. CORPORATION LTD.	Approved
		UNIVERSAL HOIST-O-FABRIK,	Approved
		CONSOLIDATED HOISTS PVT LIMITED	Approved
41	D/G EOT CRANES UP TO 100T	FURNACE & FONDRY EQUIPMENT CO.	Approved
		FURNACE & FONDRY EQUIPMENT CO.	Approved
		Grip Engineers Pvt. Ltd.,	Approved
		HEAVY ENGG. CORPORATION LTD.	Approved
		MUKAND LIMITED	Approved
		REVA INDUSTRIES LTD.	Approved
		TUOBRO FURGUSON (INDIA) PVT LTD	Approved
UNIQUE INDUSTRIAL HANDLERS PVT LTD.	Approved		
42	D/G EOT CRANES ABOVE 100T	FURNACE & FONDRY EQUIPMENT CO.	Approved
		HEAVY ENGG. CORPORATION LTD.	Approved
		MUKAND LIMITED	Approved
		REVA INDUSTRIES LTD.	Approved
		UNIQUE INDUSTRIAL HANDLERS PVT LTD.	Approved
43	Single Girder EOT / HOT Misc. Cranes	BRADY & MORRIS ENGINEERING CO. LTD.	Approved
		CONSOLIDATED HOISTS PVT LTD	Approved
		REVA INDUSTRIES LTD.	Approved
		TRACTEL TIRFOR INDIA PVT. LTD.	Approved
		Universal Hoist-O-Fabrik	Approved
44	MILL HANDLING EQUIPMENT	GRIP ENGINEERS PVT LTD, HYDERABAD	Approved
		LIFTING EQUIPMENT & ACCESSORIES ,NEWDELHI	Approved
		REVA INDUSTRIES LIMITED,FARIDABAD	Approved
		CONSOLIDATED HOIST,PUNE	Approved
		EDDYCRANES ENGINEERS PVT,MUMBAI	Approved
		CENTURY CRANE ENGINEERS (P) LTD.	Approved
UNIVERSAL HOIST-O- FABRIK,MUMBAI	Approved		
45	FURNACE MAINTENANCE PLATFORM	N.V.SKY CLIMBER EUROPE S.A	Approved
		N.V.SKY MAN INTERNATIONAL S.A.	Approved
		ALTREX B.V, Netherlands	DR
46	QUICK ERECT SCAFFOLD	INSTANT UPRIGHT LIMITED,DUBLIN	Approved
47	ELEVATOR-PASSENGER CUM GOODS	KONE ELEVATOR INDIA LTD.	Approved
		OTIS ELEVATOR	Approved



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Sl. No.	Item Description	Vendor Name	Remarks
48.	CASTABLE REFRACTORY	BASKAR REFRACTORIES AND S.W PIPES(P)LTD	Approved
		THE ACE REFRACTORIES LTD.	Approved
		DALMIA REFRACTORIES	Approved
		SOUVENIOR CERAMICS	Approved
		MAHAKOSHAL REFRACTORIES PVT. LTD,	DF
		CASTWEL INDUSTRIES	DF
49.	POURABLE INSULATION	BASKAR REFRACTORIES & STONEWARE PIPES(P)LTD	Approved
		THE ACE REFRACTORIES LTD.	Approved
		DALMIA REFRACTORIES	Approved
		INDUSTRIAL ASSOCIATES,	Approved
		CASTWEL INDUSTRIES	DF
50.	FIRE BRICKS	BASKAR REFRACTORIES AND STONEWARE PIPES (P) LTD	Approved
		DALMIA REFRACTORIES	Approved
51.	WOOL MATTRESS	ROCKWOOL INDUSTRIES LTD	Approved
		MINWOOL ROCK FIBRES LTD	Approved
		LAPINUS ROCKWOOL PVT. LTD	Approved
		ROCKWOOL INDIA LTD.	Approved
		LLOYD INSULATION (I) LTD.	Approved
		LLOYD ROCKFIBRES LTD.	Approved
		DHANBAD ROCKWOOL INSULATION PVT LTD	Approved
		GOENKA ROCKWOOL ( INDIA ) PVT LTD.,	Approved
JAMSHEDPUR MINERAL WOOL MFG.CO.	Approved		
52.	MINERAL WOOL MATTRESS	JAMSHEDPUR MINERAL WOOL MFG.CO.	Approved
		ROCKWOOL (INDIA) PVT LTD.	Approved
		ROCKWOOL INDUSTRIES	Approved
		DHANBAD ROCKWOOL INSULATION PVT LTD	Approved
		GOENKA ROCKWOOL ( INDIA ) PVT LTD.,	Approved
53.	THERMAL INSULATION OF STEAM TURBINE/THERMAL INSULATION OF TURBINE INTEGRAL PIPING/THERMAL INSULATION-ROCKWOOL MATTRESSES/ PIPE SECTIONS	LLOYD INSULATIONS	Approved
		ROCKWOOL	Approved
		HEINRICH TAPP GMBH	Approved
		EUGEN ARNOLD GMBH	Approved
		Dhanbad Rockwool Insulation (P) Ltd.	Approved
		GOENKA ROCKWOOL ( INDIA ) PVT.LTD.	Approved
54.	THERMAL INSULATION - ANCILLARY MATERIAL	LLOYD INSULATIONS ( INDIA) LIMITED	Approved
		ALLIED INSULATIONS (INDIA), GHAZIABAD	Approved
		ENERGY SAVING & ALLIED PRODUCTS	Approved
55.	INSULATION:BED MATERIALS	BHASKAR REFRACTORIES&SW PIPES P LTD, Faridabad	Approved
		SOUVENIOR CERAMICS, Faridabad	Approved
		ALWAR REFRACTORIES PVT LTD, Jaipur	Approved
		CHAMPION CERAMICS PVT LTD, Champa	DR



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Sl. No.	Item Description	Vendor Name	Remarks
56	INSULATION:CALCIUM SILICA	HYDERABAD INDUSTRIES LTD., Faridabad	DR
		NEWKEM PRODUCTS CORPORATION, Mumbai	DR
57.	INSULATION:CERAMIC WOOL	LLOYD INSULATIONS (INDIA) LIMITED, Chennai	Approved
58.	INSULATION:WOVEN WIRE CLO	BANARASWALA METAL CRAFTS PVT.,COIMBATORE	Approved
		BOKARIA WIRENETTING INDUSTRIES,CHENNAI	Approved
		JEETMULL JAICHANDLALL (MADRAS),CHENNAI	Approved
		KIRAN WIRE NETTING CO.,CHENNAI	Approved
		QUALITY WIRE PRODUCTS,NAVI MUMBAI	Approved
59	STEAM TRAPS	SPIRAX MARSHALL PVT.LTD.	Approved
		PENNANT ENGINEERING PVT.LTD.	Approved
		ESCO STEAMCON PVT. LTD.	Approved
		FORBES MARSHALL PVT. LTD.	Approved
60	AIR TRAPS	PENNANT ENGINEERING PVT.LTD.	Approved
		SPIRAX MARSHALL PVT.LTD.	Approved
		ESCO STEAMCON PVT. LTD.	Approved
		FORBES MARSHALL PVT. LTD.	Approved
61	GRAVIMETRIC FEEDER	STOCK INDIA	Approved
62	COMPRESSED AIR SYSTEM	ATLAS COPCO (INDIA) LTD.	Approved
63	SELF CLEANING STRAINERS	FILTRATION ENGINEERS (I) PVT. LTD.	Approved
		GEA BGR ENERGY SYSTEM INDIA LTD.	Approved
		MULTITEX FILTRATION ENGINEERS LIMITED	Approved
64	DEBRIS FILTER	GEA BGR ENERGY SYSTEM INDIA LTD.	Approved
		MULTITEX FILTRATION ENGINEERS LIMITED	Approved
		TAPROGGE GmBH	Approved
65	ALUMINIUM SHEETS/ COILS/CLADDING	BHARAT ALUMINIUM CO.LTD.	Approved
		INDIAN ALUMINIUM CO.LTD.	Approved
		HINDALCO INDUSTRIES LTD.	Approved
		NATIONAL ALUMINIUM COMPANY LTD.	Approved
		JINDAL ALUMINIUM LIMITED	Approved
66	CORRUGATED AL SHEET	HINDALCO INDUSTRIES LTD.,Chennai	Approved
		JINDAL ALUMINIUM LIMITED, Bangalore	Approved
		MPIL STEEL STRUCTURES LTD.,Thane	Approved
67	HOC TYPE GAS DRIER	DELAIR INDIA PVT. LTD.	Approved
		ATLAS COPCO (INDIA) LTD.	Approved
68	REFRIGERATION TYPE GAS DRIER	DELAIR INDIA PVT. LTD.	Approved
		SUMMIT	Approved
		SAVRO	Approved
		JINDAL ELECTRONICS PVT. LTD.	Approved
		SPAN MANUFACTURING CO. PVT.	DR
		MELLCON ENGINEERS PVT. LTD.	Approved



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Sl. No.	Item Description	Vendor Name	Remarks
69	MISC. TANKS (SHOP)	GENERAL MECHANICAL WORKS	Approved
		UNITECH MACHINES LTD.	Approved
		TECHNO ELECTRIC & ENGG. CO. LTD.	Approved
		THERMOPADS PVT LIMITED	Approved
		VIJAY TANKS & VESSELS LTD	Approved
		THERMOSYSTEMS PVT. LTD.	Approved
70	MISC. TANKS(SITE FABRICATED)	TECHNO ELECTRIC and ENGG. CO. LTD.	Approved
		THERMOSYSTEMS PVT. LTD. HYDERABAD	Approved
		UNITECH MACHINES LTD.	Approved
71.	FLAME ARRESTOR ( MISCELLANEOUS TANKS )	PROCESS INSTRUMENTS	Approved
		ASIAN INDUSTRIAL VALVES	Approved
		ACCOUSTICS INDIA PVT. LTD.	Approved
		MULTITEX FILTERS PVT. LTD.	Approved
72	M.E. BELLOWS	FLUIDINE ENGRS.INDIA PVT.LTD	Approved
		EXPANSION JOINT SYSTEMS INC. USA	Approved
		MUNRO & MILLER FITTINGS LTD., U.K	Approved
		SENIOR FLEXONICS, U.K.	Approved
		SUR INDUSTRIES PVT.LTD.,KOLKATA	Approved
		CORBIS	Approved
		FLEXATHERM EXPANLLOW PVT LTD	Approved
		MB METALLIC BELLOWS PVT. LTD,	Approved
FLEXICAN BELLOWS & HOSES (P) LTD	Approved		
	LONE STAR INDUSTRIES	Approved	
73	EXPANSION BELLOWS-NON METALLIC	EAGLE BURGMANN K.E. PVT.LTD, Chennai	Approved
		AIROCHEM ENGINEERING COMPANY, Kolhapur	Approved
		PATELS AIRFLOW LIMITED,Ahmedabad	Approved
		MECHWELL INDUSTRIES LTD, Mumbai	Approved
74	HEAT EXCHANGERS (PLATE TYPE)	ALFA LAVAL (INDIA) LTD.	Approved
		GEA ECOFLEX INDIA PVT LTD	Approved
		TRANTER INDIA PRIVATE LIMITED	Approved
		L&T	Approved
		IDMC LIMITED	Approved
75	JOURNAL BEARING BFP & BP/THRUST CUM JOURNAL BEARING FOR CEP/THRUST BEARING (BFP & BP)	COLHERENE, UK	Approved
		WAUKESHA BEARINGS (GLACIER), UK	Approved
		KINGSBURY, USA	Approved
		MITCHELL, UK	Approved
76	THRUST BEARING FOR CWP	MICHELL BEARINGS,	Approved
		OSBORNE ENGINEERING LIMITED	DR
		OSAKA ASAHI METAL MFG. CO. LTD.	DR
		MICHELL BEARINGS (INDIA) LLP	Approved
77.	HYDRAULIC COUPLING	VOITH TURBO PVT LTD	Approved
		VOITH TURBO PVT. LTD. - HYDERABAD, INDIA	Approved
		VOITH TURBO GMBH & CO. KG. - GERMANY	Approved
78.	DISCONNECTING COUPLING FOR TDBFP	ZURN INC, USA	Approved



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Sl. No.	Item Description	Vendor Name	Remarks
79.	SUCTION STRAINERS (BFP, BP & CEP)	OTOKLIN	Approved
		MULTITEX	Approved
		GUJARATH OTOFILT	Approved
		FILTRATION ENGINEERS INDIA PVT LTD	Approved
		JAY-EESH ENGINEERING COMPANY	Approved
80.	MECHANICAL SEAL (BFP/BP & CEP)	BURGMANN, GERMANY.	Approved
		EAGLE POONAWALA LTD.PUNE	Approved
		FLOWSERVE SANMAR, CHENNAI	Approved
81.	CONNECTING COUPLING FOR CEP , DRIP PUMP , CWP, BFP & BP	FLEXIBOX LTD., UK	Approved
		TURBOFLEX, UK	Approved
		BIBBY TURBOFLEX (FORMERLY EUROFLEX), UK	Approved
		EUROFLEX TRANSMISSION LTD., HYDERABAD.	Approved
		CUBIC TRANSMISSION PVT. LTD.	DR
		JOHN CRANE SEALING SYSTEMS, UK	Approved
82.	CONNECTING COUPLING (MEMBRANE TYPE/GEAR TYPE) FOR TDBFP	EUROFLEX TRANSMISSION, HYDERABAD.	Approved
		RENK AG,GERMANY	Approved
		JOHN CRANE, UK	Approved
		KOPFLEX, USA	Approved
		BIBBY TURBOFLEX (FORMERLY EUROFLEX), UK	Approved
		AMERIDRIVES (ZURN), USA	Approved
		LUFKIN, USA/FRANCE	Approved
		BHS, GERMANY	Approved
		FLENDER GRAFFENSTADEN, FRANCE	Approved
		RENK AKTIENGESELLSCHAFT -	Approved
83.	GEAR BOX FOR TDBFP	WALCHAND NAGAR, PUNE	Approved
		RENK AG,GERMANY	Approved
		LUFKIN, USA/FRANCE	Approved
		FLENDER GRAFFENSTADEN, FRANCE	Approved
		BHS, GERMANY	Approved
		VOITH TURBO BHS - GETRIEBE GMBH,	Approved
		RENK AKTIENGESELLSCHAFT -	Approved
		TRIVENI ENGG & IND LTD	Approved
84.	BARE RUBBER BELLOWS	CORI ENGINEERS PVT. LTD CHENNAI.	Approved
		SRM ESOFLEX PVT. LTD. KOLKATTA	Approved
		CORBIS	Approved
85.	SPRING SUPPORTS / HANGERS	SARATHI ENGG. ENTERPRISES PVT. LTD.	Approved
		HYDERABAD PIPING & ENERGY PRODUCTS (P) LTD. NEW DELHI	Approved
		SHAPE BAHADARABAD	Approved
		DARSHANI-INDIA	Approved
		PAL ENGINEERING YAMUNANAGAR	Approved
86.	SELF LUBRICATING BEARING	TEN MAT LTD UK	Approved
		(FEROFORM T 814 TUBES)	Approved



**SAGARDIGHI THERMAL Power EXTENSION PROJECT  
PHASE-III, UNIT#5 (1 x660 MW)**

Sl. No.	Item Description	Vendor Name	Remarks
	TUBES FOR BF VALVES	THORDON	Approved
		THORPLAS TUBES, CANADA	Approved
87	KNIFE GATE VALVES	VAAS	Approved
		TYCO, USA	Approved
		VELAN, UK/USA	Approved
		INDURE PVT. LTD.	Approved
		ORBINOX INDIA (P) LTD.	Approved
		JASH ENGINEERING LIMITED	Approved
		GALAXY CONTROLS PVT LTD.,	Approved
88	MS AND GI PIPES	SAIL	Approved
		JINDAL	Approved
		INDUS TUBES	Approved
		SURYA ROSHNI	Approved
		TATA	Approved
89	STAINLESS STEEL PIPES	RATNAMANI METAL & TUBES	Approved
90	VACUUM PUMP / MECHANICAL EXHAUSTER (LIQUID RING TYPE)	VACUNAIR	Approved
		GARDNER DENVER, KOREA	Approved
		EDWARDS LIMITED, UK	Approved
91	STRAINER	STRAINWELL INDIA	Approved
		ACME FLUID SYSTEMS	Approved
		SRK STRAINERS & VALVES INDIA	Approved
		FILTRATION ENGINEERS INDIA PVT LTD	Approved
		GUJARAT OTOFILT,	Approved
92	CONICAL STRAINERS	FILTRATION ENGINEERS (I) PVT. LTD.	Approved
		GUJARAT OTOFILT	Approved
		JAY-EESH ENGINEERING COMPANY	Approved
		MULTITEX FILTRATION ENGINEERS LIMITED	Approved
		OTOKLIN GLOBAL BUSINESS LIMITED	Approved
93	CONDENSER TUBES	RATNAMANI METALS & TUBES LTD	Approved
		REMI EDELSTAHL TUBULARS LTD	Approved
		RATNADEEP METAL & TUBES LTD.	Approved
94	GRINDING ROLLS	AIA Engineering Ltd., Ahmedabad	Approved
		Magotteaux Industries Pvt. Ltd., Rajkot	Approved
95	BULL RING SEGMENTS	AIA Engineering Ltd., Ahmedabad	Approved
		Magotteaux Industries Pvt. Ltd., Rajkot	Approved
96	PGB SPECIAL OIL-ISO VG 320	INDIAN OIL CORPN. LTD.,	Approved
		HINDUSTAN PETROLEUM CORPN. LTD.	Approved
		CASTROL INDIA LIMITED	Approved
		EXXONMOBIL LUBRICANTS PVT LTD	Approved
		SHELL INDIA MARKETS PRIVATE LIMITED	Approved



**SAGARDIGHI THERMAL Power EXTENSION PROJECT  
PHASE-III, UNIT#5 (1 x660 MW)**

Sl. No.	Item Description	Vendor Name	Remarks
97	CANISTER DRAINAGE PUMP SUBMERSIBLE/ BOOSTER PUMPS OF CVP	KIRLOSKAR BROTHERS LTD	Approved
		KSB PUMPS LIMITED,	Approved
		SULZER PUMPS INDIA LIMITED	Approved
		CLYDE PUMPS LTD.	Approved
98	SPIRAL WOUND GASKETS	CHAMPION SEALS (INDIA) PVT LTD.,	Approved
		STARFLEX SEALING (I) PVT .LTD	DR
		DYNAMIC GASKETS PVT LTD	DR
		SPIRASEAL GASKETS PVT LTD	DR
		GOODRICH GASKET PRIVATE LIMITED,	DR
99	PTFE SHEETS	As per BHEL Approved Sources	
100	AVERAGING PITOT TUBE	TECHNOMATIC	Approved
		EMERSON PROCESS MANAGEMENT (I) PVT	Approved
		MINCO (INDIA ) PVT. LTD.	DR
		SWITZER PROCESS INSTRUMENTS	Approved
101	SEALING COMPOUND	As per BHEL Approved Sources	
102	H2, N2 & CO2 CYLINDERS (EMPTY)	BHARAT PUMPS AND COMPRESSORS	Approved
		SARJU IMPEX LTD	Approved
		EVEREST KANTO CYLINDER LIMITED	Approved
		RAMA CYLINDERS PVT LTD.	DR
103	STROBOSCOPE	ZENTRONIC SYSTEMS	Approved
		BEM-MESSTECHNIK GMBH	Approved
		IAG AUTOMATION PVT LTD	Approved
104	AIR CYLINDER	EASTERN PNEUMATICS PRIVATE LTD., Kolkata	Approved
		INSTRUMENTATION LTD.,Kerala	Approved
		KELTRON CONTROLS,Aroor	Approved
		NUCON PNEUMATICS PVT.LTD. Medak	Approved
		VELJAN HYDRAIR LIMITED, Hyderabad	Approved
		DUNCAN ENGINEERING LIMITED, Pune	Approved
		NEWTON PNEUMATICS, Chennai	Approved
105	SLIDING BEARING	Avi Oilless die Components India Pvt. Ltd, Pune	DR
		NEXGEN FLUOROPOLYMERS PVT.LTD, Alwar	DR
106	BLOWERS	ACME AIR EQUIPMENTS CO PVT LTD,Ahmedabad	Approved
		AERZEN MACHINES INDIA PVT.LTD., Vadodara	Approved
		RKR,GEBLASE UND VERDICHTER GMBH, Germany	Approved
		SWAM PNEUMATICS PVT LTD.	Approved
107	DIRECT WATER LEVEL GUAGE	CLARK RELIANCE CORPN, USA	Approved
		IGEMA GmbH, Munster Germany	Approved
		NISAN SCIENTIFIC PROCESS,Mumbai	Approved



**SAGARDIGHI THERMAL Power EXTENSION PROJECT  
PHASE-III, UNIT#5 (1 x660 MW)**

Sl. No.	Item Description	Vendor Name	Remarks
		PENTAIR VALVES & CONTROLS INDIA, Baroda	Approved
108	HEA IGNITOR ASSY	UNISON INDUSTRIES, USA	Approved
		IGNITION SYSTEM Inc., USA	Approved
		DURAG, Germany	Approved
		FIVES COMBUSTION SYSTEMS PVT. LTD	Approved
		TESI SPA, Italy	Approved
		TURBINE TECHNICS, INC., Florida USA	Approved
109	HP FILL & PURGE FILT	PALL INDIA PVT LTD, Mumbai	Approved
		VENS HYDROLUFT (P) LTD, Chennai	Approved
110	VARIABLE ORIFICE	BMW STEELS LTD., UTTAR PRADESH	DF
		ELECTRO PORCELAIN DIVN., BANGALORE	DF
		PROMECON GmbH., GERMANY	Approved
111	Lub oil system for FANS (ID, FD & PA)	PSI ENGINEERING Systems pvt ltd	Approved
		SOUTHERN LUBRICATION PVT LTD	Approved
		YUKEN INDIA LTD	Approved
112	STEAM COIL AIR PRE HEATR	C DOCTOR INDIA PVT LTD	Approved
		PATEL AIR TEMP(INDIA) LTD	Approved
		BARODA EQUIPMENT &VESSEL PVT LTD	Approved
		NU WAY HEATRANSFER PVT LTD	Approved
		CHINTAMANI THERMAL TECHNOLOGIES PVT LTD	Approved
		PAR ENERGY INFRA PVT.LTD	Approved
113	AIR RECEIVER	VEE SONS ENERGY SYSTEM PVT LTD	Approved
		PATEL AIR TEMP(INDIA) LTD	Approved
		C DOCTOR INDIA PVT LTD	Approved
		AIRCON HANDLING SYSTEMS PVT LTD	Approved
		BARODA EQUIPMENT &VESSELS PVT LTD	Approved

**SAGARDIGHI THERMAL Power EXTENSION PROJECT  
PHASE-III, UNIT#5 (1 x660 MW)**

SL. NO.	Item Description	Vendor Name	Remarks
1	PIPES & CONDUITS/ACCESSORIES	As per BHEL approved source.	
2	EM BRAKES	SIEGERLAND-BREWSEN, GERMANY	Approved
		STROM KRAFT CONTROLS, MUMBAI	Approved
		BCH Electric Limited	Approved
		SIEMENS India Ltd.	Approved
	Caliper Brakes,EHT Gear Boxes,Industrial Valves,	KATEEL Engineering Industry Pltd	DR
3	SOLENOID VALVES	ASCO, Chennai	Approved
4	AIR CONDITIONING SYSTEMS	shall be as per approved sources listed in Package items in Main Plant Package area.	
5	VENTILATION SYSTEM	shall be as per approved sources listed in Package items in Main Plant Package area.	
6	VALVES	shall be as per approved sources listed in Mechanical Equipment in Main Plant Package area.	
7	DUST EXTRACTION SYSTEM	C.Doctor & Company Privae Ltd.,	Approved
		DUSTVEN Pvt .Ltd., Bangalore	Approved
		THERMEX	Approved
		Batlboi Environmental Engg Ltd.,	Approved
		TPS,DELHI	Approved
		F. Harley	Approved
SPRAYING SYSTEMS INDIA PVT. LTD	Approved		
8	DUST SUPPRESSION SYSTEM	SPRAYING SYSTEMS INDIA PVT. LTD	Approved
		KAVERI ULTRA POLYMER LTD.	Approved
		F. HARLEY & COMPANY. PVT. LTD.	Approved
		TPS INFRASTRUCTURE LTD.	Approved
9	E O T CRANE / MANUAL HOIST	shall be as per approved sources listed in Mechanical Equipment in Main Plant Package area.	
10	PUMPS & ACCESSORIES	shall be as per approved sources listed in Mechanical Equipment in Main Plant Package area.	
		PHOENIX CONVEYOR BELT INDIA PVT LTD	Approved
		SEMPERTRANS INDIA PRIVATE LIMITED	Approved
		HILTON-FORECH	Approved

Sagardighi Extn. U#5 (PROJ3)

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**SAGARDIGHI THERMAL Power EXTENSION PROJECT  
PHASE-III, UNIT#5 (1 x660 MW)**

11	CONVEYOR BELT	MRF	Approved
		YOKOHAMA	Approved
		FORECH INDIA LTD, KOLKATA	Approved
		HINDUSTAN RUBBERS, SILVASA	Approved
		NORTHLAND RUBBER MILLS, NEW	Approved
		ORIENTAL RUBBER INDUSTRIES PVT LTD.	DR
		JONSON RUBBER INDUSTRIES	Approved
		EUREKA COVEYOR BELTINGS PVT LTD.	Approved
		FLEXER RUBBER PVT LTD	Approved
12	BELT VULCANIZER	SHAW ALMEX	Approved
		S. V. DATTAR	Approved
		NILOS	Approved
13	STRUCTURAL STEEL	Follow Civil Structural Vendor Approval List.	
14	COAL SAMPLING UNIT	ADVANCED SYSTEMS SAMPLING PVT LTD	Approved
		THERMO RAMSAY, AUSTRALIA	Approved
		ERIEZ MAGNETICS EUROPE LTD., CAERPHILLY	Approved
		EASTMAN CRUSHER Co. (P) Ltd.	Approved
15	BELT WEIGHER SCALES	THERMO RAMSAY, AUSTRALIA	Approved
		AVERY INDIA LTD., NEW DELHI	Approved
		TRANSWEIGH	Approved
		SCHENCK PROCESS INDIA LIMITED	Approved
16	FLAP GATES	PRECISION PROCESSING EQUIPMENT CO.	Approved
		DA ENGG.	Approved
		MERIT CHENNI	Approved
		MMHE	Approved
		MSE	Approved
		HINDUSTAN M/C TOOLS CORPORATION, KOLKATA	Approved
		CONTINENTAL PROFILES LTD., FARIDABAD	Approved
17	Flow elements, Condensate pots, Manifolds etc for process instrumentation	shall be as per approved sources listed in C&I in Main Plant Package area.	
18	GRATINGS	PATNY SYSTEMS, HYDERABAD	Approved
		PINAX STEEL INDUSTRIES PVT LTD	Approved
		INDIANA GRATINGS PVT. LTD	Approved

Sagardighi Extn. Unit#5 (PR-03)

CHP-Mech. Package



**SAGARDIGHI THERMAL Power EXTENSION PROJECT  
PHASE-III, UNIT#5 (1 x660 MW)**

		CAUVERY ENGINEERING WORKS	Approved
19	GEAR BOXES	R&D MULTIPLES (METAL CAST) PVT. LTD.	Approved
		ESSENTIAL POWER TRANSMISSION PVT.LTD	Approved
		FLENDER	Approved
		NEW ALLENBURY	Approved
		KATEEL Engineering Industry Pltd	DR
		PREMIUM TRANSMISSION LIMITED	Approved
		SHANTHI GEARS LIMITED	Approved
20	ERW PIPES	STEEL AUTHORITY OF INDIA LTD.	Approved
		WELSPUN GUJARAT STAHL ROHERN LTD	Approved
		TUBES INDIA	Approved
		JCO GAS PIPE LIMITED	Approved
		RATNAMANI METALS & TUBES LTD	Approved
		MAHARASHTRA SEAMLESS LIMITED	Approved
		JINDAL PIPES LIMITED	Approved
21	COMPRESSORS	ATLAS COPCO (INDIA) LIMITED	Approved
		ELGI EQUIPMENTS LTD	Approved
		INGERSOLL- RAND (INDIA) LIMITED	Approved
22	Bull Dozer	BHARAT EARTH MOVERS LIMITED	Approved
23	Twin Wagon Trippler	THYSSENKRUPP INDUSTRIES INDIA PV	Approved
24	Feeders (Apron ; Grizzly; Vibrating; Paddle)	FL Smidth	
		Metso Minerals(I) Pvt.Ltd.	Approved
		LARSEN & TOUBRO LTD, ECC DIVN	Approved
		ELECON ENGINEERING COMPANY LTD	Approved
		TRF LTD., JAMSHEDPUR	Approved
		THYSSENKRUPP INDUSTRIES INDIA PV	Approved
25	Crusher	LARSEN & TOUBRO LTD	Approved
		TRF LIMITED	Approved
		ELECON ENGINEERING COMPANY LTD	Approved
		THYSSENKRUPP INDUSTRIES INDIA PV	Approved
		SANDVIK ASIA PRIVATE LIMITED	DR
		MCNALLY SAYAJI ENGINEERING LIMITED	Approved
		Amps Engineering & Equipments Pvt Ltd	DR
		Devas Engineering Systems	DR
		GOLDEN ENGINEERING INDUSTRIES	DR
		INDIANA CONVEYORS PVT LTD	DR
		VISHWA INDUSTRIAL COMPANY LTD.,	DR
		NEW ERA CONVEYORS PVT LTD.,	DR



**SAGARDIGHI THERMAL Power EXTENSION PROJECT  
PHASE-III, UNIT#5 (1 x660 MW)**

26	Idlers	TURBO ENGINEERS (CBE),	DR
		ROLLWELL CONVEYOR COMPONENTS PVT LTD	DR
		ELECON ENGINEERING CO. LTD.	Approved
		ARUDRA	Approved
		TRF LIMITED	Approved
		MCNALLY BHARAT, ENGG. CO. LTD.	Approved
		TEGA	Approved
		BENGAL TOOLS.	Approved
		ARYAN CLEAN COAL TECHNOLOGIES PVT LTD.,	DR
		Bevcon Wayors Pvt Ltd	DR
		I & B ENGINEERS PVT LTD	DR
TECHNO IMPEX	DR		
27	Pulleys	INDIANA CONVEYORS PVT LTD	DR
		AMPS ENGINEERING & EQUIPMENTS PVT LTD	DR
		Devas Engineering Systems	DR
		VISHWA INDUSTRIAL COMPANY LTD.,	DR
		NEW ERA CONVEYORS PVT LTD.,	DR
		TURBO ENGINEERS (CBE),	DR
		BENGAL TOOLS	Approved
		MCNALLY BHARAT ENGG. CO. LTD.	Approved
		ELECON	Approved
		ARUDRA	Approved
		ROLLWELL CONVEYOR COMPONENTS PVT LTD	DR
		ARYAN CLEAN COAL TECHNOLOGIES PVT LTD.,	DR
		BEVCON WAYORS PVT.LTD.	DR
		I & B ENGINEERS PVT LTD	DR
TECHNO IMPEX	DR		
28	Internal / External Scrapers & Skirt Board Sealing System	As per BHEL approved source.	
29	Roller SCREENS	POSCO PLANT ENGINEERING CO., LTD.,	DR
		ELECON	Approved
		msei	Approved
		Thyssen	Approved
		Electro Zavod (India) Pvt Ltd.	DR
30	RPG GATES	BENGAL TOOL	Approved
		MSEL	Approved
		DA ENGG.	Approved
		HMTC ENGINEERING CO (KOLKATA) PVT LTD	Approved

**SAGARDIGHI THERMAL Power EXTENSION PROJECT  
PHASE-III, UNIT#5 (1 x660 MW)**

31	HVAC System	shall be as per approved sources listed in Package items in Main Plant Package area.	
32	REDUCTION GEAR BOX	PREMIUM ENERGY TRANSMISSION	Approved
		FLENDER LIMITED	Approved
		ELECON ENGINEERING CO. LTD.	Approved
33	FLUID COUPLING	VOITH	Approved
		PREMIUM ENERGY TRANSMISSION	Approved
		FLUIDOMAT	Approved
34	FLEXIBLE GEAR COUPLING	GMB MFG. (P) LTD., KOLKATA	Approved
		HI-CLIFF	Approved
		FENNER	Approved
		LOVEJOY	Approved
		WELLMAN	Approved
		CONCORD	Approved
		ELECON ENGINEERING COMPANY LIMITED	Approved



**SAGARDIGHI THERMAL Power EXTENSION PROJECT  
PHASE-III, UNIT#5 (1 x660 MW)**

SL. NO.	Item Description	Vendor Name	Remarks
1	Ash Slurry Pumps	SAM TURBO INDUSTRY PRIVATE LTD	Approvec
		WIER MINERALS (India) Pvt. Ltd	Approvec
		INDURE PVT. LTD.	Approved
		METSO MINERALS (INDIA) PVT LTD.,	Approvec
2	Water Pumps & Accessories	KIRLOSKAR BROTHERS LIMITED	Approvec
		Flowmore Limited, Gurgaon	Approvec
		BEACON WEIR LTD, CHENNAI	Approvec
		Kishor Pumps Pvt. Ltd., Chennai	Approvec
		Maxflow pumps india Pvt Ltd.	Approvec
		Wilo Mather and Platt Pumps Pvt Ltd	Approvec
3	ERW Pipes	STEEL AUTHORITY OF INDIA LTD.	Approvec
		WELSPUN GUJARAT STAHL ROHERN LTD	Approvec
		TATA	Approved
		JCO GAS PIPE LIMITED	Approvec
		TUBES INDIA	Approvec
		RATNAMANI METALS & TUBES LTD	Approvec
		MAHARASHTRA SEAMLESS LIMITED	Approvec
		JINDAL PIPES LIMITED	Approvec
4	Compressors	ATLAS COPCO (INDIA) LIMITED	Approvec
		ELGI EQUIPMENTS LTD	Approvec
		INGERSOLL- RAND (INDIA) LIMITED	Approvec
5	FLUIDIZING AIR HEATER	ESCORTS	Approved
		SPHEREHOT	Approved
		RAYCOLD	Approvec
		INDURE PVT. LTD.	Approvec
6	Cast Basalt Lined bends/ fittings/ pipes	TURBO ENGINEERS (CBE)	Approvec
		INDURE PVT. LTD.	Approvec
		DEMECH	Approvec
		ENVIRO ABRASION	Approvec
		Densen Technologies, Thane	Approvec
		Deccan Mechanical and Chemical Industries Pvt. Ltd.,	Approvec
7	ALLOY C.I. FITTINGS & LINERS	MENON METALLIKS	Approvec
		CRAWLEY & RAY	Approvec
		SAM CASTINGS	Approvec
		CRESENT	Approvec

8	E O T CRANE / MANUAL / Electric HOIST	shall be as per approved sources listed in Mechanical Equipment in Main Plant Package area.	
9	Gear Box	R&D MULTIPLES (METAL CAST) PVT. LTD.	Approved
		ESSENTIAL POWER TRANSMISSION PVT.LTD	DR
		KATEEL Engineering Industry Pltd	DR
		PREMIUM TRANSMISSION LIMITED	Approved
		New Allenburry	Approved
10	Couplings	ESCO COUPLINGS & TRANSMISSIONS PVT LTD	Approved
		PREMIUM TRANSMISSION LIMITED	Approved
		ELECON ENGINEERING COMPANY LIMITED	Approved
11	Air conditioning	shall be as per approved sources listed in Package items in Main Plant Package area.	
12	Ventilation System	shall be as per approved sources listed in Package items in Main Plant Package area.	
13	Valves/Gate	shall be as per approved sources listed in Mechanical Equipment in Main Plant Package area.	
14	TWIN LOBE TYPE ROTARY FLUDIZING AIR BLOWER	SWAM PNEUMATICS	Approved
		KAY INTERNATIONAL	Approved
		EVEREST	Approved



SAGARDIGHI THERMAL Power EXTENSION PROJECT PHASE-III, UNIT#5 (1 x660 MW)			
Sl. NO.	Item Description	Vendor Name	Remarks
1	Electrical Valve Actuators	AUMA (I) LTD., BANGALORE	Approved
		AUMA, GERMANY	Approved
		LIMITORQUE (I) LTD, FARIDABAD	Approved
		LIMITORQUE, US	Approved
		ROTORK CONTROLS (I) LTD, CHENNAI & BANGALORE	Approved
		ROTORK, UK	Approved
		NIPPON GEAR CO., JAPAN	DR
2	OIL FILLED TRANSFORMER ( More than 10 MVA)	BHEL	Approved
		GE	Approved
		AREVA T & D INDIA LIMITED	Approved
		FUJI	Approved
		ABB	Approved
3	OIL FILLED SERVICE TRANSFORMER ( Applicable only for less than 10 MVA)	KIRLOSKAR ELECTRIC CO.LTD. Mysore	Approved
		BHEL	Approved
		SCHNEIDER ELECTRIC INFRASTRUCTURE LIMITED	DR
		TOSHIBA TRANSMISSION & DISTRIBUTION SYSTEMS(i) PVT.LTD.,MEDAKH	DR
		CROMPTON GREAVES LTD.	Approved
		AREVA T & D INDIA LIMITED ,	Approved
		MARSONS LIMITED	Approved
		VOLTAMP TRANSFORMERS LTD.	Approved
4	SEGREGATED PHASE BUSDUCTS	BHEL	Approved
		L&T	Approved
		SIEMENS	Approved
		ALSTOM LTD.	Approved
		BEST & CROMPTON	Approved
5	ISOLATED PHASE BUSDUCT	BHEL	Approved
		SIMELECTRO, FRANCE	Approved
6	HT MOTORS (above 500 kW)	ABB	Approved
		BHEL	Approved
		SIEMENS	Approved
7	HT MOTORS (upto 500 kW)	ABB	Approved
		BHEL	Approved
		SIEMENS	Approved
		CROMPTON GREAVES	Approved

8	ELECTRIC LT MOTOR (ABOVE 90 KW)	CG POWER AND INDUSTRIAL SOLUTIONS LIMITED	Approved
		MARATHON ELECTRIC MOTORS INDIA LIMITED	Approved
		ABB	Approved
		SIEMENS	Approved
9	ELECTRIC LT MOTOR (UPTO 90 KW)	CG POWER AND INDUSTRIAL SOLUTIONS LIMITED	Approved
		MARATHON ELECTRIC MOTORS INDIA LIMITED	Approved
		ABB	Approved
		SIEMENS	Approved
		KIRLOSKAR	Approved
		BHARAT BIJLEE	Approved
10	HT SWITCHGEAR (11KV, 3.3 KV)	AREVA LTD.	Approved
		BHEL.	Approved
		Schneider	Approved
		SIEMENS LTD	Approved
11	LT Switch Gear Panel [PMCC, PCC & MCC]	Siemens India ltd	Approved
		GE India Industrial pvt ltd	Approved
		Schneider Electric India pvt ltd	Approved
		ABB	Approved
		AREVA LTD.	Approved
		LARSEN & TOUBRO LTD.	Approved
12	TRANSFORMER (DRY TYPE)	VOLTAMP	Approved
		AREVA	Approved
		CGL	Approved
		BHEL	Approved
13	NON SEGREGATED PHASE BUS DUCTS	KGS Engineering Limited	Approved
		L&T	Approved
		SIEMENS	Approved
		ALSTOM LTD.	Approved
		BEST & CROMPTON	Approved
14	ACDB, DCDB, , MLDB, ELDB, PDB, WELDING DB, VENTILATION DB	Siemens India ltd	Approved
		GE India Industrial pvt ltd	Approved
		Unilec Engineers ltd	Approved
		Schneider Electric India pvt ltd	Approved
		ABB	Approved
		AREVA LTD.	Approved
		LARSEN & TOUBRO LTD.	Approved
15	LOCAL STARTER PANEL, LOCAL CONTROL PANEL, LIGHTING PANEL	L & T	Approved
		Schneider	Approved
		L & T	Approved
		Siemens	Approved
		UNILEC ENGINEERS LTD.	Approved
		AREVA LTD.	Approved
		PYROTECH	Approved
16	VacuumInterrupter,3.6kV40kA	BharatElectronicsLtd.	Approved
17	VacuumInterrupter,12kV50kA	EatonIncorporation	Approved



18	Air Circuit Breaker (ACB)	ABB	Approved
		Schneider	Approved
		L & T	Approved
		Siemens (3WL model only)	Approved
		AREVA LTD.	Approved
		GE-POWER	Approved
19	Molded case circuit breakers (MCCB)/Motor Protection Circuit Breaker (MPCB)/ Power Contactor/Aux. Contactor/ Thermal Overload Relay (OLR)/SFU	ABB	Approved
		Schneider	Approved
		L & T	Approved
		Siemens	Approved
		GE-POWER	Approved
20	Miniature Circuit Breaker (MCB)	ABB	Approved
		Schneider	Approved
		L & T	Approved
		Siemens	Approved
		GE-POWER	Approved
		LEGRAND	Approved
21	Electronic Motor Protection Relay (EMPR)	ABB	Approved
		Schneider	Approved
		Siemens	Approved
		GE-POWER	Approved
22	Current transformer / Voltage Transformers (VT/PT)/ Control Transformers(CST) upto 1.1KV	Automatic Electric	Approved
		Prayog Electricals	Approved
		Precise Electricals	Approved
		Kappa Electricals	Approved
		Pragati Electricals	Approved
		Indcoil	Approved
23	Interposing Relays	Jyoti	Approved
		OEN	Approved
		PLA	Approved
		Schneider	Approved
		GUARDIAN	Approved
		OMRON	Approved
24	Numerical Relay	Asea Brown Boveri Ltd., Vadodara	Approved
		Asea Brown Boveri Limited, Bangalore	Approved
		GE (Alstom)	Approved for MICOM Series
		Siemens Ltd.	Approved for SIPROTEC Series
		Schnieder Electric Infrastructure limited	Approved for MICOM Series

25	Static / Electromechanical / Auxiliary / Tripping Relays	Asea Brown Boveri Ltd., Vadodara	Approved
		Asea Brown Boveri Limited, Bangalore	Approved
		Schnieder Electric Infrastructure limited	Approved
		GE T & D India Limited	Approved
		Siemens Ltd.	Approved
		Alstom, Chennai	Approved
26	Energy Meters	SCHNEIDER CONZERVE	Approved
		Secure Meters (SEMS)	Approved
27	Multifunction Meter	Secure Meters (SEMS)	Approved
		SIEMENS Ltd.	Approved
		Schneider	Approved
28	Alarm Annunciators	MINILEC India Pvt Ltd.	Approved
		Accord Electro-Technics Pvt. Ltd.	Approved
		Alan Instrumentation Pvt. Ltd.	Approved
		JVS Electronics Pvt. Ltd.	Approved
		PROCON Instrumentation (P) Ltd.	Approved
		VESTAL Electronics	Approved
29	Timer/ TIME DELAY RELAY	ABB	Approved
		Schneider	Approved
		L & T	Approved
		Siemens	Approved
		GE-POWER	Approved
30	Digital Indicating meters	Automatic Electric Limited (AEL)	Approved
		RISHABH Instruments Pvt Ltd.	Approved
		L&T	Approved
		MECO Instrument Pvt. Ltd.	Approved
		MASIBUS AUTOMATION & INSTRUMENTATIO, GANDHI NAGAR	Approved
		Secure	Approved
Schneider/conzerv	Approved		
31	Analog Indicating meters	Automatic Electric Limited (AEL)	Approved
		MECO Instrument Pvt. Ltd.	Approved
		RISHABH Instruments Pvt Ltd.	Approved
		ABB	Approved
		GOSSSEN	Approved
		YOKOGAWA	Approved
		PYROTECH Electronics Pvt. Ltd.	Approved
SELEC Controls Pvt. Ltd.	Approved		
32	Transducers	Camille Bauer, Germany	Approved
		Automatic Electric Limited (AEL)	Approved
		ELSTER Metering Pvt Ltd, Mumbai	Approved
		Siemens	Approved
		MASIBUS Automation and Instruments (P) Ltd.	Approved
		Southern Transducers Pvt. Ltd.	Approved
33	Control / Selector Switches	KAYCEE Industries Ltd., Mumbai	Approved
		L & T (Salzer)	Approved
		Reliable Electronic Components Pvt. Ltd (RECOM)	Approved
		SETON Electrical Products	Approved
		SWITRON Devices	Approved

34	Discrepancy switch	Asea Brown Boveri Limited(ABB)	Approved
		Control Dynamics	Approved





35	FUSE Base with holder	ABB	Approved
		Schneider	Approved
		L & T	Approved
		Siemens	Approved
		GE-POWER	Approved
36	FUSES (Power/Control)	GE-Power	Approved
		Siemens	Approved
		L & T	Approved
		Schneider	Approved
		COPPER BUSSMANN	Approved
		ABB	Approved
37	Indicating Lamp	Siemens	Approved
		Vaishno	Approved
		L & T (ESBEE)	Approved
		Schneider	Approved
		ABB	Approved
		SECO	Approved
38	Push Button	Siemens	Approved
		Vaishno	Approved
		L & T (ESBEE)	Approved
		TEKNIK	Approved
		Schneider	Approved
		ABB	Approved
39	Disturbance Recorders / Event Logger	Asea Brown Boveri Limited (ABB)	Approved
		Alstom T&D India Ltd. Chennai	Approved
		Ametek Power Instruments, USA	Approved
		QUALITROL HATHWAY, UK	Approved
40	Time Synchronizer	SERTEL, Chennai	Approved
		ARBITER, USA	Approved
		SEL, USA	Approved
		MASIBUS Automation and Instruments (P) Ltd.	Approved
41	(Indoor ) CT / PT up to 11 kV, CBCT,Aux. CT / PT (ICT )	Prayog Electricals (P) Ltd.	Approved
		Pragati Electricals Pvt. Ltd.	Approved
		Silkaans Elect. Mfg. Co. Pvt. Ltd.	Approved
42	Surge Suppressor/Arrestor (Less than 15KV)	Raychem	Approved
		CGL	Approved
		Elpro	Approved
		Oblum Electrical Industries (P) Ltd.	Approved
43	Bus Transfer Scheme Panel(Numerical )	Aartech Solonics Ltd.	Approved
		Asea Brown Boveri Ltd.	Approved
44	Data Concentrator	ABB	Approved
		Schneider	Approved
		SIEMENS	Approved
		GE(ALSTOM)	Approved



45	Ethernet Switches	RUGGEDCOM	Approved
		NETGEAR	Approved
		HIRSCHMANN	Approved
		MOXA	Approved
		CISCO	Approved
46	Terminals Block	Phoenix	Approved
		Connect well	Approved
		Elemex	Approved
		Wago	Approved
47	Cable Glands	HEX	Approved
		Commet	Approved
		DOWELLS	Approved
		Jainson	Approved
		3D	Approved
		Sunil & Co.	Approved
48	Cable Lugs	HEX	Approved
		Commet	Approved
		DOWELLS	Approved
		Jainson	Approved
		3D	Approved
		Sunil & Co.	Approved
49	Local Motor Starter	L & T	Approved
		Schneider	Approved
		ABB	Approved
		BCH	Approved
50	LPBS ( NON-FLAME PROOF)	L&T	Approved
		SCHNEIDER	Approved
		Tecknic Controls	Approved
		SIEMENS	Approved
51	LPBS(FLAME PROOF)	BALLIGA	Approved
		EX-PROTECTA	Approved
52	Industrial Switch & Socket / Receptacles	Schneider	Approved
		Anchor	Approved
		Bajaj	Approved
		Philips	Approved
		crompton Greaves	Approved
		BEST & CROMPTON ENGG. LIMITED	Approved
		AJMERA INDUSTRIES & ENGG. WORKS	Approved
		BCH Electric	Approved
53	ISOLATING SWITCH	SALZER, L&T	Approved
		SIEMENS	Approved
		ALSTOM LTD.	Approved
		GE – POWER	Approved
		SCHNEIDER	Approved
		ABB	Approved
		KAYCEE	Approved

54	SYNCHROSCOPE	AUTOMATIC ELECTRIC	Approved
		GEC - ALSTHOM	Approved
55	EARTH LEAKAGE CB	SCHNEIDER	Approved
		L&T	Approved
		SIEMENS	Approved
		ABB	Approved
56	EARTH LEAKAGE RELAY [ELR] ALONGWITH CBCT	AREVA	Approved
		PRO'KDEVICES	Approved
57	EARTH LEAKAGE RELAY [ELR] ALONGWITH CBCT	AREVA	Approved
		PRO'KDEVICES	Approved
58	PANEL SPACE HEATER	C&S ELECTRIC	Approved
		SPACEAGE	Approved
59	Neutral Grounding Transformer	Pragati Electricals Pvt. Ltd., Thane	Approved
		Prayog Electricals Pvt. Ltd., Pune	Approved
60	Lightning Arrester for Busduct	Elpro International Ltd., Pune	Approved
		Oblum Electronics, Hyderabad	Approved
61	Surge Capacitor	ABB Ltd., Bangalore	Approved
		Madhav Capacitor Pvt. Ltd., Pune	Approved
62	NEUTRAL GROUNDING RESISTOR	LACHHMAN ELECTRONICS, NEW DELHI	Approved
		RSI SWITCHGEAR PVT. LTD., Bhiwadi Extn, INDIA	Approved
		RESITECH ELECTRICALS PVT.LTD. KOLKATA	Approved
		S.R.NARKHEDE ENGG.PVT.LTD. PUNE	Approved
63	TREFOIL CLAMPS	AJMERA INDUSTRIAL & ENGINEERING WORKS, MUMBAI	Approved
		ELECTROMAC INDUSTRIES, MUMBAI	Approved
		MOULDED FIBREGLASS PRODUCTS, KOLKATA	Approved
		SUMIP COMPOSITES PVT.LTD. Ahmedabad	Approved
64	CABLE TRAYS & ACC	INDUSTRIAL PERFORATION (I) PVT.LTD.	Approved
		PREMIER POWER PRODUCTS (CAL) PVT. LTD., Howrah	Approved
		PATNY SYSTEMS (P) LTD	Approved
		PARMAR METALS PVT.LTD.	Approved
		UNITECH FABRICATORS and ENGINEERS PVT LTD	Approved
		RATAN PROJECTS & ENGINEERING CO. PVT.LTD., Howrah	Approved
RABI ENGINEERING WORKS PVT. LTD., Kolkata	Approved		



65	CABLE TRAY SUPPORT SYSTEM- WELDED(GALV)	INDUSTRIAL PERFORATION (I) PVT.LTD., Kolkata	Approved
		PREMIER POWER PRODUCTS (CAL) PVT. LTD., Howrah	Approved
		UNITECH FABRICATORS and ENGINEERS PVT LTD	Approved
		PATNY SYSTEMS (P) LTD	Approved
		RATAN PROJECTS & ENGINEERING CO. PVT.LTD., Howrah	Approved
		RABI ENGINEERING KOLKATA	Approved
		HOWRAH	Approved
66	ABOVE GROUND EARTHING MATERIALS	INDUSTRIAL PERFORATION (I) PVT.LTD., Kolkata	Approved
		PREMIER POWER PRODUCTS (CAL) PVT. LTD., Howrah	Approved
		PATNY SYSTEMS (P) LTD, HYDERABAD	Approved
		UNITECH FABRICATORS and ENGINEERS PVT LTD	Approved
		RATAN PROJECTS & ENGINEERING CO. PVT.LTD., Howrah	Approved
		RABI ENGINEERING WORKS PVT. LTD.	Approved
67	CABLE TERM.& JOINT KITS	3M Electro and Communication India P.Ltd	Approved
		RAYCHEM RPG PRIVATE LIMITED	Approved
68	FIRE SEALING SYSTEM	3M INDIA LIMITED, Bangalore	Approved
		HILTI India Pvt. Ltd., New Delhi	Approved
		LLOYD INSULATIONS (INDIA) LIMITED, Chennai	Approved
		MULTI KILFIRE PVT LTD, VADODARA	Approved
		VIJAY SYSTEMS ENGINEERS PVT.LTD., MUMBAI	Approved
69	ELECTRICAL - HEAT TRACING	THERMOPADS PVT.LTD.,	Approved
		XICON INTERNATIONAL LTD.	Approved
		THERMON INDIA PVT. LTD.	Approved
		RAYCHEM RPG LIMITED	Approved
70	HT XLPE CABLES	CABLE CORPORATION OF INDIA LTD.	Approved
		UNIVERSAL CABLES LTD.	Approved
		KEC INTERNATIONAL LIMITED	Approved
		RAVIN CABLES LIMITED	Approved
		KEI INDUSTRIES LTD., ALWAR	Approved
		POLYCAB WIRES PVT. LTD. Daman	Approved
		UNIVERSAL CABLES LTD., SATNA	Approved
71	LT XLPE POWER CABLE	GEMSCAB INDUSTRIES LTD.	Approved
		SUYOG ELECTRICALS LTD.	Approved
		RAVIN CABLES LIMITED	Approved
		CORDS CABLE INDUSTRIES LTD., BHIWADI DIST.	Approved
		CMI LTD.	Approved
		CRYSTAL CABLE INDUSTRIES LTD., HOWRAH	Approved
		KEI INDUSTRIES LTD., ALWAR	Approved
		KEC INTERNATIONAL LIMITED, Silvassa	Approved

	POLYCAB WIRES PVT. LTD., Daman	Approved
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72	LT PVC CONTROL CABLE	Advance Cable Technologies (P) Ltd., Bengaluru	Approved
		CORDS CABLE INDUSTRIES LTD., BHIWADI DIST.	Approved
		CMI LTD.	Approved
		CRYSTAL CABLE INDUSTRIES LTD., HOWRAH	Approved
		KEI INDUSTRIES LTD., ALWAR	Approved
		KEC INTERNATIONAL LIMITED, Silvassa	Approved
		POLYCAB WIRES PVT. LTD., Daman	Approved
		RAVIN CABLES LIMITED	Approved
		UNIVERSAL CABLES LTD., SATNA	Approved
73	SCREENED CONTROL CABLES	CORDS CABLE INDUSTRIES LTD., BHIWADI DIST.	Approved
		DELTON CABLES LTD. FARIDABAD	Approved
		KEI INDUSTRIES LTD., ALWAR	Approved
		POLYCAB WIRES PVT. LTD., Daman	Approved
		THERMO CABLES LTD. HYDERABAD	Approved
74	LT XLPE FIRE SURVIVAL CABLES	KEI INDUSTRIES LTD., ALWAR	Approved
		POLYCAB WIRES PVT. LTD., Daman	Approved
75	DC LEAD ACID BATTERIES	EXIDE INDUSTRIES LTD, KOLKATA	Approved
		HOPPECKE BATTERIEN GMBH & CO.KG,	Approved
76	DC Ni-Cd BATTERIES	HBL Power Systems Ltd Hyderabad	Approved
77	DC BATTERY CHARGER	CHHABI ELECTRICALS PVT.LTD.(.)	Approved for Capacity < 100 AH
		AMAR RAJA POWER SYSTEMS, TIRUPATHI	Approved for Capacity < 100 AH
		Chloride Power Systems & Solutions Ltd., Kolkata	Approved
		HBL POWER SYSTEMS LTD ,	Approved
		STATCON ENERGIAA PRIVATE LIMITED,Hapur	Approved
78	MS ROD FOR BELOW GROUND EARTHING	RASHTRIYA ISPAT NIGAM LIMITED	Approved
		STEEL AUTHORITY OF INDIA LTD.	Approved
79	STATION LIGHTING SYSTEM	BAJAJ ELECTRICALS LTD., PUNE	Approved
		CROMPTON GREAVES LTD.	Approved
		PHILIPS INDIA LTD.	Approved
80	LIGHTING TRANSFORMERS	SUDHIR TRANSFORMERS LIMITED	Approved
		INDCOIL TRANSFORMERS PVT LTD	Approved
81	LIGHTING MAST	BAJAJ ELECTRICALS LIMITED	Approved
		CROMPTON GREAVES CONSUMER ELECTRICALS LIMITED	Approved

82	LIGHTING POLE	BOMBAY TUBE & POLES CO..	Approved
		BAJAJ ELECTRICALS LTD.	Approved
83	LIGHTING WIRE	CORDS CABLE INDUSTRIES LTD	Approved
		DELTON CABLES LTD.	Approved
		KEC	Approved
		KEI INDUSTRIES LTD.	Approved
		NICCO CORPORATION LTD.	Approved
		POLYCAB WIRES PVT.LTD	Approved
		TORRENT CABLES LTD.	Approved
		UNIVERSAL CABLES D.	Approved
		Finolex	Approved
		CMI Energy India Pvt. Ltd.	Approved
		Elkay Telelinks Ltd.	Approved
		Havells India Ltd	Approved
		Paramount Communications Ltd.	Approved
		Ravin Cables Ltd	Approved
		Special Cables Pvt. Ltd.	Approved
		Anchor	Approved
CABLE CORPORATION OF INDIA	Approved		
RR Kabel Limited	Approved		
Thermo Cables Limited	Approved		
84	HVR Transformer and EC Panel	ADOR POWERTRON LTD.,	DR
		BHARAT HEAVY ELECTRICALS LIMITED	Approved
		KRAFT POWERCON INDIA PRIVATE LTD	DR
85	Rubber Bellow for Bus Duct	Cori Engineers Pvt. Ltd., Chennai	Approved
		Resistoflex Pvt. Ltd., Noida	Approved
		United Rubber Industries, Mumbai	Approved
86	Epoxy Insulator for Bus Duct Package	A-Bond Strands Pvt. Ltd., Chennai	Approved
		Baroda Bushing & insulator, Vadodara	Approved
		Baroda Mould & Dies, Vadodara	Approved
		Ganpati Fibertech India (P) Ltd.	Approved
87	Epoxy Seal Off Bushing for Bus Duct Package	A-Bond Strands Pvt. Ltd., Chennai	Approved
		Baroda Bushing & insulator, Vadodara	Approved
		Baroda Mould & Dies, Vadodara	Approved
88	Current Transformer for Bus Duct Package	Instrans Engg & Mfg, Bangalore	Approved
		Pragati Electricals Pvt. Ltd., Thane	Approved
		Prayog Electricals Pvt. Ltd., Pune	Approved
		Silkaans Electrical Mfg. Co. Pvt. Ltd., Bangalore	Approved
89	Voltage/ Potential Transformer for Bus Duct Package	Instrans Engg & Mfg, Bangalore	Approved
		Pragati Electricals Pvt. Ltd., Thane	Approved
		Prayog Electricals Pvt. Ltd., Pune	Approved
		Silkaans Electrical Mfg. Co. Pvt. Ltd., Bangalore	Approved



90	Hot Air Blowing Equipment for Bus Duct	Elmech Pneumatic Industries	Approved
		Melcon Engg, New Delhi	Approved
		Powergear Ltd	Approved
91	Air Pressurization Equipment for Bus Duct Package	Elmech Pneumatic Industries, New Delhi	Approved
		Mellcon Engineers Pvt. Ltd., New Delhi	Approved
		Powergear Ltd	Approved
92	LAVT & NG Cubicle Assembly for Bus Duct Package	BHEL-RUDRAPUR	Approved
		Pyrotech Electronics Pvt. Ltd., Udaipur	Approved
		RSI Switchgear Pvt. Ltd., Gurgaon	Approved
		Busbar Systems India Ltd.	Approved
		Powergear Ltd.	Approved

93	Copper Strip Flexible/Copper Braided Flexible for Bus Duct Package	B.B. Electro Technique, Mumbai/Thane	Approved
		Shree Cable & Conductors Pvt. Ltd., Bhopal	Approved
94	DG SET ENGINE	CUMMINS	Approved
		MITSHUBISHI	DR
		CATERPILLAR	Approved
95	ALTERNATOR	NIDEC-LEROY SOMER	Approved
		CATERPILLAR	Approved
		KIRLOSKAR ELECTRIC	Approved
		CUMMINS GEN TECH.(STAMFORD)	Approved
96	DG SET ASSEMBLERS	JAKSON LTD.	Approved
		POWERICA LTD.	Approved
97	DG SET BATTERY BANK	EXIDE	Approved
		HBL	Approved
		CUMMINS	Approved
98	DG SET CONTROL PANELS / AUX.DIST. BOARD	JAKSON LTD	Approved
		PYROTECH	Approved
99	ALUMINUM TUBE	Hindalco Industries Limited	Approved
		Jindal Aluminium Ltd Bangalore Karnataka	Approved
		Balco	Approved
		Alom Extrusions Ltd.	Approved
100	CLAMPS & CONNECTORS	Electromech & Transtech Private Limited Kolkata West Bengal	Approved
		Klemmen Engineering Corporation Chennai Tamil Nadu	Approved
		Peevee Engineering Enterprises Bangalore Karnataka	Approved
		Utsav Electro-Mech Pvt Ltd Vadodara Gujarat	Approved



101	SWITCHYARD CONTROL PANELS	ABB India Limited	Approved
		GE T&D India Limited Noida Uttar Pradesh	Approved
		Schneider Electric Infrastructure Limited Noida Uttar Pradesh	Approved
		Siemens Ltd	Approved
102	SPACER COUPLING (REGIFLEX TYPE)	SIEMENS LTD	Approved
		ESCO COUPLING NV	Approved
		KTR Couplings (India) pvt.ltd	Approved
		UNIQUE TRANSMISSION INDIA P LTD.	Approved
		ESCO COUPLING & TRANSMISSION PVT LTD.	Approved
		Cubic Transmission pvt ltd unit-II	Approved
		RATHI TURBOFLEX PVT LTD	Approved
		Dipl.ing.Herwarth Reich GMBH	Approved
		Reich India ltd	Approved
KTR KUPPLUNGSTECHNIK Gmbh	Approved		
103	BAY CONTROL UNIT	ALSTOM	Approved
		SIEMENS	Approved
		ABB	Approved
104	FRP JUNCTION BOXES/ JUNCTION BOXES(POWER/CONTROL), LIGHTING JB	Jakson Engineers Limited	Approved
		Jasper Engineers Private Limited	Approved
		Mika Engineers	Approved
		Popular Switchgears Pvt Ltd	Approved
		Pyrotech Electronics Pvt Ltd	Approved
		RSI Switchgear Private Limited	Approved
		Sarvana Switchgears	Approved
Unilec Engineers Ltd	Approved		
105	MARSHALLING KIOSK	Mika Engineers Thane Maharashtra [MSE: MICRO]	Approved
		Popular Switchgears Pvt Ltd Nashik Maharashtra	Approved
		Pyrotech Electronics Pvt Ltd Udaipur Rajasthan	Approved
		RSI Switchgear Private Limited Bhiwadi Rajasthan	Approved
		RST Electricals Pvt. Ltd. Sahibabad Uttar Pradesh	Approved
		Sarvana Switchgears Bangalore Karnataka	Approved
Unilec Engineers Ltd Gurgaon Haryana	Approved		
106	PIPE STRUCTURE	Advance Steel Tubes Ltd. Ghaziabad Uttar Pradesh	Approved
		Associated Power Structures Pvt. Ltd. Vadodara Gujarat upto 400 kV System	Approved
		Goodluck India Limited Sikandrabad Uttar Pradesh	Approved
		Vijay Transmission Pvt. Ltd Raipur Chhattisgarh	Approved
		New Modern Technomech Pvt Ltd	Approved
		Rs Infraprojects Pvt. Ltd. Noida Uttar Pradesh	Approved
		UTKARSH TUBES & PIPES LIMITED Kolkata	Approved
		DEEPAK FASTNERS LTD	Approved

107	STRUCTURE HARDWARE	NAVEEN METAL INDUSTRIES, KOLKATA	Approved
		NEW INDIA ENGINEERING CORPORATION	Approved
		TECHMAN (INDIA)	Approved
108	SHIELD WIRE	Bharat Wire Ropes Ltd	Approved
109	STRING INSULATOR HARDWARE	Asbesco ( India ) Pvt. Ltd.	Approved
		Electromech & Transtech Private Limited	Approved
		EMC	Approved
		ITPPL	Approved
		TYCO	Approved
		Tag Corporation, Chennai	Approved
		IAC	Approved



110	400 kV SF6 BREAKERS	ABB	Approved
		CGL	Approved
		SIEMENS	Approved
		GE T&D India Limited	Approved
111	400 kV SWITCHYARD CURRENT TRANSFORMER	ABB	Approved
		CGL	Approved
		GE T&D India Limited	Approved
		BHEL	Approved
		SIEMENS	Approved
112	400 kV SWITCHYARD PT/POTENTIAL TRANSFORMER/VOLTAGE TRANSFORMER	ABB	Approved
		CGL	Approved
		SIEMENS	Approved
		ALSTOM	Approved
		BHEL	Approved
113	400 kV ISOLATOR	SIEMENS	Approved
		ABB	Approved
		GE T&D India Limited	DR
114	400 kV EARTH SWITCH	SIEMENS	Approved
		ABB	Approved
115	400 kV LATTICE STRUCTURE	GOOD LUCK STEEL TUBES LTD., BULANDSHAHR (UP)	Approved
		UTKARSH TUBES AND PIPES LIMITED, KOLKATA, WEST BENGAL	Approved
		Richardson & Cruddas (1972) Ltd, NAGPUR	Approved
116	ACSR CONDUCTOR	HINDUSTAN VIDYUT PRODUCTS LTD., HARYANA	Approved
		GUPTA POWER INFRASTRUCTURE LTD., BHUBANESWAR	Approved
		HIREN ALUMINIUM Ltd., SILVASSA DADRA & NAGAR HAVELI	Approved
117	RAIL POLE	SAIL	Approved
		RINL	Approved
		TATA	Approved
118	CABLE for ROLLED -E-CHAIN BAY CONTROL UNIT	IGUS	Approved
		ALSTOM	DR
		SIEMENS	DR
		ABB	DR

119	Control and Relay Panel / SAS	ABB India Limited	Approved
		GE T&D India Limited	Approved
		Siemens Ltd	Approved
120	400KV LIGHTNING ARRESTOR	Crompton Greaves Ltd	Approved
		Elpro International Ltd	Approved
		Oblum Electrical Industries Pvt Ltd	Approved
121	400 kV DISC INSULATOR/ LONG ROD INSULATOR (120KN)/ BUS POST INSULATOR( For Switchyard)	BHEL	Approved
		NGK BIRLA, JAYASHREE	Approved
		W.S. INDUSTRIES LTD,CHENNAI	Approved
		INDIAN POTTERIES	Approved
		Saravana Global Energy Limited	Approved
		Aditya Birla Insulators (A unit of Aditya Birla Nuvo Ltd.)	Approved
		Modern Insulators Ltd.	Approved
<b>ESP/HVR (Jhansi Works)</b>			
122	CRGO Steel-ESP/HVR TRANSFORMERS UPTO 95 KVP, 1400 mAmps	Bralco Resources,Canada (Mill-A K Steel, USA)	Approved
		Nippon Steel Corporation , Japan	Approved
		Kawasaki Steel , Japan	Approved
		TKES , Germany	Approved
		POSCO, Korea	Approved
		Viz Stal, Russsia	Approved
123	PICC (PAPER INSULATED COPPER CONDUCTOR)Conductor-ESP/HVR TRF	Shree Cables & Conductor, Bhopal	Approved
		BCPL , Raisen / Mandideep	Approved
		Shakti Insulated Wires, Ankleshwar / Mumbai	Approved
		Delta Trans Conductors Pvt. Ltd. Mumbai	Approved
		KSH Internationa,l Mumbai	Approved
		Signet Conductors, Rewa	Approved
		NKM Sales, Mandideep	Approved
		Electromech, Rewa	Approved
		Chandra Metals, Allahabad	Approved
		Malwa Strips, Dewas	Approved
		Precision Wires India Ltd,	Approved
		Mimani Indore.	Approved
		RIMA TRANSFORMER	Approved
124	Press Board	Senapathy Whitley, Bangalore	Approved
		Raman Boards, Mysore	Approved
		H Weidman / Weidman Systems, Switzerland	Approved



125	Transformer Oil (Mineral Oil)-ESP/HVR TRF	Apar Industries, Mumbai	Approved
		Savita Oil Tech. Ltd. Mumbai	Approved
		Raj Petro Specialties Mumbai	Approved
		COLOMBIA PETRO CHEM, INDIA	Approved
		Savita Chemicals India Pvt. Silvasa	Approved
126	Transformer Oil (Silicon Oil)	GE Momentive Silicon, USA	Approved
		DOW Corning, USA	Approved
		Shin-ETSU, Singapore	Approved
127	Synthetic Rubber Bonded Cork Sheet	James Walker, UK	Approved
		NU Cork Product, Gurgaon	Approved
		Gujrat Cork And Rubber, Valsad	Approved
		Indian Cork Industries	Approved
128	OTI	Perfect Control, Chennai	Approved
		Precimeasure, Bangalore	Approved
129	Buchholz Relay	ATVUS Industries, Kolkata	Approved
		Press-N-Forge, Mumbai	Approved
		A.J Service, Mumbai	Approved
130	MOG	Sukrut Udyog, Pune	Approved
		ATVUS Industries, Kolkata	Approved
		Yogya Enterprises, Jhansi	Approved
		Press-N-Forge, Mumbai	Approved
<b>Power Transformers Oil Filled( JHANSI WORKS)</b>			
131	CRGO STEEL (Supplier)	AK STEEL, Netherlands/ USA	Approved
		NIPPON STEEL, JAPAN	Approved
		VIZSTAL, RUSSIA (Only M4 grade)	Approved
		POSCO, KOREA	Approved
132	PAPER INSULATED COPPER CONDUCTOR (PICC)	SHREE CABLES & CONDUCTORS BHOPAL	Approved
		KSH INTERNATIONAL CHAKAN,PUNE	Approved
		RIMA TRANSFORMER & CONDUCTORS BANGALORE	Approved
		BCPL, MANDIDEEP	Approved
		PRECISION WIRES INDIA LTD, SILVASSA.	Approved
		SHAKTI INSULATED WIRES PVT LTD, ANKLESHWAR	Approved
		CHANDRA METALS LTD. TELIARGANJ	Approved
		DELTA TRANS CONDUCTORS(P)LTD. MUMBAI	Approved

133	CONTINUOUSLY TRANSPOSED CONDUCTOR	ASTA INDIA PVT LTD	Approved
		KSH INTERNATIONAL PVT LTD	Approved
		PRECISION WEIR INDIA LTD	Approved
		SAMDONG	Approved
134	PRECOMPRESSED PRESSED BOARDS	ABB INDIA LIMITED, MYSORE	Approved
		ABB AB, SWEDEN.	Approved
		SENAPATHY WHITELEY PVT.LTD. BANGALORE	Approved
135	INSULATING OIL	Apar Industries, Mumbai	Approved
		Savita Oil Tech. ltd. Mumbai	Approved
		Raj Petro Specialties Mumbai	Approved
		BPCL	Approved
136	BUCCHOLZ RELAY	P&B WEIR ELECTRICAL-UNIT 10, U.K	Approved
		PRESS-N-FORGE, MUMBAI	Approved
		A.J .SERVICES ( PRAYOG), MUMBAI	Approved
		SUKRUT ELECTRIC CO.PVT.LTD. PUNE	Approved
		VIAT INSTRUMENTS PVT. LTD. KOLKAT/AHMEDABAD	Approved
137	PRESSURE RELIEF VALVE	MESSKO GMBH GERMANY	Approved
		QUALITROL COMPANY LLC USA	Approved
		RAJSHI ENGINEERS JHANSI	Approved
		Atvus, Kolkata	Approved
		SUKRUT UDYOG PUNE	Approved
138	AIR CELL	PRONAL ASIA MANUFACTURING MALAYSIA	Approved
		UNIRUB TECHNO INDIA PVT. LTD. PUNE	Approved
139	MOLG	QUALITROL COMPANY LLC, USA	Approved
		MESSKO GMBH GERMANY	Approved
		Atvus, Kolkata	Approved
		PRESS-N-FORGE, MUMBAI	Approved
		YOGYA ENTERPRISES, JHANSI	Approved
		SUKRUT UDYOG PUNE	Approved
140	OTI / WTI/ RTD	PRECIMEASURE CONTROLS (PVT.) LTD., BANGALORE	Approved
		PERFECT CONTROL, CHENNAI	Approved
141	OFI/WFI	SUKRUT UDYOG	Approved
		VIAT INSTRUMENTS PVT LTD	Approved



142	CONDENSER BUSHING-OIP	BHEL	Approved
		CGL	Approved
		GE T&D	Approved
143	ON LOAD TAP CHANGER	M/S BHEL BHOPAL	Approved
144	RADIATORS	TTP TECHNOLOGIES PVT LTD	Approved
		CTR MANUFACTURING INDUSTRIES LTD	Approved
		GURURAJ RADIATORS PVT LTD	Approved
		HI-TECH RADIATORS PVT LTD	Approved
		P.E. ENGINEERS PVT LTD	Approved
		TRANSPARES LIMITED	Approved
		BHEL, BHOPAL	Approved
145	<del>N2 FIRE PROTECTION SYSTEM</del>	As per Approved Vendors of Fire Detection system Package for the Main Plant.	
146	BUSHING-RIP	NANJING, CHINA	DR
		HSP, GERMANY	DR
		TRENCH, CHINA	DR
		ABB, SWITZERLAND	DR
		MOSER GLAZER, SWITZERLAND	DR
		YASH HIGH VOLTAGE INSULATORS (up to 145 kV), VADODARA	DR
		<b>Dry Type Transformers( JHANSI WORKS)</b>	
147	CRGO STEEL (Supplier)	Mill-A K Steel, USA/ Netherlands	Approved
		Metal One Corp.( Mill-Nippon Steel, Japan)	Approved
		TKES , Germany	Approved
		Novex Trading, Switzerland ( Mills - Viz Stahl	Approved
		POSCO IPPC, Pune (Mill-Posco, Korea)	Approved
148	COPPER CONDUCTOR	Mimani Wires, Indore	Approved
		Malwa Strips, Dewas	Approved
		Copral Insulated, Hosur	Approved
		BCPL, Raisen/ Mandideep	Approved
		M P Cupro metals, Bhopal	Approved
		SCR Wires, Tunkur	Approved
		Chandra Metals, Allahabad	Approved
		Pearl, Bangalore	Approved
		COSMOS Conductors, Tunkur	Approved
		Vimlesh Industries, Sonipat	Approved
		Permali Wallace Ltd. Bhopal	Approved
		Mica Ply, Bhopal	Approved

149	Fiber Glass Sheet	Glass Fiber Ltd. Mumbai	Approved
		Surendra Engg. Bhopal	Approved
		Texplas, Haridwar	Approved



150	Epoxy Insulators	Baroda Mould and Die, Vadodara	Approved
		Baroda Bushing, Baroda	Approved
		India Insulator, Miraj	Approved
		Epothane Civelec, Ghaziabad	Approved
		Quality Engg. & In sulation products, Bhopal	Approved
		A-Bond Strands PVI. Ltd, Chennai	Approved
151	Epoxy Casting Materials	Huntsmann Chennai	Approved
		Atul Ltd, Val sad	Approved
152	Sheet Metal Enclosure	Electro Auto Bhopal	Approved
		Shrao Engg. Bhopal	Approved
		Bansal Fabwel, Jhansi	Approved
		Anupam Industries, Jhansi	Approved
		R Industries, Bhopal	Approved
		Bharat Fabricators, Bhopal	Approved
		Mahadev Ind. Bhopal	Approved
153	Temperature Scanner	Pecon, Ahemdabad	Approved
		Precimeasure, Bangalore	Approved
<b>Power Transformer (Bhopal Works)</b>			
154	PRECOMPRESSED PRESSED BOARDS	ABB INDIA LIMITED, MYSORE	Approved
		ABB AB, SWEDEN.	Approved
		KOKUSAI PULP AND PAPER CO. LTD. JAPAN	Approved
		KREMPEL GMBH GERMANY	Approved
		OJI F-TEX CO. LTD. JAPAN	Approved
		SENAPATHY WHITELEY PVT.LTD. BANGALORE	Approved
		WEIDMANN ELEC.TECHNOLOGY A.G. SWITZERLAND	Approved
		ENPAY ENDUSTRIYEL PAZARLAMA VE YATIRIM A.S. TURKIYE	Approved



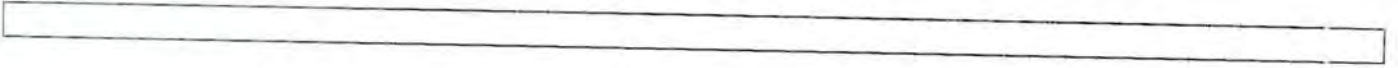
155	TRANSFORMER TANK	BHARAT HEAVY ELECTRICALS LTD BHOPAL	Approved
		BHOPAL ENGINEERING GOVINDPURA BHOPAL	Approved
		DUNHIL PRODUCTS GOVINDPURA BHOPAL	Approved
		ELECTRO AUTO INDUSTRIES GOVINDPURA BHOPAL	Approved
		E.M. ELECTRO MECHANICALS PVT.LTD GOVINDPURA BHOPAL	Approved
		GTV ENGINEERING LTD. GOVINDPURA BHOPAL	Approved
		MECH & FAB INDUSTRIES GOVINDPURA BHOPAL	Approved
		SIGMA HEAVY ENGG. INDUSTRIES GOVINDPURA BHOPAL	Approved
		SATYAM (FAB) INDUSTRIES PVT. LTD., BHOPAL	Approved
		SHRAO ENGG.WORKS GOVINDPURA BHOPAL	Approved
156	STEEL PLATE	STEEL AUTHORITY OF INDIA LTD	Approved
		IISCO	Approved
		RINL	Approved
		TISCO	Approved
157	CRGO STEEL (Supplier)	AK STEEL INTERNATIONAL B.V., USA (Regd. office at Netherlands)	Approved
		JFE SHOJI TRADE CORPORATION, JAPAN (Auth. Agent POSCO PUNE)	Approved
		NIPPON STEEL, JAPAN (Auth. Trader METAL ONE JAPAN)	Approved
		VIZSTAL, RUSSIA (Auth. Trader NOVEX TRADING	Approved
		POSCO KOREA (Auth. Agent POSCO-PUNE)	Approved
158	INSULATING OIL	APAR INDUSTRIES LTD., CHEMBUR, MUMBAI	Approved
		RAJ PETRO SPECIALITIES PVT LTD MUMBAI	Approved
		SAVITA OIL TECHNOLOGIES LTD. MUMBAI	Approved
159	PAPER INSULATED COPPER CONDUCTOR (PICC)	SHREE CABLES & CONDUCTORS BHOPAL	Approved
		KSH INTERNATIONAL CHAKAN,PUNE	Approved
		RIMA TRANSFORMER & CONDUCTORS BANGALORE	Approved
		BCPL, MANDIDEEP	Approved
		BHANDARY POWER LINE, MANIPAL	Approved
		PRECISION WIRES INDIA LTD, SILVASSA.	Approved
		SHAKTI INSULATED WIRES PVT LTD, ANKLESHWAR	Approved
		CHANDRA METALS LTD. TELIARGANJ	Approved
		M.P.CUPRO METALS PVT.LTD.BHOPAL.	Approved
DELTA TRANS CONDUCTORS(P)LTD. MUMBAI	Approved		

160	CONTINUOUSLY TRANPOSED COPPER CONDUCTOR (CTC)	KSH INTERNATIONAL CHAKAN,PUNE	Approved
		PRECISION WIRES INDIA LTD, SILVASSA.	Approved
		SAMDONG KOREA	Approved
		ASTA, INDIA VADODARA	Approved
161	UNIMPREGNATED DENSIFIED WOOD	PERMALI WALLACE PVT. LTD. GOVINDPURA, BHOPAL	Approved
		SURENDRA COMPOSITES PVT LTD RAISEN	Approved
162	ON LOAD TAP CHANGER/ OFF CIRCUIT TAP CHANGER	BHEL BHOPAL	Approved
		ABB AB COMPONENTS SWEDEN	Approved
		MASCHINENFABRIK REINHAUSEN GERMANY	Approved
163	OIL CONDENSOR BUSHING	BHEL BHOPAL	Approved
		GE T&D INDIA LIMITED, HOSUR	Approved
		GRID SOLUTIONS, A GE AND ALSTOM JOINT VENTURE, ITALY	Approved
		ABB AB COMPONENTS, SWEDEN	Approved
		CG POWER & INDUSTRIAL SOLUTIONS LTD, NASHIK	Approved
164	BUCHLOZ RELAY	P&B WEIR ELECTRICAL-UNIT 10, U.K	Approved
		SUKRUT ELECTRIC CO.PVT.LTD. PUNE	Approved
		VIAT INSTRUMENTS PVT. LTD. KOLKATA	Approved
		VIAT INSTRUMENTS PRIVATE LIMITED UNIT- II SANAND	Approved
165	OTI / WTI/ RTD	PRECIMEASURE CONTROLS (PVT.) LTD., BANGALORE	Approved
		PERFECT CONTROL, CHENNAI	Approved
166	PRESSURE RELIEF VALVE	MESSKO GMBH GERMANY	Approved
		QUALITROL COMPANY LLC USA	Approved
		RAJSHI ENGINEERS JHANSI	Approved
		SUKRUT UDYOG PUNE	Approved
167	AIR CELL	PRONAL ASIA MANUFACTURING MALAYSIA	Approved
		UNIRUB TECHNO INDIA PVT. LTD. PUNE	Approved
168	MOLG	QUALITROL COMPANY LLC, USA	Approved
		MESSKO GMBH GERMANY	Approved
		SUKRUT UDYOG PUNE	Approved
169	OIL FLOW INDICATOR	SUKRUT UDYOG, PUNE	Approved
		VIAT INSTRUMENTS PRIVATE LIMITED UNIT- II AHMEDABAD	Approved



170	OIL PUMP	FLOW OIL PUMPS PVT. LTD. BANGALORE	DR
		NXL FLOW INSTRUMENTS BANGALORE	DR
		SPP PUMPS LIMITED ENGLAND	DR
171	COOLING FAN & MOTOR ASSLY	EPC ELECTRICAL PVT.LTD. KOLKATA	Approved
		MARATHON ELECTRIC MOTORS(INDIA)LTD KOLKATA	Approved
172	RADIATOR	BHEL BHOPAL	Approved
		CTR MANUFACTURING INDUSTRIES LTD. PUNE	Approved
		TTP TECHNOLOGIES PVT. LTD. BANGALORE	Approved
173	MARSHALLING BOX / CONTROL CABINET/RTCC	ASHOKA ELECTRONICS, BHOPAL	Approved
		ENTERPRISING ENGINEERS,BHOPAL	Approved
		PURNIMA ELECTRICAL INDUSTRIES , BHOPAL	Approved
		PYROTECH ELECTRONICS PVT. LTD. (UNIT-IV), UDAIPUR	Approved
		R.S.I.SWITCH GEAR PVT LTD. BHIWADI	Approved
174	TERMINAL CONNECTOR	KLEMMEN ENGINEERING CORPN., CHENNAI	Approved
		PEE VEE ENGG. ENTERPRISES, BANGALORE	Approved
175	GAS COLLECTING DEVICE	SUKRUT UDYOG, PUNE	Approved
		YOGYA ENTERPRISES, JHANSI	Approved
176	N2 BASED FIRE PROTECTION SYSTEM	CTR MANUFACTURING INDUSTRIES LTD. NAGPUR	DR
		EASUN-MR TAP CHANGERS (P) LTD, CHENNAI	DR
		SERGI TRANSFORMER EXPLOSION PREVENTION, GURGAON (HARYANA)	DR
		VENDERE SALES SERVICES (I) PVT. LTD. AURANGABAD	DR
		GK POWER TRANSMISSION COMPANY PVT. LTD., NAGPUR	DR
177	FIBRE OPTIC HOT SPOT TEMP MONITORING SYSTEM	LUXTRON CORPORATION DBA LUMASENSE TECHNOLOGIES, USA	DR
		MACHTECH ENGINEERING SOULUTIONS LLP, VASAI	DR
		PRECIMEASURE CONTROLS (PVT.) LTD, BANGALORE	DR
		QUALITROL COMPANY LLC, USA	DR

178	ONLINE DGA	A.EBERLE GMBH AND CO. KG GERMANY	DR
		MTE METER TEST EQUIPMENT AG SWITZERLAND (Installation & Commissioning of DGA by MTE-INDIA, New Delhi)	DR
		MORGAN SCHAFFER INC CANADA (M/S Doble)	DR
		GE KELMAN (Auth. Agent PCI PRECISION CASTING LIMITED DELHI)	DR
		QUALITROL COMPANY LLC USA	DR
		CHROMATOGRAPHY & INSTRUMENTS COMPANY, VADODARA	DR
179	INSULATOR	M/S BHEL ELECTRO-PORCELAIN DIVN. BANGALORE	Approved
		M/S CJI PORCELAIN PVT. LTD. KHURJA	DR
		M/S KHYATI CERAMICS. KALOL	DR
<b>HT MOTOR COMPONENTS (Bhopal Works)</b>			
180	CACA COOLER	FITWELL CORPORATION	Approved
		KARNATAKA ENGINEERING ENTERPRISES	Approved
		LAXMI ENGG. IND.	Approved
		MEHTA INDUSTRIES	Approved
181	CACW COOLER	FITWELL CORPORATION	Approved
		KARNATAKA ENGINEERING ENTERPRISES	Approved
		LAXMI ENGG. IND.	Approved
		MEHTA INDUSTRIES	Approved
182	ANTIFRICTION BEARING	SKF	Approved
		FAG	Approved
183	COPPER SECTION/ ROUND/FLAT ROTOR BAR	BHANWARDEEP COPPER STRIPS(P)LTD	Approved
		COPPER STRIPS PVT LTD	Approved
		CHANDRA METALS LTD.	Approved
		MALWA STRIPS PVT.LTD.	Approved
		OMEGA ROLLING MILLS PVT LTD.	Approved
184	FORGED SHAFT	BHARAT FORGE LIMITED	Approved
		BAY-FORGE LTD.	Approved
		BHARAT HEAVY ELECTRICALS LTD	Approved
		GHAZIABAD ISPAT UDYOG LTD	Approved
		KISCO CASTINGS (INDIA) LTD.	Approved
		KISAAN STEELS PVT.LTD	Approved
		PUNJAB HAMMERS PVT.LTD.	Approved
		PAHLADRAI STEEL FORGING WORKS, STEEL AUTHORITY OF INDIA LIMITED	Approved
185	ENAMELLED MICA TAPED COPPER CONDUCTOR.	M.P.CUPRO METALS PVT.LTD.	Approved
		NKM CABLES & STRIPS(PVT)LTD.	Approved
		SHREE CABLES & CONDUCTORS (P) LTD	Approved
		VIMLESH INDUSTRIES(P)LTD.	Approved





186	MICA TAPED CONDUCTORS	BHANWARDEEP COPPER STRIPS(P)LTD	Approved
		BCPL CONDUCTORS PVT.LIMITED	Approved
		COSMOS CONDUCTORS PVT.LTD.	Approved
		COPRAL INSULATED CONDUCTORS PVT.,LTD.	Approved
		CHANDRA METALS LTD.	Approved
		MIMANI WIRES PVT LTD	Approved
		MALWA STRIPS PVT.LTD.	Approved
		M.P.CUPRO METALS PVT.LTD.	Approved
		NKM CABLES & STRIPS(PVT)LTD.	Approved
		SHREE CABLES & CONDUCTORS (P) LTD	Approved
		VIMLESH INDUSTRIES(P)LTD.	Approved
187	RTD/BTD	JINDAL ELECTRONICS PRIVATE LIMITED	Approved
		TECHNO INSTRUMENTS	Approved
Note:-			
1	SUB ITEMS (not covered specifically in the Vendor List) for Power Transformer, DTT and HVR Transformer from BHEL Units.		BHEL Approved sources
2	SUB ITEMS (not covered specifically in the Vendor List) for HT Motors to be supplied from IS Motors.		BHEL Approved sources
3	SUB ITEMS (not covered specifically in the Vendor List) FOR Busduct package, supplies from BHEL-Rudrapur Unit		BHEL Approved sources

SAGARDIGHI THERMAL Power EXTENSION PROJECT PHASE-III, UNIT#5 (1 x660 MW)			
Sl No	Item	Vendor Name	Status
1	Severe Service Control Valve for BFP Re-Circulation / SH & RH Attenuation Control Valve	DRESSER VALVE INDIA PVT. LTD, Coimbatore	Approved
		CONTROL COMPONENTS INC.	Approved
		KSB MIL CONTROLS LIMITED	Approved but only for 9000 Series Valves
2	Oil Trip Valves ( FUEL OIL SYSTEM)	INSTRUMENTATION LTD., KERALA	Approved
		KSB MIL CONTROLS LIMITED, THIRISSUR DIST	Approved
		Kuehne Armaturen GmbH, Germany	DR
		SAMSON CONTROLS PRIVATE LIMITED	Approved
		MASCOT VALVES PVT. LTD, AHMEDABAD	Approved
3	NORMAL SERVICE CONTROL VALVE	DRESSER VALVE INDIA PVT. LTD, Coimbatore	Approved
		EMERSON PROCESS MANAGEMENT CHENNAI LIMITED, Chennai	Approved
		INSTRUMENTATION LTD., PALAKKAD	Approved
		Koso India Private Limited, Nashik	Approved
		PARCOL S.P.A.	Approved
		SEMPELL GmbH.	Approved
		DAUME REGELARMATUREN GMBH	DR
		KSB MIL CONTROLS LTD. Thrissur	Approved
		Valvitalia S.P.A. , Italy	Approved
		WALDEMAR PRUSS ARMATURENFABRIK GMBH, Germany	Approved
4	Severe Service Control Valve for AUX PRDS	Control Component India Pvt. Ltd. Chittoor	Approved
		Daume Regelarmaturen GmbH, Isernhagen, Germany	Approved
		HOLTER REGELARMATUREN GmbH & CO., HOLTESTUKENBR OCK	Approved
		Koso India Private Limited, Nashik	Approved
		PARCOL S.p.A Canegrate MI, ITALY	Approved
5	VALVE:SOOT BLOWER PR	DRESSER VALVE INDIA PVT. LTD, Coimbatore	Approved
		CONTROL COMPONENTS INC.	Approved
		KSB MIL CONTROLS LIMITED	Approved
6	LP STARTUP CONTROL VALVES	CONTROL COMPONENT INDIA PVT LTD	Approved
		INSTRUMENTATION LTD.,	Approved
		EMERSON PROCESS MANAGEMENT CHENNAI	DR
		WELLAND & TUXHORN AG	Approved
		KOSO INDIA PRIVATE LIMITED.	Approved
		KSB MIL CONTROLS LIMITED	Approved



Sl No	Item	Vendor Name	Status
7	HIGH PR. STARTUP SCV	CONTROL COMPONENT INDIA PVT LTD, Bangalore	Approved
		SEMPELL GmbH., Germany	Approved
		KOSO INDIA PRIVATE LIMITED., Nashik	Approved
		PARCOL S.P.A., Milan Italy	Approved
8	HPBP Control Valve	SULZER-CCI AG, SWITZERLAND	Approved
		CONTROL COMPONENT INDIA PVT LTD, Bangalore	Approved
9	LP BYPASS SYSTEM	SULZER-CCI AG, SWITZERLAND	Approved
		CONTROL COMPONENT INDIA PVT	Approved
		WELLAND & TUXHORN AG	Approved
		HOLTER REGELARMATUREN GMBH & CO.	DR
10	SEAL STEAM VALVE/ LEAK STEAM VALVE WITH PNEUMATIC ACTUATOR	SAMSON CONTROLS PVT. LTD.	Approved
		INSTRUMENTATION LIMITED	Approved
		KSB MIL CONTROLS LIMITED	Approved
		GE OIL & GAS INDIA PRIVATE LIM	Approved
		WELLAND & TUXHORN AG	Approved
		HOLTER REGELARMATUREN GMBH & CO.	Approved
11	Air Filter Regulator  [Either from OEM/Authorised Source]	Parker Hannifin, Lebonon	Approved
		SHAVO NORGREN(INDIA)PVT LTD, BANGALORE	Approved
		JRU INSTRUMENTS (Formerly PLACKA)	Approved
12	HPT STEAM EVACUATION VALVE	GE OIL & GAS INDIA PRIVATE LTD	Approved
		HOLTER REGELARMATUREN GMBH & CO., GERMANY	Approved
		KSB MIL CONTROLS LIMITED, INDIA	Approved
		INSTRUMENTATION LIMITED	Approved
13	SOLENOID VALVE	ASCO (I) LTD.	Approved
		ROTEX AUTOMATION LTD.	Approved
		NUCON INDUSTRIES PVT LTD	Approved
		IMI NORGREN HERION PVT. LTD.	Approved
14	Bypass Rotameter	EUREKA INDLEQUIPMENT PVT., LTD., PUNE	Approved
		FLUIDYNE INSTRUMENTS PVT. LTD., CHEMBUR, MUMBAI	Approved
		PLACKA INSTRUMENTS INDIA PVT LTD, CHENNAI	Approved

SI No	Item	Vendor Name	Status
		INSTRUMENTATION ENGINEERS PVT LTD,JEEDIMATLA,HYDERABAD	Approved
		TRANSDUCER & CONTROL PVT LTD, HYDERABAD	Approved
15	C&I Laboratory Furniture/ Computer Furniture	ADARSHA CONTROL SYSTEMS PVT. LTD., BANGALORE	Approved
		COSMOS MEDIA PRODUCTS PVT. LTD,GREATER NOIDA,UP	Approved
		FEATHERLITE OFFICE SYSTEMS PVT. LTD,BANGALORE	Approved
		GODREJ AND BOYCE MANUFACTURING CO.,ROORKEY, UTTARAKAND.	Approved
		HARMONY SYSTEMS, GREATER NOIDA, UP	Approved
		OTS OFFICETECH SYSTEMS (P) LTD,BANGALORE	Approved
		PYROTECH WORKSPACE SOLUTIONS PVT. LTD, UDAIPUR	Approved
16	CBLM Sys (3D Type)	APM, Israel	Approved
		EIP TECHNOLOGIES PVT. LTD.NOIDA/ Process Management Mumbai	Approved
17	CBLM Sys (Ultrasonic Or RADAR Type) Panel	ENDRESS + HAUSER INDIA PVT. LTD. MUMBAI	Approved
		KISTLER MORSE AUTOMATION LTD.,HYDERABAD	Approved
		KROHNE MARSHALL PVT LTD.,PUNE	Approved
		VEGA INDIA LEVEL & PRESSURE MEASUREMENT PVT LTD.,MUMBAI.	Approved
		EMERSON PROCESS MANAGEMENT ,MUMBAI.	Approved
		SIEMENS LIMITED, BANGALORE	Approved
18	CBLM Sys(StrainGauge Type) Sensor & Panel	KISTLER - MORSE AUTOMATION LTD., HYDERABAD	Approved
		VENTURE MEASUREMENT,US	Approved
		THERMO RAMSEY INC ,CHICAGO,US	Approved
19	CO Analyser	CHEMTROLS INDUSTRIES LIMITED, POWAI, MUMBAI	Approved
		FORBES MARSHALL CODEL PVT. LTD., PUNE	Approved
		SICK INDIA PVT LTD,MUMBAI.	Approved
		MARVEL ENGG COMPANY, CHENNAI	Approved



SI No	Item	Vendor Name	Status
20	Compression Fittings	PARKER HANNIFIN INDIA PVT. LTD.,CHENGAL PATTU,TAMILANADU	Approved
		PRECISION ENGG INDUSTRIES, MUMBAI	Approved
		SWAGELock,USA	Approved
		TROUVAY & CAUVIN FRANCE	Approved
		HOKE	Approved
		METPRESS ENGINEERING WORKS, KOLKATA	DR
21	Condensate Pots	BALDOTA VALVE AND FITTING COMPANY PVT LTD,MUMBAI	Approved
		FLOWTECH, KOLKATA	Approved
		PRECISION ENGG INDUSTRIES, MUMBAI	Approved
		EXCEL HYDRO-PNEUMATICS PVT LTD,MUMBAI	DR
		PMT ENGINEERS,N.H.NO.-8, NARODA, AHMEDABAD	DR
		HP VALVES & FITTINGS (INDIA) PVT. L,MOGAPPAIR WEST, CHENNAI	DR
		ARCELLOR CONTROLS (INDIA), Ahmedabad	DR
22	Dust Density (Opacity) Monitor(Analyzer)	CODEL INTERNATIONAL LTD ,UK	Approved
		DURAG GMBH AND CO KG, HUMBURG,GERMANY	Approved
		LAND INSTRUMENTS INTERNATIONAL, ENGLAND (UK)	Approved
		SICK MAIHAK GMBH,GERMANY	Approved
23	Dust Density (Opacity) Monitor(panel)	CHEMTROLS INDUSTRIES LIMITED, POWAI,	Approved
		DURAG INDIA INSTRUMENTATION PVT LTD,BANGALORE	Approved
		SICK INDIA PVT LTD,MUMBAI.	Approved
		MARVEL ENGG COMPANY, CHENNAI	Approved
24	E/P Convertor(if required)	FAIRCHILD INDIA PRIVATE LIMITED, NOIDA	Approved
		WATSON SMITH LTD ,UK	Approved
25	Smart Positioner	EMERSON PROCESS MANAGEMENT	Approved
		SIMENS	Approved
		ABB	Approved
		ASTEC VALVE & FITTINGS PVT. LTD,MUMBAI	Approved
		AURA INC, NEW DELHI	Approved
		BALDOTA VALVE AND FITTINGS PVT LTD,MUMBAI	Approved
		EXCEL HYDRO-PNEUMATICS PVT LTD, MUMBAI	Approved
		FLOWTECH, KOLKATA	Approved



SI No	Item	Vendor Name	Status
26	Erection Material	FLUID CONTROLS PVT. LTD,PUNE	Approved
		HP VALVES & FITTINGS (INDIA) PVT LTD, CHENNAI	Approved
		MET LOK HYDRO PENUMATICS PVT LTD,MUMBAI	Approved
		METPRESS ENGINEERING WORKS, KOLKATA	Approved
		PANAM ENGINEERS LTD,MUMBAI	Approved
		PMT ENGINEERS,AHMEDABAD	Approved
		PRECISION ENGG INDUSTRIES, MUMBAI	Approved
		V.K.INDUSTRIES, BANGALORE	Approved
		VIKAS INDUSTRIAL PRODUCTS, NOIDA	Approved
		PAUL INDUSTRIES,HOWRAH	Approved
		NAV DURGA FORGING AND FITTINGS,THANE,MAHARASTRA	Approved
		SANDEEP INDUSTRIES,JALANDHAR,PUNJAB	Approved
27	FGA Insitu (SOX/NOX/CO/CO2)(Analyzer)	CODEL INTERNATIONAL LTD ,UK	Approved
		SICK MAIHAK GMBH,GERMANY	Approved
		CODEL INTERNATIONAL LTD ,UK	Approved
		SICK MAIHAK GMBH,GERMANY	Approved
28	FGA Insitu (SOX/NOX/CO/CO2)(panel)	CHEMTROLS INDUSTRIES LIMITED, POWAI, MUMBAI	Approved
		FORBES MARSHALL CODEL PVT. LTD., PUNE	Approved
		SICK INDIA PVT LTD,MUMBAI.	Approved
		ICE (ASIA) PRIVATE LIMITED, MUMBAI	Approved
29	FGA Sys(SOX/NOX/CO)Samplg Type(Analyzer)	ABB INSTRUMENTATION LTD,GLOUCESTERSHIRE,UK	Approved
		EMERSON PROCESS MANAGEMENT INDIA PVT LTD, MUMBAI	Approved
		FUJI ELECTRIC SYSTEMS CO. , LTD,SHINAGAWA-KU, TOKYO	Approved
		SICK MAIHAK GMBH,GERMANY	Approved
		SIEMENS LIMITED, BANGALORE	Approved
		YOKOGAWA ELECTRIC CORPORATION,TOKYO,JAPAN	Approved
30	FGA Sys(SOX/NOX/CO)Sampling Type(panel)	ABB LTD, Bangalore	Approved
		ADAGE AUTOMATION PRIVATE LIMITED, KHAIRANE MIDC, NAVI MUMBAI	DR
		CHEMTROLS INDUSTRIES LIMITED, POWAI, MUMBAI	Approved
		EMERSON PROCESS MANAGEMENT INDIA PVT LTD, MUMBAI	Approved

Sl No	Item	Vendor Name	Status
		YOKOGAWA INDIA LIMITED, BANGALORE	Approved
31	H <sub>2</sub> GAS ANALYSER CABINET	SIEMENS LTD.	Approved
		YOKOGAWA INDIA LIMITED	Approved
		ABB INDIA LTD	Approved
32	GI Pipes	BALDOTA VALVE AND FITTINGS PVT LTD, MUMBAI	Approved
		BHUWALKA PIPES LIMITED, BANGALORE.	Approved
		FLOWTECH, KOLKATA	Approved
		JINDAL INDUSTRIES LIMITED, NEW DELHI	Approved
		METPRESS ENGINEERING WORKS, KOLKATA	Approved
		NATHMAL DAGA & CO, BANGALORE	Approved
		PIPE CORPORATION PVT LTD, BANGALORE	Approved
		PRECISION ENGG INDUSTRIES, MUMBAI	Approved
		SURYA ROSHNI LTD, BAHADURGARH, HARYANA.	Approved
		V.K. INDUSTRIES, BANGALORE	Approved
		VIKAS INDUSTRIAL PRODUCTS, NOIDA	Approved
		SANDEEP INDUSTRIES, JALANDHAR, PUNJAB	Approved
		MKK METAL SECTIONS PVT LTD, VELLORE, TAMILANADU	Approved
		RIDDHI STEEL AND TUBE LIMITED, AHMEDABAD	Approved
		INDUS TUBES LTD, GHAZIABAD, UP	Approved
33	Impulse Pipes (Alloy steel)	BHARAT HEAVY ELECTRICALS LTD, TIRUCHIRAPALLI, TAMILANADU	Approved
		EVERGREEN SEAMLESS PIPES & TUBES PVT LTD, BANGALORE	DR
		GANPAT METALS PVT. LTD., MUMBAI	DR
		JINDAL SAW LTD, CHENNAI	Approved
		RIDHI SIDDHI STEEL CORPORATION, MUMBAI	DR
		TROUVAY CAUVIN, GULF	Approved
		SUMITOMO CORPORATION, JAPAN.	Approved
		TPS TECHNITUBE ROHREN WERKE	Approved
		BHARAT HEAVY ELECTRICALS LTD, TIRUCHIRAPALLI, TAMILANADU.	Approved
		EVERGREEN SEAMLESS PIPES & TUBES PVT LTD, BANGALORE	DR
		GANPAT METALS PVT. LTD., MUMBAI	DR
		HEAVY METAL AND TUBES LTD, AHMEDABAD/MUMBAI	DR



Sl No	Item	Vendor Name	Status
34	Impulse Pipes(Carbon Steel)	INDIAN SEAMLESS METAL TUBES LTD,PUNE.	Approvec
		JINDAL SAW LTD,CHENNAI	Approvec
		RIDHI SIDDHI STEEL CORPORATION,MUMBAI	DR
		TROUVAY CAUVIN,GULF	Approved
		SUMITOMO CORPORATION,JAPAN.	Approved
		SUMITOMO CORPORATION ASIA & OCEANIA PTE. LTD.,SINGAPORE	Approved
		TPS TECHNITUBE ROHREN WERKE GMBH,DAUN,GERMANY	Approved
35	Impulse Pipes(Stainless Steel)	RATNAMANI METALS & TUBES LTD, AHMEDABAD	Approved
		SUMITOMO CORPORATION,JAPAN.	Approved
		TPS TECHNITUBE ROHREN WERKE	Approved
		EVERGREEN SEAMLESS PIPES & TUBES PVT	DR
		GANPAT METALS PVT. LTD.,MUMBAI	DR
		RIDHI SIDDHI STEEL CORPORATION,MUMBAI	DR
		SUMITOMO CORPORATION,JAPAN.	Approved
36	Instrument Valve	TROUVAY CAUVIN,GULF	Approved
		BALDOTA VALVE AND FITTINGS PVT LTD,MUMBAI	Approved
		BHARAT HEAVY ELECTRICALS LTD, TIRUCHIRAPALLI,TAMILANADU.	Approved
		EXCEL HYDRO-PNEUMATICS PVT LTD, MUMBAI	Approved
		INSTRUMENTATION LIMITED, PALGHAT	Approved
		METPRESS ENGINEERING WORKS, KOLKATA	Approved
37	Lab Items Mechanical	PRECISION ENGG INDUSTRIES, MUMBAI	Approved
		FLUKE TECHNOLOGIES PVT. LTD., ANDHERI( EAST ), MUMBAI	Approved
		GE OIL AND GAS INDIA PVT. LTD,PUNE.	Approved
		ISOTHERMAL TECHNOLOGY PVT. LTD., DELHI	Approved
		NAGMAN INSTMTS. & ELECTRONICS (P) L, CHENBARAMBAKKAM,CHENNAI.	Approved
		WIKA INSTRUMENTS INDIA PVT. LTD., VILLAGE KESNAND, PUNE	Approved
		CHEMTROLS ENGG. (P) LTD.	Approved
		LEVCON INSTRUMENTS (P) LTD.	Approved
		S. B. ELECTRO-MECHANICALS PVT. LTD.	Approved
		V. AUTOMAT & INSTRUMENTS PVT. LTD.	Approved

SI No	Item	Vendor Name	Status
38	LEVEL GAUGE	DK INSTRUMENTS	Approved
		SIGMA INSTRUMENTS COMPANY	Approved
		IGEMA GMBH	Approved
		ASIAN INDUSTRIAL VALVES AND	Approved
		CESARE BONETTI S.P.A	Approved
39	Level Switch Capacitance Type	LEVCON INSTRUMENTS PVT. LTD.	Approved
		ENDRESS & HAUSER	Approved
40	Level Switch Conductivity Type	EMERSON PROCESS MANAGEMENT(I)PVT. L, M.I.D.C.PAWANE,NAVI MUMBAI	Approved
		IGEMA GMBH,MUNSTER,GERMANY.	Approved
		LEVELSTATE SYSTEMS LTD,U.K	Approved
		SOLARTRON TRANSDUCER, U.K	Approved
41	Level Switch Float Type	CHEMTROLS INDUSTRIES LIMITED, POWAI, MUMBAI	Approved
		IGEMA GMBH,MUNSTER,GERMANY.	Approved
42	Level Switch Top mounted	CHEMTROLS INDUSTRIES LIMITED, POWAI, MUMBAI	Approved
		D.K.INSTRUMENTS PVT. LTD., DHAKURIA, KOLKATA	Approved
		LEVCON INSTRUMENTS Pvt LTD, KOLKATA	Approved
		PUNE TECHTROL PVT LTD,PUNE	Approved
		IGEMA GMBH,MUNSTER,GERMANY.	Approved
		SBEM PRIVATE LIMITED, PUNE	Approved
		SIGMA INSTRUMENTS COMPANY,BHANDUP(WEST),MAHARASTRA.	Approved
		V.AUTOMAT & INSTRUMENTS PVT. LTD., NEW DELHI	Approved
43	LIE/LIR	CHEMIN CONTROLS AND INSTRUMENTATION, PONDICHERRY	Approved
		PYROTECH ELECTRONICS (P) LTD.,UDAIPUR	Approved
44	LOCAL GAUGE BOARD (LGBs)	PANAM CONTROLS - HYDERABAD, INDIA	Approved
		NAGARJUNA FABRICATORS - HYDERABAD, INDIA	DR
		INSTRUMENTATION LTD. - KOTA, INDIA	Approved
		PYROTECH ELECTRONICS PVT.LTD. - UDAIPUR, INDIA	Approved
		PROCON INSTRUMENTATION PVT.LTD - CHENNAI, INDIA	Approved



SI No	Item	Vendor Name	Status
45	Oxygen Analyser (LT)	EMERSON PROCESS MANAGEMENT INDIA PVT LTD, MUMBAI	Approved
		EMERSON PROCESS MANAGEMENT INDIA PVT LTD, MUMBAI	Approved
46	Oxygen Analyser (LT) Panel & Accessories	EMERSON PROCESS MANAGEMENT INDIA PVT	Approved
47	Pneumatic Actuator	EMERSON PROCESS MANAGEMENT CHENNAI, CHENNAI	Approved
		INSTRUMENTATION LIMITED, PALGHAT	Approved
		MIL CONTROLS LIMITED, ALWAYE , KERALA	Approved
48	SNUBBERS	LISEGA SE	Approved
		MAURER SOHNE GMBH & CO.KG	Approved
		JIANGSU ROAD DAMPING TECHNOLOGY CO.	Approved
		PIPE SUPPORT SYSTEMS GMBH INTL.	Approved
		QUIRI HYDROMECHANIQUE,	Approved
		SANWA TEKKI CORPORATION	Approved
49	Pressure & Differential Pressure Gauges	A.N.INSTRUMENTS PVT LTD, CHENNAI	Approved
		PRECISION MASS PRODUCTS PVT. LTD,GANDHI NAGAR,GUJARAT.	Approved
		BAUMER TECHNOLOGIES INDIA LTD,VAPI	Approved
		FORBES MARSHALL(HYD) LTD., HYDERABAD	Approved
		GAUGES BOURDON (INDIA) PVT. LTD, MUMBAI.	Approved
		GOA THERMOSTATIC INSTRUMENTS, GOA	Approved
		MANOMETER (INDIA) PVT. LTD.,, MUMBAI	Approved
50	Pressure & Differential Pressure Switch (Critical/Tripping applications of Boiler & Turbine)	DELTA CONTROLS LTD	Approved
		SOR INC.	Approved
		ASCROFT, USA	Approved
		DRESSER INDUSTRIES INC.	Approved
51	Pressure & Differential Pressure Switch (Non Critical applicaion)	PRECISION MASS PRODUCTS PVT. LTD,GANDHI NAGAR,GUJARAT.	Approved
		SWITZER PROCESS INSTRUMENTS PVT. LT, T Nagar, CHENNAI	Approved
		ASHCROFT INDIA	Approved
		TRAFAG CONTROLS INDIA PVT. LTD., IMT MANESAR, GURGAON	Approved
		CHEMTROLS SAMIL (INDIA) PVT. LTD., POWAI , MUMBAI	Approved
		INSTRUMENTATION ENGINEERS PVT LTD	Approved



SI No	Item	Vendor Name	Status
52	Sight Flow Indicator	SIGMA INSTRUMENTS CO.	Approved
		D.K.INSTRUMENTS PVT. LTD.	Approved
		LEVCON INSTRUMENTS Pvt LTD, KOLKATA	Approved
		V.AUTOMAT & INSTRUMENTS PVT LTD.	Approved
		FORBES MARSHALL LTD.	Approved
53	FLOW SWITCH	GENERAL INSTRUMENTS CONSORTIUM	Approved
		KROHNE MARSHALL	Approved
		SWITZER INSTRUMENT CO.	Approved
54	FLOW ELEMENTS (ORIFICE/NOZZLE)	MICRO PRECISION PRODUCTS	Approved
		M/S ESPL KOLKATA	Approved
		IL PALGHAT	Approved
55	IMPACT HEAD TYPE ELEMENT	DETRIECH / EMERSON PROCESS	Approved
		MIDWEST	Approved
		STARMECH	Approved
		SWITZER INSTRUMENT CO.	Approved
		VERIS INC.	Approved
		EMERSON PROCESS MANAGEMENT ( INDIA) PVT. LTD.	Approved
56	RRI FOR CVP	BRAUN GMBH INDUSTRIE - ELEKTRONIK	Approved
		SHINKAWA ELECTRIC CO LTD.,	Approved
		BENTLY NEVADA, LLC	Approved
57	Socket Weld Fittings	BALDOTA VALVE AND FITTINGS PVT LTD,MUMBAI	Approved
		METPRESS ENGINEERING WORKS, KOLKATA	Approved
		V.K.INDUSTRIES, BANGALORE	Approved
		MULTIMETAL INDUSTRIES,	DR
		COMFIT & VALVES PVT LTD.	DR
		DYNAFLUID VALVES AND FLOW	DR
		PRESHZINGER ENGINEERING CO PVT LTD.	DR
		FLUID CONTROLS PRIVATE LTD.,	DR
		VALTEX INDIA,	DR
		H.P.VALVES & FITTINGS INDIA PVT LTD	DR
VIKAS INDUSTRIAL PRODUCTS, NOIDA	Approved		
58	Steam and Water analysis Sys(Analyzer)	ABB INDUSTRIES ,SWITZERLAND.	Approved
		ABB INDUSTRIES ,SWITZERLAND.	Approved
		HACH LANGE S.A.R.L,VESENAZ,SWITZERLAND.	Approved
		METTLER-TOLEDO INDIA PVT. LTD., POWAI, MUMBAI	Approved
		EMERSON PROCESS MANAGEMENT,USA	Approved

SI No	Item	Vendor Name	Status
		SWAN ANALYTISCHE INSTRUMENTE AG, SWITZERLAND.	Approved
		THERMO ORION INC., CHELMSFORD	Approved
59	Steam and Water analysis System(Panel)	ABB LIMITED, PEENYA INDL. AREA, BANGALORE.	Approved
		EMERSON PROCESS MANAGEMENT INDIA PVT LTD,MUMBAI.	Approved
		FORBES MARSHALL PVT LTD, PUNE	Approved
60	THERMOWELL	INDUSTRIAL INSTRUMENTATION	Approved
		GENERAL INSTRUMENTS CONSORTIUM	Approved
		MICRO PRECISION PRODUCTS (P) LTD.	Approved
		DETRIV INSTRUMENTATION &	Approved
		TEMPESENS INSTRUMENTS (I) PVT.LTD.,	Approved
		GOA INSTRUMENT INDUSTRIES PVT LTD.	Approved
		BAUMER TECHNOLOGIES INDIA PVT.LTD,	Approved
61	Temperature Elements	DETRIV INSTRUMENTATION AND ELECTRONICS	Approved
		OKAZAKI MANUFACTURING COMPANY,JAPAN.	Approved
		PYRO ELECTRIC INSTRUMENTS GOA PVT.LTD,GOA.	Approved
		TECHNO INSTRUMENTS,GANDHINAGAR,GUJARAT.	Approved
		TEMPESENS INSTRUMENTS (I) PVT LTD,UDAIPUR,RAJASTHAN	Approved
		BAUMER TECHNOLOGIES INDIA LTD,MUMBAI/VAPI	Approved
		WIKA INSTRUMENTS INDIA PVT. LTD,PUNE	Approved
62	Temperature Gauges	A.N.INSTRUMENTS PVT LTD, CHENNAI	Approved
		PRECISION MASS PRODUCTS PVT. LTD,GANDHI NAGAR(Earlier Aschcroft)	Approved
		BAUMER TECHNOLOGIES INDIA LTD,MUMBAI/VAPI	Approved
		FORBES MARSHALL(HYD) LTD., HYDERABAD	Approved
		GOA THERMOSTATIC INSTRUMENTS, GOA	Approved
		WIKA INSTRUMENTS INDIA PVT. LTD,PUNE	Approved
		BALDOTA VALVE AND FITTINGS PVT LTD,MUMBAI	Approved
		EXCEL HYDRO-PNEUMATICS PVT LTD, MUMBAI	Approved
		FLOWTECH, KOLKATA	Approved



SI No	Item	Vendor Name	Status
63	Valve Manifolds	Parker HANNIFIN INDIA PVT. LTD,LEBANON (M/s Super technical dealer for Parker)	Approved
		METPRESS ENGINEERING WORKS, KOLKATA	Approved
		MICRO PRECISION PRODUCTS PVT LTD, FARIDABAD	Approved
64	Vibration Monitoring System (Sensors, Monitors & Panel)	BENTLY NEVADA INC, MINDEN, U.S.A.	Approved
		MEGGITT SA,SWITZERLAND.	Approved
		SHINKAWA ELECTRTIC CO., LTD, TOKYO, JAPAN	Approved
65	Mercury Analyzer	DURAG ,BANGALORE(MAKE OF DURAG GERMANY)	Approved
		THERMO FISHER INDIA ,MUMBAI(MAKE OF THERMO FISHER SCIENTIFIC CONTROL,USA)	Approved
		ANALYSER INSTRUMENTATION CO PVT LTD,KOTA,RAJASTHAN(MAKE OF PS ANALYTICAL ,UK)	Approved
		SICK INDIA PVT LTD,MUMBAI.(MAKE OF SICK GMBH,GERMANY)	Approved
66	24 V DC SMPS based Battery Charger	CHHABI ELECTRICALS PVT. LTD.,JALGAON	Approved
		VERTIV ENERGY PVT LTD (FORMERLY EMERSON NETWORK POWER INDIA), Ambernath	Approved
67	24 V DC thyristor based Battery Charger	CHHABI ELECTRICALS PVT. LTD.,BANGALORE	Approved
		CHLORIDE POWER SYSTEMS & SOLUTIONS LTD, Kolkata	Approved
		STATCON POWER CONTROLS LTD.,KULICHNAGAR, DHAULANA, HAPUR	Approved
68	Cable trays	shall be as per approved sources listed in Electrical Equipment list in Main Plant Package area.	
69	Electronic Transmitter - Pr. / Diff. Pr.	EMERSON PROCESS MANAGEMENT, Navi Mumbai	Approved
		FUJI ELECTRIC CO., LTD,OSAKI 1-CHOME, SHINAGAWA-KU, TOKYO	Approved
		HONEYWELL AUTOMATION INDIA LTD.,PUNE	Approved
		YOKOGAWA ELECTRIC CORPORATION,TOKYO 180	Approved

SI No	Item	Vendor Name	Status
		YOKOGAWA INDIA LIMITED,BANGALORE	Approved
70	Nickel-Cadmium Battery (Fiber type/Pocket type) for UPS and Charger	HBL POWER SYSTEMS LTD,Hyderabad	Approved
71	Flexible conduit (Lead Coated)	BANSAL LABORATORIES AND,GOVINDPURA INDL. AREA, BHOPAL	Approved
		PLICA INDIA PVT LTD,GHAZIABAD, U.P.	Approved
72	Flexible conduit (Zinc Coated)	BANSAL LABORATORIES AND,GOVINDPURA	Approved
		PLICA INDIA PVT LTD,GHAZIABAD, U.P.	Approved
73	HART Communicator	ABB LIMITED,PEENYA INDL. AREA, BANGALORE.	Approved
		EMERSON PROCESS MANAGEMENT, Navi Mumbai	Approved
		HONEYWELL AUTOMATION INDIA LTD.,PUNE	Approved
		YOKOGAWA INDIA LIMITED,BANGALORE	Approved
74	Instrumentation & Control cables (PVC, FRLS Type)	ADVANCE CABLE TECHNOLOGIES (P) LTD.,GEDDALAHALLI,ASWATHNAGAR,BANGAL ORE	Approved
		DELTON CABLES LIMITED, FARIDABAD	Approved
		KEI INDUSTRIES LIMITED,BHIWADI	Approved
		LAPP INDIA PVT. LTD.,PHASE II, ANEKAL TALUK, BANGALORE	Approved
		POLYCAB WIRES PVT. LTD, DAMAN	Approved
		THERMO CABLES LIMITED, HYDERABAD	Approved
75	Junction Box (Explosion Flame Proof)	CHEMIN CONTROLS AND INSTRUMENTATION,PONDICHERRY	Approved
		ELECTRO MECHANICAL (INDIA),KOLKATA	Approved
		FLAMEPACK, Mumbai	Approved
		K.S.INSTRUMENTS PVT LTD,Yeshwantpur, Bangalore	Approved
		KHODAY CONTROL SYSTEMS PVT. LTD.,PEENYA INDUSTRIAL ESTATE, BANGALORE	Approved
		MANISHA COMPOSITEK PVT. LTD.,PUNE	Approved
		PRAMMEN INDUSTRIES,PUDUKKOTTAI	Approved
		PYROTECH ELECTRONICS (P) LTD.,UDAIPUR	Approved
76	Junction Box (FRP )	K.S.INSTRUMENTS PVT LTD,Bangalore	Approved
		CHEMIN CONTROLS AND INSTRUMENTATION,PONDICHERRY	Approved



SI No	Item	Vendor Name	Status
		MANISHA COMPOSITEK PVT. LTD.,PUNE	Approved
77	Junction Box (Metal)	CHEMIN CONTROLS AND INSTRUMENTATION,PONDICHERRY	Approved
		ELECTRO MECHANICAL (INDIA),KOLKATA	Approved
		K.S.INSTRUMENTS PVT LTD,BANGALORE	Approved
		KHODAY CONTROL SYSTEMS PVT. LTD, BANGALORE	Approved
		MANISHA COMPOSITEK PVT. LTD.,PUNE	Approved
		PRAMMEN INDUSTRIES,PUDUKKOTTAI	Approved
		PYROTECH ELECTRONICS (P) LTD.,UDAIPUR	Approved
78	Junction Boxes (Die cast aluminium)	PYROTECH ELECTRONICS (P) LTD.,UDAIPUR	Approved
		K.S.INSTRUMENTS PVT LTD,Yeshwantpur, Bangalore	Approved
		MANISHA COMPOSITEK PVT. LTD.,PUNE	Approved
79	Lead Acid - Plante Battery for UPS and Charger	shall be as per approved sources listed in Electrical Equipment list in Main Plant Package area.	
80	Lead Acid - Tubular Battery for UPS and Charger	shall be as per approved sources listed in Electrical Equipment list in Main Plant Package area.	
81	ULTRASONIC FLOW METERS	FLEXIM Flexible Industriemesstechnik GmbH	Approved
		NIVUS GMBH	Approved
82	Level Transmitter (RADAR type)	EMERSON PROCESS MANAGEMENT, Navi Mumbai	Approved
		ENDRESS + HAUSER (I) PVT. LTD.,L.B.S. Marg, Vikhroli (West), Mumbai	Approved
		MAGNETROL INTERNATIONAL NV,BELGIUM	Approved
		VEGA GRIESHABER K.G,SCHILTACH	Approved
83	Level Transmitter (Ultrasonic type)	SIEMENS,BANGALORE	Approved
		EMERSON PROCESS MANAGEMENT, Navi Mumbai	Approved
		ENDRESS + HAUSER (I) PVT. LTD.,L.B.S. Marg, Vikhroli (West), Mumbai	Approved
		ENDRESS+HAUSER GMBH+CO.KG,WEIL AM RHEIN	Approved



SI No	Item	Vendor Name	Status
84	LT Power Cables (PVC / XLPE Insulation)	shall be as per approved sources listed in Electrical Equipment list in Main Plant Package area.	
85	Maintenance & Calibration Equipments (Electrical Package)	shall be as per approved sources listed in Electrical Equipment list in Main Plant Package area.	
86	Rigid Conduit	shall be as per approved sources listed in Electrical Equipment list in Main Plant Package area.	
87	RTD - TT Junction Box (FRP)	K.S.INSTRUMENTS PVT LTD,Yeshwantpur, Bangalore	Approved
		MANISHA COMPOSITEK PVT. LTD.,PUNE	Approved
88	RTD - TT Junction Box (Metal)	CHEMIN CONTROLS AND INSTRUMENTATION,PONDICHERRY	Approved
		ELECTRO MECHANICAL (INDIA),KOLKATA	Approved
		K.S.INSTRUMENTS PVT LTD,Yeshwantpur, Bangalore	Approved
		KHODAY CONTROL SYSTEMS PVT. LTD.,PEENYA INDUSTRIAL ESTATE, BANGALORE	Approved
		MANISHA COMPOSITEK PVT. LTD.,PUNE	Approved
		PRAMMEN INDUSTRIES,PUDUKKOTTAI	Approved
		PYROTECH ELECTRONICS (P) LTD.,UDAIPUR	Approved
89	Thermocouple extension cables (PVC, FRLS Type)	ADVANCE CABLE TECHNOLOGIES (P) LTD.,GEDDALAHALLI,ASWATHNAGAR,BANGALORE	Approved
		DELTON CABLES LIMITED,FARIDABAD	Approved
		KEI INDUSTRIES LIMITED,BHIWADI	Approved
		POLYCAB WIRES PVT. LTD, DAMAN	Approved
		THERMO CABLES LIMITED HYDERABAD	Approved
89	UPS System with ACDB	VERTIV ENERGY PRIVATE LIMITED	Approved
		HITACHI HI-REL POWER ELECTRONICS,Gandhinagar	Approved
90	UPS System with ACDB ((3Ph I/p, 1Ph O/p) IGBT based Rectifier	VERTIV ENERGY PRIVATE LIMITED	Approved
		HITACHI HI-REL POWER ELECTRONICS,Gandhinagar	Approved

SI No	Item	Vendor Name	Status
91	CCTV SYSTEM (IP BASED-OEM ) WITH ACCESSORIES .	PELCO, USA	Approved
		BOSCH	Approved
		HONEYWELL, USA	Approved
92	CCTV SYSTEM (IP BASED) SYSTEM INTEGRATORS	HARITASA CHECKMATE ELECTRONICS, BANGALORE	Approved
		SCHNEIDER ELECTRIC, BANGALORE	Approved
		TYCO FIRE AND SECURITY, BANGALORE	Approved
		HONEYWELL AUTOMATION, BANGALORE	Approved
		Siemens, BANGALORE	Approved
		SCORE INFORMATION TECHNOLOGIES LTD, KOLKATA	Approved
		WIPRO INFOTECH, BANGALORE	Approved
		ECIL, HYDERABAD	Approved
93	Public Addressing System (IP BASED-OEM)	COMMEND, AUSTRIA	Approved
		INDUSTRONICS, GERMANY	Approved
		ARMTTEL, RUSSIA	Approved
		ZENITEL, SWEDEN	Approved
94	Public Addressing System (IP BASED) SYSTEM INTEGRATORS	AISHAN TECHNOLOGIES INDIA PVT LTD, BANGALORE	Approved
		INDUSTRONIC & INDCOM ENGINEERS	Approved
95	Large Video Screen	BARCO ELECTRONICS , NOIDA	Approved
		PLANER-USA /PYROTECH-UDAIPUR	Approved
		CHRISTIE-USA	Approved
96	MODULAR DESK/CRT Desk	PYROTECH WORKSPACE SOLUTIONS PVT LTD , UDAIPUR	Approved
		CHEMIN CONTROLS AND INSTRUMENTATION , PONDICHERRY	Approved
		COSMOS MEDIA PRODUCTS PVT LTD , NOIDA	Approved
		HARMONY SYSTEMS , NEWDELHI	Approved
97	CONTROL PANEL/RACK	PYROTECH	Approved
		RITTAL	Approved
		BHEL	Approved
98	Dot matrix Printer	WIPRO	Approved
		EPSON	Approved
		TVS	Approved
		LEXMARK	Approved
99	WORKSTATIONS , SERVER, PC'S	DELL	Approved
		HP	Approved



SI No	Item	Vendor Name	Status
100	PRINTERS (Laser/Inkjet)	HP	Approved
101	TFT MONITOR	DELL	Approved
		HP	Approved
102	MINI UPS FOR HMI	HITACHI HI-REL POWER ELECTRONICS, BANGALORE	Approved
		POWERTRONIX SYSTEMS LTD., BANGALORE.	Approved
		SCHNEIDER ELECTRIC, BANGALORE	Approved
		EMERSON NETWORK INDIA, BANGALORE	Approved
		EMERSON NETWORK, PUNE	Approved
103	GIU	DIGITAL INSTRUMENTS & CONTROL SYSTEMS	Approved
		SSM INFOTECH SOLUTIONS PVT LTD.	Approved
		SCHNEIDER ELECTRIC INDIA PVT LTD, BANGALORE	Approved
		ROCKWELL AUTOMATION INDIA PVT LTD.	Approved
		ADVANCE TECH CONTROLS PVT. LTD.	Approved
104	STATION LAN EQUIPMENT	BHEL Approved Makes	
105	OFC	AKASH SOLAR	Approved
		SYSTIMAX	Approved
		BIRLA ERICSSON, REWA	Approved
		MOLEX	Approved
		TYCO	Approved
106	Turbine Supervisory System	MEGGITT SA, SWITZERLAND.	Approved
		BENTLY NEVADA INC. (GE OIL & GAS), U.S.A.	Approved
		SHINKAWA ELECTRIC CO. LTD., JAPAN	Approved
107	FEP insulated cables	DELTON CABLES, NEW DELHI	Approved
		HABIA CABLES, SWEDEN/CHINA	Approved
		LAPP CABLES, GERMANY	Approved
		LEONI KERPEN, GERMANY	Approved
		THERMOELECTRIC, USA	Approved
108	PTFE insulated Cables	ADVANCE CABLES TECHNOLOGIES, BANGALORE	Approved
		DELTON CABLES, NEW DELHI	Approved
		THERMOCABLES LIMITED	Approved
		CORDS CABLE INDUSTRIES LIMITED.,	Approved
		TEMPESENS INSTRUMENTS (I) PVT LTD, UDAIPUR	Approved
		UNIVERSAL CABLES LIMITED, SATNA	Approved


Sl No	Item	Vendor Name	Status
109	CONVERTERS/ INVERTORS AC, DC DRIVES	ROCKWELL AUTOMATION INDIA PVT., LTD.,	Approved
		SIEMENS INDIA LTD.	Approved
		KIRLOSKAR ELECTRIC COMPANY LIMITED.,	Approved
		LARSEN & TOUBRO LIMITED	Approved
		HIREL ELECTRONICS, GANDHINAGAR	Approved
		ABB LIMITED	Approved
110	PULSE JET CONTROLLER	SWITCHING CIRCUIT	Approved
		ADVANCE CONCEPT	Approved
		VOLTCRAFT	Approved
		SQUARE M	Approved
		MICRO SYSTEM	Approved
111	PLC / SCADA	ROCKWELL AUTOMATION INDIA PVT., LTD.,	Approved
		GE INTELLIGENT PLATFORMS PVT LTD	Approved
		SIEMENS INDIA LTD.	Approved
		LARSEN & TOUBRO LIMITED	Approved
		ABB LIMITED	Approved
		SCHNEIDER ELECTRIC INDIA PVT.LTD.	Approved
112	LIMIT SWITCHES	KA SCHMERSAL, GERMANY	Approved
		JOHAN VOLLENBROICH, GERMANY	Approved
		IFM ELECTRONIC, GERMANY	Approved
		JAYASHREE ELECTRON PVT. LTD,	Approved
		SIEMENS INDIA LTD.	Approved
		BCH ELECTRIC LIMITED	Approved
		PEPPERL+FUCHS(INDIA) PVT LTD	Approved
		JAI BALAJI & CO., CHENNAI	Approved
		ELECTRO MECHANICAL INDIA, KOLKATA	Approved
		AG SYSTEMS, (AG ELECTRONICS )MUMBAI	Approved
BETA SYSTEMS ENGINEERING	Approved		
113	PULLCHORD SWITCHES/BELT SWAY SWITCHES ( BELT MONITORING / CONVEYOR SAFETY SWITCHES , AC/DC TACHOGENERATORS , SERVOMOTORS, DIGITAL DRIVES AND SELSYN MOTORS )	JAYASHREE ELECTRODEVICES PVT. LTD.,	Approved
		BETA SYSTEMS ENGINEERING	Approved
		PROTOCONTROL INSTRUMENTS (I) PVT LTD	Approved
		KANTA RUBBER PVT. LTD	Approved
		MAHAVEER ENGINEERING	Approved
		SUMAN CONTROLS, BANGALORE	Approved
		JYOTHI RUBBER UDYOG, GHAZIABAD	Approved
		SLN ENTERPRISES, BANGALORE	Approved




SI No	Item	Vendor Name	Status
114	SAFETY ITEMS (RUBBER MATS,DANGER BOARDS ETC.)	PROGRESSIVE RUBBER WORKS	Approved
		VARDHAMAN HOSES PRIVATE LIMITED	Approved
		PREMIER POLYFILM LTD	Approved
		RMG POLY VINLY INDIA LTD	Approved
		KAN POWER RUBBER INDUSTRIES, BANGALORE	Approved
		ARADHANA AGENCY	Approved







MANUFACTURER'S		STANDARD QUALITY PLAN					PROJECT		1x660 MW SAGARDIGHI TPS				
NAME & ADDRESS :		ITEM : CW CHEMICAL TREATMENT.		OP.NO :	REV. :	DATE :	PAGE :	PACKAGE	CONTRACT NO.	COTRACTOR			
					0		2 OF 10						
S.NO.	COMPONENTS/ OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE/METHOD CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY**			REMARKS	
									M	C	N		
1	2	3	4	5	6	7	8	9	D*	10		11	
2.2	<b>IN PROCESS</b>												
2.2.1	BOTTOM ENDS	DIMENSIONS	MA	MEASUREMENT WITH TEMPLATE	100%	APPD.DWG.	APPD.DWG.	MFG.TC./LAB REPORT		P	V	V	
		SURFACE DEFECTS ON WELDMENTS		DP TEST	100%	ASTM E 165	NO SURFACE DEFECTS	MFG.TC		P	V	V	
2.3	<b>FINAL ASSEMBLY :</b>	DIMENSIONS & ORIENTATION	MA	MEASUREMENT	100%	APPD.DWG.	APPD.DWG.	MFG.TC		P	V	V	
2.3.1		LEAKAGE	MA	WATER FILL FOR 2 HOURS	100%	APPD.DWG.(BY BHEL)	NO LEAKAGE	MFG.TC		P	V	V	
3.0	<b>STIRRER :</b>												
3.1	RAW MATERIAL FOR SHAFT	CHEMICAL & PHY. PROPERTIES	MA	CHEMICAL & PHY. TEST	1/BAR/ HEAT	APPD. DWG/DATA SHEET	APPD. DWG/DATA SHEET	MFG.TC/LAB REPORT	}	P	V	V	
		INTERGRANULAR CORROSION TEST	MA	CORROSION TEST	DO	ASTM A 262 PR.'E'	ASTM A 262 PR.'E'	DO					
3.2	IMPELLER	CHEMICAL PROP.	MA	CHEMICAL MECHANICAL TEST	1/PLATE	ASTM A 240 GR.TP 304	ASTM A 240 GR.TP 304	MFG.TC/LAB REPORT		P	V	V	
		FOR BHEL	<b>LEGEND :</b>										
			* RECORDS IDENTIFIED WITH "TICK" SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION.										
			** M : MANUFACTURER/SUB-CONTRACTOR										
			C : CONTRACTOR/NOMINATED INSPECTION AGENCY			N: OWNER							
MANUFACTURER/ SUB CONTRACTOR	CONTRACTOR	INDICATE "P" PERFORM, "W" WITNESS, AND "V" VERIFICATION											
SIGNATURE		AS APPROPRIATE, "CHP" CUSTOMER SHALL IDENTIFIED IN COLUMN "N".						REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY				


MANUFACTURER'S		STANDARD QUALITY PLAN				PROJECT		1x660 MW SAGARDIGHI TPS						
NAME & ADDRESS :		ITEM : CW CHEMICAL TREATMENT.		OP.NO :	REV. :	0	PACKAGE							
				DATE :			CONTRACT NO.							
				PAGE :	3 OF 10		COTRACTOR							
S.NO.	COMPONENTS/ OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE/METHOD CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY**			REMARKS		
1	2	3	4	5	6	7	8	9	D*	10		11		
3.3	COMPLETE UNIT WITH MOTOR	PERFORMANCE IN WATER FILL TANK	MA											
		- VIBRATION		MEASUREMENT	100%	APPD.DWG/DATA SHEET	APPD.DWG/DATA SHEET	MFG.TC	}	P	V	V		
		- WOBBLING		VISUAL	100%									
		- POWER CONSUMPTION OR CURRENT DRAWN		MEASUREMENT	100%	APPD.DWG/DATA SHEET	APPD.DWG/DATA SHEET	MFG.TC						
4.0	MOTORS :													
		ROUTINE & TYPE TEST,	MA	VERIFICATION OF	100% FOR	APPD.DATA SHEET	APPD.DATA SHEET	MFG.TC/LAB		P	V	V	MAKE OF MOTOR	
		DEGREE OF PROTECTION		TEST CERTIFICATES	ROUTINE TEST & 1/SIZE FOR TYPE TEST & DEGREE OF PROTECTION			REPORT					SHALL BE AS PER APPD.LIST	
5.0	METERING PUMP & PRESSURE RELIEF VALVE :													
	(PUMPS SHALL BE PROCURED FROM BHEL APPD.SOURCE)													
5.1	RAW MATERIAL :													
5.1.1	WETTED PARTS	CHEMICAL & PHY. PROPERTIES	MA	CHEMICAL. & MECH. TEST	1/BAR	APPD.DWG/DATA SHEET	APPD.DWG/DATA SHEET	MFG.TC/LAB REPORT	}	P	V	V		
		SURFACE TEST		UT ON BAR>25 MM DIA	100%	ASTM A 388	REF. NOTE # 1	MFG.TC/LAB REPORT						
				DP ON M/C SURFACE	100%	ASME - E - 165	NO SURFACE DEFECTS	MFG.TC/LAB REPORT						
		FOR BHEL	LEGEND :											
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MANUFACTURER/ SUB CONTRACTOR	CONTRACTOR	INDICATE "P" PERFORM, "W" WITNESS, AND "V" VERIFICATION												
SIGNATURE		AS APPROPRIATE, "CHP" CUSTOMER SHALL IDENTIFIED IN COLUMN "N".					REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY						


MANUFACTURER'S NAME & ADDRESS :		STANDARD QUALITY PLAN					PROJECT		1x660 MW SAGARDIGHI TPS			
		ITEM : CW CHEMICAL TREATMENT.				QP.NO :		PACKAGE :				
						REV. : 0		CONTRACT NO. :				
						DATE :		COTRACTOR :				
						PAGE : 4 OF 10						
S.NO.	COMPONENTS/ OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE/ METHOD CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY**			REMARKS
1	2	3	4	5	6	7	8	9	D*	10		11
5.2	<b>FINAL INSPECTION</b>											
5.2.1	PUMP WITH MOTOR	CAP/STROKE	MA	PERFORMANCE	100%	APPD DRG/. DATA SHEET (BY OWNER), API-675	APPD DRG/. DATA SHEET (BY OWNER), API-675	INSPECTION REPORT	}			P W V
		ACCURACY		SHOP TEST								
		REPEATABILITY		SHOP TEST								
		POWER DRAWN @ 100% STROKE		MEASURED AT WORK								
		LEAKAGE & DIMENSIONS,		HYDRO TEST MEASUREMENT			1.5X DES. PRSS.					
		NOISE,		MEASUREMENT			NOISE < 85 dbA					
		VIBRATION		MEASUREMENT			≤45 MICRONS (PEAK TO PEAK)					
5.2.2	RELIEF VALVE	PERFORMANCE	MA	SET & RESET PR.	100%	APPD DRG/. DATA SHEET (BY OWNER)	APPD DRG/. DATA SHEET (BY OWNER)	INSPECTION REPORT	}			P V V
		DIMENSIONS		MEASUREMENT		APPD DRG/. DATA SHEET (BY OWNER)	APPD DRG/. DATA SHEET (BY OWNER)	INSPECTION REPORT				
		LEAKAGE DURING PERFORMANCE TEST		VISUAL		NO LEAKAGE	NO LEAKAGE	INSPECTION REPORT				
		HYDRO TEST				APPD DRG/. DATA SHEET	APPD DRG/. DATA SHEET					
		FOR BHEL	LEGEND :									
			* RECORDS IDENTIFIED WITH "TICK" SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION.					FOR CUSTOMER USE				DOC NO.
			** M : MANUFACUTRER/SUB-CONTRACTOR									
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MANUFACTURER/ SUB CONTRACTOR		CONTRACTOR		INDICATE "P" PERFORM, "W" WITNESS, AND "V" VERIFICATION								
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MANUFACTURER'S		STANDARD QUALITY PLAN				PROJECT		1x660 MW SAGARDIGHI TPS						
NAME & ADDRESS :		ITEM : CW CHEMICAL TREATMENT.				OP.NO :	PACKAGE							
						REV. :	CONTRACT NO.							
						DATE :	CONTRACTOR							
						PAGE :	5 OF 10							
S.NO.	COMPONENTS/ OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE/METHOD CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY**			REMARKS		
1	2	3	4	5	6	7	8	9	D*	M	C	N	11	
6	VALVES													
6.1	RAW MATERIAL :													
6.1.1	BODY, BONNET COVER	CHEMICAL & MECH PROPERTIES	MA	CHEMICAL & MECH TEST	1/HEAT	APPD.DWG./DATA SHEET (BY BHEL)	APPD.DWG./DATA SHEET (BY BHEL)	MFG. TC/LAB REPORT	}	P	V	V		
6.1.2	TRIM MATERIAL	CHEMICAL PROPERTIES	MA	CHEMICAL TEST	1/HEAT 1/BAR/SIZE	DO APPD. DATA SHEET BY BHEL	DO APPD. DATA SHEET BY BHEL	LAB REPORT/MGF TC						
6.2	ASSEMBLY													
		HYDRO TEST		LEAKAGE (BODY SEAT,	100%	APPD.DWG./DATA	NO LEAKAGE	MFG TC	}	P	V	V		
		AIR TEST		AIR SEAT)		SHEET (BY BHEL)	NO LEAKAGE	MFG TC						
		DIMENSIONS		MEASUREMENT			APPD.DWG./DATA SHEET (B	MFG TC						
7.0	FITTING :													
7.1	RAW MATERIAL	CHEMICAL & MECH PROPERTIES	MA	CHEMICAL & MECH TEST	1/HEAT	APPD DRG/. DATA SHEET	APPD DRG/. DATA SHEET	MFG.TC/LAB REPORT	}	P	V	V		
		HEAT TREATMENT	MA	HEAT TREATMENT	100%	APPD DRG/. DATA SHEET	APPD DRG/. DATA SHEET	MFG.TC/LAB REPORT						
		INTERGRANULAR CORROSION TEST	MI	CORROSION TEST	1/HEAT	ASTM A 262 PR. 'E'		MFG.TC/LAB REPORT MFG.TC/INSP REPORT	}					
	FINAL INSPECTION	DIMENSIONS	NA	MEASUREMENT	100%	APPD.DWG./DATA SHEETS/ANSI B 16.11/16.5	APPD.DWG./DATA SHEETS/ANSI B 16.11/16.5	MFG.TC/INSP.REPORT						
		FOR BHEL	LEGEND :						DOC NO.					
			* RECORDS IDENTIFIED WITH "TICK" SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION.					FOR CUSTOMER USE						
			** M : MANUFACUTRER/SUB-CONTRACTOR											
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MANUFACTURER/ SUB CONTRACTOR	CONTRACTOR	INDICATE "P" PERFORM, "W" WITNESS, AND "V" VERIFICATION AS APPROPRIATE, "CHP" CUSTOMER SHALL IDENTIFIED IN COLUMN "N".												
SIGNATURE							REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY						

MANUFACTURER'S		STANDARD QUALITY PLAN				PROJECT		1x660 MW SAGARDIGHI TPS					
NAME & ADDRESS :		ITEM : CW CHEMICAL TREATMENT.				OP.NO :	PACKAGE						
					REV. : 0	CONTRACT NO.							
					DATE :	COTRACTOR							
					PAGE : 6 OF 10								
S.NO.	COMPONENTS/ OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE/METHOD CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY**			REMARKS
1	2	3	4	5	6	7	8	9		M	C	N	11
8.0	<b>STRAINERS :</b>												
8.1	RAW MATERIAL FOR BODY	PHY.& CHEM. PROPERTIES	MA	PHY. & CHEM.TEST	1/BAR/SIZE	APPD.DWG./DATA SHEETS	APPD.DWG./DATA SHEETS	LAB REPORT		P	V	V	
8.2	SCREEN	CHEMICAL	MA	CHEMICAL	1/SIZE	APPD.DWG./DATA SHEETS	APPD.DWG./DATA SHEETS	MFG.TC/LAB REPORT		P	V	V	
		MESH SIZE	MA	MEASUREMENT	1/SIZE	APPD.DWG./DATA SHEETS	APPD.DWG./DATA SHEETS	MFG.TC/LAB REPORT					
8.3	FINAL INSPECTION	DIMENSIONS	MA	MEASUREMENT	100%	APPD.DWG./DATA SHEETS	APPD.DWG./DATA SHEETS	MFG.TC		P	V	V	
		LEAKAGE		HYDRO TEST	100%	APPD.DWG./DATA SHEETS	NO LEAKAGE	MFG.TC					
9.0	<b>PIPE (SEAMLESS)</b>												
	MATERIAL (REF.NOTE -2)	CHEMICAL	MA	CHEMICAL	1/HEAT/SIZE	APPD.DWG./DATA SHEETS	APPD.DWG./DATA SHEETS	MFG.TC/LAB REPORT		P	V	V	IDENTIFICATION BY BHEL
		MENICAL TEST		MENICAL TEST	1/HEAT/SIZE	APPD.DWG./DATA SHEETS	APPD.DWG./DATA SHEETS	MFG.TC/LAB REPORT		P	V	V	\$ REFER NOTE-6
		MICRO STRUCTURE		GRAINS STRUCTURE	1/HEAT/SIZE	FOR HEAT TREATMENT	FOR HEAT TREATMENT	MFG.TC/LAB REPORT		P	V	V	
		INTERGRANULAR CORROSION TEST		CORROSION TEST	1/HEAT/SIZE	ASTM A 262 PR 'E'	ASTM A 262 PR 'E'	MFG.TC/LAB REPORT		P	V	V	
		HTDRO TEST		LEAKAGE	100%	NO LEAKAGE	NO LEAKAGE	MFG.TC/LAB REPORT		P	W	V	
	FOR BHEL	LEGEND :				FOR CUSTOMER USE							
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MANUFACTURER/ SUB CONTRACTOR	CONTRACTOR	INDICATE "P" PERFORM, "W" WITNESS, AND "V" VERIFICATION											
SIGNATURE		AS APPROPRIATE, "CHP" CUSTOMER SHALL IDENTIFIED IN COLUMN "N".				REVIEWED BY			NAME & SIGN OF APPROVING AUTHORITY				

MANUFACTURER'S		STANDARD QUALITY PLAN				PROJECT		1x660 MW SAGARDIGHI TPS						
NAME & ADDRESS :		ITEM : CW CHEMICAL TREATMENT.				OP.NO :	PACKAGE							
						REV. : 0	CONTRACT NO.							
						DATE :	CONTRACTOR							
						PAGE : 7 OF 10								
S.NO.	COMPONENTS/ OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE/METHOD CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY**			REMARKS		
1	2	3	4	5	6	7	8	9	D*	M	C	N	11	
10.0	LEVEL GAUGE :													
10.1	RAW MATERIAL	CHEM.PROPERTIES	MA	CHEM.TEST	1/BAR	APPD.DWG./DATA SHEETS	APPD.DWG./DATA SHEETS	LAB REPORT	}	P	V	V		
10.2	FINAL INSPECTION	DIMENSION	MA	MEASUREMENT	100%	APPD.DWG./DATA SHEETS	APPD.DWG./DATA SHEETS	MFG.TC						
		LEAKAGE		HYDRO TEST	1/SIZE	APPD.DWG./DATA SHEETS	APPD.DWG./DATA SHEETS							
11.0	PRESSURE GAUGE & DIFF PRESSURE GAUGE													
11.1	MAT. FOR WETTED	CHEM.PROPERTIES	MA	CHEM.TEST	1/HEAT	APPD.DWG./DATA SHEETS	APPD.DWG./DATA SHEETS	MFG.TC/LAB REPORT/	}	P	V	V		
	PARTS& BOURDEN	DIMENSIONS	MA	MEASUREMENT	SIZE	APPD.DWG./DATA SHEETS	APPD.DWG./DATA SHEETS	MFG.TC/LAB REPORT						
11.2	CALIBRATION	ACCURACY, OVER PRESSURE	MA		100%	APPD.DATA SHEET	APPD.DATA SHEET	MFG. TC	}	P	V	V		
		OVERLOAD PROT.	MA	VARIFICATION	TYPE TEST			MFG.TC/LAB REPORT						
		TYPE TEST CERT. FOR DEGREE OF PROTECTION												
		FOR BHEL	LEGEND :											
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			** M : MANUFACTURER/SUB-CONTRACTOR											
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MANUFACTURER/ SUB CONTRACTOR	CONTRACTOR	INDICATE "P" PERFORM, "W" WITNESS, AND "V" VERIFICATION												
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MANUFACTURER'S		STANDARD QUALITY PLAN				PROJECT		1x660 MW SAGARDIGHI TPS					
NAME & ADDRESS :		ITEM : CW CHEMICAL TREATMENT.				OP.NO :	PACKAGE						
						REV. :	CONTRACT NO.						
						DATE :	CONTRACTOR						
						PAGE :	8 OF 10						
S.NO.	COMPONENTS/ OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE/METHOD CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY**			REMARKS	
1	2	3	4	5	6	7	8	9	D*	10		11	
12.0	<b>LEVEL SWITCH :</b>												
12.1	MAT. FOR WETTED PARTS INCLUDING FLOAT	CHEM.PROPERTIES	MA	CHEM.TEST	1/HEATR	APPD.DATA SHEET/DWG.	APPD.DATA SHEET/DWG.	MFG.TC/LAB REPORT	}	P	V	V	
12.2	PERFORMANCE	FUNCTIONAL	MA	VISUAL	100%	APPD.DATA SHEET/DWG.	APPD.DATA SHEET/DWG.	MFG.TC		P	V	V	
		IR-HV-IR DIMENSIONS DEGREE OF PROTEC.		ELECTRICAL MEASUREMENT TYPE TEST		DO DO DO	DO DO DO	MFG.TC MFG.TC MFG.TC/LAB REPORT					
13.0	<b>DIFF PRESSURE SWITCH</b> MATERIAL FOR WETTED PARTS PERFORMANCE		MA	VERIFICATION	100%	APPD.DATA SHEET/DWG.	APPD.DATA SHEET/DWG.	MFG COMPLIANCE CERTIFICATE MFG TC	}	P	V	V	
14.0	<b>CONTROL PANEL :</b>	DIMENSIONS, CONTINUITY, IR-HV-IR FUNCTIONAL, DEGREE . OF PROT, VERIFICATION OF MAKE, RATING OF COMPONENTS SIMULATION TEST \$\$ PAINT SHADES, THICK ADHESION	MA	MEASUREMENT, ELECTRICAL	100%	APPD.DWG./DATA SHEETS	APPD.DWG./DATA SHEETS	LAB REPROT		P	W	V	\$\$ REFER TEST PROCEDURE NOTE-4
15.0	<b>COMPLETE SKID ASSEMBLY :</b>	DIMENSIONS & ORIENTATION LEAKAGE, CHECK ON WELDMENTS FUNCTIONAL TEST\$\$	CR	MEASUREMENT VISUAL & HYDRO TEST	-100%	APPD.DWG/ DATA SHEET DISCH.PIPING - 1.5 x DISCH.PR. OF PUMP SUCTION PIPING -3 KG/CM2	APPD.DWG/ DATA SHEET NO LEAKAGE NO LEAKAGE	INSPECTION REPORT		}	P	W	W
			<b>LEGEND :</b>					<b>DOC NO.</b>					
			* RECORDS IDENTIFIED WITH "TICK" SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION.				<b>FOR CUSTOMER USE</b>						
			** M : MANUFACUTRER/SUB-CONTRACTOR										
			C : CONTRACTOR/NOMINATED INSPECTION AGENCY				N: OWNER						
<b>MANUFACTURER/ SUB CONTRACTOR</b>		<b>CONTRACTOR</b>		INDICATE "P" PERFORM, "W" WITNESS, AND "V" VERIFICATION									
SIGNATURE		AS APPROPRIATE, "CHP" CUSTOMER SHALL IDENTIFIED IN COLUMN "N".				REVIEWED BY		NAME & SIGN OF APPROVING AUTHORITY					



MANUFACTURER'S		STANDARD QUALITY PLAN					PROJECT		1x660 MW SAGARDIGHI TPS			
NAME & ADDRESS :												
		ITEM : CW CHEMICAL TREATMENT.			OP.NO :		PACKAGE :					
					REV. : 0		CONTRACT NO. :					
					DATE :		COTRACTOR :					
					PAGE : 9 OF 10							
S.NO.	COMPONENTS/ OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE/METHOD CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY**			REMARKS
1	2	3	4	5	6	7	8	9	D*	10		11
		PAINING	MA	VISUAL & MEASUREMENT	-100%	APPD DWN/PAINTING SCHEME	APPD DWN/PAINTING SCHEME	INSPECTION REPORT		P	V	V
		PACKING	MA	VISUAL DFT	-100% -100%	BHEL SPEC BHEL SPEC	BHEL SPEC BHEL SPEC	INSPECTION REPORT		P	V	
		LEGEND :						DOC NO.				
		* RECORDS IDENTIFIED WITH "TICK" SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION.						FOR CUSTOMER USE				
		** M : MANUFACUTRER/SUB-CONTRACTOR										
		C : CONTRACTOR/NOMINATED INSPECTION AGENCY				N: OWNER						
MANUFACTURER/ SUB CONTRACTOR		CONTRACTOR		INDICATE "P" PERFORM, "W" WITNESS, AND "V" VERIFICATION								
SIGNATURE		AS APPROPRIATE, "CHP" NTPC SHALL IDENTIFIED IN COLUMN "N".				REVIEWED BY		NAME & SIGN OF APPROVING AUTHORITY				

<b>MANUFACTURER'S</b>		<b>STANDARD QUALITY PLAN</b>			<b>PROJECT</b>		1x660 MW SAGARDIGHI TPS	
<b>NAME &amp; ADDRESS :</b>								
	<b>ITEM</b>	<b>: CW CHEMICAL TREATMENT.</b>			<b>QP.NO :</b>		<b>PACKAGE</b>	
					<b>REV. :</b>	0	<b>CONTRACT NO.</b>	
					<b>DATE :</b>		<b>COTRACTOR</b>	
					<b>PAGE :</b>	10 OF 10		
	<b>P - PERFORMANCE</b>	<b>W - WITNESS</b>						
	<b>V - VARIFICAITON</b>	<b>MA - MAJOR</b>	<b>MI - MINOR</b>					
	<b>CR - CRITICAL</b>	<b>CHP--D :CUSTOMER(BHEL/OWNER) HOLD POINT</b>						
NOTE:1 : WHEN BACK WALL ECHO IS SET TO 100% OF FSH IN SOUND AREA, DEFECT ECHO SHALL NOT EXCEED 20% OF FSH. MAX BACH WALL ECHO IS 20% OF FSH. TOTAL NO OF DEFECTS SHALL BE MAX. 5 NO IN ONE METER LENGTH. DISTANCE BETWEEN TWO DEFECTS SAHLA BE 3 MIN TIMES THE DIA OF BAR.								
NOTE: 2 : NDT REQUIREMENT ON THE PIPING WELDING SHALL BE AS a) ON BUTT WELD 25% FP AND 25% RT FOR PUMP SUCITON SIDE AND FOR PUMP DISCHARGE SIDE 100% RT AND 100% DP TEST. b) 100% DP ON FILLER WELD JOINTS NORMS SHALL BE AS PER ASME SECTION VIII.								
NOTE:3: LEVEL GAUGE, PRESSURE GAUGE , LEVEL SWITCH, CONTROL PANEL & ALL INSTRUMENTS SHALL BE PROCURED FROM OWNER/BHEL APPROVED MAKE.								
NOTE 4: SIMULATION TEST WILL BER CARRIED OUT WITH 24 VDC SUPPLY TO CONTROL PANEL AT THE CONTROL PANEL MANUFACTURER'S PLACE.								
NOTE 5 FUNTIONAL TEST WILL BE CARRIED OUT WOTHOUT 24 VDC I.e, ONLY CONTINUITY TEST WILL BE SHOWN AT VENDOR WORK.								
NOTE 6 FOR PIPES PURCHESED DIRECTLY FROM MANUFACTURER'S OR AUTHORISED DEALERS, APART FROM TC REVIEW, CHECK WILL BE AS PER CLASS 2.1.2 AND 10.0; HOWEVER FOR HYDRAULIC TEST MANUFACTURER TC SHALL BE REVIEWED . IN CASE ON IMPORTED PIPES PURCHASED FROM OPER MARKET CHECK TESTION AS PER CLAUSE 2.1.2 AND 10.0 ( INCLUDING HYDRAULIC TEST) SHALL BE CARRIED OUT ON EACH LENGTH ;P HYDRAULIC TEST SHALL BE WITNESS BY BHEL.								
NOTE 7 FOR RAW MATERIAL (BARS/PIPES/CASTINGS/FORGINGS) WHERE HEAT TREATMENT ARE CARRIED OUT BY MATERIAL OPRODUCERS ON BULK QUANTITIES, THEIR TEAT CERTIFICATE SHALL BE REVIEWD (EXCEPT TIME TEMPERATURE CHART).								
		<b>FOR BHEL</b>	<b>LEGEND :</b>			<b>FOR CUSTOMER USE</b>	<b>DOC NO.</b>	
			* RECORDS IDENTIFIED WITH "TICK" SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION.					
			** M : MANUFACUTRER/SUB-CONTRACTOR					
			C : CONTRACTOR/NOMINATED INSPECTION AGENCY		N: OWNER			
<b>MANUFACTURER/</b>	<b>CONTRACTOR</b>							
<b>SUB CONTRACTOR</b>		INDICATE "P" PERFORM, "W" WITNESS, AND "V" VERIFICATION						
<b>SIGNATURE</b>		AS APPROPRIATE, "CHP" CUSTOMER SHALL IDENTIFIED IN COLUMN "N".			<b>REVIEWED BY</b>	<b>NAME &amp; SIGN OF APPROVING AUTHORITY</b>		



WBPDCL - 1X660 MW Sagardighi TPP, Extension, Unit-5				
				Dtd. 10.11.2021
S. No	Type of Doc D-Drawing Q-Quality Plan V-Vendor List	Drawing No	BHEL DRG NO.	Title
<b>Water Treatment Package - Pre Treatment plant</b>				
1	D	RP-DC-445-WTP-A001	4-WT-220-01575	PROCESS DESIGN & DESIGN PHILOSOPHY FOR CWBD WATER TREATMENT PLANT
2			1-WT-220-01881	HYDRAULIC FLOW DIAGRAM
3	D	RP-DG-445-WTP-A002	1-WT-220-01882	P&ID FOR PT PLANT INCLUDING CHEMICAL DOSING SYSTEM.
4	D	RP-DG-445-WTP-A003	1-WT-220-01883	EQUIPMENT LAYOUT FOR PT PLANT
5	D		1-WT-220-01889	MECHANICAL GA OF CLARIFIER SLUDGE SURGE SUMP
6	D		1-WT-220-01890	PLANT & YARD PIPING LAYOUT FOR PT PLANT
7	D		1-WT-220-01891	GA OF PT PLANT CHEMICAL HOUSE (FECL <sub>3</sub> & POLY ELECTROLYTE DOSING)
8	D		1-WT-220-01892	PLC INPUT /OUTPUT SIGNAL LIST
9	D		1-WT-220-01893	MOTORISED BUTTERFLY VALVES DATASHEET
10	D		1-WT-220-01894	MECHANICAL GA OF CLARIFIER SLUDGE SURGE SUMP (DIFFUSER PIPE)
11	D		1-WT-220-01895	LCP FOR DOSING SYSTEMS
12	D		1-WT-220-01896	CABLE TRAY LAYOUT OF PT PLANT
13	D	RP-DG-445-WTP-A006	1-WT-025-01886	MECHANICAL GAD FOR CLARIFIER & SCRAPER BRIDGE
14	D	RP-DC-445-WTP-A008	4-WT-220-01576	CONTROL PHILOSOPHY FOR PT PLANT
15	D	RP-DC-445-WTP-A009	4-WT-220-01577	PG TEST PROCEDURE FOR PT PLANT
16	D	RP-DG-445-WTP-A010	4-WT-220-01578	DATSHEET FOR PUMP WITH MOTOR
17	Q	RP-MQ-445-WTP-A011	4-WT-220-01579	QAP FOR PT PLANT
18	D	RP-DG-445-WTP-E012	4-WT-220-01580	CONTROL ROOM LAYOUT ALONGWITH CABLE SPREADER FORPT PLANT
19	D	RP-DG-445-WTP-I013	4-WT-220-01581	INSTRUMENT HOOK-UP DRAWING FOR PT PLANT
20	D	RP-DG-445-WTP-I014	4-WT-220-01582	INSTRUMENT DATASHEETS OF PT PLANT
21	D	RP-DG-445-WTP-I015	4-WT-220-01583	ANALYSER DATASHEET OF PT PLANT

S. No	Type of Doc D-Drawing Q-Quality Plan V-Vendor List	Drawing No	BHEL DRG NO.	Title
22	D	RP-DG-445-WTP-I016	4-WT-220-01584	INSTRUMENT SCHEDULE FOR PT PLANT
23	D	RP-DG-445-WTP-E017	1-WT-220-01888	CABLE TRAY AND EARTHING LAYOUT FOR PT PLANT
24	D	RP-OM-445-WTP-A018	4-WT-220-01585	O&M MANUAL FOR PT PLANT
25	D	RP-DC-445-WTP-C021	4-WT-221-01587	CLARIFIER CIVIL DESIGN REPORT
26	D	RP-DG-445-WTP-C022	1-WT-221-01890	CLARIFIER GA & RCC DETAILS
27	D	RP-DC-445-WTP-C023	4-WT-221-01588	SLUDGE PIT DESIGN REPORT
28	D	RP-DG-445-WTP-C024	1-WT-221-01891	SLUDGE PIT GA & RCC DETAILS
29	D		1-WT-221-01892	DESIGN REPORT FOR CLARIFIER INLET CHANNEL, STILLING CHAMBER & OUTLET CHANNEL
30	D		1-WT-221-01893	RCC DETAILS FOR CLARIFIER INLET CHANNEL, STILLING CHAMBER & OUTLET CHANNEL
31	D	RP-DG-445-WTP-I118	4-WT-220-01597	INSTRUMENTATION CABLE SCHEDULE FOR CWBD WATER TREATMENT

**PERFORMANCE GUARANTEE TEST PROCEDURE AND  
PERFORMANCE GUARANTEE**

Clarification and Filtration System

**Performance Test Procedure:**

- a) After water supply is established, the flow control valve at inlet to pH correction chamber should be adjusted to give desired flow.
- b) Isolation gates shall be adjusted to ensure equal flow distribution to each unit as determined by flow measuring device.
- c) Bidder shall conduct a test during the period when the turbidity is maximum. The duration of the test shall not be less than 72 hours. The actual duration, type and mode of conducting the above test shall be mutually decided upon between the Owner and the Bidder.

These tests will be carried out within a reasonable period from the date of commissioning of the plant. Basically the test shall be such as to prove beyond doubt the guaranteed performance of the plant under varying flow conditions (within the specified units) to the satisfaction of the Owner. The test procedures shall be as per relevant equivalent standards from recognized origins (where Indian Standard is not available and/or applicable).



The average turbidity in the Clarifier effluent at normal flow rate shall not exceed 10 NTU and any individual reading shall be within 10 NTU. In the event of 20% over loading, average turbidity shall not exceed 15 NTU and any individual reading shall be within 15 NTU.

- d) The test shall be deemed to be a failure when either of the limits as indicated in (d) is exceeded and retesting will have to be arranged.
- e) During this test, ferric chloride and lime dosage will be calculated by determining the concentration, level gauge readings and duration of test. The chemical consumption value shall not exceed 15% over the requirement as established from Jar test result.
- f) Sludge disposal system will be periodically checked with respect to ability and sludge consistency.
- g) Soluble iron shall not exceed 0.3 ppm as Fe and insoluble iron shall be "Not Detectable".
- i) By adjusting the control valve, flow is adjusted to 120%, 75% and 50% tests will be repeated each time. Lime and alum feed rate shall be adjusted proportional to raw water flow.
- j) Capacity of the chlorinator shall be checked by determining the flow of chlorinated water and concentration of chlorine in chlorinated water.
- k) The plant must meet the guarantee on turbidity, iron value, chemical consumption & ensure satisfactory performance of the chemical dosing and sludge disposal system in each test run.

8.01.02 **Performance Guarantee Parameters:**

**High Rate Solid Contact Clarifier**

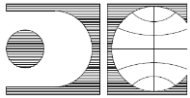
- a) The unit will have rated output capacity not less than 292 m<sup>3</sup>/hr (net).
- b) Dissolved Silica concentration shall not exceed 25 ppm as SiO<sub>2</sub> in clarified treated water.
- c) Soluble iron shall not exceed 0.1 ppm as Fe.

**Annexure - 5**

03	24.09.2021	DBN/MEGA	MSM/VNS	MRK	Customer comments incorporated
02	05.08.2021	DBN/MEGA	MSM/VNS	MRK	Customer comments incorporated
01	12.03.2021	DBN/MEGA	MSM/VNS	MRK	Customer comments incorporated
00	19.01.2021	DBN/MEGA	MSM/VNS	MRK	Fresh Issue
<b>Rev.No</b>	<b>Date</b>	<b>Prepared</b>	<b>Checked</b>	<b>Approved</b>	<b>Remarks</b>



**WEST BENGAL POWER DISTRIBUTION CORPORATION LTD**  
**WEST BENGAL STATE, INDIA**  
**1 X 660 MW UNIT No-5, PHASE-III SAGARDIGHI THERMAL POWER STATION**



**DEVELOPMENT CONSULTANTS PRIVATE LIMITED**  
**KOLKATA**



**BHARAT HEAVY ELECTRICALS LTD**  
**BOILER AUXILIARIES PLANT**  
**RANIPET – 632 406.**

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DEPT CODE		NAME	SIGN	DATE
9776	PRPD	DBN		19.01.21
	CHD	MSM		19.01.21
	APPD	MRK		19.01.21

<b>TITLE</b> <b>DESIGN MEMORANDUM FOR CTBD TREATMENT PLANT (PT,UF &amp; RO)</b>	Customer Doc No. RP-DC-445-WTP-A001	<b>REV.NO</b>  <b>03</b>
	BHEL Doc No. <b>4-WT-220-01575</b>	



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<b>3) Technical Datasheet-A .....</b>	<b>19</b>



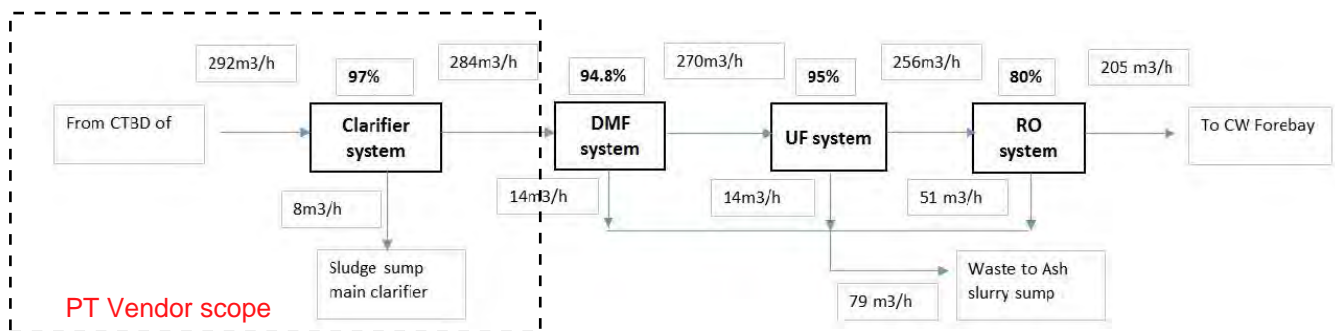
## 1.0 INTRODUCTION

The purpose of the system is to reduce the Total Suspended Solids (TSS) in blow down water through Clarifier system (Pretreatment Plant). Clarified water will be further treated through DMF, UF & RO before let into the CW fore-bay. Supply of DMF, UF & RO systems are in BHEL scope & are excluded from bidder scope.

## 2.0 SYSTEM DESCRIPTION FOR CTBD PRE TREATMENT PLANT

- Clarifier system
- Dosing system for clarifier
- Chemical house for PT plant
- Piping & Valves
- Electrical, Controls & Instrumentation (E, C&I)

## 2.1 MASS BALANCE FOR PRE-TREATMENT PLANT



## 2.2 PT PLANT - MAIN CLARIFIER SYSTEM

CT Blow down water from stage#2 and stage#3 will be fed directly to clarifier through a flow control station and terminated before pH correction chamber (stilling chambers) and further it will flow through Parshall flume and then to High Rate Solid Contact type Clarifier (HRSCC).

PT plant – Clarifier system is designed for 1 set Clarifier of 292 m<sup>3</sup>/hr (with 20% margin 350 m<sup>3</sup>/hr) streams for catering to treat the blow down water. The treated water will be stored in clarified water storage tank. Further the clarified water will be fed to Dual Media Filters (DMF) and to Ultra Filtration (UF) units followed by Reverse Osmosis (RO) system. Supply of DMF, UF & RO systems. Supply of DMF, UF & RO systems are in BHEL scope & are excluded from bidder scope.

Water from Stilling Chamber will then flow to Parshall Flume for measurement of flow in open Channel. It will flow further to Feed well/ Distribution Chamber. From Distribution Chamber water will be directed to High Rate Solids Contact Clarifier (HRSCC).

A provision for by-pass across HRSCCs is considered and in this regard a by-pass channel from Stilling Chamber to Clarified Water storage tank is provided.

To remove the suspended particles in the blowdown water, Ferric Chloride (FeCl<sub>3</sub>) as Coagulant and Lime as and when necessary for pH adjustment, and Dolomite will be





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dosed in blow down water. A dilute solution of polyelectrolyte shall also be added which will further improve flocculation and settlement of suspended solids.

The sludge generated from the Clarifier will be collected in local sludge pit and shall be transferred to main Sludge Pit of Raw Water Pre-Treatment Plant. Bidder to terminate the sludge pump common discharge line at a distance of 5 mtr from sludge sump (refer TP for the details in P&ID and equipment layout). Further piping from terminal point to sludge sump of main PT plant shall be in BHEL scope.

The Clarifiers comprise of three zones: the reaction zone, the clarification zone and the thickener zone. In the reaction zone, influent water is combined with reactants and solids that will be recirculated from the thickener zone. The water then goes to the thickener zone, where sludge is thickened and then either recycled back into the reaction zone of the Clarifier or discharged to waste. The water then proceeds into the clarification zone and collection of clarified water is achieved into an effluent collection launder.

The clarified water from PT Main Clarifiers will flow through open channels and enter through a segment of bypass channel to Clarified Water Reservoir. Clarified water storage tank is top covered two compartment section and each section is 250 cu. M (BHEL Scope).

The sludge generated from the Clarifiers will be collected in periphery sludge pit and further sent to a local sludge Sump. Sludge will be pumped from Sludge Sump by means of Sludge Disposal Pumps to Sludge Pit (WBPDCL scope) of Raw Water Pre-Treatment Plant.

### **Chemical Injection Systems**

#### **a) Coagulant Ferric Chloride (FeCl<sub>3</sub>) Injection System**

- The Coagulant Ferric Chloride (FeCl<sub>3</sub>) Injection System will be sized for 50 mg/l dosage rate.
- The feed rate & dosing rate will be controlled in proportion to the feed water flow measured on the inlet of the Clarifiers.
- Jar test to be done to arrive at the optimum dosage rate

#### **b) Lime /Dolomite injection system**

- The Lime/Dolomite Injection System will be sized for 100 mg/l dosage rate.
- The feed rate & dosing rate will be controlled in proportion to the CWBD water flow measured on the inlet of the Clarifier.

#### **c) Polymer Injection system**

- The Polymer Injection System shall be sized for 1.0 mg/l polymer dosage.
- The feed rate & dosing shall be controlled in proportion to the feed water flow measured on the inlet of the Clarifier.



## **2.3 CHEMICAL HOUSE**

All the dosing system shall be located in a Chemical house (single/two-storied building) under PTP area. All chemicals required to operate 1x660 MW Unit for thirty (30) days, on continuous and full load basis will be stored in the Chemical House.

The storage space for each chemical will be separated from other by partition walls. Chemicals will be directly unloaded from the trucks and thereafter be stacked in the respective storage space by means of electrically operated monorail hoist. Preparation of chemical solutions of Ferric Chloride ( $\text{FeCl}_3$ ), Lime/Dolomite and Polyelectrolyte for injection to feed (blow down) water shall also be carried out in the Chemical House.

Chemicals will be lifted by means of another electrically operated monorail hoist to the chemical preparation area. The water required for preparation of solutions Water for solution preparation shall be taken from one (1) no. RCC top covered overhead clear water Storage Tank of 20 Cu. m effective capacity.

### **3.1 TENDER WATER BALANCE DIAGRAM (12A05-DWG-M-001Q, AMEND-02)**

### **3.2 SAGARDIGHI 1X660MW SPECIFICATION NO. (V.II2/AMEND-03 FOR RO SYSTEM EQUIPMENT & FACILITIES AND.V.II2/AMEND-03 FOR CLARIFICATION SYSTEM EQUIPMENT & FACILITIES**

### **3.3 PLOT PLAN DRG. PE-DG-G45-M001-R03**

### **3.0 BRIEF SCOPE**

Datasheet – A

### **4.0 CONTROL PHILOSOPHY FOR CWBD PLANT (CLARIFIER SYSTEM)**

PT of CWBD Treatment plant shall be controlled from a redundant DCS located CWBD Control building. DCS, I/O, UPS and other Equipment to control CWBD plant is located in CWBD control building. PT plant can be operated in Remote manual mode from DCS. All electrical drives of CWBD Treatment plant will be controlled & monitored from DCS.

Tripping of drive motors shall be permissible by local lockable stop irrespective of local / remote selector switch position. Tripping of drive from LPBS (Emergency stop) shall be free from any interlock/ switch selection.

Rake Mechanism Drive Motor and Re-circulator Drive Motor for each Clarifier will be operated from DCS. The start/stop indication shall be shown in the DCS.

All the drives shall be started and stopped from DCS.

The following pumps & agitators shall be started and stopped from DCS.

- a. Propeller Drive
- b. Periphery Drive
- c.  $\text{FeCl}_3$  unloading pump
- d.  $\text{FeCl}_3$  Tank Agitator



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- e. FeCl<sub>3</sub> dosing pump
- f. Lime/Dolomite Slaking Tank Agitator (Solution)
- g. Lime/Dolomite Transfer Pump
- h. Lime/Dolomite Dosing Tank Agitator
- i. Lime/Dolomite Dosing Pumps
- j. Polyelectrolyte preparation cum dosing tank Agitator
- k. Polyelectrolyte injection pump
- l. Sludge Transfer Pump
- m. Air Blower for Sludge Sump

A soft mimic in the OWS with the status of drives including ON, OFF, TRIP indication of respective motors/pumps and control valve shall be provided in the DCS.

All the dosing pumps shall be capable of being adjusted manually to any output with in the stated range.

All pumps shall trip at level low in respective tanks or Sumps.

Alarms pertaining to Clarified Water Storage tank- High (H) and Low (L) shall be indicated in DCS.

Flow at inlet of parshall flume shall be controlled through motor operated valve w.r.t. clarified water storage tank.

The following interlocks and protections shall be envisaged for the clarifier feed pump

(a). Clarifier feed Pumps as minimum:

- Start permissive: Level is not low in the CWBD Reservoir,
- Trip condition: Level is low low in the CWBD Reservoir,
- Auto start of standby pump: When the pump in operation trips.

(b) The sludge generated from the Clarifiers will be collected in periphery sludge pit and further sent to a local sludge Sump. Sludge will be pumped from Sludge Sump by means of Sludge Disposal Pumps to Sludge Pit (WBPDC scope) of Raw Water Pre-Treatment Plant. The following interlocks and protections shall be envisaged for Sludge Transfer Pumps as minimum:

- Start permissive: Level is not low in the Sludge Sump,
- Trip condition: Level is low low in the Sludge Sump,
- Auto start of standby pump: When the pump in operation trips.

(c). Dosing permissive:

The FeCl<sub>3</sub> Dosing Pumps shall be provided for the Clarifiers. Each pump shall stop either by STOP push button or low level in the selected FeCl<sub>3</sub> Solution Preparation cum Dosing Tank.

The following interlocks and protections shall be envisaged for the pumps as minimum.

- Start permissive: FeCl<sub>3</sub> Solution Preparation cum Dosing Tank level is not low.



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- Trip condition: FeCl<sub>3</sub> Solution Preparation cum Dosing Tank level is low low.
- Auto start of standby pump: When any of the pumps in operation trips.

The Polyelectrolyte Solution Dosing Pumps shall be provided for the Clarifiers. Pump shall stop either by STOP pushbutton or low level in the selected Polyelectrolyte Solution Preparation Tank.

The following interlocks and protections shall be envisaged for the pumps as minimum:

- Start permissive: Polyelectrolyte Preparation cum Dosing Tank level is not low.
- Trip condition: Polyelectrolyte Preparation cum Dosing Tank level is low low.
- Auto start of standby pump: When any of the pumps in operation trips.

The Slaked Lime/Dolomite Transfer Pumps shall be provided for the Clarifier. One pump shall be kept under operation for preparation of slaked lime/Dolomite. The other pump shall remain as stand-by. Each pump shall stop either by STOP pushbutton or low level in the selected Slaked Lime Preparation Tank.

The following interlocks and protections shall be envisaged for the pumps as minimum:

- Start permissive: Slaked Lime/Dolomite Preparation Tank level is not low.
- Trip condition: Slaked Lime/Dolomite Preparation Tank level is low low.
- Auto start of standby pump: When any of the pumps in operation trips

The following interlocks and protections shall be envisaged for the agitators as minimum:

- Start Permissive: Level in the corresponding dosing tank is not low.
- Trip Permissive: Level in the corresponding dosing tank is low.

Note: kindly refer the following Documents/ Drawings

- ~~1. Control philosophy (Drg no. RP-DC-445-WTP-A008)~~
2. Equipment layout for CWBD (Drg. No. RP-DG-445-WTP-A003) CWBD
- ~~3. Control room layout for CWBD (Drg no. RP-DG-445-WTP-E012)~~

## 5.0 FUNCTIONAL GUARANTEE

Qualities of treated water at CWBD Clarifier outlet are envisaged as follows

### 6.1 PT PLANT

<b>Water Quality at the outlet of Clarifier systems:</b>	
Turbidity	≤ 10 NTU (average) ≤ 15 NTU (under overload)
Dissolved Silica (SiO <sub>2</sub> )	≤ 25 ppm

The average Suspended Solids / Turbidity in the treated water from Solids Contact Clarifier shall not exceed 10 mg per lit / 10 NTU during normal operation and any individual reading shall not exceed 15 mg per lit / 15 NTU. The average suspended solids/ turbidity in the treated water from Solid contact clarifier shall not exceed 15mg/l/ 15NTU during overload condition.



## 7.0 PROCESS DESCRIPTION

The process detail for each system of CWBD plant is described in this section.

### 7.1 PRETREATMENT SYSTEM

The pretreatment system is meant for conditioning the CTBD Water for treatment using membranes. This consists of Clarifiers, DMF, Ultra Filtration system (Pressurized), UF-CIP, UF-backwash systems and dosing systems. Supply of DMF, UF & RO systems are in BHEL scope & are excluded from bidders scope..

#### 1) Clarifier system

Clarifiers are provided for reducing the suspended solids in the blowdown water and turbidity of the raw water (CWBD) before it is fed to the UF system.

Clarifier system consists of Flow control station, stilling arrangement, Parshall flume, feed distribution chamber, flash mixers, flocculators and with suitable clarification system. Clarified water is stored in clarified water storage tank.

Necessary dosing systems such as Coagulant and Poly Electrolyte are envisaged for effective clarification and treatment process.

The sludge generated from the Clarifiers will be collected in periphery sludge pit and further sent to a local sludge Sump. Sludge will be pumped from Sludge Sump by means of Sludge Disposal Pumps to Sludge Pit (WBPDC Scope) of Raw Water Pre-Treatment Plant.

Technical details are covered in Technical datasheet -A

The following materials are selected for LP piping & fittings

S.No.	Service	Sizes	Pipes	Fittings
1	Clarifier Area: Filtered water, Clear Water, Service Water, Sludge line.		Carbon Steel Pipe to ASTM 53 Gr. B / IS-1239, Part-I heavy grade for pipe size up to 150 mm NB and IS-3589 for 200 mm NB and above	
2	All chemical dosing line piping	All sizes	c-PVC sch.80	c-PVC sch.80
3	All Instrument/ Plant air piping/Process air	All sizes	SS 304	SS 304
4	Velocity Pump suction  Pump discharge & recirculation  Header	≤150mm ≥200mm <50mm ≤150mm ≥200mm  ≤150mm	1.2-1.5 m/s 1.2-1.5 m/s 1.2-1.8 m/s 1.8-2.4 m/s 2.1-2.5 m/s  1.5-2.4 m/s	





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S.No.	Service	Sizes	Pipes	Fittings
		≥200mm	2.1-2.4 m/s	

The following materials are selected for LP valves. (Valves are of #150 rating)

S.No.	Service	Size	Body	Disc	Seat
	Brackish water applications (butterfly valves)	All	Cast Iron/ Cast steel	SS316	EPDM/ Nitrile Rubber
	Compressed air application	< DN50 > DN65	Gun metal Cast/ Forged		

### 7.9 DCS BASED CONTROL SYSTEM

DCS is a Programmable Automation unit consisting of Processor, I/O Modules, Power Supply Modules, communication interface modules, Ethernet networking components etc., One PC with monitor & key board is provided as Operator workstation and One PC is provided for Operator and Engineering workstation.

The DCS unit caters to the composite requirements of measurement, signal conditioning, algorithm execution and final element(s) control of each process sub-system.

~~The UF-RO Plant is designed for remote operation through the DCS system. Taking the equipment into Service and initiation of RO units shall be initiated manually from the operator station and balance operation shall be carried out sequentially by the DCS system. Detailed programming will be based on UF & RO membrane OEM guidelines.~~

**REFERENCE DRAWING:** Tender water balance diagram (12A05-DWG-M-001Q)

**Analysis of Blow down Water**

**Table-2**

S.No.	CONSTITUENTS	As	CONTENT (mg/l)
1.	Calcium	CaCO <sub>3</sub>	525 ppm
2.	Magnesium	CaCO <sub>3</sub>	260 ppm
3.	Sodium & Potassium	CaCO <sub>3</sub>	690 ppm
	<b>TOTAL CATIONS (Except Fe)</b>	<b>CaCO<sub>3</sub></b>	<b>1475 ppm</b>
4.	Bicarbonate	CaCO <sub>3</sub>	150 ppm
5.	Carbonate	CaCO <sub>3</sub>	--
6.	Sulphate	CaCO <sub>3</sub>	1120 ppm
7.	Chloride	CaCO <sub>3</sub>	205 ppm
	<b>TOTAL ANIONS</b>	<b>CaCO<sub>3</sub></b>	<b>1475 ppm</b>
8.	M.O Alkalinity	CaCO <sub>3</sub>	150
9.	P. Alkalinity	CaCO <sub>3</sub>	
10.	Total Hardness	CaCO <sub>3</sub>	785
11.	Carbon-di-oxide	CO <sub>2</sub>	3.5



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12.	Dissolved Silica	SiO <sub>2</sub>	100 ppm
13.	pH value		7.0 to 8.0
14.	Turbidity, NTU		100
15.	TDS		2020 ppm

**Note:**

- 1) Other parameters not indicated in above list has been considered as nil.

**8.0 PUMPS AND PIPE SELECTION CRITERIA**

Pump and pipeline carrying water and chemicals etc. shall generally be sized on the following velocities. However, wherever minimum pipe sizes are defined in the drawing/datasheets, the selected size shall not be less than the specified size.

**(Table-3)**

Pipe Size	Velocity in m/sec		
	Below 50 mm	50 mm - 150 mm	200 mm & above
Pump Suction for Water		1.2 - 1.5	1.2 - 1.8
Pump Discharge for Water	1.2 - 1.8	1.8 - 2.4	2.1 - 2.5
Header for water		1.5 - 2.4	2.1 - 2.4
Gravity flows	1.0 (maximum)		
Compressed air below 2 Kg/cm <sup>2</sup> (g)	15 - 20	20 - 30	25 - 35
Compressed air 2 Kg/cm <sup>2</sup> (g) & above	20 - 30	25 - 40	35 - 45
Suction to compressor/ Blowers		7-8	
Pump Suction for Chemical Solution	0.8 - 1.2	0.8 - 1.3	-
Pump Discharge for Chemical Solution	1.2 - 1.4	1.3 - 1.5	-

**Note:**

1. All piping system shall be capable of withstanding the maximum pressure in the corresponding line.
2. TDH of all pumps shall be decided by the supplier assuming the following 'C' values in Hazen Williams equation for calculation of friction loss.
  - a. Carbon steel pipes – 100
  - b. C.I pipes – 100
  - c. Rubber lined steel pipes – 120



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- d. PVC/ HDPE pipes – 140  
10% margin shall be taken over the pipe friction losses for calculating the pump head.
  
- 3. Sampling of water shall be taken from the following points
  - a. CWBD water inlet to pH Correction Chamber (before control station of clarifier)
  - b. Sludge water from clarifiers – Tapping will be provided at sludge transfer pump common discharge line
  - c. Clarified water from the launders



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**Technical Datasheet-A**

**Common datasheet for Clarifier System**

Sl.no.	Equipment details	Description
<b>1.00.00</b>	<b>CLARIFIER SYSTEM</b>	<b>PT Clarifiers system</b>
A)	INLET PIPE	
i)	Inlet pipe	As per P&ID
ii)	Material of construction	Mild Steel
iii)	By pass to Clarifier	Provided. Suitable for 100% bypass and provided from upstream of pH Correction Chamber to inlet channel of Clarified Water Reservoir.
iv)	Control station (inlet control & isolation valves)	Provided (refer P&ID for details)
	Type	Ball valve inching type
	Valve MOC	Body: Cast Iron (IS 210 FG 260), Disc: Cast Iron (IS 210 FG 260) Shaft: AISI 316. Handle : Cast Iron
	Type of control	Inching type
	Design Pressure & Temperature	6.0 bar & 60 Deg C
<b>2.00.00</b>	<b>STILLING CHAMBER/ pH correction</b>	<b>PT Clarifiers system</b>
A)	Quantity	1
B)	Description for unit	
i)	Type	Rectangular in cross section with baffles.
ii)	Purpose	To dampen out any turbulence of incoming water for ease of flow measurement & for pre-chlorination and pH correction.
iii)	Effective capacity in m <sup>3</sup> /hr	Suitable to handle the flow rate equal to (clarified water output) + water loss for Sludge Disposal through Clarifiers & recirculated water from Thickener. Minimum flow: 292 m <sup>3</sup> /hr
iv)	Design residence time	60 seconds in order to dampen out any turbulence of incoming water.
v)	Design temperature	60 Degree Celsius
vi)	Design code	As per supplier standard practice to meet system requirements.
vii)	Material of construction	RCC
viii)	Accessories	Suitable drain arrangement shall be provided for the stilling chamber and drain line shall be extended up to the nearest local sludge drain.
ix)	Hand railing	Shall be provided



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<b>3.00.00</b>	<b>PARSHALL FLUME</b>	<b>PT Clarifiers system</b>
A)	Quantity	One
B)	Description for each inlet channel	
i)	Type	Rectangular in cross section.
ii)	Type of fluid to be handled	Blowdown water
iii)	Effective Capacity m <sup>3</sup> /hr	Suitable to handle the flow rate equal to (clarified water output) + water loss for Sludge Disposal through Clarifiers Minimum flow: 292 m <sup>3</sup> /hr
iv)	Design velocity in m/sec	0.6 Maximum.
v)	Minimum Free Board in mm	300 mm.
vi)	Design Temperature, °C	60
vii)	Design Code	As per supplier standard practice to meet system requirements.
viii)	Code for Tests and Inspections	As per supplier standard practice to meet system requirements.
ix)	Material of Construction	RCC
x)	Special features	The primary flow element shall be Parshall Flume type. Primary transmitter shall be at parshall flume in a float chamber. Flushing and draining provision of each float chamber shall be provided.
<b>4.00.00</b>	<b>FEED CHAMBERS</b>	<b>PT Main Clarifiers system</b>
A)	Quantity	1
B)	Description for each unit	
i)	Type	Rectangular.
ii)	Effective capacity, each, m <sup>3</sup>	Suitable to handle the flow rate equal to (clarified water output) + water loss for Sludge Disposal through Clarifiers Minimum flow: 292 m <sup>3</sup> /hr (Hydraulics with 20% is 350 m <sup>3</sup> /hr)
iii)	Material of Construction	RCC
	a) Isolation Gate Complete With Hand Wheel.	Shall be provided
	b) Drain	Suitable drain line shall be extended up to nearest local drain/sludge pit for final disposal.
iv)	Hand railing	Shall be provided
<b>5.00.00</b>	<b>SOLID CONTACT REACTOR TYPE CLARIFIER (HRSCC)</b>	<b>PT Main Clarifiers system</b>
A)	Quantity	1
B)	Description for each Clariflocculator	
i)	Type	Solid Contact Reactor Type with integral variable speed impeller/turbine to





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		internally recirculate water and sludge at adjustable rate to produce consistent water quality at varying hydraulic load and turbidity Clarifier
ii)	Output Capacity at rated condition, m <sup>3</sup> /hr	Rated output capacity shall be not less than 292 m <sup>3</sup> /hr.
	Output capacity at 20% overload condition	350 m <sup>3</sup> /hr
	Inlet pipe	MS ERW as per IS 2062 / IS 3589
iii)	Turbidity of treated water at rated condition,	<10 NTU
iv)	Design Criteria	
	• Residence time in Draft Tube	Not less than 15 seconds
	• Residence time in Flocculation zone	15 min minimum
	• Residence time in Clarification zone	90 min minimum
	• Surface flow rate in Clarification zone	Not to exceed <3.0 m <sup>3</sup> /hr/m <sup>2</sup> , Side water depth = 4.5 meters (minimum)
v)	Material of Construction	RCC
	• Recirculation Drive	
	• Number	One (1)
vi)	Rake mechanism	
	• Number	One (1)
	• Material of construction	Shaft – Mild steel with epoxy painted Impeller – Stainless steel
vii)	Clarifier Bridge	
	Type	Rotary
	Material of Construction	Carbon steel
viii)	Bridge drive	Slow speed motor driven through reduction gear.
ix)	Clarifier Scrapper Assembly	
	Number	One.
	Type	Supported and suspended from Clarifier Bridge.
	Material of construction	Carbon Steel with rubber inserts as squeezers and painting shall be as per painting specification.
x)	Overflow Weir / Peripheral Orifice	
	Location	To be fixed in the overflow launder of Clarifier.
	Type	Open type all along the periphery of Clarifier. For uniform overflow over weirs, saw tooth weir may be provided as necessary.
xi)	Sludge disposal arrangement	
	• Type	By gravity



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	<ul style="list-style-type: none"> <li>• Continuous</li> <li>• Intermittent</li> </ul>	<p>By gravity through standpipe</p> <p>Sludge outlet pipe from the sludge hopper of the Clarifier shall be branched for a continuous bleed. The top of telescopic stand pipe shall be maintained at a desired elevation to ensure trickle flow of sludge. Sludge outlet pipe shall include an adjustable timer operated periodic blow-off valve (at downstream of Telescopic Device) with manual over riding facilities. The timer set point shall be independently manually adjustable.</p>
xii)	Accessories	Shall be provided as per system requirements in line with attached P&ID.
	Sludge Outlet Pipe	Cast iron as per IS-1536, Class-A
	Constant bleed arrangement with telescopic device	Shall be Provided
	Flushing connection	Shall be Provided & size of flushing line shall be not less than 50 NB. Other accessories shall be provided as per system requirements in line with attached P&ID.
	Operation	Automatic operation through independent and adjustable timer. Local manual operation facility shall also be provided through extended spindle, headstock arrangement & hand wheel.
xiii)	Instruments	Shall be provided as per approved P&ID.
xiv)	Painting	Shall be provided
xv)	Walkway	Shall be provided with handrails around launder periphery of each clarifier. Width of the walkway shall not be less than 1000 mm.
xvi)	Special feature	Power supply/control of all electric drive motors on Clarifier shall be done by a Rotary Current Collector located at the pivot point of rotation. One (1) Distribution Board to be located on Clarifier Bridge.
<b>6.00.00</b>	<b>SLUDGE SUMP</b>	
A)	Numbers	One (1) number
B)	Description	
i)	Type	Rectangular and Underground, Outdoor Location.



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ii)	Type of fluid to be handled	Sludge from Stilling Chamber, Distribution Chamber and Clarifier
iii)	Effective capacity	Not less than 60m <sup>3</sup>
iv)	Minimum Free Board, in mm.	500
v)	Material of Construction	RCC.
vi)	Type of protection	
	a) Internal	Epoxy painted
	b) External	Not applicable
vi)	Sludge Flushing Arrangement	Required through high pressure water and nozzles to ensure no deposition / settling of sludge as per the P&ID. Water shall be taken from service water tank.
vii)	Accessories	Shall be provided as per system requirements in line with attached P&ID.
viii)	Instruments	Shall be provided as per approved P&ID
<b>7.00.00</b>	<b>SLUDGE TRANSFER PUMPS</b>	
A)	Quantity	Two (2) (1Working +1Standby)
B)	Description for each Pump	
i)	Type	Vertical Centrifugal Non Clog type
ii)	Type of Impeller	Open
iii)	Location	Outdoor
iv)	Fluid to be handled	Sludge-water Slurry
v)	Duty	Intermittent
vi)	Design Standard	As per supplier standard practice to meet system requirements
vii)	Design Temperature in degree Celsius	60
viii)	Rated Capacity m <sup>3</sup> /hr	60 m <sup>3</sup> /hr.
ix)	Suction Condition	Flooded.
x)	Tentative Head to be developed at rated capacity, MLC	Shall be specified during detailed engineering considering 10% margin to meet the requirements of the system. As per supplier standard practice (C should be considered as 120 to calculate frictional loss in pipe as per Hazen Williams Equation).
xi)	Shut off Head	To be suitable for stable operation at rated duty point.
xii)	Range of operation	20% - 120%
xiii)	Pump speed (RPM)	1500 (maximum)
xiv)	Material of construction	
	Inner Casing	C.I IS 210 Gr. FG 260
	Shaft	EN-8 as per BS-970 (or) SS 410
	Impeller	Ni hard C.I. as per ASTM A 532.



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	Nuts and Bolts	SS-316 (under wetted condition) and MS Cadmium plated (in other places)
xv)	Type of drive	Electrical Motor
xvi)	Criteria for selection of drive motor	Minimum 15 % margin over BKW at rated duty point shall be taken and standard motor with next higher KW as available shall be selected. This shall in no way be less than the maximum power required by the Pump.
xvii)	Rated speed (RPM)	1500 (Sync.) maximum.
xviii)	Voltage, Phase & Frequency ( $\pm$ % Variation)	415 V (+10%), 3 Phase, 50 HZ (+5%).
xix)	Type of coupling between Pump & Motor	Flexible Spacer.
xx)	Noise level (for complete set of Pump & Motor)	Not more than 85 db (At a distance of 1.0 m from the outer surface of Motor).
xxi)	Painting for complete set of Pump & Motor	
	Primer	Shall be provided
	Finish paint	Shall be provided
xxii)	Tests and Inspection	
	Material Test required for	Casing, Impeller, Shaft and Shaft Sleeve.
	a) Hydro-test	As per Relevant Code
	b) Dynamic Balancing Test	Shall be provided
	c) Performance Test	Shall be provided
xxiii)	Instruments along with alarms, interlocks and accessories	Shall be provided as per approved P&ID.
xxiv)	Trip interlock	Shall be provided.
<b>8.00.00</b>	<b>AIR BLOWERS FOR SLUDGE SUMP</b>	
A)	Quantity	2 Nos. (1W + 1S)
B)	Description for each Blower	
i)	Location	Outdoor.
ii)	Fluid to be handled	Ambient Air.
iii)	Service	To scour the sludge bed
iv)	Duty	Intermittent.
v)	Type of Blower	Rotary Twin Lobe Oil Free.
vi)	Type of Impeller	Involutes.
vii)	Design standard	As per supplier standard practice
viii)	Service temperature, in <sup>o</sup> C	60 maximum.
ix)	Rated Capacity, (each) in m <sup>3</sup> /hr	40 (100% requirement of Sump)
x)	Permissible tolerance in rated capacity, in %	As per BS-1571-Part II.
xi)	Head to be developed at rated capacity	To ensure the desired performance.



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xii)	Material of construction	
	a. Casing	CI (IS-210, Gr. FG 260).
	b. Lobe	CI (IS-210, Gr. FG 260)
	c. Common Base plate	Fabricated Carbon Steel
	d. Coupling Pulley	C.I./Carbon Steel
	e. Coupling Guard	Carbon Steel.
	f. Safety Relief Valve	SS-316
	g. Nuts and bolts	Carbon Steel
xiii)	Type of drive	Electrical Motor
xiv)	Criteria for selection of drive motor	Minimum 15 % margin over BkW at rated duty point shall be taken and standard motor with next higher KW as available shall be selected. This shall in no be less than the maximum power required by the Blower.
xv)	Rated speed (RPM)	1500 (Sync.) maximum.
xvi)	Voltage, Phase & Frequency ( $\pm$ % Variation)	415 V (+10%), 3 Phase, 50 (+5%), HZ
xvii)	Type of coupling between Blower & Motor	V Belt.
xviii)	Noise level (for complete set of Blower & Motor)	Not more than 85 db (At a distance of 1.0 m from the outer surface of Motor).
xix)	Tests and Inspection	
	a) Material Test required for	Casing and Lobe
	b) Hydro-test	BS-1571-Part II.
	c) Dynamic Balancing Test	Shall be provided
xx)	Performance Test	
	a) Test Code	BS-1571-Part II.
	b) Tests to be done for determination of	Head-Capacity Curve and BHP-Capacity Curve.
	c) Test to be carried out	On prototype model at rated speed.
	d) Test for satisfactory operation of Blower at site	Required.
xxi)	Instruments and alarm	Shall be provided as per approved P&ID.
xxii)	Trip interlock	Not required.
xxiii)	Accessories	Common base frame, Pulley, V-Belt Guard, Acoustic Hood, Suction Filter, Suction Silencer, Discharge Silencer, Anti Vibration Pad, Safety Relief Valve, Non Return Valve
8.10	<b>OVERHEAD CLARIFIED WATER TANK</b>	
	a) Number	One (1)
	b) Service	Storing of clarified water for supply to necessary Areas i.e chemical





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		preparation & flushing line.
	Location	Overhead, on the roof of chemical house.
	Material	R.C.C
	Capacity	20 Cu.m effective
	Vent , overflow, drain,	Provided
	Level Indicator	Mechanical float type with dial type indication
	Level Switch	Two (2) nos. float type one (1) for high and one (1) for low level with alarm.
<b>9.00.00</b>	<b>BULK FERRIC CHLORIDE STORAGE TANK</b>	
a)	Cap	20 m3 Qty - 1 No
b)	Type	Horizontal & cylindrical
c)	MOC	MSRL
d)	Instruments	As per approved P&ID
<b>9.10.00</b>	<b>BULK FERRIC CHLORIDE UNLOADING CUM TRANSFER PUMP</b>	
a)	Numbers	Two (2) (1W+1S)
b)	Cap	10 m3/hr
c)	Head	As per system requirement
d)	MOC	PP pump
<b>9.20.00</b>	<b>FERRIC CHLORIDE PREPARATION CUM DOSING TANKS</b>	
A)	Numbers	Two (2) One (1) no. to be under operation and one (1) no. under solution preparation
B)	Description (applicable for each Tank)	
i)	Type	Vertical cylindrical MSRL with flat bottom
ii)	Type of fluid to be handled	10 % w / w FeCl <sub>3</sub> solution. Available concentration 40%
iii)	Effective capacity of each tank, m <sup>3</sup>	2000 ltrs
iv)	Free Board, mm	300
v)	Design Pressure, Kg/sq. cm (g)	Atmospheric
vi)	Design Temperature in degree Celsius	60
vii)	Design Code	As per supplier standard practice to meet system requirements
viii)	Code for Test and Inspection	As per supplier standard practice to meet system requirements
ix)	Material of Construction	MSRL
x)	Protection	



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	a) Internal	Rubber lined
	b) Agitator along with drive motor and all other accessories	
	• Number	One (1) per Tank
	• Material of Construction	All wetted parts of the agitator shall be of SS 316 constructions.
xi)	Dissolving Basket	
	Number	One (1) per Tank
	Material of Construction	Dissolving Basket shall be of SS-316
xii)	Accessories	Shall be provided as per system requirements in line with attached P&ID.
xiii)	Instruments	Shall be provided as per approved P&ID.
	Staircase & Approach Platform complete with handrails for operation	Shall be provided
<b>10.00.00</b>	<b>FERRIC CHLORIDE SOLUTION DOSING PUMPS</b>	<b>PT Clarifiers system</b>
A)	Quantity	2 Nos. (1W +1S)
B)	Description for each Pump	
i)	Type of Pump	Electromechanical, positive displacement, constant speed, variable stroke and hydraulically operated diaphragm type.
ii)	Location	Indoor.
iii)	Fluid to be handled	10 % w / w FeCl <sub>3</sub> solution.
iv)	Service	To dose FeCl <sub>3</sub> solution to the Clarifiers.
v)	Duty	Continuous and suitable for parallel operation
vi)	Suction Condition	Flooded
vii)	Rated Capacity, m <sup>3</sup> /hr	300 lph
viii)	Tentative head to be developed at rated capacity, MLC	Shall be specified during detailed engineering stage to meet the system requirements
ix)	Design Standard	As per supplier standard practice to meet system requirements
x)	Design Temperature in degree Celsius	60
xi)	Range of Operation (%)	0 – 100
xii)	Capacity Adjustment	Local manual through Micrometer Dial and remote manual from Control Panel
	Rated speed (RPM)	100 strokes per minutes (maximum).
xiii)	Material of construction	
	a) All wetted parts	SS 316
	b) Diaphragm	PTFE
	c ) pump head	As per manufacturer standard
xiv)	Type of drive	Electrical Motor



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xv)	Criteria for selection of drive motor	Minimum 15 % margin over BKW at rated duty point shall be taken and standard motor with next higher KW as available shall be selected. This shall in no way be less than the maximum power required by the Pump.
xvi)	Rated speed (RPM)	1500 (Sync.) maximum.
xvii)	Voltage, Phase & Frequency ( $\pm$ % Variation)	415 V (+10%), 3 Phase, 50 HZ (+5%).
xviii)	Type of coupling between Pump & Motor	Flexible Spacer.
xix)	Noise level (for complete set of Pump & Motor)	Not more than 85 db (At a distance of 1.0 m from the outer surface of Motor).
xx)	Painting for complete set of Pump & Motor	
	a) Primer	Shall be provided
	b) Finish paint	Shall be provided
	C) shade	As per painting schedule
xxi)	Tests and Inspection	
	• Material Test required for	Casing, Impeller, Shaft and Shaft Sleeve.
	• Hydro-test	As per applicable code.
	• Dynamic Balancing Test	Shall be provided
	• Performance Test	Shall be provided
xxii)	Instruments along with alarms, interlocks and accessories	Shall be provided as per approved P&ID
xxiii)	Trip interlock	Shall be provided.
xxiv)	Accessories	
	a) Pulsation Dampener	Shall be provided.
	b) Pressure Relief Valve	Shall be provided.
	c) Pressure Gauge	Shall be provided.
<b>11.00.00</b>	<b>LIME/DOLOMITE SOLUTION SLAKING TANKS</b>	
A)	Numbers	Two(2)
B)	Description for each Tank	
i)	Type	Rectangular
ii)	Type of fluid to be handled	6% w/w Lime Solution.
iii)	Effective capacity of each tank, m <sup>3</sup> /hr	Not less 120% of the quantity required for PT Clarifiers for twelve (12) hours of continuous full load operation.
iv)	Free Board, mm	300
v)	Design Pressure, Kg/sq. cm (g)	Atmospheric.
vi)	Design Temperature in degree Celsius	60
vii)	Design Code	As per supplier standard practice to



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		meet system requirements
viii)	Code for Test and Inspection	As per supplier standard practice to meet system requirements
ix)	Material of Construction	RCC.
x)	Type of Protection	
	a) Internal	Acid Resistance tiling
	b) External	Not applicable.
	c) Agitator along with drive motor and all other accessories	
	• Number	One (1) per Tank
	• Material of Construction	SS 316
xi)	Accessories	Shall be provided as per system requirements in line with attached P&ID.
xii)	Instruments	Shall be provided as per approved P&ID.
<b>12.00.00</b>	<b>SLAKED LIME /DOLOMITE TRANSFER PUMPS</b>	
A)	Numbers	Two (2) (1W+1S)
B)	Description for each Pump	
i)	Location	Indoor
ii)	Fluid to be handled	6 % w/w Lime Solution.
iii)	Duty	Continuous and suitable for parallel operation
iv)	Type of Pump	Screw type
v)	Drive	Electric motor
vi)	Suction condition	Flooded
C)	Design data	
i)	Rated capacity of each pump	15 m <sup>3</sup> /hr
ii)	Total developed head at rated capacity, MLC	10 mwc
iii)	Pumping temperature	10 degree C/ 60 degree C (max)
iv)	Speed	1500 maximum
v)	No of stages	One (1) max.
D)	Constructional feature	
i)	Pump type	Single screw / Twin screw
ii)	Bearing lubrication	Grease / oil
iii)	Seal	Mechanical
iv)	Drive transmission	Direct
v)	Mounting	Common base plate
vi)	Flange drilling	ANSI B 16.5 Class 150
vii)	Nozzle orientation	
	1. Suction	End / Side
	2. Discharge	Top / Side
viii)	Gear box for speed reduction provided	Yes
ix)	Relief valve	Provided
E)	Material of construction	



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i)	Casing	2% Ni Cl to IS 210 FG 260
ii)	Rotor / gear	SS 316
iii)	Stator	Nitrile / EPDM
iv)	Shaft and shaft sleeve	ASTM A 276 Gr 410 & SS 316
F)	Accessories	
i)	Coupling with coupling guard, base plate, foundation bolts, counter flanges	Provided
ii)	Sealing and flushing connections for mechanical seal testing and inspection	Provided
iii)	Instruments along with alarms, interlocks and accessories	Shall be provided as per approved P&ID
<b>13.00.00</b>	<b>LIME/DOLOMITE SOLUTION DOSING TANKS</b>	
A)	Numbers	<b>Two (2)</b>
B)	Description for each Tank	
i)	Type	Vertical rectangular with flat bottom.
ii)	Type of fluid to be handled	6 % w/w Lime Solution.
iii)	Effective capacity of each tank, m <sup>3</sup>	Not less 120% of the quantity required for Clarifier for twelve (12) hours of continuous operation of the entire Pretreatment Plant.
iv)	Material of Construction	<b>SS 304</b>
v)	Type of Protection	
	a. Internal	<del>Epoxy painted as per painting sub-section.</del> <b>Not applicable</b>
	b) External	Not applicable.
	c) Agitator along with drive motor and all other accessories	
	• Number	One (1) per Tank
	• Material of Construction	SS 316
vi)	Accessories	Shall be provided as per system requirements in line with attached P&ID.
vii)	Instruments	Shall be provided as per approved P&ID.
<b>14.00.00</b>	<b>LIME DOSING PUMPS</b>	<b>PT Clarifiers system</b>
A)	Numbers	2 Nos. (1W + 1S)
B)	Description for each Pump	
i)	Location	Indoor
ii)	Fluid to be handled	6 % w/w Lime Solution.
iii)	Duty	Continuous and suitable for parallel operation
iv)	Type of Pump	Screw type pump
v)	Drive	Electric motor





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vi)	Suction condition	Flooded
C)	Design data	
i)	Rated capacity of each pump	1500 lph, Magnesium oxide (from Lime) 2.5 mg/mg of SiO <sub>2</sub> adsorbed
ii)	Total developed head at rated capacity, MLC	Shall be specified During detailed engineering to meet the system requirements
iii)	Pumping temperature	10 degree C/ 60 degree C (max)
iv)	Speed	1500 maximum
v)	No of stages	One (1) max.
D)	Constructional feature	
i)	Pump type	Single screw / Twin screw
ii)	Bearing lubrication	Grease / oil
iii)	Seal	Mechanical
iv)	Drive transmission	Direct
v)	Mounting	Common base plate
vi)	Flange drilling	ANSI B 16.5 Class 150
vii)	Nozzle orientation	
	1. Suction	End / Side
	2. Discharge	Top / Side
viii)	Gear box for speed reduction provided	Yes
ix)	Relief valve	Provided
E)	Material of construction	
i)	Casing	2% Ni Cl to IS 210 FG 260
ii)	Rotor / gear	SS 316
iii)	Stator	Nitrile / EPDM
iv)	Shaft and shaft sleeve	ASTM A 276 Gr 410 & SS 316
F)	Accessories	
i)	Coupling with coupling guard, base plate, foundation bolts, counter flanges	Provided
ii)	Sealing and flushing connections for mechanical seal testing and inspection	Provided
iii)	Instruments along with alarms, interlocks and accessories	Shall be provided as per approved P&ID
<b>15.00.00</b>	<b>POLYELECTROLYTE PREPARATION CUM DOSING TANK</b>	
A)	Quantity	Two (2) (1W+1S)
B)	Description for each Tank	
i)	Type	Vertical cylindrical with flat bottom.



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ii)	Type of fluid to be handled	1% Polyelectrolyte solution
iii)	Effective capacity of each tank, m <sup>3</sup>	1000 Ltrs.
iv)	Material of Construction	SS 304
	Thickness in mm	Not less than 6
	Design temperature Deg. C	60
	Design code	As per standard
v)	Type of Protection	
	a. Internal	Natural rubber [thickness - 4.5 mm in three (3) layers, shore hardness 60° – 70° A], suitable to withstand the design temperature.
	b) External	Primer - Two coats of epoxy zinc phosphate primer. DFT per coat – 30 microns. Finish paint - Two coats of amine-cured epoxy high build paint. DFT per coat – 125 microns.
	c) Agitator along with drive motor and all other accessories	
	• Number	One (1) per Tank
	• Material of Construction	SS316
vi)	Dissolving basket	1 no. per tank, MOC:SS316
vii)	Accessories	Shall be provided as per system requirements in line with attached P&ID.
viii)	Instruments	Shall be provided as per approved P&ID.
	Staircase	Shall be provided for access from finished floor level to Operation Platform at First Floor of Chemical House.
<b>16.00.00</b>	<b>POLYELECTROLYTE INJECTION PUMPS</b>	<b>PT Clarifiers system</b>
A)	Numbers	2 Nos. (1W + 1S)
B)	Description (applicable for each Pump)	
i)	Type	Diaphragm type with remote / local, positive displacement, variable stroke adjustment type metering pumps
ii)	Location	Indoor.
iii)	Fluid to be handled	1 % Polyelectrolyte Solution.
iv)	Service	To dose Polyelectrolyte solution to the Clarifier.
v)	Duty	Continuous and suitable for parallel operation
vi)	Suction Condition	Flooded
vii)	Rated Capacity, m <sup>3</sup> /hr	500 LPH
viii)	Tentative head to be developed at	Shall be specified during detailed



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	rated capacity, MLC	engineering stage to meet the system requirements
ix)	Design Standard	As per supplier standard practice to meet system requirements
x)	Design Temperature in degree Celsius	60
xi)	Range of Operation (%)	0 – 100
xii)	Rated Speed	1500 maximum
xiii)	Material of construction	
	a) All wetted parts	SS 316
	b) Diaphragm	PTFE/Teflon faced Hypalon
	C) Housing & pump head	PP
	D) worm & shaft	As per manufacturing standard
xiv)	Type of drive	Electrical Motor
xv)	Criteria for selection of drive motor	Minimum 15 % margin over BKW at rated duty point shall be taken and standard motor with next higher KW as available shall be selected. This shall in no way be less than the maximum power required by the Pump.
xvi)	Rated speed (RPM)	1500 (Sync.) maximum.
xvii)	Voltage, Phase & Frequency ( $\pm$ % Variation)	415 V (+10%), 3 Phase, 50 HZ (+5%).
xviii)	Type of coupling between Pump & Motor	Flexible Spacer.
xix)	Noise level (for complete set of Pump & Motor)	Not more than 85 db (At a distance of 1.0 m from the outer surface of Motor).
xx)	Painting for complete set of Pump & Motor	
	a) Primer	Two coats of epoxy zinc phosphate primer. DFT per coat – 30 microns.
	b) Finish paint	Two coats of amine-cured epoxy high build paint. DFT per coat – 125 microns
	c) shade	As per painting schedule
xxi)	Tests and Inspection	
	• Material Test required for	Casing, Impeller, Shaft and Shaft Sleeve.
	• Hydro-test	As per applicable code.
	• Dynamic Balancing Test	Shall be provided
	• Performance Test	Shall be provided
xxii)	Instruments along with alarms, interlocks and accessories	Shall be provided as per approved P&ID
xxiii)	Trip interlock	Shall be provided.
xxiv)	Accessories	
xxv)	a) Pulsation Dampener, Pressure	Shall be provided.



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	Relief Valve & pressure gauge	
16.1	Electric Hoist	
a.	Qty	02 No
b.	Cap.	1 Tons
c.	Location	Chemical House
17.0	<b>CLARIFIED WATER STORAGE TANK</b>	
i	Type	Twin compartment tank above ground
ii	Capacity	500 m3 (250 m3/each compartment)
iii	MOC	RCC

**Datasheet of Piping, Isolation gates & Valves in Pretreatment plant**

SL NO.	SERVICE	MATERIAL
<b>1.00.00</b>	<b>PIPING</b>	
1.1	Raw water piping & service water piping	Carbon Steel IS-1239 Heavy Grade up to 150 mm NB and IS-3589 for sizes above 150 mm with minimum pipe thickness as indicated in the P&ID.
1.2	Sludge handling piping (piping from periphery sludge sump to sludge sump)	<ul style="list-style-type: none"> <li>Cast iron (underground) as per IS-1536, Class-A</li> <li>Carbon steel (over ground) IS-1239 Heavy Grade up to 150 mm NB and IS-3589 for sizes above 150 mm</li> </ul>
1.2 (a)	Sludge handling piping (piping from local sludge sump to existing sludge sump of main PT plant)	<ul style="list-style-type: none"> <li>Carbon steel IS-1239 Heavy Grade up to 150 mm NB and IS-3589 for sizes above 150 mm</li> </ul>
1.3	Potable Water piping.	Carbon Steel IS-1239 Heavy Grade upto 150 mm NB and IS-3589 for sizes above 150 mm with minimum pipe thickness as indicated in the P&ID. The pipes shall be galvanized as per IS-4736.
1.4	Service and Instrument Air Piping less than and equal to 50 mm NB.	Service Air GI Pipe as per IS 1239 heavy grade. Instrument Air SS 304
1.5	Service air, Instrument air & sample collection piping for sizes equal to greater than 65 mm NB.	Service air GI Pipe as per IS 1239 heavy grade. Instrument Air SS 304 Sample collection line SS 304
1.6	Piping handling FeCl <sub>3</sub> , lime, poly electrolyte.	CPVC (SCH. 80)/ Carbon Steel Rubber lined to IS-1239 Heavy Grade up to 150 mm NB and IS-3589 for sizes above 150 mm with minimum pipe thickness of 6 mm. Rubber lining thickness shall be - 4.5 mm in three (3) layers) of shore hardness 60 – 70 A.
1.7	Sampling Pipe	Stainless Steel to ASTM A312, Gr.304, Schedule-10.
1.13	PT plant sludge	Carbon Steel as per IS-1239 Heavy Grade up to 150 mm NB and IS-3589 for sizes above



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		150 mm.
<b>2.00.00</b>	<b>VALVES</b>	
2.1	<b><u>CAST IRON BODY BUTTERFLY VALVES:</u></b> i. Service: For Blow down water, clarified water, filtered water. ii. Basic Design Code: All the Butterfly valves shall be of wafer type of low leakage rate confirming to AWWA-C-504 class 150 (min.) or BS 5155. iii. Material of construction <ul style="list-style-type: none"><li>• Body: 2% Ni Cast Iron as per IS-210 Gr. FG260 with 2% Ni.</li><li>• Valve Disc: 2% Ni Cast Iron as per IS-210 Gr. FG260 with 2% Ni.</li><li>• Shaft: Stainless Steel ASTM-A-296 type 316.</li><li>• Seat ring: Nitrile rubber, EPDM (Ethylene propylene rubber), Hypalon.</li><li>• Shaft Bearing: Ferrobestos LA-33.</li><li>• Gland Packing: Impregnated Teflon</li><li>• Seal: Nitrile Rubber</li><li>• Handle: steel or malleable Cast Iron</li></ul> iv. Construction: Cast Body and Disc v. Pressure: To be suitably chosen according to requirement, but not less than class 75A as per AWWA-C-504. vi. All the butterfly valves shall be provided with Hand wheel or lever as per the requirements. vii. End preparation: Flanged, Drilled as per ANSI B16.5. Necessary counter flange nuts, bolts, gaskets are to be provided with each valve. viii. Testing: As per AWWA-C-504. However, valve disc strength for both forward reverse flow is to be carried out as per BS5155. All the butterfly valves Shall be provided with an indicator to show the position of the disc.	
2.2	<b><u>CAST IRON BODY GATE/GLOBE/CHECK/BALL VALVE</u></b> i. Service: For Service Water & Clarified Water. ii. Basic Design Code <ul style="list-style-type: none"><li>• Gate valve - IS 14846 for 50 mm - 1200 mm NB (or) API-600</li><li>• Gate valve- API 602 for below 50 mm.</li><li>• Globe valve - MSS - SP – 85 (or) BS-5352 up to 50 mm and above BS-1873</li><li>• Check valve - IS-5312/MSS - SP -71 (or) BS-5352 up to 50 mm and above BS-1868</li><li>• Ball - BS-5351</li></ul> iii. Pressure Class - To be suitably chosen considering the pressure requirement. iv. Construction: Cast body and bonnet / cover v. Material of Construction	





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- Body & Bonnet/ cover: IS 210 Gr. FG 260
- Trim / Disc.: IS-210 Gr. FG 260
- Seating surface: 13% Cr steel as per IS 1570
- Stem: Stainless steel AISI 410/ 13% chrome steel.
- End Preparation: Socket welded for size equal to and below 50mm NB and flanged with counter flanges for 65mm NB and above.

vi. Testing

- Gate: As per IS - 780 for 50 mm - 300 mm NB (or) API-598 up to 50 mm & API-598 above 50 mm
- Gate: IS-2906 for sizes equal to and above 350 mm NB
- Globe: Hydrostatic Test as per MSS-SP-85
- Check: S-5312/MSS-SP-71

2.3

**STAINLESS STEEL BODY/ GATE/GLOBE /CHECK/BALL VALVE**

i. Service: Potable Water, Service and Instrument Air.

ii. Sizes:

Potable Water - For sizes less than and equal to 50 mm NB.

Service and Instrument Air- For all sizes. Ball valves shall be used in air line.

iii. Basic Design Code

- Gate valve - ANSI-B-16.34
- Globe valve - ANSI-B-16.34
- Check valve - ANSI-B-16.34
- Ball - BS-5351

iv. Pressure Class - To be suitably chosen considering the pressure requirement as indicated below:

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

v. Construction: Forged body up to 50mm NB and Cast body above that

vi. Material of Construction

- Body & Bonnet/ cover: ASTM-A-182 F304 for Ball Valves:
- Body & Bonnet/ cover: A351 CF8M for cast body, A 182 F304 for forged body,
- Trim / Disc/Ball.: ASTM-A-182 F304 for Gate, Globe, Check valves and Stainless steel ASME-SA 479 Grade 316 for Ball valves.
- Seating surface: 13% Cr steel as per IS 1570. For Ball valves PTFE seats and seals.
- End Preparation: Socket welded for size equal to and below 50mm NB and flanged with counter flanges for 65mm NB and above.



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vii. Testing : As per ANSI B-16.34

2.4

**STEEL BODY GATE/ GLOBE/CHECK VALVE/ BALL VALVE**

- i. Service: Clarified water
- ii. Sizes: For sizes less than and equal to 50 mm NB
- iii. Basic Design Code
  - Gate valve - API 602 for less than 50mm NB. API 600 for sizes above 50 mm NB.
  - Globe valve - BS-1873/ANSI-B-16.34 (or) BS-5352 up to 50 mm & BS-1873 above 50 mm
  - Check valve - BS-1868/ANSI B16.34 (or) BS-5352 up to 50 mm & BS-1868 above 50 mm
  - Ball - BS-5351
- iv. Pressure Class - To be suitably chosen considering the pressure requirement as indicated below:

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

- i. Construction: Forged body
- ii. Material of Construction
  - Body & Bonnet/ cover: ASTM-A-216 Gr. WCB for cast body & ASTM-A-105 for forged body
  - Trim / Disc.: 13% Cr Steel as per ASTM-A- 182 Gr. F6 heat treated and hardened (min 250 NB) for cast body and ASTM-A-105 Hard faced with Stellite (min 350 HB) for forged body
  - Seating surface: 13% Cr. Steel as per ASTM-A- 182 Gr. F6
  - End Preparation: Socket welded for size equal to and below 50mm NB and flanged with counter flanges for 65mm NB and above.
- iii. Testing: As per ANSI B-16.34
  - Gate: As per API-598
  - Globe: BS-1873
  - Check: BS-1868

2.5

**DIAPHRAGM VALVE**

- i. Service: For FeCl<sub>3</sub> and poly electrolyte chemical.
- ii. The Diaphragm shall conform to following requirement
  - Design standard: BS: 5156 or equivalent of required rating/class. (Minimum rating of valves shall be PN 10).
  - Type: Flanged and lined body ends, sealed bonnet, weir pattern, tight shut off type



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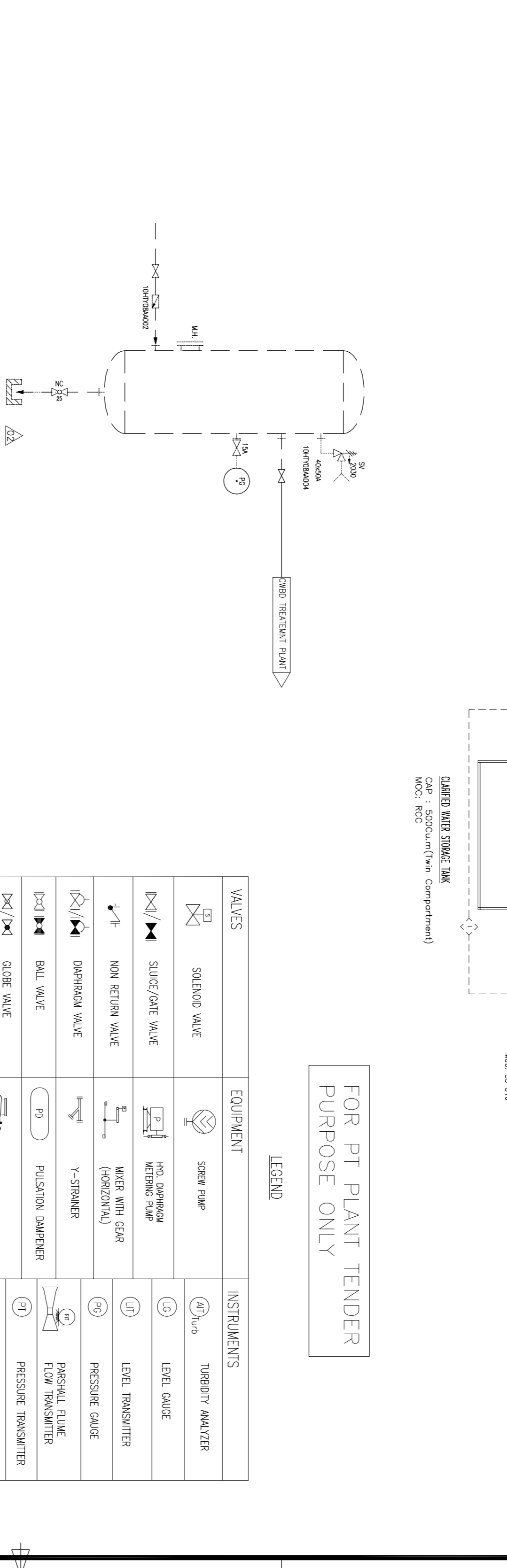
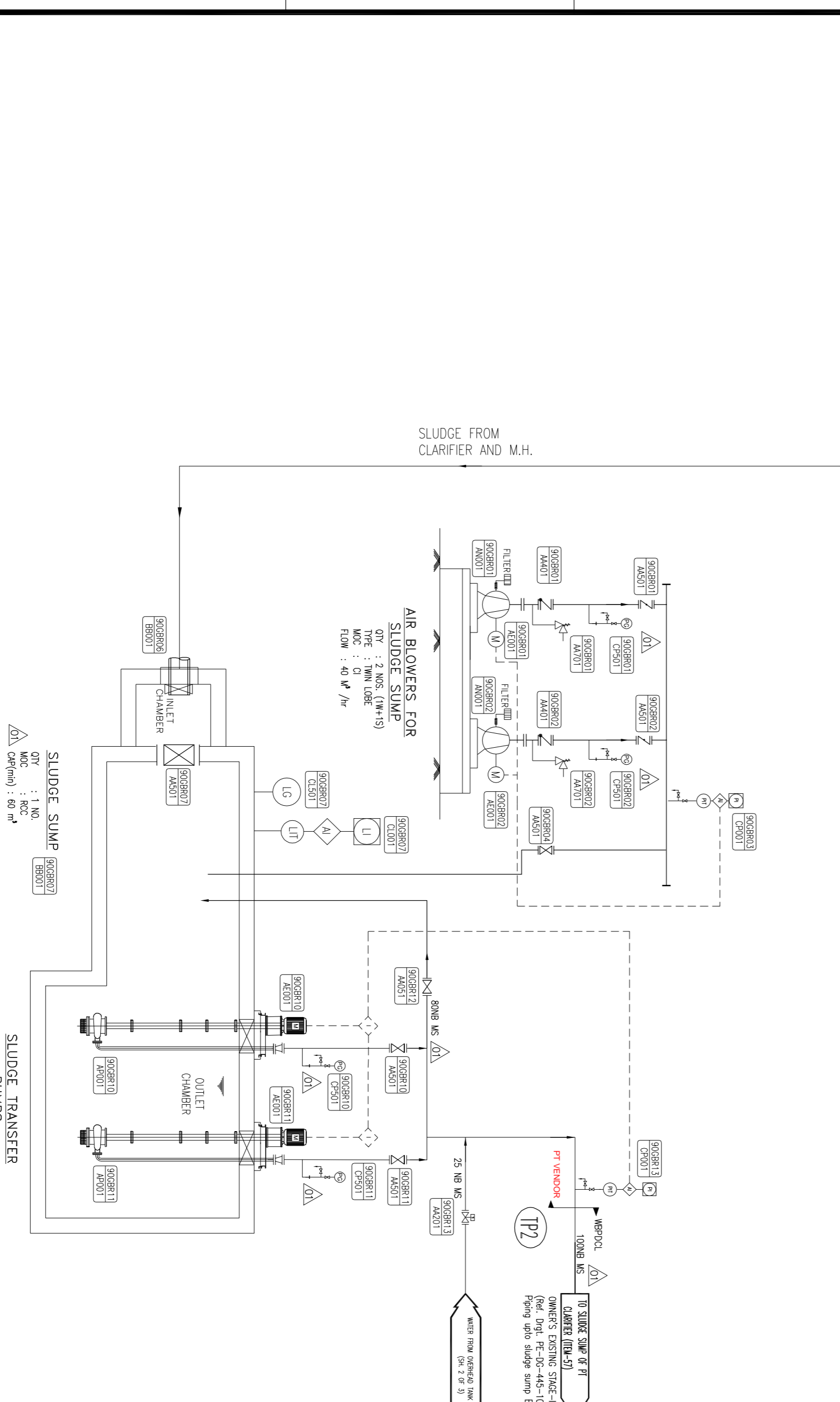
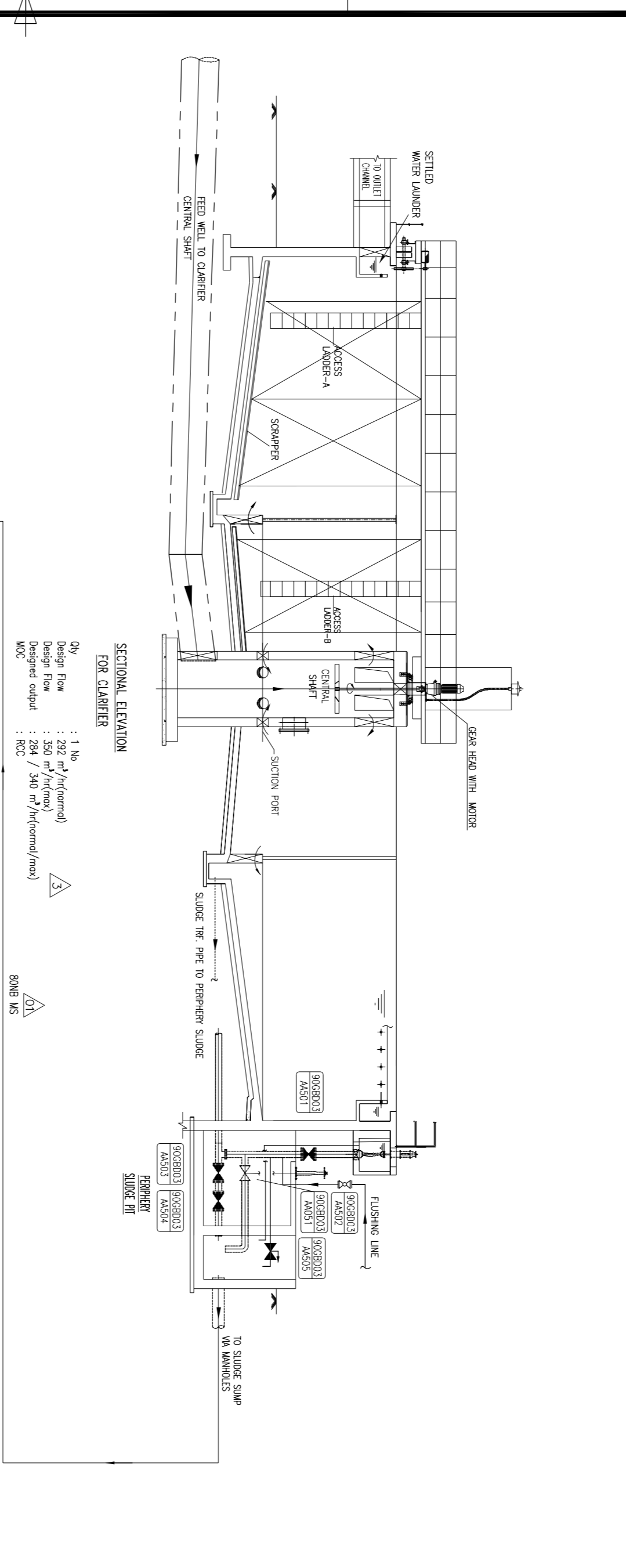
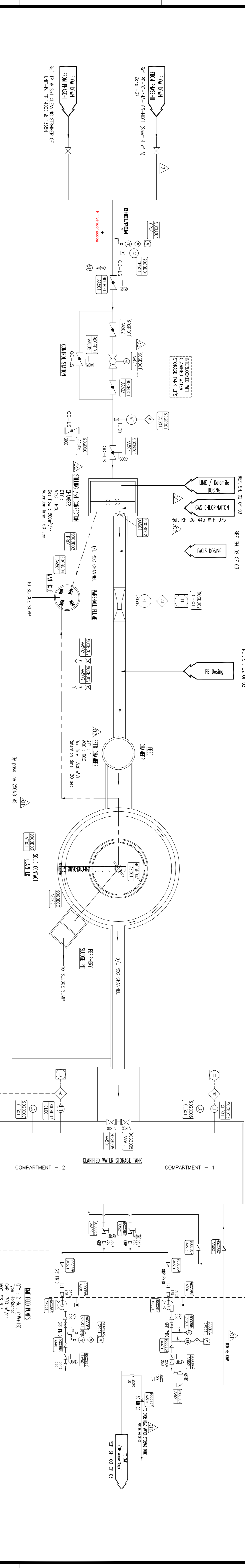
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	<ul style="list-style-type: none"><li>• Material of Construction</li><li>• Body, Bonnet: Cast iron IS 210 Gr. FG 260 or equivalent or Cast steel ASTM A-216 Gr. WCB</li><li>• Handwheel: Cast Iron</li><li>• Compressor: Stainless Steel</li><li>• Stem and Bush: Stainless Steel.</li></ul>
2.6	<p><b><u>ISOLATION GATES</u></b></p> <ul style="list-style-type: none"><li>i. Design standard for each gate shall be IS:3042 or Eqv.</li><li>ii. The gates shall be rectangular or square sluice, rising spindle type conforming to class-1 of IS:3042.</li><li>iii. Material of Construction of each gate:<ul style="list-style-type: none"><li>• Frame and Door: Cast Iron IS:210 Gr. 20</li><li>• Spindles, bolts &amp; nuts: M.S. to IS:2062</li><li>• Face &amp; seat rings: Gun metal (as per IS:3042).</li><li>• All the parts of each gates shall be applied with the coats of heavy duty bitumastic paint.</li><li>• Each of the gates Shall be provided with hand wheel, and a position indicator.</li><li>• Each gate shall be FRP coated on both sides</li></ul></li></ul>



- NOTES**
1. PIPE DIMENSIONS AND THICKNESS FOR STEEL UP TO 150 MM SHALL CONFORM TO IS : 1239 HEAVY GRADE.
  2. THE THICKNESS SPECIFICATION SHALL BE FOR AS PER PIPE SIZE AND PRESSURE RATING TO BE SPECIFIED IN THE LINE.
  3. ALL PIPE FLANGE DRILLING SHALL BE AS PER AISI B 16.5 # 150 CLASS.
  4. ALL WIDENED VALVES ARE OPERATED / CONTROLLED FROM DCS.
  5. THE INSTRUMENTATION FOR THE FINALIZATION OF LAYOUT, INCLUDING PIPES TO EACH VARIABLE SHALL BE TERMINATED WITH ISOLATION VALVE.
  6. THE INSTRUMENTATION FOR THE FINALIZATION OF LAYOUT, INCLUDING PIPES TO EACH VARIABLE SHALL BE TERMINATED WITH ISOLATION VALVE.
  7. SLUDGE FROM PERIPHERY SLUDGE THIS WILL BE LEFT INTO SLUDGE SWAPS VIA MAN HOLES. NO. OF MAN HOLES SHALL BE AS PER LAYOUT.
  8. TERMINAL POINT LOCATION WILL BE PROVIDED IN MECHANICAL CAD FOR CLARIFIER AND SCRAPER BRIDGE. (OCC NO. RP-02-445-WP-A006)
  9. TERMINAL POINT LOCATION WILL BE PROVIDED IN MECHANICAL CAD FOR CLARIFIER AND SCRAPER BRIDGE. (OCC NO. RP-02-445-WP-A006)
  10. DESIGN DETAILS WILL BE PROVIDED IN MECHANICAL CAD FOR CLARIFIER AND SCRAPER BRIDGE. (OCC NO. RP-02-445-WP-A006)
  11. BHEL WILL TERMINATE THE SLUDGE PIPE UP TO THE OWNER'S EXISTING STAGE-II SLUDGE PIT OF RAW WATER TREATMENT PLANT.

- REFERENCE DRAWINGS :**
1. P&ID TYP - CWK ACW DMC RP-02-445-163-A001
  2. P&ID TYP - CWK ACW DMC RP-02-445-163-A002
  3. P&ID TYP - CWK ACW DMC RP-02-445-163-A003
  4. CLARIFIER DESIGN DETAILS REFER DRG NO. RP-02-445-WP-A006

FOR PT PLANT TENDER  
 PURPOSE ONLY

**LEGEND**

VALVES	EQUIPMENT	INSTRUMENTS

**MECHANICAL / INST. KEY**

MECHANICAL :	EQUIPMENT / INST. NO. KEY
A-1 : WATER	00 - CLARIFIER
B-1 : AIR	01 - AIR RECEIVER
C-1 : AIR BLOWERS	02 - AIR BLOWERS
D-1 : AIR RECEIVER	03 - AIR RECEIVER
E-1 : AIR RECEIVER	04 - AIR RECEIVER
F-1 : AIR RECEIVER	05 - AIR RECEIVER
G-1 : AIR RECEIVER	06 - AIR RECEIVER
H-1 : AIR RECEIVER	07 - AIR RECEIVER
I-1 : AIR RECEIVER	08 - AIR RECEIVER
J-1 : AIR RECEIVER	09 - AIR RECEIVER
K-1 : AIR RECEIVER	10 - AIR RECEIVER
L-1 : AIR RECEIVER	11 - AIR RECEIVER
M-1 : AIR RECEIVER	12 - AIR RECEIVER
N-1 : AIR RECEIVER	13 - AIR RECEIVER
O-1 : AIR RECEIVER	14 - AIR RECEIVER
P-1 : AIR RECEIVER	15 - AIR RECEIVER
Q-1 : AIR RECEIVER	16 - AIR RECEIVER
R-1 : AIR RECEIVER	17 - AIR RECEIVER
S-1 : AIR RECEIVER	18 - AIR RECEIVER
T-1 : AIR RECEIVER	19 - AIR RECEIVER
U-1 : AIR RECEIVER	20 - AIR RECEIVER
V-1 : AIR RECEIVER	21 - AIR RECEIVER
W-1 : AIR RECEIVER	22 - AIR RECEIVER
X-1 : AIR RECEIVER	23 - AIR RECEIVER
Y-1 : AIR RECEIVER	24 - AIR RECEIVER
Z-1 : AIR RECEIVER	25 - AIR RECEIVER

**CUSTOMER No. : RAW2**

**CUSTOMER :**  
 THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD. (WBPDCL)  
 1480BWS/SAVADIGHI THERMAL POWER EXTENSION PROJECT (UNIT #9)

**CONSULTANT :**  
 BHARAT HEAVY ELECTRICALS LTD.  
 BOILER AUXILIARIES PLANT  
 KOLKATA

**DEVELOPMENT CONSULTANTS PRIVATE LIMITED**

**DATE :** 08/07/2021

**SCALE :** NTS

**DRG NO. :** 1-WT-220-01802

**SHEET :** 01 of 03

**REV :** 02

**APPD. :** MSA

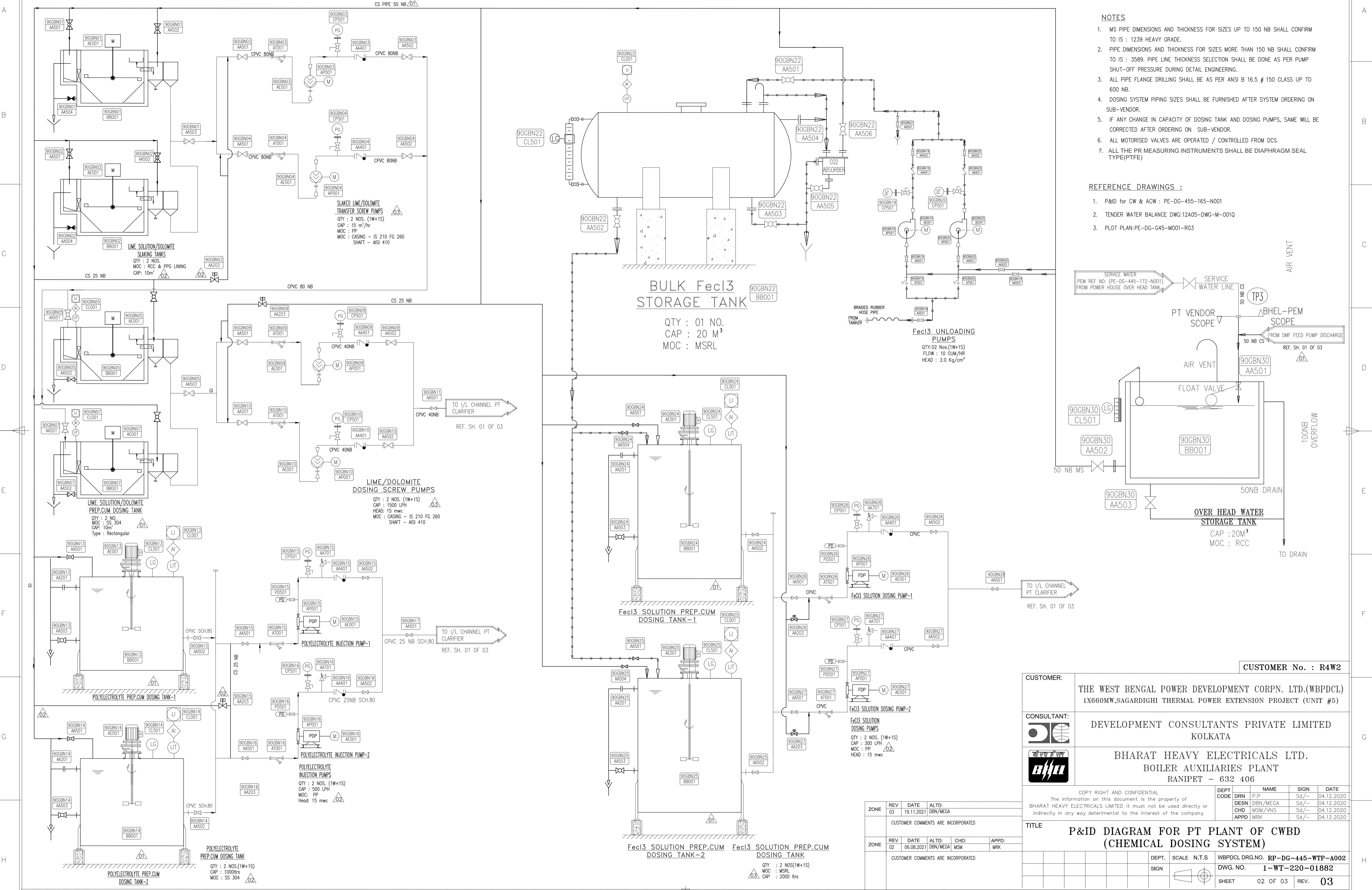
**CHKD. :** MSA

**DATE :** 08/07/2021

**REV. I :** 02

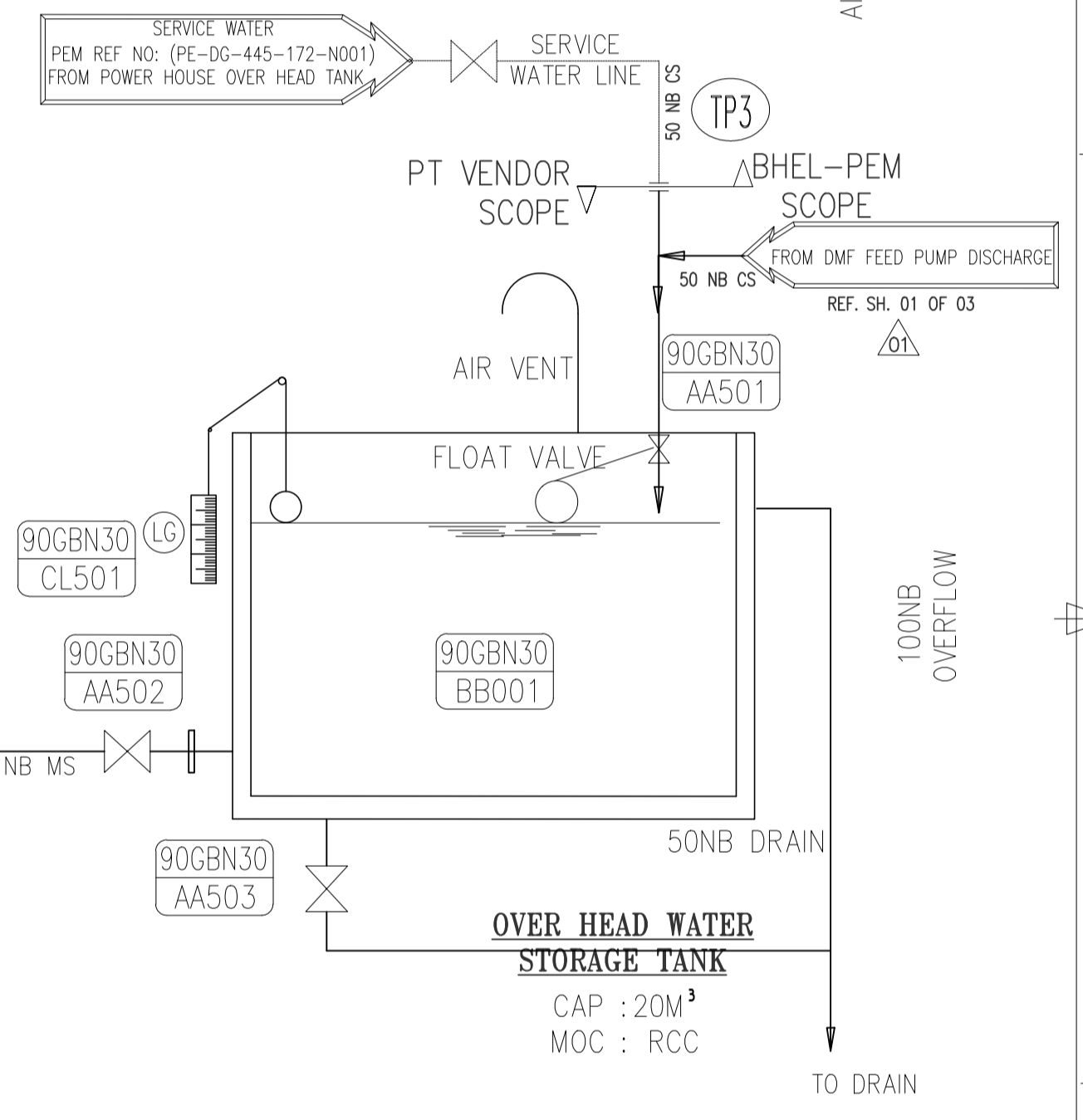
**ZONE :**

**TITLE :** P&ID DIAGRAM FOR PT PLANT OF CWBD (CLARIFIER SYSTEM)



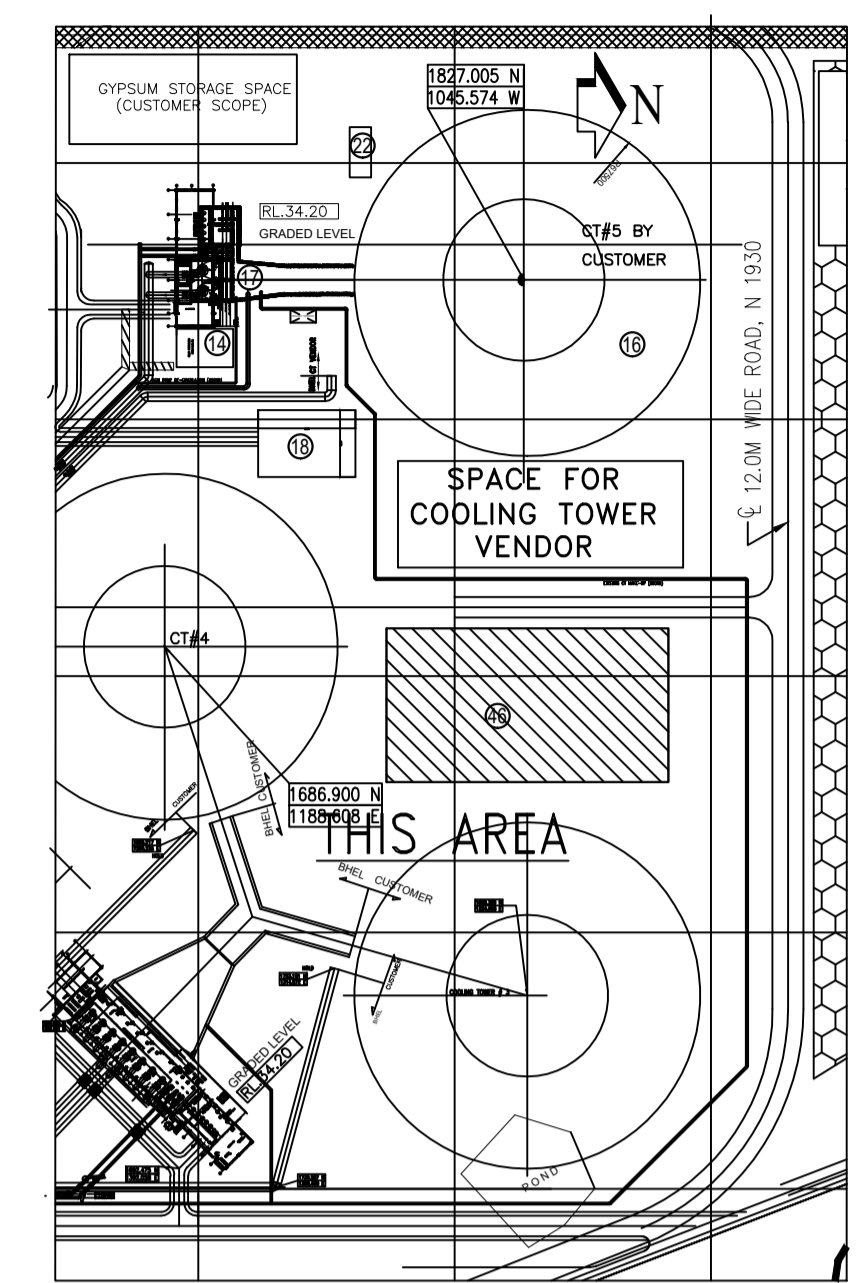
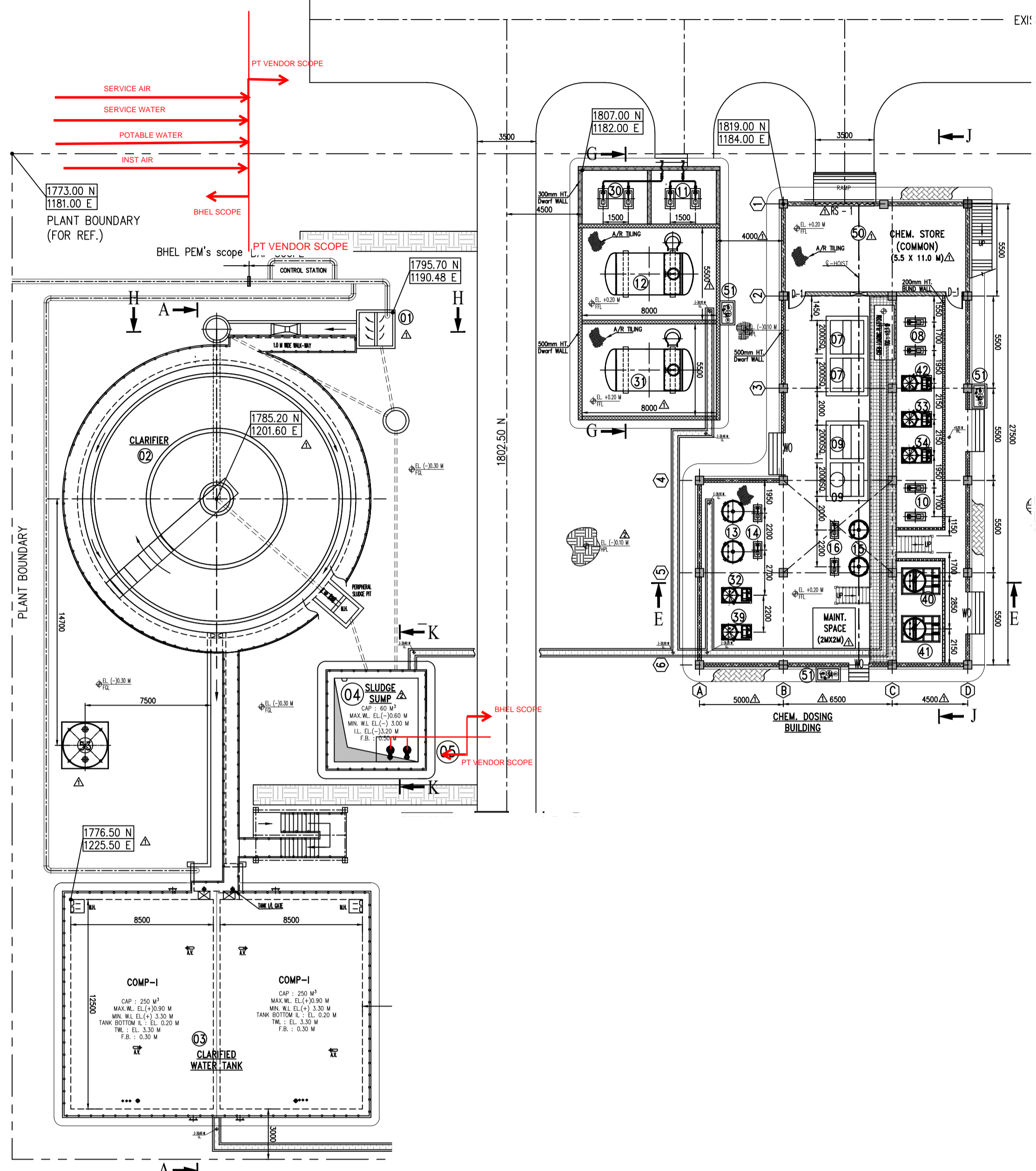
- NOTES**
- MS PIPE DIMENSIONS AND THICKNESS FOR SIZES UP TO 150 NB SHALL CONFIRM TO IS : 1239 HEAVY GRADE.
  - PIPE DIMENSIONS AND THICKNESS FOR SIZES MORE THAN 150 NB SHALL CONFIRM TO IS : 3589. PIPE LINE THICKNESS SELECTION SHALL BE DONE AS PER PUMP SHUT-OFF PRESSURE DURING DETAIL ENGINEERING.
  - ALL PIPE FLANGE DRILLING SHALL BE AS PER ANSI B 16.5 # 150 CLASS UP TO 600 NB.
  - DOSING SYSTEM PIPING SIZES SHALL BE FURNISHED AFTER SYSTEM ORDERING ON SUB-VENDOR.
  - IF ANY CHANGE IN CAPACITY OF DOSING TANK AND DOSING PUMPS, SAME WILL BE CORRECTED AFTER ORDERING ON SUB-VENDOR.
  - ALL MOTORISED VALVES ARE OPERATED / CONTROLLED FROM DCS.
  - ALL THE PR MEASURING INSTRUMENTS SHALL BE DIAPHRAGM SEAL TYPE (PTFE)

- REFERENCE DRAWINGS :**
- P&ID for CW & ACW : PE-DG-455-165-N001
  - TENDER WATER BALANCE DWG: 12A05-DWG-M-001Q
  - PLOT PLAN: PE-DG-445-M001-R03



<b>CUSTOMER:</b>		CUSTOMER No. : R4W2			
		THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD.(WBPCL) 1X660MW,SAGARDIGHI THERMAL POWER EXTENSION PROJECT (UNIT #5)			
<b>CONSULTANT:</b>		DEVELOPMENT CONSULTANTS PRIVATE LIMITED KOLKATA			
		BHARAT HEAVY ELECTRICALS LTD. BOILER AUXILIARIES PLANT RANIPET - 632 406			
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<b>DEPT CODE</b>		<b>DRN</b>	<b>P.P</b>	<b>NAME</b>	<b>SIGN</b>
03		02	02	DBN/MEGA	Sd/-
02		02	02	MSM/MEGA	Sd/-
02		02	02	MNS/VNS	Sd/-
02		02	02	MRK	Sd/-
<b>TITLE</b>					
<b>P&amp;ID DIAGRAM FOR PT PLANT OF CWBD (CHEMICAL DOSING SYSTEM)</b>					
<b>DEPT.</b>		<b>SCALE</b>	<b>N.T.S</b>	WBPCL DRG.NO. RP-DG-445-WTP-A002	
03				DWG. NO. 1-WT-220-01882	
<b>SHEET</b>				<b>REV.</b>	<b>03</b>
02 OF 03					





KEY-PLAN

**EQUIPMENT LIST :**

EQPT. NO	DESCRIPTION	CAPACITY	QUANTITY	EQPT. DIMENSION IN MTR.(Approx.)
01	STILLING CHAMBER	292 m <sup>3</sup> /hr	1	2.0LX2.0WX2.0H
02	CLARIFIER	292 m <sup>3</sup> /hr	1	#16.0 X 4.35H(CYL)
03	CLARIFIED WATER TANK (TWIN COMP.)	250 m <sup>3</sup> each	1	12.5LX8.5WX3.4H
04	SLUDGE SUMP	60 m <sup>3</sup>	1	5.0LX5.0WX3.3D
05	SLUDGE TRANSFER PUMP	60 m <sup>3</sup> /hr	2(1W+1S)	#0.5 X 3.3 H
06	SLUDGE SUMP BLOWERS	40 m <sup>3</sup> /hr	2(1W+1S)	1.0LX0.7WX0.7H
07	LIME SLAKING TANK	10 m <sup>3</sup>	2	2.0LX2.0WX2.5H
08	SLAKED LIME TRANSFER PUMP	15 m <sup>3</sup> /hr	2(1W+1S)	1.2LX0.5WX0.5H
09	LIME DOSING TANK	10 m <sup>3</sup>	2	2.0LX2.0WX2.5H
10	LIME DOSING PUMP	1500 LPH	2(1W+1S)	1.2LX0.5WX0.5H
11	FeCl <sub>3</sub> UNLOADING PUMP	10 m <sup>3</sup> /hr @ 2 kg/cm <sup>2</sup>	2(1W+1S)	1.0LX0.4WX0.4H
12	BULK FeCl <sub>3</sub> TANK	20 m <sup>3</sup>	1	#3.0X5.5L (CYL)
13	FeCl <sub>3</sub> DOSING TANK	1500 litres	2(1W+1S)	#1.2X1.75H (CYL)
14	FeCl <sub>3</sub> DOSING PUMP	300 LPH	2(1W+1S)	1.0LX0.5WX0.4H
15	POLYELECTROLYTE DOSING TANK	1000 litres	2(1W+1S)	#1.0X1.7H (CYL)
16	POLYELECTROLYTE DOSING PUMP	500 LPH	2(1W+1S)	1.0LX0.5WX0.4H
17	DMF FEED PUMP	300 m <sup>3</sup> /hr	2(1W+1S)	1.4LX0.6WX0.6H
18	DMF MEDIA FILTER	150 m <sup>3</sup> /hr	3(2W+1S)	#4.5X2.0L (CYL)
19	DMF BACKWASH TANK	120 m <sup>3</sup>	1	15.5LX3.5WX3.35H
20	DMF BACKWASH PUMP	400 m <sup>3</sup> /hr @ 2 kg/cm <sup>2</sup>	2(1W+1S)	1.4LX0.6WX0.6H
21	DMF BLOWERS	800 m <sup>3</sup> /hr @ 5-9 PSI	2(1W+1S)	2.3LX1.9WX2.0H
22	UF BASKET STRAINER	300 m <sup>3</sup> /hr	2(1W+1S)	#0.8X1.6H
23	UF SKIDS	153 m <sup>3</sup> /hr	2	4.1LX2.1WX2.5H
24	UF BACKWASH TANK	12 m <sup>3</sup>	1	#2.6X2.7H
25	UF BACKWASH PUMPS	100 m <sup>3</sup> /hr @ 3 kg/cm <sup>2</sup>	2(1W+1S)	1.4LX0.6WX0.6H
26	UF AIR BLOWERS	280 m <sup>3</sup> /hr @ 5-9 PSI	2(1W+1S)	2.3LX1.9WX2.0H

EQPT. NO	DESCRIPTION	CAPACITY	QUANTITY	EQPT. DIMENSION IN MTR.(Approx.)
27	UF CIP TANK	12 m <sup>3</sup>	1	#2.6X2.7H
28	UF CIP PUMP	165 m <sup>3</sup> /hr @ 3.0 kg/cm <sup>2</sup>	2(1W+1S)	1.4LX0.6WX0.6H
29	UF PERMEATE TANK (TWIN COMP.)	300 m <sup>3</sup> each	1	15.5LX3.5WX3.35H
30	HCl UNLOADING PUMP	10 m <sup>3</sup> /hr @ 2.0 kg/cm <sup>2</sup>	2(1W+1S)	1.0LX0.4WX0.4H
31	BULK HCl TANK	20 m <sup>3</sup>	1	#2.5X4.0L (CYL)
32	HCl DOSING SKID - UF	Tank: 500 Ltrs; Pump: 10-50LPH	1	1.8LX1.0WX1.5H
33	NaOCl DOSING SKID - UF	Tank: 500 Ltrs; Pump: 10-50LPH	1	1.8LX1.0WX1.5H
34	Citric DOSING SKID - UF	Tank: 500 Ltrs; Pump: 10-50LPH	1	1.8LX1.0WX1.5H
35	BWRO FEED PUMP	153 m <sup>3</sup> /hr @ 3.5 kg/cm <sup>2</sup>	3(2W+1S)	1.4LX0.6WX0.6H
36	BWRO CARTRIDGE FILTER	153 m <sup>3</sup> /hr	3(2W+1S)	#0.8X2.365H
37	BWRO RP PUMP	153 m <sup>3</sup> /hr @ 13 kg/cm <sup>2</sup>	4(2W+2S)	#0.8X2.0H
38	BWRO SKID	---	2W	6.6LX2.4WX2.3H
39	HCl DOSING SKID - RO	Tank: 500 Ltrs; Pump: 50LPH	1	1.8LX1.0WX1.5H
40	ANTISCALANT DOSING SKID - RO	Tank: 2000 Ltrs; Pump: 50LPH	1	2.4LX1.6WX2.2H
41	SMS DOSING SKID - RO	Tank: 2000 Ltrs; Pump: 50LPH	1	2.4LX1.6WX2.2H
42	pH CORRECTION DOSING SKID - RO	Tank: 500 Ltrs; Pump: 50LPH	1	2.4LX1.6WX1.5H
43	REJECT SUMP	300 m <sup>3</sup>	1	15LX0.7WX2.9H
44	REJECT SUMP PUMP	145 m <sup>3</sup> /hr @ 3.5 kg/cm <sup>2</sup>	2(1W+1S)	#0.7 X 2.8 H
45	BWRO OF TANK	12 m <sup>3</sup>	1	#2.6X2.7H
46	BWRO CIP PUMP	150 m <sup>3</sup> /hr @ 5 kg/cm <sup>2</sup>	2(1W+1S)	1.4LX0.6WX0.6H
47	BWRO CIP CARTRIDGE FILTER	150 m <sup>3</sup> /hr	1W	#0.8X2.365H
48	SERVICE WATER TANK	20 m <sup>3</sup>	1	6.2LX5.2WX1.0H
49	UTILITY WATER TANK	2.5 m <sup>3</sup>	1	#1.8X1.4H
50	MONORAIL HOST @ Chemical House	1 MT	1	
51	SAFETY SHOWERS	---	3	
52	UF CIP CARTRIDGE FILTER	160 m <sup>3</sup> /hr	1W	#0.8X2.365H
53	AIR BLOWER TANK (SUPPLY BY BHEL PEM)	10 m <sup>3</sup>	1W	#2.6X2.7H
54	MONORAIL HOST @ UF-RO building	2 MT	1	
55	MONORAIL HOST @ Clear Water Pump House	1 MT	1	
56	SAMPLING POINT-1	---	1	
57	SAMPLING POINT-2	---	1	

**LEGEND :**

- FGL - FINISHED GRADED LEVEL
- FFL - FINISHED FLOOR LEVEL
- RS - ROLLING SHUTTER
- DD - DOUBLE DOOR
- D - SINGLE DOOR
- HPL - HIGH PAVED LEVEL
- FULL HEIGHT WALL
- PLATFORM
- 500 MM HEIGHT DWARF WALL
- 300 MM HEIGHT DWARF WALL
- 200 MM HEIGHT DWARF WALL
- DRAIN CHANNEL
- AIR TILED FLOOR
- PLINTH PROTECTION OF 1.0M WIDTH ALL AROUND BUILDING
- PAVEMENT

**ROLLING SHUTTER & DOOR SIZE DETAILS**

TAG	WIDTH IN M X HT. IN M	QTY
RS-1	3.5 X 4.0	01
RS-2	3.0 X 4.0	02
DD-1	2.2 X 2.1	06
D-1	1.2 X 2.1	05
D-2	1.0 X 2.1	06

**REFERENCE DRGS :**

- KEY PLAN : PE-DG-445-100-M001 LAT. REV.
- P&ID FOR PT : 1-WT-220-01882 / RP-DG-445-WTP-A002
- P&ID FOR UF : 1-WT-220-01884 / RP-DG-445-WTP-A004
- P&ID FOR RO : 1-WT-220-01885 / RP-DG-445-WTP-A005

**NOTES :**

- FINISHED GRADED LEVEL (FGL) ELEVATION OF THIS AREA IS -0.300 M WHICH CORRESPONDS TO RL (+)34.20 FROM MSL.
- UF-RO BUILDING & CHEMICAL DOSING FINISHED FLOOR LEVEL (FFL) EL. IS (+)0.20M
- SERVICE WATER TANK IS LOCATED ON THE TERRACE OF THE CHEMICAL DOSING BUILDING AS SHOWN IN THE DRAWING.
- EQPT. NO : 38 & 48 CONSISTS OF BWRO PROCESS CART. FILTERS FOR TWO WORKING STREAMS AND COMMON CIP CART FILTERS.
- LIME AND POLY ELECTROLYTE STORAGE ARE INSIDE CHEMICAL DOSING BUILDING.
- ALL THE DOSING SYSTEM ARE KEPT IN CHEMICAL DOSING BUILDING.
- EQUIPMENT LOCATION DIMENSION & PIPE LINE ROUTING ARE FOR INFORMATION. FINAL DIMENSION WILL BE FURNISHED DURING DETAILED ENGINEERING.
- DRAIN CHANNEL/TRENCH AND PIPE LINE SHOWN ARE TENTATIVE AND THESE SHALL BE UPDATED AFTER DETAILED ENGINEERING.
- ALL THE DRAIN CHANNELS LEADING TO RO REJECT SUMP SHALL BE COVERED WITH PRECAST SLAB.
- PLINTH PROTECTION OF 1.0 M WIDTH SHALL BE PROVIDED AROUND RCC BUILDING.
- ADEQUATE EXHAUST FANS IN UF-RO BUILDING SHALL BE PROVIDED IN SUITABLE LOCATION.
- MCC BUILDING IS TWO STOREYED. CABLE CELLAR ROOM, BATTERY ROOM AND TOILET SHALL BE ACCOMMODATED IN THE GROUND FLOOR. TRANSFORMERS, LTMCC, DCS & VFD PANELS, OPERATOR ROOM SHALL BE ACCOMMODATED IN THE FIRST FLOOR.
- FOR GROUND FLOOR PLAN & ELEVATION VIEW OF CONTROL ROOM, PLEASE REF DWG NO. RP-DG-445-WTP-E012.
- 1.2 M WIDE CONCRETE PAVING SHALL BE PROVIDED FOR PT AREA AS WALKWAY AS SHOWN IN THE PLAN.
- 500 MM DWARF WALL IS PROVIDED IN BULK CHEMICAL STORAGE AREA & STORAGE AREA WILL BE PPG LINED.
- HOISTS/CHAIN PULLEYS ARE PROVIDED FOR THE EQUIPMENT WT. 100 KG & ABOVE.
- CONCRETE PAVING SHALL BE PROVIDED IN BUILDING AREA AS SHOWN IN THE PLAN.

**CUSTOMER:**  
THE WEST BENGAL POWER DEVELOPMENT CORPN. LTD.(WBPDCI)  
1X660MW,SAGARDIGHI THERMAL POWER EXTENSION PROJECT (UNIT #5)

**CONSULTANT:**  
DEVELOPMENT CONSULTANTS PRIVATE LIMITED  
KOLKATA

**CLIENT:**  
BHARAT HEAVY ELECTRICALS LTD.  
BOILER AUXILIARIES PLANT  
RANIPET - 632 406

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DEPT CODE	NAME	SIGN	DATE
DRN	SHAKTHI	Sd/-	05.03.2021
DESN	BBS/MEGA/AK	Sd/-	05.03.2021
CHD	GR/VNS	Sd/-	05.03.2021
APPD	MRK	Sd/-	05.03.2021

**TITLE**  
EQUIPMENT LAYOUT FOR CWBD WATER TREATMENT PLANT

REV	DATE	ALTERED:	REV	DATE	ALTERED:
01	03.11.2021	CHECKED: A. KARMAKAR	01	04.09.2021	CHECKED: A. KARMAKAR

ZONE REVISED BASED ON CONSULTANT (DCPL) COMMENT DATED 30.09.2021

ZONE REVISED BASED ON CONSULTANT (DCPL) COMMENT DATED 08.06.2021

DEPT. SCALE N.T.S  
SIGN

WBPDCI DRG NO. RP-DG-445-WTP-A003  
DRG NO. 1-WT-220-01883  
SHEET 1 of 2 REV. 02

SUGGESTED PROCEDURE FOR JOINING UPVC/CPVC PIPES AND FITTINGS

I. GENERAL POINTS

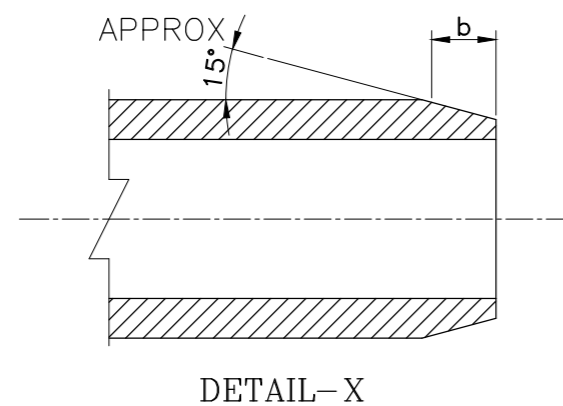
- 1) ALWAYS CAREFULLY INSPECT THE PIPES, FITTINGS AND VALVES FOR ANY EXTERNAL DAMAGE BEFORE JOINING.
- 2) TRIAL ASSEMBLE ALL PIPES AND FITTINGS WITHOUT SOLVENT CEMENTING. THIS WILL ENSURE THE PERFECT MATCHING (ESPECIALLY FLANGED JOINTS)
- 3) ALL PIPES SHOULD BE CUT SQUARE.
- 4) USE CUTTING TOOLS DESIGNED FOR THE PIPES CUTTING.
- 5) DEBURR AND BEVEL ALL UPVC/CPVC PIPE BEFORE JOINING, AS PER DETAIL-X AND FOR THE CORRESPONDING 'B' VALUE GIVEN IN TABLE -1
- 6) LIST OF TOOLS AND EQUIPMENTS REQUIRED:
  - A) PIPE CUTTER
  - B) PIPE CHAMFERING TOOL
  - C) CLEANER FOR UPVC/CPVC (APPROVED MAKE)
  - D) SOLVENT CEMENT FOR UPVC/CPVC (APPROVED MAKE)
  - E) SCRAPER, PENCIL, BRUSH COVER, WHITE ABSORBENT PAPER

II. DETAILED PROCEDURE

- 1) CLEAN THE SURFACE ENDS OF ALL PIPES AND FITTINGS TO BE JOINED USING APPROVED CLEANING SOLUTION. THE JOINING SURFACES SHOULD BE FREE OF DIRT, GREASE, WATER, MOULD RELEASE, OR OTHER FOREIGN SUBSTANCES. SOLVENT CEMENT SOLUTION APPROVED BY THE PIPES AND FITTINGS' SUPPLIER SHALL BE USED FOR JOINING THE UPVC/CPVC ITEMS. NO OTHER LOCAL MAKE WILL BE ACCEPTED.
- 2) USING A NATURAL BRISTLE BRUSH OF THE CORRECT WIDTH, APPLY A COMPLETE COATING OF SOLVENT CEMENT TO THE ENTIRE OUTSIDE SURFACE OF THE PIPE END TO BE INSERTED INSIDE THE FITTING AND TO THE MATING INSIDE SURFACE OF THE CONNECTING SOCKET OF THE FITTING AS FOLLOWS.
  - A) ON THE PIPE - BRUSH LIBERALLY ONCE AROUND THE ENTIRE SURFACE OF THE PIPE OD
  - B) ON THE FITTING - BRUSH LIGHTLY BUT COMPLETELY AROUND THE ENTIRE DEPTH OF THE SOCKET SURFACE.
  - C) ON THE PIPE - APPLY ANOTHER LIBERAL COATING OF CEMENT AS BEFORE.
  - D) IF THE SIZE OF THE PIPE IS MORE THAN 110MM, SOLVENT CEMENT SHOULD BE APPLIED TO THE PIPE AND FITTINGS SIMULTANEOUSLY BY TWO PEOPLE.
- 3) IMMEDIATELY UPON FINISHING THE CEMENT APPLICATION, INSERT THE PIPE INTO THE FULL SOCKET DEPTH OF THE FITTING WITHOUT ANY ROTATION OF PIPE OR FITTING.
- 4) HOLD THE JOINT TOGETHER FOR A MINIMUM OF 10 TO 15 SECONDS TO ENSURE THAT THE PIPE DOES NOT BACK OUT OF THE SOCKET.
- 5) IMMEDIATELY AFTER JOINING, WIPE ALL EXCESS CEMENT FROM THE SURFACE OF THE PIPE AND FITTINGS INCLUDING ANY GLOBES OF CEMENT THAT MAY HAVE BEEN DROPPED ON TO THE PIPE OR FITTING.

TABLE-1

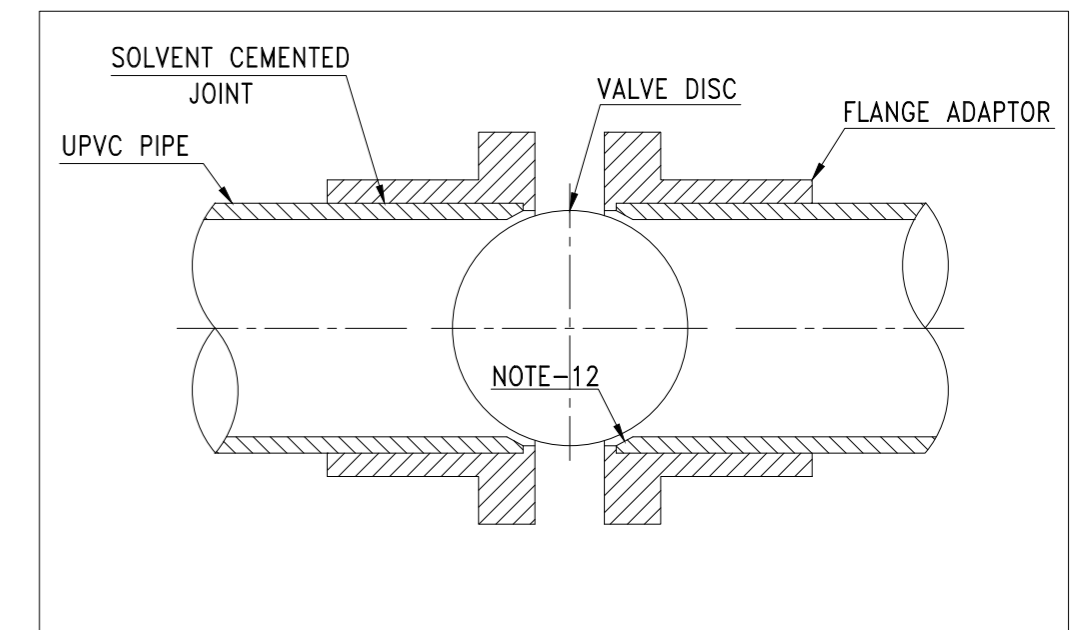
PIPE OD	DIM b
6-16 MM	1-2 MM
20-50 MM	2-4 MM
63-315 MM	4-6 MM



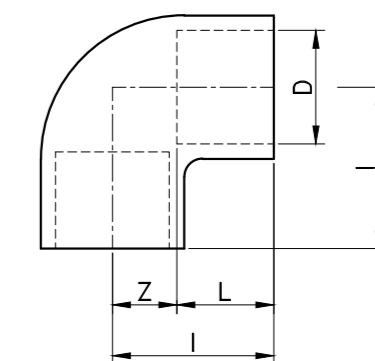
III. SPECIAL POINTS

- 1) DO NOT ATTEMPT TO CEMENT WET SURFACES. (DO NOT DO CEMENTING IN THE RAIN)
- 2) PIPE, FITTINGS AND SOLVENT CEMENT SHOULD BE KEPT AT THE SAME TEMPERATURE FOR ATLEAST AN HOUR PRIOR TO CEMENTING.
- 3) USE ONLY NATURAL BRISTLE BRUSHES FOR APPLYING SOLVENT CEMENT. DO NOT USE SYNTHETIC BRISTLE BRUSHES, AS THE SOLVENT SOLUTION WILL DISSOLVE SYNTHETIC BRISTLES.
- 4) WHEN THE AMBIENT TEMPERATURE IS ABOVE 38°C AND UNDER DIRECT EXPOSURE TO SUN, CEMENTING SHOULD BE DONE AS FOLLOWS.
  - A) SHADE THE JOINT SURFACES FROM EXPOSURE TO SUN'S RAYS FOR A MINIMUM OF ONE HOUR PRIOR TO JOINING AND CONTINUE JOINING IN THE SHADE.
  - B) APPLY CEMENT QUICKLY AND INSERT PIPE INTO THE SOCKET AS QUICKLY AS POSSIBLE AFTER APPLYING CEMENT.
- 5) DO NOT USE CLEANING AND SOLVENT CEMENTS DESIGNED FOR A PARTICULAR PLASTIC WITH ANOTHER PLASTIC MATERIAL. CPVC CLEANING AND SOLVENT CEMENT SHOULD BE USED ONLY FOR ALL CPVC JOINTS (CPVC SHOULD BE USED FOR ALL APPLICATIONS OF HOT WATER) DO NOT USE THE CEMENTS BEYOND THE DATE OF EXPIRY.
- 6) ON PIPES WITH OD 160MM OR MORE, ESPECIALLY IN HOT WEATHER, TWO MEN SHOULD APPLY CEMENT TO THE PIPE WHILE ONE MAN IS APPLYING CEMENT TO THE FITTINGS TO MINIMIZE APPLICATION TIME, THEREBY AVOIDING PREMATURE SETTING IN EARLIER COATS OF CEMENT.
- 7) DO NOT DISCARD EMPTY CEMENT CANS NEAR PLASTIC PIPE.
- 8) IF CEMENT BECOMES LUMPY AND STRING, THROW IT AWAY. DO NOT ATTEMPT TO THIN OUT SLUGGISH CEMENT WITH THINNER OR PRIMER. THROWING AWAY POTENTIALLY INEFFECTIVE CEMENT IS LESS COSTLY THAN FIXING A LEAK.
- 9) APPROPRIATE JOINT DRYING TIME SHOULD ELAPSE BEFORE THE CEMENT JOINT IS MOVED OR SUBJECTED TO INTERNAL OR EXTERNAL PRESSURE. (FOR ADDITIONAL INFORMATION, CATALOGUE OF THE SUPPLIER OF THE PIPES AND FITTINGS SHOULD BE REFERRED TO)
- 10) FOR DECIDING THE LENGTH OF THE PIPE BETWEEN FITTINGS THE LAYING LENGTH (Z) AND SOCKET DEPTH (L) OF THE FITTINGS ARE TO BE TAKEN INTO ACCOUNT. REFER TYPICAL FITTING DIMENSION DETAILS.
- 11) TANGIT MAKE OF BOTH SOLVENT CEMENT AND CLEANING SOLUTION MANUFACTURED BY GEORGE FISCHER SHOULD BE USED FOR ALL UPVC JOINTS. SEPARATE SOLVENT CEMENT AND CLEANING SOLUTION FOR CPVC SHOULD BE USED.
- 12) GRINDING OF THE INSIDE SURFACE OF THE PIPE FOR THE BFV SHOULD BE DONE TO THE REQUIRED DIMENSION PRIOR TO JOINING THE PIPE WITH SOLVENT CEMENT, FOR BFV OF SIZES DN150 AND ABOVE UNDER THE SUPERVISION OF BHEL ENGINEER.
- 13) ALL UPVC/CPVC PIPE LINE ( EXCEPT ACID LINE) SUBJECTED TO A HYDRAULIC TEST PRESSURE OF 9 KG/SQ.CM AFTER COMPLETION OF ERECTION . ACID LINE SUBJECTED TO PNEUMATIC TEST PRESSURE OF 6 KG/SQ.CM. AIR LINE (HDPE ) TO BE SUBJECTED TO A PNEUMATIC TEST PRESSURE OF 3 KG/SQ.CM.

PIPE CORRECTION DETAIL FOR BFV DISC MOVEMENT



TYPICAL FITTING DIMENSION DETAILS



Dim. (D)	Dim. (I)	Dim. (Z)	Dim. (L)
20	27	11	16
32	39	17	22
50	57	26	31
63	71	33	38
75	83	39.5	43.5
90	97	46	51
110	116	55	61
160	166	80	86
225	233	114	119
280	298	151	147
315	332	168	164

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		DEPT FANS CODE 864	GRADE OF UNTOL.DIM PR: QA: 500	SCALE 	WEIGHT (KG). REF. TO ASSY/OLD DRG. <b>2-BW-220-00196</b>
TITLE <b>UPVC/CPVC JOINING PROCEDURE</b>		CARD CODE U 01	DRAWING NO. <b>2-WT-220-00057</b>		NO.OF VAR. NO.OF ITEMS REV

REV	DATE	ALTERED
		CHECKED
ZONE		



### **ELECTRIC OPERATED HOISTS**

BHEL will provide one number 415 V (3ph, 4W) supply feeder only up to isolating switches for cranes. Any other voltage level (AC/DC) required will be derived by the vendor. Motor starter shall be part of crane control panel. Each hoist shall be provided with Isolating switch (Bidder scope) mounted at floor level and further cabling from isolator to hoist is in bidder scope. Motor shall be as per relevant motor specification should be suitable for hoist duty. However, motor shall be suitable for 240 starts per hour.

Electric hoist shall include but not be limited to the following: -

- a. Hoisting and CT drive arrangement
- b. All electrical equipment including isolator, cables, limit switches and control panel.
- c. Shrouded bus bar DSL/ Flexible trailing (festoon) cable
- d. Earthing arrangement.
- e. Fill of lubricant till commissioning.
- f. Painting of electric hoist and accessories.
- g. Maintenance tools & Tackles
- h. Erection & Commissioning spares
- i. Isolating switch in enclosure at operating floor for disconnecting supply to DSL while maintaining the electric hoist.

### **DESIGN CRITERIA**

Capacity of electric and manual (Chain pulley block) hoists shall be decided keeping 25% margin over heaviest equipment to be handled.

For hand operated hoists, the hoists shall be suitable for operation from floor level. Hand chain shall be provided for long travel of trolley and the Hoisting mechanism. For electric hoist, operator shall be able to control the movement of the electrical hoist with the help of floor operated pendant.

Note

1. Area, type, capacity mentioned are minimum requirement and shall be finalized during detail engineering without any commercial implication
2. Travel and Lift are layout dependent and shall be finalized during detail engineering without any commercial implication
3. Additional electric/manual hoist required during detail engineering shall be provided as per design criteria given above without any commercial implication.

### **DEMONSTRATION TEST**

Hoist along with its drives, controls and other accessories shall be demonstrated for the rated capacity against the rated speed of motions and for the service conditions specified as specified in QAP and as per IS 3938 for electric hoist and IS 3832 for manual hoist.

The bidder shall have the full responsibility for the safe and efficient operation of the hoist with associated accessories as a single unit.

If the shop/site performance tests indicate the failure of any of the components to achieve the guaranteed performance, the deficiency shall be made good at bidder's cost.

Demonstration tests shall be carried out each time after the rectification /modification is carried out.

### **TESTING AT SITE**

A) ELECTRIC HOIST:

As required for statutory clearance for operating at site i.e., overload test, load test and other tests as per IS 3938.

Test for Operation -After the supply has been connected, tests shall be carried out to prove the following:

- a) The satisfactory operation of each controller, switch, contactor, relay and other control devices and in particular the correct operation of all limit switches under the most unfavorable conditions;
- b) The correctness of all circuits and interlocks and sequence of operation; and
- c) The satisfactory operation of all protective devices.

Overload Test - After test but before the hoist is put into service, it shall be tested with overload relays appropriately set, to lift and sustain a test load of 125 percent of the working load. During the overload test, the hoist shall sustain the load under full control. The specified speeds need not be attained but the hoist shall show itself capable of dealing with the overload without difficulty.

#### **DRAWING/DOCUMENT SUBMISSION**

The successful bidder shall submit the following drawings / documents during detail engineering for customer's approval /information:

- Manufacturing Quality Plan with Sub vendor list
- GA Drawing for Electric Hoist, DSL arrangement and painting details
- Schematic Circuit Diagram
- Mechanism Sizing Calculation
- Detailed BOM/BOQ for EOH

O& M Manual including Erection procedure



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**EPC Bid Document  
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## **CONTENT**

<b>CLAUSE NO.</b>	<b>DESCRIPTION</b>
1.00.00	GENERAL INFORMATION
2.00.00	CODES AND STANDARDS
3.00.00	SCOPE OF WORK
4.00.00	SPECIFIC DESIGN REQUIREMENTS
5.00.00	DESIGN AND CONSTRUCTION
6.00.00	INSPECTION AND TESTING
7.00.00	DRAWINGS, DATA AND INFORMATION



**Development Consultants Pvt. Ltd.**

**Volume : II-K  
Section : III  
Miscellaneous Hoists**





## MISCELLANEOUS HOISTS

### 1.00.00 GENERAL INFORMATION

- 1.01.00 The hoists will be used for erection and maintenance of various equipment in different buildings under the scope of Entire Package, except FGD and Coal Handling Plant, of 1 x 660 MW Sagardighi Thermal Power Project Unit 5, Phase-III.
- 1.02.00 Hoists are divided into two separate groups - (a) Hand operated and (b) Electric operated.

### 2.00.00 CODES AND STANDARDS

The design, manufacture and testing of the equipment covered under this specification shall conform to the latest editions of the following Indian Standards:

- 2.01.00 IS : 3832 : Specification for Hand Operated Chain Pulley-blocks.
- 2.02.00 IS : 807 : Code of Practice for Design, Manufacture, Erection and Testing (Structural Portion) of Cranes and Hoists.
- 2.03.00 IS : 6216 : Short link Chain, Grade T(8) for Pulley-blocks & other Lifting Appliances.
- 2.04.00 IS : 2429 (part -I) : Non-calibrated Load Chain for Lifting Purposes.
- 2.05.00 IS : 15560 : Point Hook with Shank up to 160 tones - Specification
- 2.06.00 IS : 3938 : Specification for Electric Wire Rope Hoists.

and other Indian Standards referred to in the above standards.

### 3.00.00 SCOPE OF WORK

- 3.01.00 Hoists shall be provided in all areas under the scope of this specification (except the areas covered by E.O.T. cranes) where any equipment/component weighing above 100 kg is installed and needs to be handled for maintenance purposes. Number of monorail beams shall be such that the centre line of the hoist and the centre line of equipment to be handled shall be not more than 500 mm.





- 3.01.01 The location and no. of hoists is to be finalised during detailed engineering. Final arrangement is subject to approval of Owner/Consultant.
- 3.01.02 Monorail hoists shall at least be provided in the areas mentioned in Annexure-I. The list is indicative only and not an exhaustive one.
- 3.01.03 Besides monorail hoists, fixed Chain Pulley blocks of following capacities shall be provided:

<b>Capacity (T)</b>	<b>Nos.</b>
1	10
3	10
5	8
10	3

- 3.02.00 All drive motors and driving gears as necessary.
- 3.03.00 Limit switches for electrical hoist as necessary.
- 3.04.00 Trailing cable with all supporting fixtures as necessary for electric hoists.
- 3.05.00 Pendant control station with all accessories for electric hoists.
- 3.06.00 Lifting lug, eye bolts etc., for handling hoist parts.
- 3.07.00 Protection guard as specified.
- 3.08.00 Lifting hook block assembly for hoists.

**4.00.00 SPECIFIC DESIGN REQUIREMENTS**

- 4.01.00 Lifting capacity
  - 4.01.01 Capacity of each hoist shall be 1.2 times the maximum working load.
  - 4.01.02 Hoists of capacity below 3 tones shall be manual hoists.
  - 4.01.03 Hoists of capacity equal and above 3 tones shall be electric hoists.
- 4.02.00 Effort for Mechanical Hoists
  - 4.02.01 Hoisting
    - Hoisting effort for hoists up to 3 tones capacity shall not be more than 20 kg.





4.02.02 Trolley Motion

Effort for trolley motion for hoists upto 3 tones capacity shall not be more than 43 Kg.

4.02.03 For Electric operated hoist both hoisting and trolley motion shall be motor operated.

4.03.00 Lift

4.03.01 Lift above operating floor

Highest position of the hook shall be such that during operation of hoists, the vertical distance between bottom of any equipment handled and top of any permanent structure or equipment in the operating area shall be at least one metre.

4.03.02 Approach below operating floor

To be decided by the Bidder for safe and reliable handling of any equipment above half ton below the operating floor.

4.04.00 Length of monorail hoist

To be decided by the Bidder depending on the floor and machine layout. The horizontal distance between the centre line of the hoist and centre line of any installed equipment in its operating shall not be more than half metre.

**5.00.00 DESIGN AND CONSTRUCTION**

5.01.00 All parts requiring replacement or lubrication shall be easily accessible without the need for dismantling of other equipment and structures.

Robust construction and ample rating merging which experience has shown to be necessary shall be ensured throughout manufacture.

5.02.00 All components of hoists of identical capacity and duty shall be interchangeable. The hoists of identical capacity and duty shall be identical in all respects unless otherwise required. The hoist design shall be such that these can be quickly removed from one monorail beam and fixed on another beam without disassembling major components.

5.03.00 All machinery and equipment included under this specification must be equipped with safety devices and clearances to comply with recognized standards and specification requirements.

5.04.00 Cast iron parts wherever used, shall conform to IS:210 - FG 260. Also no wood or other combustible materials shall be used.

5.05.00 Defects in material like fractures, cracks, blowholes, laminations, pitting etc. are not allowed. Rectifications of any such flaw is permissible only with the approval of the Owner.





- 5.06.00 Each hoist shall be permanently and legibly stamped with the tag number, manufacturer's name, safe working load, grade of load chain (where applicable), range of lift etc.
- 5.07.00 Load chain (where applicable) shall be of grade T(8) as per IS:6216 and Hand chain shall be as per IS:2429 (Part-I) grade 30.
- 5.08.00 Wheels in trolley unit travel shall be single flanged with straight/tapper/barrel shaped tread to suit the monorail. Wheels should be preferably of forged steel construction. Material of construction for wheels of traversing block and hoist gear for hoist used in hazardous areas shall be of non-ferrous material to avoid spark during operation.
- 5.09.00 All gears shall be hardened and tempered steel with machine out teeth.
- 5.10.00 Hoist (Manually Operated)
- 5.10.01 Manually operated hoists shall be of spur gear chain pulley block type. It shall be suspended from the trolley by a hook. The design of the hoist shall conform to IS:3832 (Specification for hand operated chain pulley blocks).
- The hooks and brakes of hoist shall conform to the requirements stipulated in (a) and (b) below
- a) Hooks shall conform to IS:3832. The load hook shall be swiveling type fitted with a locking device.
  - b) The pulley blocks shall be fitted with an automatic mechanical load brake to prevent self-lowering of load in all working positions. The load brake shall also allow smooth lowering of load without serious overheating.
  - c) All manually operated hoists, unless stated otherwise, shall be trolley suspended type.
- 5.10.02 The trolley of hoists shall be manually operated.
- 5.10.03 The hoists shall be of Mechanism class 2 as per IS:3832.
- 5.11.00 Electric Hoist
- 5.11.01 Electric hoist shall be electric wire rope trolley suspended type. The design, operation, testing of electric hoist shall conform to IS:3938 (Specification for electric wire rope hoist).
- Minimum speed for hoisting shall be 3 m/min. and that of for trolley motion shall be 15 m/min.
- 5.11.02 Lifting hook shall conform to IS 15560 as applicable.
- 5.11.03 Wire rope for hoists shall conform to IS-2266.





- 5.11.04 Electro-mechanical brakes of fail to safety type shall be provided for hoist motion as well as per trolley motion for electrically driven trolley. Load brake shall allow smooth lowering of load and arrangement shall be such as it can not be released accidentally. Capacity of brake and other relevant data shall conform to IS:3938.
- 5.11.05 The trolley of the hoists shall be electrically driven.
- 5.11.06 For other components of hoist such as rope, sheave, drum, bearings, gears etc. stipulations of IS: 3938 shall be followed.
- 5.11.07 Motor shall be rated for duty S4, CDF 40% and 150 starts per hour. Service class of motor shall be "4" as per IS:3938. Conditions given in IS:3938 for hoist motor shall be followed over and above the specification of electric motor in Volume II-F1/F2.
- In case of any contradiction of the aforesaid standard and the motor specification, the conditions, which are more stringent, shall be considered. All the motors shall be suitable for reversing, frequent starting and braking. Motors shall be provided with suitable space heating arrangement.
- 5.11.08 Hoist shall be designed so that remote control can be effected by means of pendant push button switch from the operating floor. Operation, arrangement etc. of pendant push button switch shall conform to IS:3938.
- 5.11.09 Micro-speed attachment in hoist shall be provided if considered necessary by the Bidder.
- 5.11.10 The hoists shall be of mechanism class 2 as per IS-3938.
- 5.12.00 Ball and roller bearings of reputed make shall be used throughout.
- 5.13.00 Suitable lubrication system shall be provided for all gear drives.
- 5.14.00 Other Electrical Items
- 5.14.01 The cross conductor on monorail for power supply to the hoist shall be of festoon type flexible insulated cable conductors. All fixtures and accessories shall be provided by the Bidder for this purpose.
- 5.14.02 Necessary insulators, supports, clamps and all other accessories shall be provided as per standard design.
- 5.14.03 Each hoist shall be provided with a starter panel with protective relays.
- 5.14.04 One main isolating switch shall be used to cut-off the supply to the hoist assembly.
- 5.14.05 One main electro-magnetic contactor together with magnetic overload relay (hand reset) for each motor circuit shall be housed in the protection panel.





- 5.14.06 The operation of overload relay shall interrupt the main magnetic contactor.
- 5.14.07 Adequate short circuit protection shall be provided for main and individual circuits.
- 5.14.08 415V  $\pm$  10%, 3 Phase, 4 Wire, 50 Hz  $\pm$  5%, power supply for the hoist shall be arranged through switch fuse unit mounted at standing height at a convenient location near each hoist. The above switch fuse unit and the connecting cables between switch fuse unit and the cross conductor are included within the scope of this specification.
- 5.14.09 Transformers to step down the voltage and rectifiers as necessary shall be provided by the Bidder.
- 5.14.10 All external and internal power, control and auxiliary circuit wiring of the electrical drive and accessories and panels shall be provided. The wiring shall be done with 1100 V grade PVC insulated stranded aluminium conductor cable of suitable size not less than 2.5 sq.mm nominal equivalent copper area of cross-section. All control and auxiliary circuit wiring shall be done with 1100 V grade PVC insulated, 2.5 sq.mm. stranded copper conductor. Control wire terminations to the panels shall be made with compression type connectors. Multiway terminal blocks shall be furnished for terminating panel wiring and outgoing cable.
- 5.14.11 The hoist structure, motor frame and metal cases of all electrical equipment including metal conduit shall be effectively connected to earth. All grounding materials shall be supplied under this specification to grounding risers.
- 5.14.12 Single speed control shall be used for both hoist and trolley travel in each direction of motion.
- 5.15.00 Final painting at manufacturer's works shall be provided by the Bidder.

**6.00.00 INSPECTION AND TESTING**

- 6.01.00 The manufacturer shall conduct all tests required to ensure that the equipment furnished shall conform to the requirements of the specification and in compliance with the requirements of the latest edition of IS:3832 or equivalent standards for manually operated hoists and shall be as per IS:3938 for electrically operated hoist.
- 6.02.00 All hoists performance test shall be duly certified by govt. approved agency.

**7.00.00 DRAWINGS, DATA AND INFORMATION**

- 7.01.00 General arrangement drawings incorporating all dimensions information on head rooms, lift, wheel loads, hook suspension arrangement and other relevant data for all the hoists.





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- 7.02.00 Design calculation for selection of electric motor capacities for electric hoist.
- 7.03.00 Complete list of location, number and capacity of hoists provided.



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**Annexure - 7**

## **QUALITY ASSURANCE REQUIREMENTS**



**Development Consultants Pvt. Ltd.**

**Volume : II-A  
Section : VIII  
Quality Assurance Requirements**



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**EPC Bid Document  
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## **CONTENT**

<b>CLAUSE NO.</b>	<b>DESCRIPTION</b>
1.00.00	QUALITY ASSURANCE PROGRAMME
2.00.00	GENERAL REQUIREMENTS QUALITY ASSURANCE
3.00.00	QUALITY ASSURANCE DOCUMENTS
4.00.00	INSPECTION, TESTING & INSPECTION CERTIFICATES



## QUALITY ASSURANCE REQUIREMENTS

### 1.00.00 QUALITY ASSURANCE PROGRAMME

1.01.00 To ensure that the equipment and services under the scope of Contract whether manufactured or performed within the Successful Bidder's works or at his Sub-Vendor's premises or at the Owner's site or at any other place or work are in accordance with the specifications, the Successful Bidder shall adopt suitable quality assurance programme to control such activities at all points, as necessary. Such programmes shall be outlined by the Successful Bidder and shall be finally accepted by the Owner/Authorised representative after discussions before the award of contract. A quality assurance programme of the Successful Bidder shall generally cover the following :

- a) His organisation structure for the management and implementation of the proposed quality assurance programme.
- b) Documentation control system.
- c) Qualification data for Bidder's key personnel.
- d) The procedure for purchase of materials, parts, components and selection of Sub-Vendor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.
- e) System for shop manufacturing and site erection control including process controls and fabrication and assembly controls.
- f) Control of non-conforming items and system for corrective actions.
- g) Inspection and test procedure both for manufacture and all site related works.
- h) Control of calibration and testing of measuring and testing equipments.
- i) System for quality audit.
- j) System for indication and appraisal of inspection status.
- k) System for authorising release of manufactured product to the Owner.
- l) System for handling storage and delivery.
- m) System for maintenance of records.





- n) Furnishing of quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component as per format enclosed at Annexure-A to this section.

2.00.00 **GENERAL REQUIREMENTS - QUALITY ASSURANCE**

2.01.00 All materials, components and equipment covered under this specification shall be procured, manufactured and tested at all the stages, as well as Services provided for erection, commissioning and testing shall be as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the Bidder for some of the major items is given in the respective technical specification. This is however, not intended to form a comprehensive programme as it is the Bidder's responsibility to draw up and implement such programme and reviewed by by the Owner/Consultant. The detailed Quality Plans for manufacturing and field activities should be drawn up by the Bidder, separately in the format attached at Annexure-I and will be submitted to Owner/Owner's representative for review. Schedule of finalisation of such quality plans will be finalised before award.

2.02.00 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Bidder's Quality Control organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing.

2.03.00 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Bidder's site Quality Control organisation, during various stages of site activities from receipt of materials/equipment at site.

2.04.00 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality plans and reference documents/standards etc. will be subject to Consultant's approval without which manufacture shall not proceed. In these approved quality plans, Owner/Authorised representative/Consultant shall identify Customer Hold Points (CHP), test/checks which shall be carried out in presence of the Owner/Consultant/Owners Owner's Engineer or his Authorised Representative and beyond which the work will not proceed without consent of Owner/Authorised representative/Consultant in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Owner/Authorised Representative/Consultant for acceptance and dispositioning.

2.05.00 The Bidder shall provide adequate notice to the Owner for inspection before the material is dispatched as per the provisions of the Contract. No material shall be despatched from the manufacturer's works before the same is accepted subsequent to pre-despatch final inspection including verification of records of





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all previous tests/inspections by Owner's Owner's Engineer/Authorised representative, and duly authorised for despatch issuance of Material Despatch Clearance Certificate (MDCC).

2.06.00 All materials used or supplied shall be accompanied by valid and approved materials certificates and tests and inspection report. These certificates and reports shall indicate the sheet numbers or other such acceptable identification numbers of the material. The material certified shall also have the identification details stamped on it.

2.07.00 All the individual and assembled rotating parts shall be statically and dynamically balanced in the works.

Where accurate alignment is necessary for component parts of machinery normally assembled on site, the Bidder shall allow for trial assembly prior to despatch from place of manufacture.

2.08.00 Castings and forgings used for construction shall be of tested quality. Details of results of chemical analysis, heat treatment record, mechanical property test results shall be furnished.

2.09.00 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section-IX/BS-4870 or other International equivalent standard acceptable to the Owner.

All brazers, welders etc. employed on any part of the contract at Bidder's/Sub-Vendor's works or at site shall be qualified as per ASME Section-IX or BS-4871 or equivalent international standard approved by the Owner. Such qualification tests shall be conducted in presence of Owner/his authorised representative.

For welding of pressure parts and high pressure piping the requirements of IBR shall also be complied with.

Under no circumstances any repair or welding of castings be carried out without the consent of the Owner. Proof of the effectiveness of each repair by radiographic and/or other non-destructive testing technique, shall be provided to the Owner.

All pressure parts shall be subjected to hydraulic testing as per the requirements of IBR. Other parts shall be tested for one and half times the maximum operating pressure, for a period not less than thirty (30) minutes.

2.10.00 All non-destructive examination (NDT) shall be carried out in accordance with approved international standard. The NDT operator shall be qualified as per SNT-TC-IA (of American Society of non- destructive examination). Results of NDT shall be properly recorded and submitted for acceptance.

All welding procedures adopted for performing welding work shall be qualified in accordance with the requirements of Section-IX of ASME code or IBR as applicable. All welded joints for pressure parts shall be tested by liquid

penetrant examination according to the method outlined in ASME Boiler and Pressure Vessel code. Radiography, magnetic particle examination and ultrasonic testing shall be employed wherever necessary/ recommended by the applicable code. At least 10% of all major butt welding joints shall be radiographed. Statutory payments in respect of IBR approvals including inspection shall be made by Bidder. Bidder's scope and responsibility shall also include preparation and submission of all necessary documents in the specific formats and manner stipulated by the statutory bodies, coordination and follow up for above approvals.

2.11.00 All the Sub-Vendors proposed by the Bidder for procurement of major bought out items including castings, forgings, semi-finished and finished components/equipment list of which shall be drawn up by the Bidder and finalised with the Owner shall be subject to Owner's review. Quality Plans of the successful Sub-Vendors shall be discussed, finalised and accepted by the Owner/Authorised representative and form part of the Purchase Order between the Bidder and the Sub-Vendor.

2.12.00 All the purchase specifications for the major bought-out items, list of which shall be drawn up by the Bidder and finalised with the Owner shall be furnished to the Owner for comments and subsequent acceptance before orders are placed.

Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Bidder's or their Sub-Vendor's quality management and control activities. The Bidder shall provide all necessary assistance to enable the Owner carry out such audit and surveillance.

Quality audit/acceptance of the results of tests and inspection will not prejudice the right of the Owner to reject equipment not giving the desired performance after erection and shall not in no way limit the liabilities and responsibilities of the Bidder in earning satisfactory performance of equipment as per specification.

2.13.00 Quality requirements for main equipment shall equally apply for spares and replacement items.

2.14.00 Repair/rectification procedures to be adopted to make any job acceptable shall be subject to the acceptance of the Owner.

2.15.00 For quality assurance of all civil works refer to the specifications for civil works.

### 3.00.00 **QUALITY ASSURANCE DOCUMENTS**

3.01.00 The Bidder shall be required to submit two (2) copies and two (2) sets of microfilms of the following Quality Assurance documents within three (3) weeks after despatch of the equipment:

- a) Material mill test reports on components as specified by the specification.

- b) The inspection plan with verification, inspection plan check points, verification sketches, if used and methods used to verify that the inspection and testing points in the inspection plan were performed satisfactorily.
- c) Non-destructive examination results /reports including radiography interpretation reports.
- d) Factory tests results for testing required as per applicable codes and standards referred in the specification.
- e) Welder identification list listing welder's and welding operator's qualification procedure and welding identification symbols.
- f) Sketches and drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
- g) Stress relief time temperature charts.
- h) Inspection reports duly signed by QA personnel of the Owner and Bidder for the agreed inspection hold points. During the course of inspection, the following will also be recorded :
  - i) When some important repair work is involved to make the job acceptable.
  - ii) The repair work remains part of the accepted product quality.
- i) Letter of conformity certifying that the requirement is in compliance with finalised specification requirements.

4.00.00 **INSPECTION, TESTING AND INSPECTION CERTIFICATES**

4.01.00 The Successful Bidder shall give the Owner's Engineer/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Successful Bidder's account except for the expenses of the Inspector. The Owner's Engineer/Inspector, unless the witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date on which the equipment is notified as being ready for test/inspection failing which the Successful Bidder may proceed with test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector duly certified copies of test reports in six (6) copies.

4.02.00 The Owner's Engineer or Inspector shall within fifteen (15) days from the date of Inspection as defined herein give notice in writing to the Successful Bidder, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Successful Bidder shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall confirm in writing to the Owner's Engineer/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.

- 4.03.00 When the factory tests have been completed at the Bidder's or sub-Vendor's works, the Owner/Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Owner/Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Bidder's test certificate by the Owner/Inspector. Failure of the Owner/Inspector to issue such a certificate shall not prevent the Bidder from proceeding with the works. The completion of these tests, or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the contract.
- 4.04.00 The Bidder shall furnish quarterly inspection programme indicating schedule dates of inspection at customer hold point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.



### FORMAT OF QUALITY ASSURANCE PROGRAMME

Name of Company / Successful Bidder	NAME OF CONTRACT PACKAGE			QUALITY PLAN FOR						
	Package No. : _____  Contractor : _____			QP No. : _____ Date _____  Rev.No.: _____ Date _____						
Sl. No.	Component & Operation	Characteristics	Class	Type of Check	Quantum of Check	Reference Document	Acceptance Norm	Format of Record	Agency	Remarks

## FIELD WELDING SCHEDULE

PROJECT : FWS NO :

CONTRACTOR : REV NO. :

PACKAGE : FIELD WELDING CODE :

SYSTEM : PAGE NO. :

SI No	Drawing No. for Weld Locations & Identification mark	Description of parts to be welded	Material specification	Dimensions	Process of Welding	Type of Weld	Electrode Filler Specification	WPS No.	Minimum Pre-heat Temperature	Heat Treatment Temperature [Holding Time in secs]	NDT Method	NDT Quantum	NDT Specification Number	Acceptance Norm Ref.	Remarks

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The Field Welding Schedule should be submitted for :

- Pressure Parts
- Tanks/Vessels
- Piping
- Heavy/Important Structural Steel
- Heat Exchangers
- Bus Ducts



**14.00.00 DRAWINGS / DOCUMENTS TO BE FURNISHED AFTER AWARD OF CONTRACT**

The Bidder need to comply with all Documents/Drawings/Information already furnished in their Bid and subsequent correspondences/clarifications if any till the date of issue of notice of award of Contract. Revision of any data must meet the approval of the Purchaser.

Requirements of Documents/Drawings/Information (not limited to) from the successful Bidder after finalization of contract in respect of individual equipment as well as the complete system covered under the specification are furnished below:

Requirements of Documents/Drawings/Information under 'Approval' category

- 14.01.00 Process Design Calculations, Mechanical Design Calculations (Sizing Calculations for each equipment, miscellaneous Hydraulic Calculations, miscellaneous Pressure Drop Calculations, miscellaneous Thickness Calculations, etc).
- 14.02.00 Process and Instrumentation Diagram for the entire system complete with all kinds of details.
- 14.03.00 Dimensional General Arrangement Drawing for the entire system complete with all kinds of applicable details.
- 14.04.00 Dimensional General Arrangement and Cross Sectional Drawing for each of all major equipment and each of all buildings complete with all kinds of applicable details.
- 14.05.00 Indoor and Outdoor Piping Layout with suitable sectional views for the complete system.
- 14.06.00 Procedures for Performance Guarantee Tests.
- 14.07.00 All Documents/Drawings/Information as addressed in Technical Specifications for Instrumentation and Control - of this Bid Document.
- 14.08.00 All Documents/Drawings/Information as addressed in Technical Specifications for Electrical Equipment & Accessories of this Bid Document.
- 14.09.00 All Documents/Drawings/Information as addressed in General Specification and Design Criteria for Civil and Structural Work - General Specification and Design Criteria for Architectural Work - & Technical Specification for Civil, Structural and Architectural Work - Volume VII/C of this Bid Document.
- 14.10.00 All Documents/Drawings/Information as addressed in Specifications for Ventilation and Air Conditioning System - Volume III-D of this Bid Document.

Requirements of Documents/Drawings/Information under 'Information' Category

- 14.11.00 Pipe Schedule for the complete system.
- 14.12.00 Valve Schedule for the complete system.
- 14.13.00 Isometric Piping Drawings the complete system.
- 14.14.00 Data Sheets, Dimensional General Arrangement and Cross Sectional Drawing for each of pumps, blowers, agitators, valves, isolation gates, monorail hoists, etc.
- 14.15.00 Following test certificates/test curves/data shall be furnished :
  - a) Material test certificates.
  - b) Performance tests results and characteristics curves of pumps, fans and electric drive motors.
  - c) Hydraulic test results of pressure vessels, pipes, valves, fittings, etc.
  - d) Test results to anticorrosive coatings.
  - e) Nondestructive test results as applicable.
- 14.16.00 All Documents/Drawings/Information as addressed in Technical Specifications for Instrumentation and Control of this Bid Document.
- 14.17.00 All Documents/Drawings/Information as addressed in Technical Specifications for Electrical Equipment & Accessories - of this Bid Document.
- 14.18.00 All Documents/Drawings/Information as addressed in General Specification and Design Criteria for Civil and Structural Work - , General Specification and Design Criteria for Architectural Work - & Technical Specification for Civil, Structural and Architectural Work - of this Bid Document.
- 14.19.00 All Documents/Drawings/Information as addressed in Specifications for Ventilation and Air Conditioning System - of this Bid Document.

The Bidder shall submit a complete list of documents and drawings along with the category for review/approval by Purchaser.

Before manufacturing of the equipment, the Bidder shall have to take approval of the relevant design calculations/drawings from the Purchaser. Any manufacturing done prior to approval of the of the relevant design calculations/drawing shall be at risk of the Bidder and in case of any discrepancy with reference to approved design calculations/drawings rectification shall be made by the Bidder at their own cost without any violation of delivery schedule.

It is to be noted by the Bidder that approval or release of Documents / Drawings by Purchaser does not include the checking for drafting and other errors, but only review of basic concepts and general principles involved. Approval does not relieve the Bidder from responsibility for correctness of design, details and dimensions.





**WBPDC**

**EPC Bid Document  
Sagardighi Thermal Power Project  
1x660 MW Unit No. 5, Phase - III**

**Annexure - 9**

**TECHNICAL SPECIFICATION  
FOR  
PROTECTIVE LINING AND PAINTING**



**WBPDCL**

**EPC Bid Document  
Sagardighi Thermal Power Project  
1x660 MW Unit No. 5, Phase - III**

## **CONTENTS**

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2.00.00	CODES & STANDARDS
3.00.00	GENERAL REQUIREMENTS
4.00.00	EQUIPMENT, MATERIAL AND SERVICES TO BE FURNISHED BY THE BIDDER
5.00.00	COATING PROCEDURE AND APPLICATION
6.00.00	TEST REQUIREMENTS
7.00.00	INFORMATION / DATA REQUIRED



## PROTECTIVE LINING AND PAINTING

### 1.00.00 INTENT OF SPECIFICATION

1.01.00 This specification addresses the requirements of all labour, material, and appliances necessary with reference to preparations for lining / painting, application as well as finishing of all lining / painting for all mechanical and electrical equipment, piping and valves, structures etc. included under the scope of this Package.

1.02.00 The Bidder shall furnish and apply all lining, primers including wash primers if required, under-coats, finish coats and colour bands as described hereinafter or necessary to complete the work in all respects.

### 2.00.00 CODES & STANDARDS

2.01.00 The Bidder shall follow relevant Indian and International Standards wherever applicable in cleaning of surface, selection of lining material / paints and their application. The entire work shall conform to the following standards / specifications (latest revision or as specified).

- a) SSPC SP 10 / NACE 2 / : Near White Blast Cleaning
- b) SSPC PA 2 : Measurement of dry film Coating Thickness with magnetic gauges.
- c) ASTM D 4541 : Method for pull off strength using portable Adhesion Tester.
- d) NACE RP 0274 – 2004 : High-Voltage Electrical Inspection of Pipeline Coatings
- e) NACE SP 0188 – 2006 : Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
- f) NACE RP 0169 – 2002 : Control of External Corrosion on Underground or Submerged Metallic Piping Systems
- g) AWWA C 210 – 2007 : Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
- h) IS 3589:2001 Annexure B : Steel Pipes for Water and Sewage Specification.





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- i) AWWA C222-2000 : Polyurethane Coating for the Interior and Exterior of Steel Water Pipe and Fittings.
- j) IS 13213 : 2000 : Polyurethane Full Gloss Enamel (Two pack)

**3.00.00 GENERAL REQUIREMENTS**

- 3.01.00 The steel surface preparation prior to actual commencement of coating shall conform to SSPC SP 10 / NACE 2 / Sa2½ (near white metal) with sand blasting.
- 3.02.00 The contractor shall submit a detailed written description in the form of a manual covering coating equipment, procedures, materials inspection test, and repair etc. to Owner/Consultant for approval.
- 3.03.00 The contractor shall also provide copies of test reports from NABL approved laboratory (like National Test House, Kolkata) in support of the paint/primer materials to be used shall conform to the specification requirement.
- 3.04.00 The contractor shall also provide certificates from paint/primer manufacturer mentioning the batch numbers, date of manufacture and shelf life etc. of the materials to be used. In addition to that Manufacturing Quality Plan (MQP) and Field Quality Plan (FQP) shall also be submitted prior to commencement of supply of material and field application.
- 3.05.00 Paint/coating application work at site shall be done either by paint manufacturer or by their authorized applicator. The authorized applicator shall have proper training & certification from manufacturer. Applicator shall possess all the necessary specialized equipment and manpower experienced in similar job.
- 3.06.00 Applied coating shall be tested for dry film thickness, holiday (electrical inspection for continuity) and adhesion as per relevant standard such as SSPC PA 2, NACE RP 0274 and ASTM D 4541.
- 3.07.00 If necessary, the material may be heated and applied by airless spray / plural component spray system.
- 3.08.00 Manufacturer's specific recommendation, if any, shall be followed during application of lining / paints.
- 3.09.00 In areas where there is danger of spotting automobiles or other finally finished equipment or building by wind borne particles from paint spraying, a Purchaser approved method shall be adopted.
- 3.10.00 The colour scheme of the entire Plant, covered under this specification shall be approved by the Purchaser in advance before application.





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- 3.11.00 All indoor and outdoor piping, insulated as well as uninsulated will have approved colour bands painted on the pipes at conspicuous places throughout the system, as approved by Purchaser.
- 3.12.00 Inside surfaces of vessels / tanks shall be protected by anticorrosive paints or rubber lining as required / specified elsewhere in the specification. External surfaces of all vessels / tanks shall be protected by anti corrosive painting.
- 3.13.00 For vessels / tanks requiring lining and epoxy painting all inside surface shall be blast cleaned using non-siliceous abrasive after usual wire brushing.
- 3.14.00 Natural rubber lining shall be provided on the inside of vessels / tanks as required / specified elsewhere in the specification, in three layers resulting in a total thickness not less than 4.5 mm.
- 3.15.00 Surface hardness of rubber lining shall be 65 +/- 5 deg. A (shore).
- 3.16.00 After the lining is completed, the vessels / tanks shall not be subjected to any prolonged exposure to direct sunlight in course of its transportation, erection etc. They shall not be stored in direct sunlight. No further lining or burning shall be carried out on the vessel, after application of the lining.
- 3.17.00 All lining projecting outside of the vessel shall be protected adequately from mechanical damages during shipment, handling storage etc.
- 3.18.00 Suitable warnings, indicating the special care that must be taken with respect to these lined vessels shall be stenciled on their outside surface with the letters at least 12 mm high.
- 3.19.00 All insulated piping shall have aluminium sheet jacketing.

**4.00.00 EQUIPMENT, MATERIAL AND SERVICES TO BE FURNISHED BY THE BIDDER**

- 4.01.00 After erection at site, the outside surfaces of all equipment having a shop coat shall be given further priming coat and finished coats of paint as detailed in following clauses. However, if the painting system is such that the shop coat and primer coat to be applied at site are not compatible, then shop coat has to be removed from the surface of equipment before application of primer coat with prior blasting.

All factory finished paints shall be touched up at site as required.

All uninsulated piping shall be finished with final paintings after use of proper wash primer and primer. Aluminium sheet jacketed piping need not be painted.







Colour bands of Purchaser's approved shade shall however be applied on jacketed piping near walls or partitions, at all junctions, near valves and all other places as instructed by the Purchaser. All structures shall be painted with approved paint.

4.02.00 Surface Preparation

4.02.01 Unless mentioned otherwise, all rust and mill scale shall be removed by blasting to Sa 2-1/2 Swiss Standard before applying the primer.

4.02.02 Special care shall be taken to remove grease and oil by means of suitable solvents like Trichloroethylene or Carbon Tetrachloride.

4.02.03 The minimum degree of surface preparations for all equipment, piping, fittings, valves, structures etc. shall be "Near White" according to Steel Structure, Painting Council-SSPC-SP-10 before application of any primer/paint.

4.03.00 Painting

4.03.01 Specification for application of paints for external surfaces protection of vessels / tanks / equipment / piping / fittings / valves etc. to be installed indoor shall be as follows :

- a) Surface preparation shall be done either manually or by any other approved method.
- b) Primer Coat shall consist of one coat (minimum DFT of 50 microns) of chlorinated rubber based zinc phosphate.
- c) Intermediate Coat (or Under Coat) shall consist of one coat (minimum DFT of 50 microns) of chlorinated rubber based paint pigmented with Titanium Dioxide.
- d) Top Coat shall consist of one coat (minimum DFT of 50 microns) of chlorinated rubber paint of approved shade and colour with glossy finish.
- e) Total DFT of paint system shall not be less than 150 microns.

4.03.02 Specification for application of paints for external surfaces protection of vessels / tanks / equipment / piping / fittings / valves etc to be installed **outdoor** shall be as follows :

- a) Surface preparation shall be done by means of sand blasting, which shall conform to Sa 2-1/2 Swiss Standard.
- b) Primer Coat shall consist of one coat (minimum DFT of 100 microns) of epoxy resin based zinc phosphate primer.





- c) Intermediate Coat (or Under Coat) shall consist of one coat (minimum DFT of 100 microns) epoxy resin based paint pigmented with Titanium Dioxide.
- d) Top Coat shall consist of one coat (minimum DFT of 75 microns) of epoxy paint of approved shade and colour with glossy finish. Additional one coat (minimum DFT of 25 microns) of Finish Coat of polyurethane shall be provided.
- e) Total DFT of paint system shall not be less than 300 microns.

4.03.03 Specification for application of paints for external surfaces protection of steel pipes and fittings which are **buried underground / laid inside a hume pipe & or submerged Under Water and laid under Pipe Trenches** (in road/rail/pipe or trench crossings) shall be as follows :

External surface of the pipe, fittings, specialties etc. handling raw water/clarified water/filter water shall be painted with one coat of two part chemically cured polyurethane primer of min 50 micron dry film thickness followed by three or maximum four coats of two part solvent less polyurethane to build up coating of dry film thickness of 2000 micron including primer coat.

4.03.04 Specification for application of paints for **internal surface protection of large diameter pipes** (sizes above 600 mm NB and above) if any, shall be as follows :

- a) All Internal surfaces of steel pipes, fittings, specialties etc. buried underground or located within pipe trenches shall be given epoxy coating to protect them from (except for drinking water service, where the compatible painting shall be so selected to meet relevant quality standards) corrosion.
- b) Internal surface of the pipe should be coated with one coat of two part epoxy primer with not less than 50 micron DFT (dry film thickness) followed by two part polyamide cured solvent less epoxy.
- c) The minimum dry film thickness (DFT) of internal lining shall be 600 micron.

4.03.05 Specification for application of paints for protection of **internal surfaces of DM Water Storage Tank(s)** shall be as follows :

- a) Primer - One coat of epoxy primer containing high level of Zinc Phosphate anticorrosive pigment. Total Dry Film Thickness (DFT) of primer shall not be less than 125 microns.
- b) Finish Paint - Three (3) coats Polyamine HB Epoxy Paint. Total Dry Film Thickness (DFT) of finish paint shall not be less than 125 microns per coat.
- c) Total thickness of primer and paint should not be less than 500 microns.

4.03.06 All motors, local push button stations, cable racks, structures used for supports etc. are to be painted with acid proof paint.





- 4.03.07 The following surfaces shall not be painted - stainless steel, galvanized steel, aluminum, copper, brass, bronze and other nonferrous materials.
- 4.03.08 No painting or filler shall be applied until all repairs, hydrostatic tests and final shop inspection are completed.
- 4.03.09 All machined surfaces shall have two (2) coats of water repellent grease after thorough cleaning.

**5.00.00 COATING PROCEDURE AND APPLICATION**

5.01.00 Surface Preparation :

Pipe shall be blast cleaned by sand. The cleanliness achieved prior to application shall be in accordance with the requirement of SSPC SP 10 / NACE 2 / Sa2½ of ISO 8501 (near white metal)

- a) The blast pattern or profile depth shall be 40 to 100 micron and shall be measured by dial micrometer.
- b) Before sand blasting is started or during blasting or coating, temperature of the pipe surface should be more than 3°C above dew point temperature. Blast cleaned surface should be primed within 4 hours and shall be protected from rainfall or surface moisture and shall not be allowed to flash rust. If the rust occurs, the surface again to be prepared by sand blasting or wire brushing.

5.02.00 Application of Epoxy Coating

- a) Coating shall be applied when
  - i) When the pipe surface temperature shall be atleast 3°C above dew point temperature.
  - ii) The temperature of mixed coating material and the pipe at the time of application shall not be lower than 10°C or greater that 50°C.
- b) Material preparation shall be in accordance with manufacturer's recommendations.
- c) Application of epoxy coating system :

The epoxy coating system shall be applied as per recommendation of the manufacturer and shall be applied by airless spray / plural component spray machine. For more than one coat, the second shall be applied with the time limits as recommended by the manufacturer.



5.03.00 Application of PU Coating

- a) PU coating shall be applied when the pipe surface temperature atleast 3°C above dew point temperature (when R.H is more than 85%).
- b) Material preparation and application shall be done as per manufacturer recommendation.

**6.00.00 TEST REQUIREMENTS**

6.01.00 Measurement of dry film thickness

Measurement of dry film thickness of coating : Coating thickness shall be in the range of  $\pm 20\%$  and as per SSPC PA 2.

6.01.01 Apparatus / Instrument:-

The instrument used for dry film thickness may be Type 1 pull of gauges or Type 2 electronic gauges.

6.01.02 Procedures:-

- a) Number of measurements:  
For 100 square feet (9.29 square meters), five (5) spots per test area (each spot is 3.8 cm) in diameter. Three gauge readings per spot (average becomes the spot measurement).
- b) If the structure is less than 300 square feet, each 100 square feet should be measured.
- c) If the structure is between 300 and 1000 sq ft, select 3 random 100 square feet test areas and measure.
- d) For structure exceeding 1000 square feet, select 3 random 100 square feet testing areas for the first 1000 sq ft and select 1 random 100 square feet testing area for each additional 1000 square feet
- e) Coating thickness Tolerance: Individual reading taken to get a representative measurement for the spot are unrestricted (usually low or high readings are discarded). Spot measurements (the average of 3 gauge readings) must be within 80% of the minimum thickness and 120% of the maximum thickness. Area measurement must be within specified range.

6.02.00 **ELECTRICAL INSPECTION (HOLIDAY) TESTS**

6.02.01 All the coated / lined pipes shall be tested with an approved high voltage holiday detector preferably equipped with an audio visual signaling device to indicate any faults, holes, breaks or conductive particles in the protective coating.



- 6.03.00 The applied output voltage of holiday detector shall have a spark discharge of thickness equal to at least twice the thickness of the coating to assure adequate inspection voltage and compensate for any variation in coating thickness. The electrode shall be passed over the coated surface at approximately half the spark discharge distance from the coated surface only one time at the rate of approximately 10 to 20m/min. The edge effect shall be ignored. Excessive voltage shall be avoided as it tends to induce holiday in the coated surface thereby giving erroneous readings.
- 6.04.00 While selecting test voltages, consideration should be given to the tolerance on coating thickness and voltage should be selected on the basis of maximum coating thickness likely to be encountered during testing of a particular pipe.
- The testing voltage shall be calculated by using following formula. (as per NACE 0274 : 2004)
- Testing Voltage  $V = 7900 \sqrt{T} \pm 10$  percent where T is the average coating thickness in mm.
- 6.05.00 Any audio visual sound or spark leads to indicate pinhole, break or conductive particle.
- 6.06.00 **ADHESION PULL OFF TEST**
- After holiday the coated surface is subjected to adhesion pull off test as per ASTM D 4541.
- 6.06.01 Apparatus / Instrument: Adhesion tester consists of three basic components:
- A hand wheel, a black column containing a dragging indicator pin and scale in the middle and a base containing three legs and a pulling "Jaw" at the bottom and also dollies.
- 6.06.02 Prepare the test surface
- Once test area is selected, test area shall be free of grease, oil, dirt, water. The area should be flat surfaces and large enough to accommodate the specified number of replicate test.
- 6.06.03 Prepare Dolly (Test Pull Stub)
- The dolly is a round, two sided aluminium fixture. Both sides of the dolly looks same, however, one side sloped on top surface while flat on bottom surface. As the surface of the dolly is polished aluminium, roughen the same using a coarse sand paper.





6.07.00 Select an adhesive:

Use araldite, a 100% solid epoxy adhesive. This adhesive requires at least 24 hours at room temperature to cure.

6.08.00 Attach the dolly to the surface.

- a) Using a wooden stick, apply an even layer of adhesive to the entire contact surface area of the dolly.
- b) Carefully remove the excessive adhesive by using a cotton swab. Allow the adhesive to fully cure before performing the adhesion test.
- c) Attach the dolly to the coated surface and gently push downward to displace any excessive adhesive.
- d) Push the dolly inward against the surface, then apply tape across the head of the dolly.

6.09.00 Adhesion Test Procedure

- a) Attach the adhesion tester to the dolly by rotating the hand wheel counter clockwise to lower the jaw of the device.
- b) Slide the jaw completely under the head of the dolly. Position the three legs of the instruments so that they are sitting flat on the coated surface.
- c) Slide the dragging indicator pin on the black column to zero by pushing it downward.
- d) Firmly hold the base of the instrument in one hand and rotate the handwheel clockwise to raise the jaw of the device that is attached to the head of the dolly. The dragging indicator pin will move upward on the black column as the force is increased and will hold the reading. Apply the tension using a moderate speed. Continue to increase the tension on the head of the dolly until (a) the minimum PSI/MPa/Kg/cm<sup>2</sup> required by project specification is exceeded and the test is discontinued, (b) the maximum PSI/MPa/Kg/cm<sup>2</sup> of adhesion tester has been achieved and dolly is still attached, (c) The force applied by the adhesion tester causes the dolly to dislodge.
- e) Read the scale and record the adhesion value.

6.10.00 **COATING REPAIR**

Defective Coating shall be repaired in accordance with the following subsections.

6.10.01 Surface Preparation:

Accessible areas of pipe requiring coating repairs shall be cleaned to remove debris and damaged coating using surface grinders or other means. The





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adjacent coating shall be feathered by sanding, grinding or other method. Accumulated debris shall be removed by blowing with contaminant free air or wiping with clean rags.

6.10.02 Areas not accessible for coating repair such as interior surfaces of small diameter pipe shall be reprocessed and recoated.

6.11.00 Coating Application

The coating system shall be applied to the prepared areas in accordance with procedure.

6.12.00 Repair Inspection

Repaired portion shall be electrically inspected using a holiday detector.

6.13.00 **WELDED FIELD JOINTS**

6.13.01 Preparation :

The weld joints shall be cleaned so as to be free from mud, oil, grease, welding flux, weld spatter and other foreign contaminants. The cleaned metal surfaces of the weld joint shall then be blasted or abraded using rotary abrading pads. The adjacent liquid Epoxy / PU coating shall be feathered by abrading the coating surface for a distance of 25 mm.

6.13.02 Electrical Inspection :

After curing the coating system applied to the welding joints shall be holiday tested. Any holidays indicated by the detector shall be marked with chalk to identify the area of repair.

**7.00.00 INFORMATION/DATA REQUIRED**

The Bidder shall submit complete list of paints and primers proposed, giving detail information, such as, chemical composition, drying time etc. and also unit rates for application of each type of paint along with supply shall be furnished.





HEALTH, SAFETY AND ENVIRONMENT  
PLAN FOR  
SITE OPERATION by SUBCONTRACTORS

Doc no.: HSEP: 14

REV: 00

Date: 12.08.2014

POWER SECTOR

## DOCUMENT ISSUE SHEET

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Designation	Dy. Manager PSHQ(FQA & Safety)	GM PSHQ(FQA & Safety)	ED PSHQ(FQA & Safety)
Signature			
Date	12/8/14	12/8/14	12/8/14

# HSE PLAN FOR SITE OPERATIONS BY BHEL'S SUBCONTRACTORS

## AT A GLANCE

BEFORE START	<b>SIGNING OF MOU</b> Agree to comply to HSE requirement- Statutory and BHEL's	
PLAN	<b>HSE ORGANISATION</b>	
	<b>Manpower</b> <ul style="list-style-type: none"> <li>1 (one) safety officer for every 500 workers or part thereof</li> <li>1(one) safety-steward/ supervisor for every 100 workers</li> </ul> <b>Qualification</b> As per Cl. 7.1	<b>HSE Roles and responsibilities</b> <ul style="list-style-type: none"> <li>Site In-charge- As per clause 7.2.1</li> <li>Safety officer- As per clause 7.2.2</li> </ul>
	<b>HSE Planning</b> for Man , Machinery/Equipment/Tools & Tackles	
PROVIDE	<b>HSE INFRASTRUCTURE</b>	
	<ul style="list-style-type: none"> <li>PPEs</li> <li>Drinking Water</li> <li>Washing Facilities</li> <li>Latrines and Urinals</li> <li>Provision of shelter for rest</li> <li>Medical facilities</li> </ul>	<ul style="list-style-type: none"> <li>Canteen facilities</li> <li>Labour Colony</li> <li>Emergency Vehicle</li> <li>Pest Control</li> <li>Scrapyard</li> <li>Illumination</li> </ul>
TRAIN	<b>HSE TRAINING , AWARENESS &amp; PROMOTION</b>	
	<b>Training</b> <ul style="list-style-type: none"> <li>Induction training</li> <li>Height work and other critical areas</li> <li>Tool Box talk &amp; Pep Talk</li> </ul>	<b>Awareness &amp; Promotion</b> <ul style="list-style-type: none"> <li>Signage</li> <li>Poster</li> <li>Banner</li> <li>Competition</li> <li>Awards</li> </ul>
COMMUNICATE	<b>HSE COMMUNICATION</b>	
	<b>Incident Reporting</b> <ul style="list-style-type: none"> <li>Accident- Fatal &amp; Major</li> <li>Property damage</li> <li>Near Miss</li> </ul>	<b>Event Reporting</b> <ul style="list-style-type: none"> <li>Celebrations</li> <li>Training</li> <li>Medical camp</li> </ul>

**EXECUTE SAFELY**

**OPERATIONAL CONTROL PROCEDURES**

**PERMIT TO WORK**

Height work ( above 2 metres), Hot Work, Heavy Lifting, Confined Space, Radiography, excavation( More than 4 metres)

**SAFETY DURING WORK EXECUTION**

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li>• Welding</li> <li>• Rigging</li> <li>• Cylinder- storage &amp; Movement</li> <li>• Demolition work</li> <li>• T&amp;Ps</li> <li>• Chemical Handling</li> <li>• Electrical works</li> </ul> | <ul style="list-style-type: none"> <li>• Fire</li> <li>• Scaffolding</li> <li>• Height work</li> <li>• Working Platform</li> <li>• Excavation</li> <li>• Ladder</li> <li>• Lifting</li> <li>• Hoisting appliance</li> </ul> |
|--|---|

**HOUSE KEEPING**

**WASTE MANGEMENT**

**TRAFFIC MANAGEMENT**

**ENVIRONMENTAL CONTROL**

**EMERGENCY PREPAREDNESS AND RESPONSE PLAN**

**CHECKS**

**HSE AUDITS & INSPECTION**

- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>• Daily Checks</li> <li>• Inspection of PPEs</li> <li>• Inspection of T&amp; Ps</li> <li>• Inspection of Cranes &amp; Winches</li> </ul> | <ul style="list-style-type: none"> <li>• Inspection of Height work</li> <li>• Inspection of Welding and Gas cutting</li> <li>• Inspection of elevators etc</li> </ul> |
|---|---|

**HSE PERFORMANCE EVALUATION PARAMETERS**

**NON CONFORMANCE**

**PENALTY for NON CONFORMANCE**

**Refer Clause 16**

**Incremental penalty**

For repeated violation by the same person, the penalty would be double of the previous penalty

For repeated fatal incident in the same Unit incremental penalty to be imposed. The subcontractor will pay 2 times the penalty compared to previously paid in case there are repeated cases of fatal incidents under the same subcontractor for the same package in the same unit.





**HEALTH, SAFETY AND ENVIRONMENT  
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SITE OPERATION by SUBCONTRACTORS**

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## 1.0 PURPOSE

- 1.1 The purpose of this HSE Plan is to provide for the systematic identification, evaluation, prevention and control of general workplace hazards, specific job hazards, potential hazards and environmental impacts that may arise from foreseeable conditions during installation and servicing of industrial projects and power plants.
- 1.2 This document shall be followed by BHEL's subcontractors at all installation and servicing sites. In case customer specific documents are to be implemented, this document will be followed in conjunction with customer specific documents.
- 1.3 Although every effort has been made to make the procedures and guidelines in line with statutory requirements, in case of any discrepancy relevant statutory guidelines must be followed.
- 1.4 In case the customer has any specific requirement, the same is to be fulfilled.

## 2.0 SCOPE

The document is applicable for BHEL's Subcontractors at all installation / servicing activities of BHEL Power Sector as per the relevant contractual obligations.

## 3.0 OBJECTIVES AND TARGETS

The HSE Plan reflects that BHEL places high priority upon the Occupational Health, Safety and Environment at workplaces.

- Ensure the Health and Safety of all persons at work site is not adversely affected by the work.
- Ensure protection of environment of the work site.
- Comply at all times with the relevant statutory and contractual HSE requirements.
- Provide trained, experienced and competent personnel. Ensure medically fit personnel only are engaged at work.
- Provide and maintain plant, places and systems of work that are safe and without risk to health and the environment.
- Provide all personnel with adequate information, instruction, training and supervision on the safety aspect of their work.
- Effectively control, co-ordinate and monitor the activities of all personnel on the Project sites including subcontractors in respects of HSE.
- Establish effective communication on HSE matters with all relevant parties involved in the Project works.
- Ensure that all work planning takes into account all persons that may be affected by the work.
- Ensure fitness testing of all T&Ps/Lifting appliances like cranes, chain pulley blocks etc. are to be certified by competent person.
- Ensure timely provision of resources to facilitate effective implementation of HSE requirements.
- Ensure continual improvements in HSE performance
- Ensure conservation of resources and reduction of wastage.
- Capture the data of all incidents including near misses, process deviation etc. Investigate and analyze the same to find out the root cause.
- Ensure timely implementation of correction, corrective action and preventive action.



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**HSE TARGETS**

EXPLOSION	ZERO
FATALITY	ZERO
LOST TIME INJURY	ZERO
FIRE	ZERO
VEHICLE INCIDENTS	ZERO
ENVIRONMENTAL INCIDENTS	ZERO

**4.0 BHEL POWER SECTOR HEALTH, SAFETY & ENVIRONMENT POLICY**

**Power Sector HSE Policy**

We, at BHEL Power Sector, reaffirm our belief that the Health and Safety of our stakeholders and conservation of Environment is of utmost importance and takes precedence in all our business decisions. In pursuit of this belief and commitment, we strive to:

- ✓ Ensure total compliance with applicable legislation, regulations and other requirements concerning Occupational Health, Safety and Environment.
- ✓ Ensure continual improvement in the Occupational Health, Safety and Environment Management System performance.
- ✓ Enhance Occupational Health, Safety and Environment awareness amongst employees, customers and suppliers by proactive communication and training.
- ✓ Review periodically and improve Occupational Health, Safety and Environment Management System to ensure its continuing suitability, adequacy and effectiveness in a continuously changing business environment.
- ✓ Develop a culture of safety through active leadership and provide appropriate training at all levels to enable employees to fulfill their Health, Safety and Environmental obligations.
- ✓ Incorporate appropriate Occupational Health, Safety and Environmental criteria into business decisions for selection of plant, technology and services as well as appointment of key personnel.
- ✓ Ensure availability at all times of appropriate resources to fully implement the Occupational Health, Safety and Environmental policy of the company.

This policy will be communicated to all employees and made available to interested parties.

Sd/-

Date: 01.05.2013

Director (Power)





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**5.0 MEMORANDUM OF UNDERSTANDING:**

After award of work, subcontractors are required to enter into a memorandum of understanding as given below:

**Memorandum of Understanding**

BHEL, Power Sector \_\_\_\_\_ Region is committed to Health, Safety and Environment Policy (HSE Policy).

M/s \_\_\_\_\_ do hereby also commit to comply with the same HSE Policy while executing the Contract Number \_\_\_\_\_

M/s \_\_\_\_\_ shall ensure that safe work practices as per the HSE plan. Spirit and content therein shall be reached to all workers and supervisors for compliance.

In addition to this, M/S \_\_\_\_\_ shall comply to all applicable statutory and regulatory requirements which are in force in the place of project and any special requirement specified in the contract document of the principal customer.

M/s \_\_\_\_\_ shall co-operate in HSE audits/inspections conducted by BHEL /customer/ third party and ensure to close any non-conformity observed/reported within prescribed time limit.

Signed by authorized representative of M/s -----

Name :

Place & Date:



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## 6.0 TERMS AND DEFINITIONS

### 6.1 DEFINITIONS

#### 6.1.1 INCIDENT

Work- related or natural event(s) in which an injury , or ill health (regardless of severity), damage to property or fatality occurred, or could have occurred.

#### 6.1.2 NEAR MISS

An incident where no ill health, injury, damage or other loss occurs, but it had a potential to cause, is referred to as "Near-Miss".

#### 6.1.3 MAN-HOUR WORKED

The total number of man hours worked by all employees including subcontractors working in the premises. It includes managerial, supervisory, professional, technical, clerical and other workers including contract labours. Man-hours worked shall be calculated from the payroll or time clock recorded including overtime. When this is not feasible, the same shall be estimated by multiplying the total man-days worked for the period covered by the number of hours worked per day. The total number of workdays for a period is the sum of the number of men at work on each day of period. If the daily hours vary from department to department separate estimate shall be made for each department and the result added together.

#### 6.1.4 FIRST AID CASES

First aids are not essentially all reportable cases, where the injured person is given medical treatment and discharged immediately for reporting on duty, without counting any lost time.

#### 6.1.5 LOST TIME INJURY

Any work injury which renders the injured person unable to perform his regular job or an alternative restricted work assignment on the next scheduled work day after the day on which the injury occurred.

#### 6.1.6 MEDICAL CASES

Medical cases come under non-reportable cases, where owing to illness or other reason the employee was absent from work and seeks Medical treatment.

#### 6.1.7 TYPE OF INCIDENTS & THEIR REPORTING:

The three categories of Incident are as follows:

##### **Non-Reportable Cases:**

An incident, where the injured person is given medical help and discharged for work without counting any lost time.



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**Reportable Cases:**

In this case the injured person is disable for 48 hours or more and is not able to perform his duty.

**Injury Cases:**

These are covered under the heading of non-reportable cases. In these cases the incident caused injury to the person, but he still continues his duty.

**6.1.8 TOTAL REPORTABLE FREQUENCY RATE**

Frequency rate is the number of Reportable Lost Time Injury (LTI) per one Million Man hours worked. Mathematically, the formula read as:

$$\frac{\text{Number of Reportable LTI} \times 1,000,000}{\text{Total Man Hours Worked}}$$

**6.1.9 SEVERITY RATE**

Severity rate is the Number of days lost due to Lost Time Injury (LTI) per one Million Man hours worked. Mathematically, the formula reads as:

$$\frac{\text{Days lost due to LTI} \times 1,000,000}{\text{Total Man Hours Worked}}$$

**6.1.10 INCIDENCE RATE**

Incidence Rate is the Number of LTI per one thousand manpower deployed. Mathematically, the formula reads as:

$$\frac{\text{Number of LTI} \times 1000}{\text{Average number of manpower deployed}}$$

**7.0 HSE ORGANISATION**

**Number of safety officers:**

The subcontractor must deploy one safety officer for every 500 workers or part thereof in each package. In addition, there must be one safety-steward/safety-supervisor for every 100 workers.

**Deployment:** The subcontractor should deploy sufficient safety officers and safety-steward/Safety-supervisor, as per requirement given above, since initial stage and add more in proportion to the added strength in work force. Any delay in deployment will attract a penalty of Rs.30,000/- per man month for the delayed period.

**7.1 QUALIFICATION FOR HSE PERSONNEL**

Sl.no	Designation	Qualification	Experience
1	Safety officer (Construction Agency)	Degree or Diploma in Engineering with full time diploma in Industrial Safety with construction safety as one of the subjects	Minimum two years for degree holder and five years for diploma holder in the field of Construction of power plant/ major industries



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2	Safety-Steward/ Supervisor	Safety-	Degree or diploma in any discipline with full time diploma in Industrial Safety with construction safety as one of the subjects	Minimum two years
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**7.2 RESPONSIBILITIES**

**7.2.1 SITE IN -CHARGE OF SUBCONTRACTOR**

- Shall sign Memorandum of Understanding (MoU) for compliance to BHEL's HSE Plan for Site Operations as per clause 5.0
- Shall engage qualified safety officer(s) and steward (s) as per clause 7.0
- Shall adhere to the rules and regulations mentioned in this code, practice very strictly in his area of work in consultation with his concerned engineer and the safety coordinator.
- Shall screen all workmen for health and competence requirement before engaging for the job and periodically thereafter as required.
- Shall not engage any employee below 18 years.
- Shall arrange for all necessary PPEs like safety helmets, belts, full body harness, shoes, face shield, hand gloves etc. before starting the job. Shall ensure that no working men/women carry excessive weight more than stipulated in Factory Rule Regulation R57.
- Shall ensure that all T&Ps engaged are tested for fitness and have valid certificates from competent person.
- Shall ensure that provisions stipulated in contract Labour Regulation Act 1970, Chapter V C.9, canteen, rest rooms/washing facilities to contracted employees at site.
- Shall adhere to the instructions laid down in Operation Control Procedures (OCPs) available with the site management.
- Shall ensure that person working above 2.0 meter should use Safety Harness tied to a life line/stable structure.
- Shall ensure that materials are not thrown from height. Cautions to be exercised to prevent fall of material from height.
- Shall report all incidents(Fatal/Major/Minor/Near Miss)to the Site engineer /HSE officer of BHEL.
- Shall ensure that Horseplay is strictly forbidden.
- Shall ensure that adequate illumination is arranged during night work.
- Shall ensure that all personnel working under subcontractor are working safely and do not create any Hazard to self and to others.
- Shall ensure display of adequate signage/posters on HSE.
- Shall ensure that mobile phone is not used by workers while working.
- Shall ensure conductance of HSE audit, mockdrill, medical camps, induction training and training on HSE at site.
- Shall ensure full co-operation during HQ/External /Customer HSE audits.



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- Shall ensure submission of look-ahead plan for procurement of HSE equipment's and PPEs as per work schedule.
- Shall ensure good housekeeping.
- Shall ensure adequate valid fire extinguishers are provided at the work site.
- Shall ensure availability of sufficient number of toilets /restrooms and adequate drinking water at work site and labour colony.
- Shall ensure adequate emergency preparedness.
- Shall be member of site HSE committee and attend all meetings of the committee
- Power source for hand lamps shall be maximum of 24 v.
- Temporary fencing should be done for open edges if Hand – railings and Toe-guards are not available.

**7.2.2 HEALTH, SAFETY AND ENVIRONMENT OFFICER OF SUBCONTRACTOR**

- Carry out safety inspection of Work Area, Work Method, Men, Machine & Material, P&M and other tools and tackles.
- Facilitate inclusion of safety elements into Work Method Statement.
- Highlight the requirements of safety through Tool-box / other meetings.
- Help concerned HOS to prepare Job Specific instructions for critical jobs.
- Conduct investigation of all incident/dangerous occurrences & recommend appropriate safety measures.
- Advice & co-ordinate for implementation of HSE permit systems, OCPs & MPs.
- Convene HSE meeting & minute the proceeding for circulation & follow-up action.
- Plan procurement of PPE & Safety devices and inspect their healthiness.
- Report to PS Region/HQ on all matters pertaining to status of safety and promotional program at site level.
- Facilitate administration of First Aid
- Facilitate screening of workmen and safety induction.
- Conduct fire Drill and facilitate emergency preparedness
- Design campaigns, competitions & other special emphasis programs to promote safety in the workplace.
- Apprise PS– Region on safety related problems.
- Notify site personnel non-conformance to safety norms observed during site visits / site inspections.
- Recommend to Site In charge, immediate discontinuance of work until rectification, of such situations warranting immediate action in view of imminent danger to life or property or environment.
- To decline acceptance of such PPE / safety equipment that do not conform to specified requirements.
- Encourage raising Near Miss Report on safety along with, improvement initiatives on safety.
- Shall work as interface between various agencies such customer, package-in-charges, subcontractors on HSE matters





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## 8.0 PLANNING BY SUBCONTRACTOR

### 8.1 MOBILISATION OF MACHINERY/EQUIPMENT/TOOLS BY SUBCONTRACTOR

- As a measure to ensure that machinery, equipment and tools being mobilized to the construction site are fit for purpose and are maintained in safe operating condition and complies with legislative and owner requirement, inspection shall be arranged by in-house competent authority for acceptance as applicable.
- The machinery and equipment to be embraced for this purpose shall include but not limited to the following:
  - Mobile cranes.
  - Side Booms.
  - Forklifts.
  - Grinding machine.
  - Drilling machine.
  - Air compressors.
  - Welding machine.
  - Generator sets.
  - Dump Trucks.
  - Excavators.
  - Dozers
  - Grit Blasting Equipment.
  - Hand tools.
- Subcontractor shall notify the engineer, of his intention to bring on to site any equipment or any container, with liquid or gaseous fuel or other substance which may create a hazard. The Engineer shall have the right to prescribe the condition under which such equipment or container may be handled and used during the performance of the works and the subcontractor shall strictly adhere to such instructions. The Engineer shall have the right to inspect any construction tool and to forbid its use, if in his opinion it is unsafe. No claim due to such prohibition will be entertained.

### 8.2 MOBILISATION OF MANPOWER BY SUBCONTRACTOR

- The subcontractor shall arrange induction and regular health check of their employees as per schedule VII of BOCW rules by a registered medical practitioner.
- The subcontractor shall take special care of the employees affected with occupational diseases under rule 230 and schedule II of BOCW Rules. The employees not meeting the fitness requirement should not be engaged for such job.
- Ensure that the regulatory requirements of excessive weight limit (to carry/lift/ move weights beyond prescribed limits) for male and female workers are complied with.
- Appropriate accommodation to be arranged for all workmen in hygienic condition.



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**8.3 PROVISION OF PPEs**

- Personnel Protective Equipment (PPEs), in adequate numbers, will be made available at site & their regular use by all concerned will be ensured
- The following matrix recommends usage of minimum PPEs against the respective job.

Sl. No	Type of work	PPEs
1	Concrete and asphalt mixing	Nose mask, hand glove, apron and gum boot
2	Welders/Grinders/ Gas cutters	Welding/face screen, apron, hand gloves, nose mask and ear muffs if noise level exceeds 90dB. Helmet fitted with welding shield is preferred for welders
3	Stone/ concrete breakers	Ear muffs, safety goggles, hand gloves
4	Electrical Work	Rubber hand glove, Electrical Resistance shoes
5	Insulation Work	Respiratory mask, Hand gloves, safety goggles
6	Work at height	Double lanyard full body harness, Fall arrestor (specific cases)
7	Grit/Sand blasting	Blast suit, blast helmet, respirator, leather gloves
8	Painting	Plastic gloves, Respirators (particularly for spray painting)
9	Radiography	As per BARC guidelines

- The PPEs shall conform to the relevant standards as below and bear ISI mark.

**Relevant is-codes for personal protection**

IS: 2925 – 1984	Industrial Safety Helmets.
IS: 4770 – 1968	Rubber gloves for electrical purposes.
IS: 6994 – 1973 (Part-I)	Industrial Safety Gloves (Leather & Cotton Gloves).
IS: 1989 – 1986 (Part-I-II)	Leather safety boots and shoes.
IS: 5557 – 1969	Industrial and Safety rubber knee boots.
IS: 6519 – 1971	Code of practice for selections care and repair of Safety footwear.
IS: 11226 – 1985	Leather Safety footwear having direct molding sole.
IS: 5983 – 1978	Eye protectors.
IS: 9167 – 1979	Ear protectors.
IS: 1179-1967	Eye & Face protection during welding
IS: 3521 – 1983	Industrial Safety Belts and Harness
IS:8519 -1977	Guide for selection of industrial Safety equipment for body protection
IS:9473-2002,14166-1994,14746-1999	Respiratory Protective Devices

The list is not exhaustive. The safety officer may demand additional PPEs based on specific requirement.



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- Where workers are employed in sewers and manholes, which are in use, the subcontractor shall ensure that the manhole covers are opened and ventilated at least for an hour before the workers are allowed to get into manhole, and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent incident to the public
- Besides the PPEs mentioned above, the persons shall use helmet and safety shoe. The visitors shall use Helmet and any other PPEs as deemed appropriate for the area of work.

Colour scheme for Helmets:

1. Workmen: Yellow
  2. Safety staff: Green or white with green band
  3. Electrician: Red
  4. Others including visitors: White
- All the PPEs shall be checked for its quality before issue and the same shall be periodically checked. The users shall be advised to check the PPEs themselves for any defect before putting on. The defective ones shall be repaired/ replaced.
  - The issuing agency shall maintain register for issue and receipt of PPEs.
  - The Helmets shall have logo or name (abbreviation of agency name permitted) affixed or printed on the front.
  - The body harnesses shall be serial numbered.

#### **8.4 ARRANGEMENT OF INFRASTRUCTURE**

##### **8.4.1 DRINKING WATER**

- Drinking water shall be provided and maintained at suitable places at different elevations.
- Container should be labeled as " Drinking Water"
- Cleaning of the storage tank shall be ensured atleast once in 3 months indicating date of cleaning and next due date.
- Potability of water should be tested as per IS10500 at least once in a year.

##### **8.4.2 WASHING FACILITIES**

- In every workplace, adequate and suitable facilities for washing shall be provided and maintained.
- Separate and adequate cleaning facilities shall be provided for the use of male and female workers. Such facilities shall be conveniently accessible and shall be kept in clean and hygienic condition and dully illuminated for night use.
- Overalls shall be supplied by the subcontractor to the workmen and adequate facilities shall be provided to enable the painters and other workers to wash during the cessation of work.

##### **8.4.3 LATRINES AND URINALS**

- Latrines and urinals shall be provided in every work place.
- Urinals shall also be provided at different elevations.
- They shall be adequately lighted and shall be maintained in a clean and sanitary condition at all times, by appointing designated person.
- Separate facilities shall be provided for the use of male and female worker if any.



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**8.4.4 PROVISION OF SHELTER DURING REST**

Proper Shed & Shelter shall be provided for rest during break

**8.4.5 MEDICAL FACILITIES**

**8.4.5.1 MEDICAL CENTRE (As per Schedule V, X and XI of BOCW central Rules, 1998)**

- A medical centre shall be ensured/identified at site with basic facilities for handling medical emergencies. The medical center can be jointly developed on proportionate sharing basis with permission from BHEL
- A qualified medical professional, not less than MBBS, shall be deployed at the medical centre
- The medical centre shall be equipped with one ambulance, with trained driver and oxygen cylinder.
- Medical waste shall be disposed as per prevailing legislation (Bio-Medical Waste –Management and Handling Rules, 1998)

**8.4.5.2 FIRST AIDER**

- Ensure availability of Qualified First-aider throughout the working hours.
- Every injury shall be treated, recorded and reported.
- Refresher course on first aid shall be conducted as necessary.
- List of Qualified first aiders and their contact numbers should be displayed at conspicuous places.

**8.4.5.3 FIRST AID BOX (as per schedule III of BOCW)**

- The subcontractor shall provide necessary first aid facilities as per schedule III of BOCW. At every work place first aid facilities shall be provided and maintained.
- The first aid box shall be kept by first aider who shall always be readily available during the working hours of the work place. His name and contact no to be displayed on the box.
- The first aid boxes should be placed at various elevations so as to make them available within the reach and at the quickest possible time.
- The first aid box shall be distinctly marked with a Green Cross on white background.
- Details of contents of first aid box is given in Annexure No. 01
- Monthly inspection of First Aid Box shall be carried out by the owner as per format no. HSEP:13-F01
- The subcontractor should conduct periodical first –aid classes to keep his supervisor and Engineers properly trained for attending to any emergency.

**8.4.5.4 HEALTH CHECK UP (As per schedule VII and Form XI)**

The persons engaged at the site shall undergo health checkup as per the format no. HSEP:13-F02 before induction. The persons engaged in the following works shall undergo health checkup at least once in a year:

- a. Height workers
- b. Drivers/crane operators/riggers



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- c. Confined space workers
- d. Shot/sand blaster
- e. Welding and NDE personnel

**8.4.6 PROVISION OF CANTEEN FACILITY**

- Canteen facilities shall be provided for the workmen of the project inside the project site.
- Proper cleaning and hygienic condition shall be maintained.
- Proper care should be taken to prevent biological contamination.
- Adequate drinking water should be available at canteen.
- Fire extinguisher shall be provided inside canteen.
- Regular health check-up and medication to the canteen workers shall be ensured.

**8.4.7 PROVISION OF ACCOMODATION/LABOUR COLONY**

- The subcontractor shall arrange for the accommodation of workmen at nearby localities or by making a labour colony.
- Regular housekeeping of the labour colony shall be ensured.
- Proper sanitation and hygienic conditions to be maintained.
- Drinking water and electricity to be provided at the labour colony.
- Bathing/ washing bay
- Room ventilation and electrification.

**8.4.8 PROVISION OF EMERGENCY VEHICLE**

- Dedicated emergency vehicle shall be made available at workplace by each subcontractor to handle any emergency

**8.4.9 PEST CONTROL**

Regular pest control should be carried out at all offices, mainly laboratories, canteen, labour colony and stores.

**8.4.10 SCRAPYARD**

- In consultation with customer, scrapyard shall be developed to store metal scrap, wooden scrap, waste, hazardous waste.
- Scrap/Waste shall be segregated as Bio-degradable and non-bio-degradable and stored separately.

**8.4.11 ILLUMINATION**

- The subcontractor shall arrange at his cost adequate lighting facilities e.g. flood lighting, hand lamps, area lighting etc. at various levels for safe and proper working operations at dark places and during night hours at the work spot as well as at the pre-assembly area.
- Adequate and suitable light shall be provided at all work places & their approaches including passage ways as per IS: 3646 (Part-II). Some recommended values are given below:





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S. No.	Location	Illumination (Lux)
<b>A. Construction Area</b>		
1.	Outdoor areas like store yards, entrance and exit roads	20
2.	Platforms	50
3.	Entrances, corridors and stairs	100
4.	General illumination of work area	150
5.	Rough work like fabrication, assembly of major items	150
6.	Medium work like assembly of small machined parts	300
	rough measurements etc.	
7.	Fine work like precision assembly, precision measurements etc.	700
8.	Sheet metal works	200
9.	Electrical and instrument labs	450
<b>B. Office</b>		
1.	Outdoor area like entrance and exit roads	20
2.	Entrance halls	150
3.	Corridors and lift cars	70
4.	Lift landing	150
5.	Stairs	100
6.	Office rooms, conference rooms, library reading tables	300
7.	Drawing table	450
8.	Manual telephone exchange	200

- Lamp (hand held) shall not be powered by mains supply but either by 24V or dry cells.
- Lamps shall be protected by suitable guards where necessary to prevent danger, in case of breakage of lamp.
- Emergency lighting provision for night work shall be made to minimise danger in case of main supply failure.

If the subcontractor fails to take appropriate safety precautions or to provide necessary safety devices and equipment or to carry out instructions issued by the authorized BHEL official, BHEL shall have the right to take corrective steps at the risk and cost of the subcontractor

## 9.0 HSE TRAINING & AWARENESS

### 9.1 HSE INDUCTION TRAINING

All persons entering into project site shall be given HSE induction training by the HSE officer of BHEL /subcontractor before being assigned to work.

In-house induction training subjects shall include but not limited to:

- Briefing of the Project details.
- Safety objectives and targets.
- Site HSE rules.
- Site HSE hazards and aspects.
- First aid facility.
- Emergency Contact No.
- Incident reporting.
- Fire prevention and emergency response.
- Rules to be followed in the labour colony (if applicable)



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- Proper safety wear & gear must be issued to all the workers being registered for the induction (i.e., Shoes/Helmets/Goggles/Leg guard/Apron etc.)
- They must arrive fully dressed in safety wear & gear to attend the induction.
- Any one failing to conform to this safety wear& gear requirement shall not qualify to attend.
- On completing attending subcontractor's in-house HSE induction, each employee shall sign an induction training form (format no. HSEP:13-F03) to declare that he had understood the content and shall abide to follow and comply with safe work practices. They may only then be qualified to be issued with a personal I.D. card, for access to the work site.

## 9.2 HSE TOOLBOX TALK

- HSE tool Box talk shall be conducted by frontline foreman/supervisor of subcontractor to specific work groups prior to the start of work. The agenda shall consist of the followings:
  - Details of the job being intended for immediate execution.
  - The relevant hazards and risks involved in executing the job and their control and mitigating measures.
  - Specific site condition to be considered while executing the job like high temperature, humidity, unfavorable weather etc.
  - Recent non-compliances observed.
  - Appreciation of good work done by any person.
  - Any doubt clearing session at the end.
- Record of Tool box talk shall be maintained as per format no. HSEP:13-F04
- Tool box talk to be conducted at least once a week for the specific work.

## 9.3 TRAINING ON HEIGHT WORK

Training on height work shall be imparted to all workers working at height by in-house/external faculty at least twice in a year. The training shall include following topics:

- Use of PPEs
- Use of fall arrester, retractable fall arrester, life line, safety nets etc.
- Safe climbing through monkey ladders.
- Inspection of PPEs.
- Medical fitness requirements.
- Mock drill on rescue at height.
- Dos & Don'ts during height work.

## 9.4 HSE TRAINING DURING PROJECT EXECUTION

- Other HSE training shall be arranged by BHEL/ subcontractor as per the need of the project execution and recommendation of HSE committee of site.
- The topics of the HSE training shall be as follows but not limited to:
  - Hazards identification and risk analysis (HIRA)
  - Work Permit System
  - Incident investigation and reporting
  - Fire fighting
  - First aid
  - Fire-warden training
  - EMS and OHSMS
  - T & Ps fitness and operation



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- Electrical safety
- Welding, NDE & Radiological safety
- Storage, preservation & material handling.
- A matrix shall be maintained to keep an up-to-date record of attendance of training sessions carried out.

**9.5 HSE PROMOTION-SIGNAGE, POSTERS, COMPETITION, AWARDS ETC**

**9.5.1 Display of HSE posters and banners**

- Site shall arrange appropriate posters, banners, slogans in local/Hindi/English languages at work place

**9.5.2 Display of HSE signage**

- Appropriate HSE signage shall be displayed at the work area to aware workmen and passersby about the work going on and do's and don'ts to be followed

**9.5.3 Competition on HSE and award**

- Site will arrange different competition (slogan, poster, essay etc.) on HSE time to time (Safety day, BHEL day, World Environment Day etc.) and winners will be suitably awarded.

**9.5.4 HSE awareness programme**

- Subcontractor shall arrange HSE awareness programme periodically on different topics including medical awareness for all personnel working at site

**10.0 HSE COMMUNICATION**

**10.1 INCIDENT REPORTING**

- The subcontractor shall submit report of all incidents, fires and property damage etc to the Engineer immediately after such occurrence, but in any case not later than 24 hours of the occurrence. Such reports shall be furnished in the manner prescribed by BHEL. ( Refer HSE procedure for incident investigation, analysis and reporting for details)
- In addition, periodic reports on safety shall also be submitted by the subcontractor to BHEL from time to time as prescribed by the Engineer. Compiled monthly reports of all kinds of incidents, fire and property damage to be submitted to BHEL safety officer as per prescribed formats.
- HSE incidents of site shall be reported to BHEL site Management as per Procedure for Incident Investigation and Reporting in format no. HSEP:14-F15. Corrective action shall be immediately implemented at the work place and compliance shall be verified by BHEL HSE officer and until then, work shall be put on hold by Construction Manager.

**10.2 HSE EVENT REPORTING**

- Important HSE events like HSE training, Medical camp etc. organized at site shall be reported to BHEL site management in detail with photographs for publication in different in-house magazines
- Celebration of important days like National Safety Day, World Environment Day etc. shall also be reported as mentioned above.



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**11.0 OPERATIONAL CONTROL**

All applicable OCPs (Operational control procedures) will be followed by subcontractor as per BHEL instructions. This will be done as part of normal scope of work. List of such OCPs is given below. In case any other OCP is found to be applicable during the execution of work at site, then subcontractor will follow this as well, within quoted rate. These OCPs (applicable ones) will be made available to subcontractor during work execution at site. However for reference purpose, these are kept with Safety Officer of BHEL at the Power Sector Regional HQ, or available in downloadable format in the website, which may be referred by subcontractor, if they so desire.

**LIST OF OCPs**

Safe handling of chemicals	Safety in use of cranes	Hydraulic test
Electrical safety	Storage and handing of gas cylinders	Spray insulation
Energy conservation	Manual arc welding	Trial run of rotary equipment
Safe welding and gas cutting operation	Safe use of helmets	Stress relieving
Fire safety	Good house keeping	Material preservation
Safety in use of hand tools	Working at height	Cable laying/tray work
First aid	Safe excavation	Transformer charging
Food safety at canteen	Safe filling of hydrogen in cylinder	Electrical maintenance
Illumination	Vehicle maintenance	Safe handling of battery system
Handling and erection of heavy metals	Safe radiography	Computer operation
Safe acid cleaning	Waste disposal	Storage in open yard
Safe alkali boil out	Working at night	For sanitary maintenance
Safe oil flushing	Blasting	Batching
Steam blowing	DG set	Piling rig operation
Safe working in confined area	Handling & storage of mineral wool	Gas distribution test
Safe operation of passenger lift, material hoists & cages	Drilling, reaming and grinding(machining)	Cleaning of hotwell / deaerator
Electro-resistance heating	Compressor operation	O&M of control of AC plant & system
Air compressor	Passivation	Safe Loading of Unit
Safe EDTA Cleaning	Safe Chemical cleaning of Pre boiler system	Safe Boiler Light up
Safe Rolling and Synchronisation		

**11.1 HSE ACTIVITIES**

HSE activities shall be conducted at site based on the HSEMSM developed by Power Sector and issued to site by Regions.

While planning for any activity the following documents shall be referred for infrastructural requirements to establish control measures:

- 1) HSE Procedure for Register of OHS Hazards and Risks
- 2) HSE Procedure for Register of Environmental Aspects and Impacts
- 3) HSE Procedure for Register of Regulations



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- 4) Operational Control Procedures
- 5) HSE Procedure for Emergency Preparedness and Response Plan
- 6) Contract documents

### 11.2 WORK PERMIT SYSTEM

- The following activities shall come under Work Permit System
  - a. Height working above 2 metres
  - b. Hot working at height
  - c. Confined space
  - d. Radiography
  - e. Excavation more than 4 meter depth
  - f. Heavy lifting above 50 tonRefer Annexure 05 for Work permit formats.
- "HSE Procedure for Work Permit System" shall be followed while implementing permit system. Where customer is having separate Work Permit System the same shall be followed.
- Permit applicant shall apply for work permit of particular work activity at particular location before starting of the work with Job Hazard Analysis.
- Permit signatory shall check that all the control measures necessary for the activity are in place and issue the permit to the permit holder.
- Permit holder shall implement and maintain all control measures during the period of permit .He will close the permit after completion of the work. The closed permit shall be archived in HSE Department of site.

### 11.3 SAFETY DURING WORK EXECUTION

Respective OCPS are to be followed and adherence to the same would be contractually binding

#### 11.3.1 WELDING SAFETY

All safety precautions shall be taken for welding and cutting operations as per IS-818. All safety precautions shall be taken for foundation and other excavation marks as per IS-3764.

#### 11.3.2 RIGGING


Rigging equipment shall not be loaded in excess of its recommended safe working load. Rigging equipment, when not in use, shall be removed from the original work area so as not to present a hazard to employees.

#### 11.3.3 CYLINDERS STORAGE AND MOVEMENT

All gas cylinders shall be stored in upright position. Suitable trolley shall be used. There shall be flash-back arrestors conforming to IS-11006 at both cylinder and burner ends. Damaged tube and regulators must be immediately replaced. No of cylinders shall not exceed the specified quantity as per OCP

Cylinders shall be moved by tilting and rolling them on their bottom edges. They shall not be intentionally dragged, struck or permitted to strike each other violently.



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When cylinders are transported by powered vehicle they shall be secured in a vertical position.

#### 11.3.4 DEMOLITION WORK

Before any demolition work is commenced and also during the process of the work the following shall be ensured:

- All roads and open areas adjacent to the work site shall either be closed or suitably protected.
- No electric cable or apparatus which is liable to be a source of danger nor a cable or an apparatus used by the operator shall remain electrically charged.
- All practical steps shall be taken to prevent danger to persons employed from the risks of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render them unsafe.

#### 11.3.5 T&Ps

All T&Ps/ MMEs should be of reputed brand/appropriate quality & must have valid test/calibration certificates bearing endorsement from competent authority of BHEL..Subcontractor to also submit monthly reports of T&Ps deployed and validity test certificates to BHEL safety Officer as per the format/procedure of BHEL.

#### 11.3.6 CHEMICAL HANDLING

Displaying safe handling procedures for all chemicals such as lube oil, acid, alkali, sealing compounds etc , at work place. Where it is necessary to provide and/or store petroleum products or petroleum mixture & explosives, the subcontractor shall be responsible for carrying out such provision / storage in accordance with the rules & regulations laid down in the relevant petroleum act, explosive act and petroleum and carbide of calcium manual, published by the chief inspector of explosives of India. All such storage shall have prior approval if necessary from the chief inspector of explosives or any other statutory authority. The subcontractor shall be responsible for obtaining the same.

#### 11.3.7 ELECTRICAL SAFETY

- Providing adequate no. of 24 V sources and ensure that no hand lamps are operating at voltage level above 24 Volts.
- Fulfilling safety requirements at all power tapping points.
- High/ Low pressure welders to be identified with separate colour clothings. No welders will be deployed without passing appropriate tests and holding valid welding certificates. Approved welding procedure should be displayed at work place.
- The subcontractor shall not use any hand lamp energized by Electric power with supply voltage of more than 24 volts in confined spaces like inside water boxes, turbine casings, condensers etc.
- All portable electric tools used by the subcontractor shall have safe plugging system to source of power and be appropriately earthed. Only electricians licensed by appropriate statutory authority shall be employed by the subcontractor to carry out all types of electrical works. Details of earth resource and their test date to be given to BHEL safety officer as per the prescribed formats of BHEL
- The subcontractor shall use only properly insulated and armored cables which conform to the requirement of Indian Electricity Act and Rules for all wiring, electrical applications at site.



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- BHEL reserves the right to replace any unsafe electrical installations, wiring, cabling etc. at the cost of the subcontractor.
- All electrical appliances used in the work shall be in good working condition and shall be properly earthed.
- No maintenance work shall be carried out on live equipment.
- The subcontractor shall maintain adequate number of qualified electricians to maintain his temporary electrical installations.
- Area wise Electrical safety inspection is to be carried out on monthly basis as per "Electrical Safety Inspection checklist" and the report is to be submitted to BHEL safety officer
- Adequate precautions shall be taken to prevent danger for electrical equipment. No materials on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any person or the public
- The subcontractor shall carefully follow the safety requirement of BHEL/ the purchaser with the regard to voltages used in critical areas.

**11.3.8 FIRE SAFETY**

- Providing appropriate fire fighting equipment at designated work place and nominate a fire officer/warden adequately trained for his job.
- Subcontractor shall provide enough fire protecting equipment of the types and numbers at his office, stores, temporary structure in labor colony etc. Such fire protection equipment shall be easy and kept open at all times.
- The fire extinguishers shall be properly refilled and kept ready which should be certified at periodic intervals. The date of changing should be marked on the Cylinders.
- All other fire safety measures as laid down in the "codes for fire safety at construction site" issued by safety coordinator of BHEL shall be followed.
- Non-compliance of the above requirement under fire protection shall in no way relieve the subcontractor of any of his responsibility and liabilities to fire incident occurring either to his materials or equipment or those of others.
- Emergency contacts nos must be displayed at prominent locations
- Tarpaulin being inflammable should not be used (instead, only non infusible covering materials shall be used) as protective cover while preheating, welding, stress relieving etc. at site.

**11.3.9 SCAFFOLDING**

- Suitable scaffolds shall be provided for workman for all works that cannot safely be done from the ground, or from solid construction except in the case of short duration of work which can be done safely from ladders.
- When a ladder is used, it shall be of rigid construction made of steel. The steps shall have a minimum width of 45 cm and a maximum rise of 30 cm. Suitable handholds of good quality wood or steel shall be provided and the ladder shall be given an inclination not steeper than 1/4 horizontal and 1 vertical.
- Scaffolding or staging more than 3.6 m above the ground floor, swung or suspended from an overhead support or erected with stationery support shall have a guard rail properly bolted, braced or otherwise secured, at least 90 cm above the floor or platform of such scaffolding or staging and extending along the entire length of the out side and ends thereof with only such openings as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from savor, from swaying, from the building or structure.

**11.3.10 WORK AT HEIGHT:**

- Guardrails and toe-board/barricades and sound platform conforming to IS:4912-1978 should be provided.



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- Wherever necessary, life-line(pp or metallic) and fall arrestor along with Polyamide rope or Retractable lifeline should be provided.
- Safety Net as per IS:11057:1984 should be used extensively for prevention/ arrest of men and materials falling from height. The safety nets shall be fire resistant, duly tested and shall be of ISI marked and the nets shall be located as per site requirements to arrest or to reduce the consequences of a possible fall of persons working at different heights.
- Reaching beyond barricaded area without lifeline support, moving with support of bracings, walking on beams without support, jumping from one level to another, throwing objects and taking shortcut must be discouraged.
- Use of Rebar steel for making Jhoola and monkey-ladder (Rods welded to vertical or inclined structural members), temporary platform etc. must be avoided.
- Monkey Ladder should be properly made and fitted with cages.
- Jhoola should be made with angles and flats and tested like any lifting tools before use.
- Lanyard must be anchored always and in case of double lanyard, each should be anchored separately.
- In case of pipe-rack, persons should not walk on pipes and walk on platforms only.
- In case of roof work, walking ladder/ platform should be provided along with lifeline and/ or fall arrestor.
- Empty drums must not be used.
- For chimney or structure painting, both hanging platform and men should be anchored separately to a firm structure alongwith separate fall arrestor. Rope ladder should be discouraged.

#### 11.3.11 WORKING PLATFORM

Working platforms, gangways and stairways shall be so constructed that they do not sag unduly or unequally and if the height of the platform gangways provided is more than 3.6 m above ground level or floor level, they shall be closely boarded and shall have adequate width which shall not be less than 750 mm and be suitably fenced as described above. Every opening in the floor or a building or in a working platform shall be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be 90 cm.

#### 11.3.12 EXCAVATION

Wherever there are open excavation in ground, they shall be fenced off by suitable railing and danger signals installed at night so as to prevent persons slipping into the excavations.

#### 11.3.13 LADDER SAFETY

Safe means of access shall be provided to all working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9 m in the length while the width between side rails in rung ladder shall in no case be less than app. 29.2 cm for ladder upto and including 3 m in length. For longer ladders this width shall be increased at least 1/4" for each additional foot of length.

A sketch of the ladders and scaffolds proposed to be used shall be prepared and approval of the Engineer obtained prior to Construction.

#### 11.3.14 LIFTING SAFETY

- It will be the responsibility of the subcontractor to ensure safe lifting of the equipment, taking due precaution to avoid any incident and damage to other equipment and personnel.



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- All requisite tests and inspection of handling equipment, tools & tackle shall be periodically done by the subcontractor by engaging only the Competent Persons as per law.
- Defective equipment or uncertified shall be removed from service.
- Any equipment shall not be loaded in excess of its recommended safe working load.

**11.3.15 HOISTING APPLIANCE**

- Motors, gearing, transmission, electric wiring and other dangerous parts of hoisting appliances should be provided with efficient safe guards.
- Hoisting appliance should be provided with such means as will reduce to the minimum the risk of any part of a suspended load becoming incidentally displaced.
- When workers employed on electrical installations which are already energized, insulating mats, wearing apparel, such as gloves, sleeves and boots as may be necessary should be provided.
- The worker should not wear any rings, watches and carry keys or other materials which are good conductor of electricity.

**11.4 ENVIRONMENTAL CONTROL**

Environment protection has always been given prime importance by BHEL. Environmental damage is a major concern of the principal subcontractor and every effort shall be made, to have effective control measures in place to avoid pollution of Air, Water and Land and associated life. Chlorofluorocarbons such as carbon tetrachloride and trichloroethylene shall not be used. Waste disposal shall be done in accordance with the guidelines laid down in the project specification.

Any chemical including solvents and paints, required for construction shall be stored in designated bonded areas around the site as per Material Safety Data Sheet (MSDS).

In the event of any spillage, the principle is to recover as much material as possible before it enters drainage system and to take all possible action to prevent spilled materials from running off the site. The subcontractor shall use appropriate MSDS for clean-up technique

All subcontractors shall be responsible for the cleanliness of their own areas.

The subcontractors shall ensure that noise levels generated by plant or machinery are as low as reasonably practicable. Where the subcontractor anticipates the generation of excessive noise levels from his operations the subcontractor shall inform to Construction Manager of BHEL accordingly so that reasonable & practicable precautions can be taken to protect other persons who may be affected.

It is imperative on the part of the subcontractor to join and effectively contribute in joint measures such as tree plantation, environment protection, contributing towards social upliftment, conversion of packing woods to school furniture, keeping good relation with local populace etc.

The subcontractor shall carry out periodic air and water quality check and illumination level checking in his area of work place and take suitable control measure.

**11.5 HOUSEKEEPING**

- Keeping the work area clean/ free from debris, removed scaffoldings, scraps, insulation/sheeting wastage /cut pieces, temporary structures, packing woods etc. will be in the scope of the subcontractor. Such cleanings has to be done by



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subcontractor within quoted rate, on daily basis by an identified group. If such activity is not carried out by subcontractor / BHEL is not satisfied, then BHEL may get it done by other agency and actual cost along with BHEL overheads will be deducted from contractor's bill. Such decisions of BHEL shall be binding on the subcontractor

- Proper housekeeping to be maintained at work place and the following are to be taken care of on daily basis.
- All surplus earth and debris are removed/disposed off from the working areas to identified locations.
- Unused/Surplus cables, steel items and steel scrap lying scattered at different places/elevation within the working areas are removed to identified locations.
- All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from workplace to identified locations. Sufficient waste bins shall be provided at
- Different work places for easy collection of scrap/waste. Scrap chute shall be installed to remove scrap from high location.
- Access and egress (stair case, gangways, ladders etc.) path should be free from all scrap and other hindrances.
- Workmen shall be educated through tool box talk about the importance of housekeeping and encourage not to litter.
- Labour camp area shall be kept clear and materials like pipes, steel, sand, concrete, chips and bricks, etc. shall not be allowed in the camp to obstruct free movement of men and machineries.
- Fabricated steel structures, pipes & piping materials shall be stacked properly.
- No parking of trucks/trolleys, cranes and trailers etc. shall be allowed in the camp, which may obstruct the traffic movement as well as below LT/HT power line.
- Utmost care shall be taken to ensure over all cleanliness and proper upkeep of the working areas

#### 11.6 WASTE MANAGEMENT

Take suitable measures for waste management and environment related laws/legislation as a part of normal construction activities. Compliance with the legal requirements on storage/ disposal of paint drums (including the empty ones), Lubricant containers, Chemical Containers, and transportation and storage of hazardous chemicals will be strictly maintained.


##### 11.6.1 BINS AT WORK PLACE

- Sufficient rubbish bins shall be provided close to workplaces.
- Bins should be painted yellow and numbered.
- Sufficient nos. of drip trays shall be provided to collect oil and grease.
- Sufficient qty. of broomsticks with handle shall be provided.
- Adequate strength of employees should be deployed to ensure daily monitoring and service for waste management.

##### 11.6.2 STORAGE AND COLLECTION

- Different types of rubbish/waste should be collected and stored separately.
- Paper, oily rags, smoking material, flammable, metal pieces should be collected in separate bins with close fitting lids.
- Rubbish should not be left or allowed to accumulate on construction and other work places.
- Do not burn construction rubbish near working site.



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### 11.6.3 SEGREGATION

- Earmark the scrap area for different types of waste.
- Store wastes away from building.
- Oil spill absorbed by non-combustible absorbent should be kept in separate bin.
- Clinical and first aid waste stored and incinerated separately.

### 11.6.4 DISPOSAL

- Sufficient containers and scrap disposal area should be allocated.
- All scrap bin and containers should be conveniently located.
- Provide self-closing containers for flammable/spontaneously combustible material.
- Keep drainage channels free from choking.
- Make schedule for collection and disposal of waste.

### 11.6.5 WARNING AND SIGNS

- Appropriate sign to be displayed at scrap storage area
- No toxic, corrosive or flammable substance to be discarded into public sewage system.
- Waste disposal shall be in accordance with best practice.
- Comply with all the requirements of Pollution Control Board (PCB) for storage and disposal of hazardous waste.

## 11.7 TRAFFIC MANAGEMENT SYSTEM

### 11.7.1 SAFE WORKPLACE TRANSPORT SYSTEM

- Traffic routes in a work place shall be suitable for the persons or vehicles using them. This shall be sufficient in number and of sufficient size. This shall reflect the suitability of traffic routes for vehicles and pedestrians.
- Where vehicles and pedestrians use the same traffic routes there shall be sufficient space between them. Where necessary all traffic routes must be suitably indicated. Pedestrians or vehicles must be able to use traffic routes without endangering those at work. There must be sufficient separation of traffic routes from doors, gates and pedestrian traffic routes.
- For internal traffic, lines marked on roads / access routes and between buildings shall clearly indicate where vehicles are to pass.
- Temporary obstacles shall be brought to the attention of drivers by warning signs or hazard cones.
- Speed limits shall be clearly displayed. Speed ramps preceded by a warning signs or marker are necessary.
- The traffic route should be wide enough to allow vehicles to pass and re-pass oncoming or parked traffic and it may be advisable to introduce on-way system or parking restrictions.
- Safest route shall be provided between places where vehicles have to call or deliver.
- Avoid vulnerable areas/items such as fuel or chemicals tanks or pipes, open or unprotected edges and structures likely to collapse



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- Safe areas shall be provided for loading and unloading.
- Avoid sharp or blind bends. If this is not possible hazards should be indicated e.g. blind corner.
- Ensure road crossings are minimum and clearly signed.
- Entrance and gateways shall be wide enough to accommodate a second vehicle without causing obstruction.
- Set sensible speed limits which are clearly sign posted.
- Where necessary ramps should be used to retard speed. This shall be preceded by a warning sign or mark on the road.
- Forklift trucks shall not pass over road hump unless of a type capable of doing so.
- Overhead electric cable, pipes containing flammable hazardous chemical shall be shielded by using goal posts height gauge posts or barriers.
- Road traffic signs shall be provided on prominent locations for prevention of incidents and hazards and for quick guidance and warning to employees and public. Safety signs shall be displayed as per the project working requirement and guideline of the state in which project is done. Vehicles hired or used shall not be parked within the 15m radius of any working area. Any vehicle, that is required to be at the immediate/near the vicinity, shall be approved by the person in-charge of the site.

#### 11.7.2 TRAFFIC ROUTE FOR PEDESTRIANS

- Where traffic routes are used by both pedestrians and vehicles road shall be wide enough to allow vehicles and pedestrians safely.
- Separate routes shall be provided for pedestrians to keep them away from vehicles. Provide suitable barriers/guard at entrances/exit and the corners or buildings.
- Where pedestrian and vehicle routes cross, appropriate crossing shall be provided.
- Where crowd is likely to use roadway e.g. at the end of shift, stop vehicles from using them at such times.
- Provide high visibility clothing for people permitted in delivery area.

#### 11.7.3 WORK VEHICLE

Work vehicle shall be as safe stable efficient and roadworthy as private vehicles on public roads. Site management shall ensure that drivers are suitably trained. All vehicle e.g. heavy motor vehicle forklift trucks dump trucks mobile cranes shall ensure that the work equipment conforms to the following:

- A high level of stability.
- A safe means of access/egress.
- Suitable and effective service and parking brakes.
- Windscreens with wipers and external mirrors giving optimum all round visibility.
- Provision of horn, vehicle lights, reflectors, reversing lights, reversing alarms.
- Provision of seat belts.
- Guards on dangerous parts.
- Driver protection - to prevent injury from overturning and from falling objects/materials.
- Driver protection from adverse weather.
- No vehicle shall be parked below HT/LT power lines.
- Valid Pollution Under Control certification for all vehicles



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#### 11.7.4 DAILY CHECK BY DRIVER

- There should also be daily safety checks containing below mentioned points by the driver before the vehicle is used.
  - Brakes.
  - Tires.
  - Steering.
  - Mirrors.
  - Windscreen waters.
  - Wipers.
  - Warning signals.
  - Specific safety system i.e. control interlocks
- Management should ensure that drivers carry out these checks.

#### 11.7.5 TRANSPORTATION OF PERSONNEL AND MATERIALS BY VEHICLES

- All drivers shall hold a valid driving License for the class of vehicle to be driven and be registered as an authorized BHEL driver with the Administration Department.
- Securing of the load shall be by established and approved methods, i.e. chains with patented tightening equipment for steel/heavy loads. Sharp corners on loads shall be avoided when employing ropes for securing.
- All overhangs shall be made clearly visible and restricted to acceptable limits
- Load shall be checked before moving off and after traveling a suitable distance.
- On no account is construction site to be blocked by parked vehicles Drivers of vehicles shall only stop or park in the areas designate by the stringing foreman.
- Warning signs shall be displayed during transportation of material.  
All vehicles used by BHEL shall be in worthy condition and in conformance to the Land Transport requirement.

#### 11.7.6 MAINTENANCE

All Vehicles used for transportation of man and material shall undergo scheduled inspections on frequent intervals to secure safe operation. Such inspections shall be conducted in particular for steering, brakes, lights, horn, doors etc. Site management shall ensure that work equipment is maintained in an efficient, working order and in good repair. Inspections and services carried out at regular intervals of time and or mileage. No maintenance shall be carried below HT/LT power lines.

#### 11.8 EMERGENCY PREPAREDNESS AND RESPONSE

- Emergency preparedness and response capability of site shall be developed as per Emergency Preparedness and Response plan issued by Regional HQ
- Availability of adequate number of first aiders and fire warden shall be ensured with BHEL and its subcontractors
- All the subcontractor's supervisory personnel and sufficient number of workers shall be trained for fire protection systems. Enough number of such trained personnel must be available during the tenure of contract. Subcontractor should nominate his supervisor to coordinate and implement the safety measures.
- Assembly point shall be earmarked and access to the same from different location shall be shown
- Fire exit shall be identified and pathway shall be clear for emergency escape.



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- Appropriate type and number of fire extinguisher shall be deployed as per Fire extinguisher deployment plan and validity shall be ensured periodically through inspection
- Adequate number of first aid boxes shall be strategically placed at different work places to cater emergency need. Holder of the first aid box shall be identified on the box itself who will have the responsibility to maintain the same.
- First aid center shall be developed at site with trained medical personnel and ambulance
- Emergency contact numbers (format given in EPRP) of the site shall be displayed at prominent locations.
- Tie up with fire brigade shall be done in case customer is not having fire station.
- Tie up with hospital shall be done in case customer is not having hospital.
- Disaster Management group shall be formed at site
- Mock drill shall be arranged at regular intervals. Monthly report of the above to be given to BHEL safety Officer as per prescribed BHEL formats
- Mock drill shall be conducted on different emergencies periodically to find out gaps in emergency preparedness and taking necessary corrective action

## 12.0 HSE INSPECTION

Inspection on HSE for different activities being carried out at site shall be done to ensure compliance to HSEMS requirements. The subcontractor shall maintain and ensure necessary safety measures as required for inspection and tests HV test, Pneumatic test, Hydraulic test, Spring test, Bend test etc as applicable, to enable inspection agency for performing Inspection. If any test equipment is found not complying with proper safety requirements then the Inspection Agency may withhold inspection, till such time the desired safety requirements are met.

### 12.1 DAILY HSE CHECKS

Both the Site Supervisors and safety officer of Subcontractor are to conduct daily site Safety inspection around work activities and premises to ensure that work methods and the sites are maintained to an acceptable standard. The following are to form the common subjects of a daily safety inspection:

- Personal Safety wears & gear compliance.
- Complying with site safety rules and permit-to-work (PTW).
- Positions and postures of workers.
- Use of tools and equipment etc. by the workers.

The inspection should be carried out just when work starts in beginning of the day, during peak activities period of the day and just before the day's work ends.

### 12.2 INSPECTION OF PPE

- PPEs shall be inspected by HSE officer at random once in a week as per format no. HSEP:13-F06 for its compliance to standard and compliance to use and any adverse observation shall be recorded in the PPE register.
- The applicable PPEs for carrying out particular activities are listed below.



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### 12.3 INSPECTION OF T&Ps

- A master list of T&Ps shall be maintained by each subcontractor.
- All T&Ps being used at site shall be inspected by HSE officer once in a month as per format no. HSEP:13-F07 for its healthiness and maintenance.
- The T&Ps which require third party inspection shall be checked for its validity during inspection. The third party test certificate should be accompanied with a copy of the concerned competent person's valid qualification record.
- The validity of T&P shall be monitored as per "Status of T&Ps" format no. HSEP:13-F08

### 12.4 INSPECTION OF CRANES AND WINCHES

- Cranes and winches shall be inspected by the operator through a daily checklist for its safe condition (as provided by the equipment manufacturer) before first use of the day.
- Cranes and Winches shall be inspected by HSE officer once in a month as per format no. HSEP:13-F09 for healthiness, maintenance and validity of third party inspection.
- The date of third party inspection and next due date shall be painted on cranes and winches.
- The operators/drivers shall be authorized by sub-contractor based on their competency and experience and shall carry the I-card.
- The operator should be above 18 years of age and should be in possession of driving license of HMV man & goods), vision test certificate and should have minimum qualification so that he can read the instructions and check list.

### 12.5 INSPECTION ON HEIGHT WORKING

- Inspection on height working shall be conducted daily by supervisors before start of work to ensure safe working condition including provision of
  - Fall arrestor
  - Lifelines
  - Safety nets
  - Fencing and barricading
  - Warning signage
  - Covering of opening
  - Proper scaffolding with access and egress.
  - Illumination
- Inspection on height working shall be conducted once in a week by HSE officer as per format no. HSEP:14-F10.
- Medical fitness of height worker shall be ensured.
- Height working shall not be allowed during adverse weather.

### 12.6 INSPECTION ON WELDING AND GAS CUTTING OPERATION

- Supervisor shall ensure that no flammable items are available in near vicinity during welding and gas cutting activity.
- Gas cylinders shall be kept upright.
- Use of Flash back arrestor shall be ensured at both ends.



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- Inspection during welding and gas cutting operations shall be carried out by HSE officer once a month as per format no. HSEP:14-F11.
- Use of fire blanket to be ensured to avoid falling of splatters during welding or gas cutting operation at height.
- Availability of fire extinguisher at vicinity shall be ensured.

**12.7 INSPECTION ON ELECTRICAL INSTALLATION / APPLIANCES**

- Ensure proper earthing in electrical installation
- Use ELCB at electrical booth
- Electrical installation shall be properly covered at top where required
- Use appropriate PPEs while working
- Use portable electrical light < 24 V in confined space and potentially wet area.
- Monthly inspection shall be carried out as per format no. HSEP:14-F12.

**12.8 INSPECTION OF ELEVATOR**

- Elevators shall be inspected by concerned supervisors once in a week as per format no. HSEP:14-F13.
- All elevators shall be inspected by competent person and validity shall be ensured.
- The date of third party inspection and next due date shall be painted on elevator.


**13.0 HSE PERFORMANCE**

HSE performance of the subcontractor shall be monitored as per the following parameters:

Sl. No.	Parameters of measurement
1	Timely deployment of qualified safety officer and cumulative number of days in a month the required no. of qualified safety officer is available
2	Shortfall in number of meetings in the month conducted or attended by the safety officer
3	Level of compliance wrt decisions taken in previous meetings/audit/inspection/as reported.
4	Delay in submission of monthly report on safety in the prescribed format
5	Delay in reporting any incident including near-miss to BHEL /Customer/statutory authority( if required)
6	Degree of PPE non-compliance
7	Non- conducting of health check-up as per BOCW equirements
8	Non availability of proper first-aid facility , ambulance, adequate labour welfare initiatives
9	Non conductance of induction training and tool box meeting
10	Total number of instances in the month, House keeping NOT attended inspite of instructions by BHEL i.e. removal/disposal of surplus earth/ debris/scrap/unused/surplus cable drums/other electrical items/surplus steel items/packing material

- Suitable HSE reward system shall be developed at site level to promote HSE compliance amongst workmen.
- To decide HSE reward performance towards HSE shall be evaluated for workmen and it shall be awarded regularly in public gathering.
- If safety record of the subcontractor in execution of the awarded job is to the satisfaction of safety department of BHEL, issue of an appropriate certificate to recognize the safety performance of the subcontractor may be considered by BHEL after completion of the job.



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#### 14.0 HSE PENALTIES

- As per contractual provision HSE penalties shall be imposed on subcontractors for non-compliance on HSE requirement as per format no. HSEP:14-F14. The list in the format is only indicative. For any other violation, not listed in the format, the minimum penalty amount is to be decided as per BOCW act.
- If principal customer/statutory and regulatory bodies impose some penalty on HSE due to the non-compliance of the subcontractor the same shall be passed on to them.
- The penalty amount shall be recovered by Site Finance department from subcontractors from the RA/Final bill.

#### 15.0 OTHER REQUIREMENTS

- In case of any delay in completion of a job due to mishaps attributable to lapses by the subcontractor, BHEL shall have the right to recover cost of such delay from the payments due to the subcontractor, after notifying the subcontractor suitably.
- If the subcontractor fails to improve the standards of safety in its operation to the satisfaction of BHEL after being given reasonable opportunity to do so and/or if the subcontractor fails to take appropriate safety precautions or to provide necessary safety devices and equipment or to carry out instruction regarding safety issued by BHEL, BHEL shall have the right to take corrective steps at the risk and cost of the subcontractor after giving a notice of not less than 7 days indicating the steps that would be taken by BHEL.
- If the subcontractor succeeds in carrying out its job in time without any fatal or disabling injury incident and without any damage to property BHEL may, at its sole discretion, favorably consider to reward the subcontractor suitably for the performance.
- In case of any damage to property due to lapses by the subcontractor, BHEL shall have the right to recover the cost of such damages from the subcontractor after holding an appropriate enquiry.
- The subcontractor shall take all measures at the sites of the work to protect all persons from incidents and shall be bound to bear the expenses of defense of every suit, action or other proceeding of law that may be brought by any persons for injury sustained or death owing to neglect of the above precautions and to pay any such persons such compensation or which may with the consent of the subcontractor be paid to compromise any claim by any such person, should such claim proceeding be filed against BHEL, the subcontractor hereby agrees to indemnify BHEL against the same.
- The subcontractor shall not employ men below the age of 18 years and women on the work of painting with products containing lead in any form. Wherever men above the age of 18 are employed on the work of lead painting, overalls shall be supplied by the subcontractor to the workmen and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.
- The subcontractor shall notify BHEL of his intention to bring to site any equipment or material which may create hazard.
- BHEL shall have the right to prescribe the conditions under which such equipment or materials may be handled and the subcontractor shall adhere to such instructions.



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- BHEL may prohibit the use of any construction machinery, which according to the organization is unsafe. No claim for compensation due to such prohibition will be entertained by BHEL.

**16. NON COMPLIANCE**

NONCONFORMITY OF SAFETY RULES AND SAFETY APPLIANCES WILL BE VIEWED SERIOUSLY AND BHEL HAS RIGHT TO IMPOSE FINES ON THE SUBCONTRACTOR AS UNDER FOR EVERY INSTANCE OF VIOLATION NOTICED:

SN	Violation of Safety Norms	Fine (in Rs)
01	Not Wearing Safety Helmet	200/- *
02.	Not wearing Safety Belt or not anchoring life line	500/-*
03	Not wearing safety shoe	200/-*
04	Not keeping gas cylinders vertically	200/-
05	Not using flash back arrestors	100/-
06	Not wearing gloves	50/- *
07.	Grinding Without Goggles	50/- *
08.	Not using 24 V Supply For Internal Work	500/-
09.	Electrical Plugs Not used for hand Machine	100/-
10.	Not Slings properly	200/-
11.	Using Damaged Sling	200/-
12.	Lifting Cylinders Without Cage	500/-
13.	Not Using Proper Welding Cable With Lot of Joints And Not Insulated Property.	200/-
14.	Not Removing Small Scrap From Platforms	500/-
15.	Gas Cutting Without Taking Proper Precaution or Not Using Sheet Below Gas Cutting	500/-
16.	Not Maintaining Electric Winches Which are Operated Dangerously	500/-
17.	Improper Earthing Of Electrical T&P	500/-
18	No or improper barricading	500/-
19.	Activity carried out without Safety work permit (Height work, Lifting activity, Hot work-each person/case)	1000/-
20.	Incident Resulting in Partial Loss in Earning Capacity	25,000/- per victim
21.	Fatal Incident Resulting in total loss in Earning Capacity	1,00,000/- per victim for first instance #

- Legend:-

\*: per head. For repeated violation by the same person, the penalty would be double of the previous penalty. Date of "Repeated violation" will be counted from subsequent days.

#: or as deducted by customer, whichever is higher. For repeated fatal incident in the same Unit incremental penalty to be imposed. The subcontractor will pay 2 times the penalty compared to previously paid in case there are repeated cases of fatal incidents under the same subcontractor for the same package in the same unit.

Any other non-conformity noticed not listed above will also be fined as deemed fit by BHEL. The decision of BHEL engineer is final on the above. The amount will be deducted from running bills of the subcontractor. The amount collected above will be utilized for giving award to the employees who could avoid incident by following safety rules. Also the amount will be spent for purchasing the safety appliances and supporting the safety activity at site.



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#### 17.0 HSE AUDIT/INSPECTION

- Regular HSE Audit/inspection shall be carried out by Subcontractor as per Site HSE audit calendar.
- HSE checklist(**Annexure 02**)shall be used for carrying out audit/inspection and report shall be submitted to BHEL sitemangement
- All non-conformities and observations on HSE identified during internal or external HSE audit shall be disposed off by site in a time bound manner and reported back the implementation status
- Corrective action and Preventive action on HSE issues raised by certification body issued by Regional HQs shall be implemented by site and reported to Site management.

#### 18.0 MONTHLY HSE REVIEW MEETING

- Site shall hold HSE review meeting every month to discuss and resolve HSE issues of site and improve HSE performance. It will also discuss the incidents occurred since previous meeting,its root causeand Corrective action and Preventive action.The agenda is given below:
  - Implementation of earlier MOM
  - HSE performance
  - HSE inspection
  - HSE audit and CAPA
  - HSE training
  - Health check-up camp
  - HSE planning for the erection and commissioning and installation activities in the coming month
  - HSE reward and promotional activities
- The meeting shall be chaired by Construction Manager, convened by HSE coordinator and attended by all HOS, Site Incharge of Subcontractors and HSE officer of Subcontractors.
- MOM on the discussion will be circulated to the concerned for implementation.

#### 19.0 FORMATS USED(Details available in Annexure-04)

SL. No.	Format Name	Format No.	Rev No.
01	Inspection of First Aid Box	HSEP:13-F01	00
02	Health Check Up	HSEP:13-F02	00
03	HSE Induction Training	HSEP:13-F03	00
04	Tool Box Talk	HSEP:13-F04	00
05	Monthly Site HSE Report	HSEP:13-F05	00
06	Inspection of PPE	HSEP:13-F06	00



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07	Inspection of T&Ps	HSEP:13-F07	00
08	Status of T&Ps	HSEP:13-F08	00
09	Inspection of Cranes and Winches	HSEP:13-F09	00
10	Inspection on Height Working	HSEP:13-F10	00
11	Inspection on Welding & Gas Cutting	HSEP:13-F11	00
12	Inspection on Electrical Installation	HSEP:13-F12	00
13	Inspection on Elevator	HSEP:13-F13	00
14	HSE Penalty	HSEP:13-F14	00
15	Accident /incident / property damage /fire incident report	HSEP:13-F15	00



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**20.0 ANNEXURES**

**ANNEXURE 01**

**As per Contract Labour (Regulation & Abolition Act), Central Rules, 1971,**

- (1) The first-aid box shall be distinctively marked with a Red Cross on a white background and shall contain the following items, namely:

**(a) For establishments in which the number of contract labour employed does not exceed fifty, each first aid box shall contain the following equipment:**

(i)	6 small sterilized dressings
(ii)	3 medium size sterilized dressings
(iii)	3 large size sterilized dressings
(iv)	6 pieces of sterilized eye pads in separate sealed packets.
(v)	6 roller bandages 10 cm wide.
(vi)	6 roller bandages 5 cm wide.
(vii)	One tourniquet
(viii)	A supply of suitable splints
(ix)	Three packets of safety pins.
(x)	Kidney tray.
(xi)	3 large sterilized burn dressings.
(xii)	1 (30ml) bottle containing a two percent alcoholic solution of iodine
(xiii)	1 (30 ml) bottle containing Sal volatile having the dose and mode of administration indicated on the label
(xiv)	1 snake bite lancet
(xv)	1 (30gms) bottle of potassium permanganate crystals.
(xvi)	1 pair scissors
(xvii)	1 copy of the First-Aid leaflet issued by the Director General, Factory Advice Service and Labour Institutes, Government of India.
(xviii)	A bottle containing 100 tablets (each of 5 grains) of aspirin
(xix)	Ointment for burns
(xx)	A bottle of suitable surgical anti-septic solution

**(b) For establishment in which the number of contract labour exceeds fifty each first-aid box shall contain the following equipment:**

(i)	12 small sterilized dressings
(ii)	6 medium size sterilized dressings
(iii)	6 large size sterilized dressings.
(iv)	6 large size sterilized burn dressings
(v)	6 (15 grams) packets sterilized cotton wool
(vi)	12 pieces of sterilized eye pads in separate sealed packets.



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(vii)	12 roller bandages 10 cm wide.
(viii)	12 roller bandages 5 cm wide.
(ix)	One tourniquet.
(x)	A supply of suitable splints.
(xi)	Three packets of safety pins.
(xii)	Kidney tray.
(xiii)	Sufficient number of eye washes bottles filled with distilled water or suitable liquid clearly indicated by a distinctive sign which shall be visible at all times.
(xiv)	4 per cent Xylocaine eye drops, and boric acid eye drops and soda by carbonate eye drops.
(xv)	1 (60ml) bottle containing a two percent alcoholic solution of iodine
(xvi)	One (two hundred ml) bottle of mercurochrome (2 per cent) solution in water.
(xvii)	1 (120ml) bottle containing Sal volatile having the dose and mode of administration indicated on the label.
(xviii)	1 roll of adhesive plaster (6 cmX1 meter)
(xix)	2 rolls of adhesive plaster (2 cmX1 meter)
(xx)	A snake bite lancet.
(xxi)	1 (30 grams) bottle of potassium permanganate crystals.
(xxii)	1 pair scissors
(xxiii)	1 copy of the First-Aid leaflet issued by the Director-General, Factory Advice service and labour Institutes, Government of India.
(xxiv)	a bottle containing 100 tablets (each of 5 grains) of aspirin
(xxv)	Ointment for burns
(xxvi)	A bottle of a suitable surgical anti septic solution.

(2) Adequate arrangement shall be made for immediate recoument of the equipment when necessary.





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**ANNEXURE 02**

**HSE AUDIT/INSPECTION CHECKLIST CUM COMPLIANCE REPORT**

PROJECT: \_\_\_\_\_

SUBCONTRACTOR: \_\_\_\_\_

DATE : \_\_\_\_\_

OWNER : \_\_\_\_\_

INSPECTION BY: \_\_\_\_\_

Note : write 'NA' wherever the items is not applicable

Item	Y e s	N o	Remarks	Action
<b>HOUSEKEEPING</b>				
Waste containers provided and used				
Passageways and walkways clear				
General neatness of working area				
Other				
<b>PERSONNEL PROTECTIVE EQUIPMENTS</b>				
Goggles; shields				
Face protection				
Hearing protection				
Respiratory masks etc.				
Safety belts				
Other				
<b>EXCAVATIONS / OPENINGS</b>				
Openings properly covered or barricaded				
Excavations shored				
Excavations barricaded				
Overnight lighting provided				
Other				
<b>WELDING, CUTTING</b>				
Gas cylinders chained upright				
Cable and hoses not obstructing				
Fire extinguisher (s) accessible				
Others				
<b>SCAFFOLDING</b>				
Fully decked platforms				
Guard and intermediate rails in place				
Toe boards in place				
Adequate shoring				
Adequate access				
Others				
<b>LADDER</b>				
Extension side rails 1 m above				
Top of landing				
Properly secured				



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Angle $\pm 70^{\circ}$ from horizontal				
Other				
<b>HOISTS, CRANES AND DERRICKS</b>				
Condition of cables and sheaf OK				
Condition of slings, chains, hooks OK				
Inspection & maintenance log maintained				
Outriggers used				
Signals observed and understood				
Qualified operators				
Others				
<b>MACHINERY, TOOLS &amp; EQUIPMENT</b>				
Proper instruction				
Safety devices				
Proper cords				
Inspection and maintenance				
Other				
<b>VEHICLE AND TRAFFIC</b>				
Rules and regulations observed				
Inspection and maintenance				
Licensed drivers				
Other				
<b>TEMPORARY FACILITIES</b>				
Emergency instructions posted				
Fire extinguishers provided				
Fire-aid equipment available				
General neatness				
Others				
<b>FIRE PREVENTION</b>				
Personnel instructed				
Fire extinguishers checked				
No smoking in prohibited areas.				
Hydrants				
Clearance				
Others				
<b>ELECTRICAL</b>				
Proper wiring				
ELCB's provided				
Ground fault circuit interrupters				
Protection against damage				
Prevention of tripping hazards				
Other				
<b>HANDLING &amp; STORAGE OF MATERIALS</b>				
Properly stored or stacked				
Passageways clear				
Other				
<b>FLAMMABLE GASES AND LIQUIDS</b>				
Containers clearly identified				
Proper storage				
Fire extinguisher nearby				



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Other				
<b>WORKING AT HEIGHT</b>				
Safety nets				
Safety belts				
Safety helmets				
Anchoring of safety belt to the life line rope				
<b>ENVIRONMENT</b>				
Lubricant waste/engine oils properly dispose.				
Waste from Canteen, offices, sanitation etc. disposed properly.				
Disposal of surplus earth, stripping materials, expired batteries, oily rags and combustible materials done properly.				
<b>HEALTH CHECKS</b>				
Hygienic conditions at labor camps O.K.				
Availability of first-aid facilities				
Proper sanitation at site, office & labor camps.				
Arrangement of medical facilities.				
Measures for dealing with illness.				
Availability of potable drinking water for workmen & staff.				
Provision of crèches for children.				



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**ANNEXURE 03**

**REFERENCES**

- Contract documents
- Relevant legislations
- HSEMSM
- Relevant Indian standards as listed below (illustrative only):

SL NO	CODE NAME	TITLE
(1)	IS : 818-1888 (Reaffirmed 2003)	Code of Practice for safety and health requirements in Electric and Gas Welding and Cutting operations.
(2)	IS: 1179-1967 (Reaffirmed 2003)	Specification for Equipment for Eye & Face protection during welding.
(3)	IS : 1989 (Part 2):1986 (Reaffirmed 1997)	Specification for Leather Safety Boots & Shoes
(4)	IS:2925 – 1984 (Reaffirmed 2010)	Specification for Industrial Safety Helmets
(5)	IS:3521 : 1999 (Reaffirmed 2002)	Industrial Safety Belts & Harnesses-Specification
(6)	IS:3646(Part II) – 1966 (Reaffirmed 2003)	Code of Practice for Interior Illumination
(7)	IS:3696 (Part I) – 1987 (Reaffirmed 2002)	Safety Code for Scaffolds and Ladders
(8)	IS: 3696(Part 2) : 1991 (Reaffirmed 2002 )	Scaffolds and Ladders-Code of Safety
(9)	IS:3786 – 1983 (Reaffirmed 2002)	Method for Computation of Frequency and Severity Rates for Industrial Injuries and Classification of Industrial Incidents
(10)	IS:4770 : 1991 (Reaffirmed 2006)	Rubber Gloves – Electricals purposes-Specification
(11)	IS:4912 : 1978 (Reaffirmed 2002)	Safety Requirements for Floor and Wall Openings, Railings and Toe Boards
(12)	IS: 5983 – 1980 (Reaffirmed 2002)	Specification for Eye-Protectors
(13)	IS:6519 – 1971 (Reaffirmed 1997)	Code of Practice for Selection, Care and Repair of Safety Footwear
(14)	IS:9167:1979	Specification for Ear-Protectors
(15)	IS:6994(Part I)-1973 (Re affirmed 1996)	Specification for Industrial Safety Gloves Leather and Cotton Gloves
(16)	IS:8519 – 1977 (Reaffirmed 1983)	Guide for Selection of Industrial Safety Equipment for Body Protection.
(17)	IS 11006 : 2011	Flash Back(Flame Arrestor) Specification



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(18)	IS:8520 – 1977 (Reaffirmed 2002)	Guide for Selection of Industrial Safety Equipment for Eye, Face and Ear Protection.
(19)	IS:9473:2002	Respiratory Protective Devices-Filtering Half Masks to protect against Particles-Specification.
(20)	IS:9944:1992 (Reaffirmed 2003)	Natural and Man-made Fiber Rope Slings-Recommendations on Safe working loads.
(21)	IS:11057 – 1884 (Reaffirmed 2001)	Specification for Industrial Safety Nets
(22)	IS:12254:1993 (Reaffirmed 2002)	Polyvinyl Chloride (PVC) Industrial Boots-Specification
(23)	IS:13367(Part 1):1992 (Reaffirmed 2003)	Safe Use of Cranes-Code of Practice
(24)	IS:14166:1994 (Reaffirmed 2002)	Respiratory Protective Devices-Full Face Masks Specification
(25)	IS:14746 : 1999 (Reaffirmed 2003)	Respiratory Protective Devices-Half Masks and Quarter Masks - Specification
(26)	IS : 15397 :2003 (Reaffirmed 2008)	Portable Extinguisher Mechanical Foam Type(Stored Pressure)-Specification
(27)	IS: 19011:2002	Guidelines for Quality and/or Environmental Management Systems Auditing



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**ANNEXURE 04 : SAFETY FORMATS  
&  
ANNEXURE 05 : WORK PERMIT FORMATS**



**POWER SECTOR****INSPECTION OF FIRST AID BOX**

FORMAT NO: HSEP:13-F01

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<b>Name of Site :</b>	
<b>Name of Sub-Contractor :</b>	
<b>Inspected by :</b>	
<b>Date of Inspection :</b>	

Number of employees on the site:- \_\_\_\_\_

Sl.No.	Item	No. Available	Remarks
1	No. of small sterilized dressings		
2	No of medium sized sterilized dressings		
3	No of large sized sterilized dressings.		
4	No of large sized sterilized burn dressings		
5	No of (15 grams) packets sterilized cotton wool		
6	No of pieces of sterilized eye pads in separate sealed packets.		
7	No of roller bandages 10 cm wide.		
8	No of roller bandages 5 cm wide.		
9	Whether tourniquet available		
10	Whether supply of suitable splints available.		
11	No of packets of safety pins.		
12	Whether kidney tray available		
13	Whether sufficient number of eye wash bottles, filled with distilled water or suitable liquid, clearly indicated by a distinctive sign which shall be visible at all times, available.		
14	Whether 4%-xylocaine eye drops, and boric acid eye drops and soda by carbonate eye drops available.		
15	Whether (60ml) bottle containing a two percent alcoholic solution of iodine available		
16	Whether (two hundred ml) bottle of mercurochrome (2 per cent) solution in water available.		

**POWER SECTOR****INSPECTION OF FIRST AID BOX**

FORMAT NO: HSEP:13-F01

REV NO.: 00

PAGE NO. 02 OF 02

Sl.No.	Item	No. Available	Remarks
17	Whether 120ml bottle containing Sal volatile having the dose and mode of administration indicated on the label, available.		
18	Whether roll of adhesive plaster (6 cmX1 meter) available		
19	No of rolls of adhesive plaster (2 cmX1 meter)		
20	Whether snake bite lancet available.		
21	Whether (30 grams) bottle of potassium permanganate crystals available.		
22	Whether a pair scissors available		
23	Whether copy of the First-Aid leaflet issued by the Director-General, Factory Advice service and labour Institutes, Government of India available.		
24	Whether bottle containing 100 tablets (each of 5 grains) of aspirin available		
25	Whether Ointment for burns available		
26	Whether bottle of a suitable surgical anti septic solution available		

Signature of Subcontractor's Site I/C::

**POWER SECTOR****HEALTH CHECK UP**

FORMAT NO: HSEP:13-F02

REV NO.: 00

PAGE NO. 01 OF 02

<b>Name of Site :</b>	
<b>Name of Sub-Contractor :</b>	
<b>Name of Employee :</b>	

**NAME:**

History Of Past Illness	H/O Epilepsy
	H/O Drug Allergy
	H/O Diabetics/ Hypertension
	H/O Unconsciousness

Personal History

<b>EXAMINATION</b>		<b>OBSERVATION</b>	
<b><u>General Physical Examination</u></b>			
Height	:		
Weight	:		
BMI	:		
Built And nourishment	:		
Pallor	:		
Temperature	:		
Chest Expansion	:	Inspiration	Expansion
Lymph Node Enlargement	:		
<b><u>Ear, Nose, Throat</u></b>	:		
Ear	:		
Nose	:		
Throat	:		



**POWER SECTOR**

**HEALTH CHECK UP**

FORMAT NO: HSEP:13-F02

REV NO.: 00

PAGE NO. 02 OF 02

EXAMINATION	OBSERVATION
<b>Cardiovascular System Examination :</b>	
Inspection :	
Palpation :	Pulse BP
Auscultation (Heart Sounds) :	
<b>Respiratory System :</b>	
Inspection :	Respiratory Rate
Palpation:	
Percussion :	
Auscultation (Breath Sounds) :	
<b>Examination of Abdomen :</b>	
Inspection :	
Palpation :	
Auscultation (Bowel Sounds) :	
<b>Any Other :</b>	
<b>Clinical Impression</b>	

Signature of the examining doctor









**POWER SECTOR**

**PERSONAL PROTECTIVE EQUIPMENTS**

FORMAT NO: HSEP:13-F06

REV NO.: 00

PAGE NO. 01 OF 01

<b>Name of Site :</b>	
<b>Name of Sub-Contractor :</b>	
<b>Inspected by :</b>	
<b>Date of Inspection :</b>	

<b>Item</b>	<b>Issued this Month</b>	<b>Nos. Issued up to the Month</b>	<b>Percentage of usage at site</b>
Safety Helmet			
Safety Shoes			
Full Body Harness			
Fall Arrestor			
Safety Nets			
Other PPEs.			

**Signature of Site I/C of Subcontractor :**

**POWER SECTOR****INSPECTION OF T&Ps**

FORMAT NO: HSEP:13-F07

REV NO.: 00

PAGE NO. 01 OF 01

<b>Name of Site :</b>	
<b>Name of Sub-Contractor :</b>	
<b>Date of Inspection :</b>	

Sl.No.	Description	Remarks
1.0	Name of equipment	
2.0	Basic Information of equipment	
2.1	Specification	
2.2	Sr. No. of equipment	
2.3	Make	
2.4	Year of manufacture	
3.0	Major repairs / overhauls(Furnish details of work carried out)	Date(s) of major repair/overhaul
3.1		
3.2		
3.3	Repairs carried out at site	
4.0	Any performance test conducted	Yes/No
5.0	Document Submitted	Yes/No
6.0	Manufacturer's test / guarantee certificate	Available/ Not available
7.0	Performance test	Done/ Not Done
8.0	Acceptance Norms	
9.0	Committee Observations	
10.0	Date of next review (if accepted)	

Signature-Site Safety Officer ( BHEL)

Signature-Subcontractor/ Subcontractor's  
Safety Officer

**POWER SECTOR****STATUS OF T&Ps**

FORMAT NO: HSEP:13-F08

REV NO.: 00

PAGE NO. 01 OF 01

Name of Site	
Name of Sub-Contractor	
Date of Inspection	

Item	Nos. Deployed	Identification No.	Nos. Tested by competent person	Validity of Test Certificate
Winches				
Chain Blocks				
Wire Rope Slings				
Man Cages				
D-Shackles				
Air Compressors				
Crawler Cranes				
Mobile Cranes				
Hydra Cranes				
Others				

Signature of Site I/C of subcontractor :

**POWER SECTOR****INSPECTION OF CRANES AND WINCHES**

FORMAT NO: HSEP:13-F09

REV NO.: 00

PAGE NO. 01 OF 03

<b>Name of Site :</b>	
<b>Name of Sub-Contractor :</b>	
<b>Inspected by :</b>	
<b>Date of Inspection:</b>	

Crane Reg. No (Make/Model) \_\_\_\_\_

Name of Driver/Operator \_\_\_\_\_

Sl.no.	Description	Observation	Measures
1	Valid Driving license		
2	Hook & Hook Latch		
3	Over Hoist limit switch		
4	Boom limit switch		
5	Boom Angle Indicator		
6	Boom limit cutoff switch		
7	Condition of Boom		
8	Condition of ropes		
9	Number of load lines		
10	Size and condition of the slings		
11	Stability of the cranes		
12	Soil Condition		
13	Swing Break And Lock		
14	Proper Break And Lock		
15	Hoist Break And Lock		
16	Boom Break And Lock		
17	Main Clutch		
18	Leakage in Hydraulic Cylinders		
19	Out riggers fully extendable		
20	Tyre pressure		
21	Condition of Battery And Lamps		



**POWER SECTOR**

**INSPECTION OF CRANES AND WINCHES**

FORMAT NO: HSEP:13-F09  
REV NO.: 00  
PAGE NO. 02 OF 03

Sl.no.	Description	Observation	Measures
22	Guards of moving and rotating parts		
23	Load chart provided		
24	Number and position of pedant ropes		
25	Reverse Horn		
26	Load Test Details		
27	Operator's fitness		
28	Pollution under control certificate		
29	Fire extinguisher of appropriate type.		
30	Training of the operator		

**WINCH**

Sl. No.	Description	YES	NO	NA	Remarks
1	Has the copy of Third Party Inspection certificate been provided in winch machine shed?				
2	Is winch machine operator experienced enough to operate the winch machine?				
3	Is the winch machine operated by someone other than the winch machine operator?				
4	Is there guard provided in all moving parts like wheel and motor's shaft?				
5	Will it protect against unforeseen operational contingencies?				
6	Are brakes, clutch and locking arrangement working properly?				
7	Has it been ensured that the guard does not constitute a hazard by itself?				
8	Are the cranks and the connecting rods protected by guardrails?				
9	Is there provision for fully covered shed with wooden plank roof?				

**POWER SECTOR****INSPECTION OF CRANES AND WINCHES**

FORMAT NO: HSEP:13-F09


REV NO.: 00

PAGE NO. 03 OF 03

Sl. No.	Description	YES	NO	NA	Remarks
10	Is wire rope free from any kind of damage or wear and tear?				
11	Is split pin provided for the protection of clutch and brake locking arrangement?				
12	Is pulley inspected by competent person and certified before use?				
13	Is pulley free from any wear and tear visually?				
14	Is winch rope barricaded with clipsheet for the protection of rope and person?				
15	Is the wire rope lubricated by cardium oil?				
16	Is there any friction in wire rope which may damage the wire rope rather than the rolling parts?				
17	Is there any oil leakage in the hydraulic system of the winch machine?				
18	Has it been ensured that the guard will not cause discomfort or inconvenience to operator?				
	<b>Total Number of NO:</b>				
	<b>Total Number of NA:</b>				
	<b>% Compliance :</b>				

Signature of Site I/C of subcontractor :



	<b>POWER SECTOR</b>	FORMAT NO: HSEP:13-F10 REV NO.: 00 PAGE NO. 01 OF 02
	<b>INSPECTION OF HEIGHT WORKING</b>	

<b>Name of Site :</b>	
<b>Name of Sub-Contractor :</b>	
<b>Inspected by :</b>	
<b>Date of Inspection:</b>	

Sl. No.	Descriptions	Observation (Yes/No)	Remarks
1	All the workers have been explained safe work method?		
2	An established communication system has been established and explained to the workers.		
3	Adequate illumination has been ensured.		
4	Work area inspected prior to the start of the work.		
5	Area below the work place barricaded, particularly below hot work.		
6	Workers provided with bags /box to carry bolts, nuts and hand tools		
7	Arrangement for fastening hand tools made.		
8	All work platforms ensured to be of adequate strength and ergonomically suitable.		
9	Fabricated makeshift arrangements are checked for quality and type of material welding, anchoring etc.		
10.	Work at more than one elevation at the same segment is restricted.		
	<b>ACCESS/EGRESS</b>		
1	Walkways provided with handrail, mid-rail and toe guard?		
2	All checkered plates, gratings properly welded/ bolted?		
3	Are ladders inspected and they are in good condition?		
4	Are ladders spliced?		
5	Are ladders properly secured to prevent slipping, sliding or falling?		
6	Do side rails extend 36" above top landing?		
7	Are built up ladders constructed of sound materials?		



**POWER SECTOR**

**INSPECTION OF HEIGHT WORKING**

FORMAT NO: HSEP:13-F10  
 REV NO.: 00  
 PAGE NO. 02 OF 02

Sl. No.	Descriptions	Observation (Yes/No)	Remarks
8	Are rugs and cleats not over 12" on center?		
9	Metal ladders not used around electrical hazards.		
10	Proper maintenance and storage.		
11	Ladders placed at right slope.		
12	Ladders / staircases welded/ bolted properly.		
13	Any obstruction in the stairs.		
14	Are landing provided with handrails, knee rails, toe boards etc.?		
15	Whether ramp is provided with proper slope.		
16	Proper hand rails / guards provided in ramps.		
	<b>Housekeeping</b>		
1	Walkways, aisles & all overhead workplaces cleared of loose material.		
2	Flammable materials, if any, are cleared.		
3	All the de shuttering materials are removed after de shuttering is done.		
4	Platforms and walkways free from oil/grease or other slippery material.		
5	Collected scrap are brought down or lowered down and not dropped from height.		
	<b>PPE And Safety Devices</b>		
1	Use of safety helmet, safety belts ensured for all workers		
2	Anchoring points provided at all places of work.		
3	Common lifeline provided wherever linear movement at height is required.		
4	Safety nets are use wherever required.		
5	Proper fall arrest system is deployed at critical workplaces.		
6	Crawler boards/Safety system or works on fragile roof are used.		

Signature of Site I/C of subcontractor :

**POWER SECTOR****INSPECTION OF WELDING AND GAS  
CUTTING**FORMAT NO: HSEP:13-F11  
REV NO.: 00  
PAGE NO. 01 OF 02

<b>Name of Site</b>	
<b>Name of Sub-Contractor</b>	
<b>Inspected by</b>	
<b>Date of Inspection</b>	

<b>Welding</b>				
Sl.no.	Description	Y e s	N o	Remarks
1	Is electric connection given through 30 mA ELCB/RCCB to welding m/c?			
2	Is electric cable fitted properly in junction box on m/c?			
3	Is electrical cable free from joints?			
4	Are the joints attached firmly & insulated with tape?			
5	Is double earthing given to body of m/c?			
6	Is the physical condition of the m/c good?			
7	Is ON/OFF switch connected to the m/c is working and in good condition?			
8	Are indication lamps on m/c working?			
9	Is the electrode holder in good condition?			
10	Are the cables of the welding m/c lugged & tight properly?			
11	Are return lead connected properly (Rod, Angle, Channels shall not be used)			
	Total No of NO			
	Total No of YES			

**POWER SECTOR****INSPECTION OF WELDING AND GAS  
CUTTING**


FORMAT NO: HSEP:13-F11

REV NO.: 00

PAGE NO. 02 OF 02

Gas Cutting				
Sl. no	Description	Yes	No	Remarks
1	Are Cylinders kept on trolleys?			
2	Physical condition of Gas cylinders Good?			
3	Is there Oil/Grease on valve of the cylinder?			
4	Are pressure regulators in good condition?			
5	Condition of hose pipe OK?			
6	Are hose pipe clamped with hose clip?			
7	Is flash back arrestor & NRV fitted on torch both for O2 and LPG cylinder?			
8	Is nozzle of the torch cleaned?			
	Total Number of NO			
	Total No of YES			
	<b>% Compliance</b>			

Signature of Site I/C of subcontractor :

	<b>POWER SECTOR</b>	FORMAT NO: HSEP:13-F12 REV NO.: 00 PAGE NO. 01 OF 02
	<b>INSPECTION OF ELECTRICAL INSTALLATION</b>	

<b>Name of Site</b>	
<b>Name of Sub-Contractor</b>	
<b>Inspected by</b>	
<b>Date of Inspection:</b>	

Sr. No.	Contents	Yes/No	Remarks
<b>A</b>	<b>Cable</b>		
1.	Whether the condition of cable is checked?		
2.	Are cables received from other sites checked for insulation resistance before putting them into use?		
3.	Are all main cables taken either underground / overhead?		
4.	Are welding cables routed properly above the ground?		
5.	Are welding and electrical cables overlapping?		
6.	Is any improper joining of cables/wires prevailing at site?		
<b>B</b>	<b>DBs/SDBs</b>		
1.	Is earth conductor continued upto DB / SDB?		
2.	Whether DBs and extension boards are protected from rain / water?		
3.	Is there any overloading of DBs / SDBs?		
4.	Are correct / proper fuses & CBs provided at main boards and sub-boards?		
5.	Is energized wiring in junction boxes, CB panels & similar places covered all times?		
<b>C</b>	<b>ELCB</b>		
1.	Whether the connections are routed through ELCB?		
2.	Is ELCB sensitivity maintained at 30 mA?		

**POWER SECTOR****INSPECTION OF ELECTRICAL INSTALLATION**

FORMAT NO: HSEP:13-F12

REV NO.: 00

PAGE NO. 02 OF 02

Sr. No.	Contents	Yes/No	Remarks
3.	Are the ELCB numbered and tested periodically & test results recorded in a logbook countersigned by a competent person?		
<b>D</b>	<b>Grounding</b>		
1.	Is natural earthing ensured at the source of power (main DB at Generator or Transformer)?		
2.	Whether the continuity and tightness of the earth conductor are checked?		
3.	Mention the gauge of the earth conductor used at the site.		
4.	Mention the value of Earth Resistance.		
<b>E</b>	<b>Electrically operated Machines or Accessories.</b>		
1.	Whether the plug top is provided everywhere.		
2.	Are all metal parts of electrical equipment and light fittings / accessories grounded?		
3.	Is there any shed or cover for welding machines?		
4.	Are halogen lamps fixed at proper places?		
5.	Are portable power tools maintained as per norms?		
6.	Any other information:		

Signature of Site I/C of subcontractor :





**POWER SECTOR**

**INSPECTION OF ELEVATOR**

FORMAT NO: HSEP:13-F13  
REV NO.: 00  
PAGE NO. 01 OF 01

<b>Name of Site</b>	
<b>Name of Sub-Contractor</b>	
<b>Inspected by</b>	
<b>Date of Inspection</b>	

Sr. No.	Description	Remarks
1.0	Name of equipment	
2.0	Basic Information of equipment	
2.1	Specification	
2.2	Sr. No. of equipment	
2.3	Make	
2.4	Year of manufacture	
3.0	Major repairs/overhauls(Furnish details of work carried out)	Date(s) of major repair/overhaul
3.1		
3.2		
3.3	Repairs carried out at site	
4.0	Any performance test conducted	Yes/No
5.0	Document Submitted	Yes/No
6.0	Manufacturer's test / guarantee certificate	Available/ Not available
7.0	Performance test	Done/ Not Done
8.0	Acceptance Norms	
9.0	Committee Observations	
10.0	Date of next review (if accepted)	

<b>Signature-Subcontractor/ Subcontractor's Safety Officer</b>	<b>Signature-Site Safety Officer ( BHEL)</b>
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**POWER SECTOR****HSE PENALTY**

FORMAT NO: HSEP:13-F14

REV NO.: 00

PAGE NO. 01 OF 02

**Sub: MEMO for Penalty for non compliances in Safety**

Following lapse (tick marked) was observed and penalty is imposed as stated at the bottom of this memo. It is requested that such occurrences be please avoided in future.

**Safety Area**

SN	Violation of Safety Norms	Fine (in Rs)
01	Not Wearing Safety Helmet	200/- *
02.	Not wearing Safety Belt or not anchoring life line	500/-*
03	Not wearing safety shoe	200/-*
04	Not keeping gas cylinders vertically	200/-
05	Not using flash back arrestors	100/-
06	Not wearing gloves	50/- *
07.	Grinding Without Goggles	50/- *
08.	Not using 24 V Supply For Internal Work	500/-
09.	Electrical Plugs Not used for hand Machine	100/-
10.	Not Slings properly	200/-
11.	Using Damaged Sling	200/-
12.	Lifting Cylinders Without Cage	500/-
13.	Not Using Proper Welding Cable With Lot of Joints And Not Insulated Property.	200/-
14.	Not Removing Small Scrap From Platforms	500/-
15.	Gas Cutting Without Taking Proper Precaution or Not Using Sheet Below Gas Cutting	500/-
16.	Not Maintaining Electric Winches Which are Operated Dangerously	500/-
17.	Improper Earthing Of Electrical T&P	500/-
18	No or improper barricading	500/-
19.	Activity carried out without Safety work permit (Height work, Lifting activity, Hot work-each person/case)	1000/-
20.	Incident Resulting in Partial Loss in Earning Capacity	25,000/- per victim
21.	Fatal Incident Resulting in total loss in Earning Capacity	1,00,000/- per victim for first instance #

**Legend:-**

\*: per head. For repeated violation by the same person, the penalty would be double of the previous penalty. Date of "Repeated violation" will be counted from subsequent days.

#: or as deducted by customer, whichever is higher. For repeated fatal incident in the same Unit incremental penalty to be imposed. The subcontractor will pay 2 times the penalty compared to previously paid in case there are repeated cases of fatal incidents under the same subcontractor for the same package in the same unit.



**POWER SECTOR**

**HSE PENALTY**

FORMAT NO: HSEP:13-F14

REV NO.: 00

PAGE NO. 02 OF 02

Details (if any) related to non- compliance (Name of persons, Nature of deficiency, etc.)

\_\_\_\_\_

Penalty imposed:

1, Rate as per above chart \_\_\_\_\_

2. No. of Persons/ machine/ event/ labour \_\_\_\_\_

3. Total Penalty= 1. X 2. = \_\_\_\_\_


Signature :

Witnessed by: (Sub- Contractor representative) (BHEL Personnel)

Name \_\_\_\_\_

Name \_\_\_\_\_

Distribution: 1 Copy: to Sub- contractor,  
1 Copy to Site Construction Manager(BHEL)

	<b>POWER SECTOR- HQ</b>	FORMAT NO: HSEP:13-F15
	<b>Incident Report</b>	REV NO.: 00
(To be submitted within 24 hours of time of incident)		PAGE NO. 01 OF 01

Type of incident: Fatal/Major/ Minor/Fire/Property Damage/Near-miss

1	NAME OF SITE		3	ACTIVITY AREA	
2	SCOPE OF WORK		4	NAME OF CONTRACTOR	
			5	NAME & DESIGNATION OF BHEL ACTIVITY I/C	
6	DATE & TIME OF ACCIDENT		7	DATE RESUMED	
8	NO. OF WORK-DAYS LOST BY VICTIM (If duty not resumed, give estimated figure)				
9	NO. OF MANHOURS LOST BY OTHERS				
10	PERSONAL DETAILS OF INJURED AND / OR DETAILS OF MATERIALS / EQUIPMENT / PROPERTY DAMAGED				
	NAME		NAME OF MATERIAL / EQUIPMENT / PROPERTY		
	PERIOD OF EMPLOYMENT				
	AGE	YRS	SEX	MALE/ FEMALE	ESTIMATED COST
	MARITAL STATUS		SINGLE / MARRIED		ACTUAL COST
	OCCUPATION		NATURE OF DAMAGE		
	PART OF BODY INJURED				
	NATURE OF INJURY				
	AGENCY ( OBJECT / EQUIPMENT / SUBSTANCE ) MOST RESPONSIBLE FOR CAUSING ACCIDENT / INJURY / DAMAGE				
12	PERSON (NAME & DESIGNATION) WITH MOST CONTROL OVER AGENCY (OBJECT / EQUIPMENT / SUBSTANCE ) CAUSING ACCIDENT INJURY / DAMAGE				
13	DESCRIBE CLEARLY HOW THE ACCIDENT OCCURRED (USE ADDITIONAL SHEET, IF REQUIRED)				
<b>ANALYSIS</b>					
14	WHAT ACTS AND / OR CONDITIONS CONTRIBUTED MOST DIRECTLY TO THIS ACCIDENT				
15	WHAT ARE THE BASIC REASON FOR THE EXISTENCE OF THESE ACTS AND / OR CONDITION ?				
16	WHAT CORRECTIVE ACTIONS HAVE BEEN TAKEN TO PREVENT ACCIDENT RECURRENCE ?				
	DATE :			SIGNATURE OF SITE HSE COORDINATOR	
17	COMMENTS OF HEAD / SOX				
	DATE:			SIGNATURE OF HEAD/SOX	



# SAFETY WORK CLEARANCE

Permit no. \_\_\_\_\_

Project: \_\_\_\_\_

Emergency Contact Nos: \_\_\_\_\_

Subcontractor: \_\_\_\_\_

## BURNING/WELDING /HOT WORK PERMIT

Area : \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Name of Site Engineer (Permit Requesting Authority): \_\_\_\_\_ Sign: \_\_\_\_\_

Name of Work Performing Contractor: \_\_\_\_\_

Name of Package In charge: \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_

Description of Work: \_\_\_\_\_

Work Execution Date: \_\_\_\_\_ Time Valid from: \_\_\_\_\_ to \_\_\_\_\_

The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	Proper Access/Exit available		
2.	Proper ventilation and /or lighting provided.		
3.	Proper and safe scaffolding, platform, ladder provided.		
4.	Welding machine located in a clean and dry area.		
5.	Welding machine grounded at the equipment and proper leakage current protection device (ELCB) provided for welding machine.		
6.	Emergency STOP buttons are in working condition. Welder /Helper knows how to operate it.		
7.	Welding machine input/output cables, welding holder and weld return clamp (Holder) are insulated and in good condition.		
8.	Welder & Fitter trained to connect ground/work return clamps (Holder) to work place prior to energization of welding machine.		
9.	Gas cylinders are stacked vertically and not below the welding / cutting area. Regulator key is available with cylinder.		
10.	Pressure gauges/Flash back arrestor provided and in working condition.		
11.	Personal Protective equipment Minimum applicable: safety helmet, safety goggles, welding helmet, safety shoes, leather gloves, long sleeve and nose mask -provided		
12.	In case of pits, water removed from the pit and wood/rubber insulation provided.		
13.	Safety signboards are in place.		
14.	Adequate and Suitable nos. of fire fighting extinguisher provided.		
15.	Nearby combustible material removed. Housekeeping done.		
16.	Other		

Name of Contractor Safety Officer: \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

**Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):**

Name: \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Name of BHEL Safety Representative: \_\_\_\_\_ Sign: \_\_\_\_\_

I understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.

Name of Work Performing Authority: \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

**Permit Cancellation:**

I hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.

Name of Work performing Authority: \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Name of Site Engr. (Permit Requesting Authority): \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Name of BHEL Site Engr. (Permit Issuing Authority): \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

(This permit is valid only for the date it is issued)

Original at BHEL site

Second Copy – BHEL SAFETY

Third Copy : Contractor



# SAFETY WORK CLEARANCE

Permit no. \_\_\_\_\_

Project: \_\_\_\_\_

Emergency Contact Nos: \_\_\_\_\_

Subcontractor: \_\_\_\_\_

## LIFTING ACTIVITY PERMIT

Area : \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Name of Site Engineer (Permit Requesting Authority): \_\_\_\_\_ Sign: \_\_\_\_\_

Name of Work Performing Contractor: \_\_\_\_\_

Name of Package In charge: \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_

Description of Work: \_\_\_\_\_

Work Execution Date: \_\_\_\_\_ Time Valid from: \_\_\_\_\_ to \_\_\_\_\_

*The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.*

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	Crane used for lifting activity tested, certified and approved for rated lifting		
2.	All lifting tackles, gears/appliances are tested and certified for lifting works.		
3.	Crane operator is trained and competent for lifting operation.		
4.	Lifting sling/ belt is protected against sharp edge of the jobs to be lifted.		
5.	Access and exit marked and without obstruction.		
6.	Lifting arrangement adequate.		
7.	Uwanted rubbish material removed from work platform.		
8.	Minimum 2 guidelines have been provided for balancing and guiding jobs to be lifted.		
9.	Periphery area of crane booms as well as lifting job is barricaded and unauthorised/no-entry sign board posted.		
10.	Rigger and signal man is trained and competent for lifting work.		
11.	No lifting activity to be carried out during lightening, heavy wind/rain.		
12.	If scaffolding to be used during lift, scaffolding with valid tag available for use.		
13.	Double lanyards safety harness/belt checked an in working condition.		
14.	Safety shoes (non-slip), helmet with chin strap available with employees.		
15.	Others.		

Name of Contractor Safety Officer: \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

### Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):

Name: \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Name of BHEL Safety Representative: \_\_\_\_\_ Sign: \_\_\_\_\_

*I understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.*

Name of Work Performing Authority: \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

### Permit Cancellation:

*I hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.*

Name of Work performing Authority: \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Name of Site Engr. (Permit Requesting Authority): \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Name of BHEL Site Engr. (Permit Issuing Authority): \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

(This permit is valid only for the date it is issued)

Original at BHEL site

Second Copy – BHEL SAFETY

Third Copy : Contractor





# SAFETY WORK CLEARANCE

Permit no. \_\_\_\_\_

Project: \_\_\_\_\_

Emergency Contact Nos: \_\_\_\_\_

Subcontractor: \_\_\_\_\_

## WORKING AT HEIGHT PERMIT

Area : \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Name of Site Engineer (Permit Requesting Authority): \_\_\_\_\_ Sign: \_\_\_\_\_

Name of Work Performing Contractor: \_\_\_\_\_

Name of Package In charge: \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_

Description of Work: \_\_\_\_\_

Work Execution Date: \_\_\_\_\_ Time Valid from: \_\_\_\_\_ to \_\_\_\_\_

*The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.*

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	All workers on job are medically fit for working at height (Person should not have vertigo)		
2.	Scaffolding with valid tag available for use		
3.	Safety harness with life line support/ fall arrester are checked and in working condition		
4.	Safety shoes ( non-slip), Helmet with chin strip available with employees		
5.	Safety nets are provided as per design and provided 25 ft. below working area & extending 8 ft beyond.		
6.	Horizontal life lines are provided to cater to design specification of 2300kg per person.		
7.	Ladders have been inspected and provided as per BHEL standard/contract.		
8.	All lifting / tightening tools, hand tools/equipment checked and in good condition		
9.	Access and exit marked and without obstruction.		
10.	Lighting arrangement adequate.		
11.	Unwanted and rubbish material removed from working platform.		
12.	Electrical cable, welding Hose/Compressed air hose properly secured and lay down without obstruction.		
13.	Signboards provided on working platforms		
14.	Hazards in the vicinity are identified and communicated to the worker.		
15.	Other		

Name of Contractor Safety Officer: \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

**Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):**

Name: \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Name of BHEL Safety Representative: \_\_\_\_\_ Sign: \_\_\_\_\_

*I understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.*

**Name of Work Performing Authority:** \_\_\_\_\_ **Sign:** \_\_\_\_\_ **Date:** \_\_\_\_\_ **Time:** \_\_\_\_\_

**Permit Cancellation:**

*I hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.*

Name of Work performing Authority: \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Name of Site Engr. (Permit Requesting Authority): \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Name of BHEL Site Engr. (Permit Issuing Authority): \_\_\_\_\_ Sign: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

(This permit is valid only for the date it is issued)

<b>Original at BHEL site</b>	<b>Second Copy – BHEL SAFETY</b>	<b>Third Copy : Contractor</b>
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**V.II-I2/AMEND-03**

**TECHNICAL SPECIFICATION  
FOR  
CLARIFICATION SYSTEM EQUIPMENT AND FACILITIES**

# CONTENT

<b>CLAUSE NO.</b>	<b>DESCRIPTION</b>
1.00.00	INTRODUCTION
2.00.00	NOT USED
3.00.00	SYSTEM DESCRIPTION
4.00.00	SCOPE OF SUPPLY & SERVICES
5.00.00	TERMINAL POINTS
6.00.00	EXCLUSIONS
7.00.00	SALIENT DESIGN FEATURES
8.00.00	DESIGN & CONSTRUCTION
9.00.00	PERFORMANCE GUARENTEE TEST PROCEDURE AND PERFORMANCE GUARENTEE
10.00.00	OPERATION & CONTROL PHILOSOPHY

## **ATTACHMENT**

ANNEXURE-I DATA SHEETS FOR PROCESS EQUIPMENT AND ACCESSORIES  
CWBD WATER CLARIFICATION PLANT

**TECHNICAL SPECIFICATION  
FOR  
CLARIFICATION SYSTEM EQUIPMENT AND FACILITIES**

**1.00.00 INTRODUCTION**

1.01.00 This Document is intended to cover the design, engineering, manufacture, assembly, testing at manufacturer's works, supply and delivery to project site properly packed for transportation, including shop painting, freight, transit insurance, all taxes, duties, octroy, other charges/levies as applicable, erection, testing and commissioning at site of all materials and equipment inclusive of electrical, instrumentation & control and civil works as specified and as required for Clarification System ~~prior to Reverse Osmosis (RO) as specified hereinafter,~~ complete with all materials and accessories for safe and trouble-free operation.

1.02.00 This Document also includes site unloading, handling, local transportation, site storage, final check-up, final painting and trial run & performance testing of the Clarification Plant along with all equipment and accessories specified herein, to the satisfaction of the Owner and all other incidental works thereto like all labour, supervision, supply of erection and testing equipment, and consumable as necessary, etc.

1.03.00 The Document also makes it obligatory for the Bidder for arranging the necessary clearances from the statutory authorities, as required for the installation of the plant and machinery and render all assistance and services required in this regard.

1.04.00 It is not the intent to completely specify all details of design and construction herein. Nevertheless, the equipment and installation shall conform to high standard of engineering design and workmanship in all respect and shall be capable of performing continuous satisfactory commercial operation.

2.00.00 NOT USED

Note :  
DMF,UF & RO system scope of supply are excluded from bidder scope.

### 3.00.00      **SYSTEM DESCRIPTION**

Blow down water will be fed to Clarifier-Ultrafiltration-Reverse Osmosis System.

CT Blow down water from Stage#2 and Stage#3 CW return to be fed directly to High Rate Solid Contact type Clarifier (HRSCC) and then ~~(Vertical Dual Media Filters for removal of the suspended solids present in the Blow down water. The availability of pressure at the inlet of Dual Media Filter is envisaged around 6.0 kg / cm<sup>2</sup> g. Then the filtered water is fed to Ultrafiltration Units followed by Reverse Osmosis System.~~

The schematic arrangement for the above mentioned Systems has been delineated in P&I Diagrams enclosed with this document.

The general description of the above mentioned Systems is given below:

#### **Clarification System**

Blow down water will be taken through one (1) motorized flow control station to 1 X 100% pH Correction Chamber where Lime will be dosed.

Water will then flow separately through one (1) no. Parshall Flume (for flow measurement) to one (1) no. Feed Chamber, water will flow to one (1) no. Clarifier of 292 m<sup>3</sup>/hr design output capacity However, Hydraulics shall be such that 20% overloading of clarifier is achieved. Chemicals such as Ferric Chloride, Lime and polyelectrolyte will be added as per tests to blow down water in Clarifiers.

The sludge generated from the Clarifier as addressed above will be collected in Sludge Pit of Blow Down Water Clarification Plant. Bidder shall terminate the sludge pipe from Clarifier up to the Sludge Pit of Blow Down Water Clarification Plant.

All chemicals required for the entire plant will be stored in the ground floor of a two-storied Chemical House. Chemicals will be directly unloaded from the trucks

and thereafter be stacked in the respective storage space at ground floor by means of electrically operated hoist. However, preparation of chemical solution of Ferric Chloride, Lime and Polyelectrolyte for injection to Blow down water shall be carried out in the first floor of the Chemical House. Chemicals will be lifted from ground floor to first floor by means of electrically operated monorail hoists.

**DMF Units** Note : DMF scope of supply is excluded from bidders scope

Clarified Blow down Water will be pumped to 3X50% Vertical DMF Units.

Clarified Blow down Water will enter the Dual Media Filters and suspended solids present shall be removed.

DMF Air Blowers have been envisaged to scour the filter beds prior to backwash event.

DMF Units shall be backwashed with filtered water from Backwash Tank by means of Filter Backwash Pumps.

Backwash waste from DMF Units will be collected in RO Reject Tank.

From the Dual Media Filters, water shall flow to UF Modules.

#### 4.00.00

### SCOPE OF SUPPLY AND SERVICES

#### I. PRETREATMENT FOR RO PLANT

- i) One (1) no of inlet pipe (consisting of CW blow down from Phase-II & phase-III) shall be connected to the pH correction chamber along with One (1) no. motorized flow control station. The motorized flow control station shall consist of one (1) no modulating type control valve, motorized on-off type valve at the upstream & downstream of control valve, manual bypass valve and necessary valve pits.
- ii) One (1) no. pH Correction Chamber with agitator and all other accessories.
- iii) One (1) no. Parshall Flume type flow measuring instrument. Water level in the channel shall be measured using Ultrasonic



Level Transmitter and the measured level shall be calibrated in terms of channel flow.

- iv) One (1) no. Feed Chamber
- v) One (1) no. High Rate Solid Contact Reactor type Clarifier, complete with rake mechanism along with drive and drive motors, reaction turbine for internal recirculation of solids along with drive and drive motors, telescopic type continuous sludge discharge arrangement, intermittent timer operated main sludge disposal system etc. for clarifier.
- vi) One (1) no. top covered RCC Clear water reservoir (in two compartments). Each compartment of the reservoir shall be of 250Cu.m effective capacity and shall be complete with isolation gates etc. The clear water reservoir shall be overground / semi underground.
- vii) One (1) set of equipment, piping, instruments, etc. for Ferric Chloride Dosing System, one (1) set for Lime Dosing system and one (1) set for Polyelectrolyte Dosing system. Ferric Chloride Dosing System consists of two (2) nos. Ferric Chloride solution preparation/dosing tanks, fitted with gear operated agitators along with level gauges & switches / transmitters, two (2) nos. Ferric Chloride solution dosing pumps, connecting pipe lines, valves, pressure gauges and switches / transmitters, etc. Lime Dosing System consists of two (2) nos. Lime solution dosing tanks with geared agitators along with level gauges & switches / transmitters, two (2) nos. Lime solution dosing pumps, connecting pipe lines, valves, pressure gauges and switches / transmitters, etc. Polyelectrolyte Dosing system consists of two (2) nos. Polyelectrolyte tank with geared agitators along with level gauges & switches / transmitters, two (2) nos. Polyelectrolyte dosing pumps, connecting pipe lines, valves, pressure gauges and switches / transmitters, etc.

- viii) One (1) no. RCC top covered overhead clear water Storage Tank of 20 Cu.m effective capacity along with other accessories for solution preparation at chemical house.
- ix) The sludge generated from the Clarifier as addressed above will be collected in Sludge Pit of Blow Down Water Clarification Plant. Overflow of the sludge pit shall be fed to pH correction chamber by Two (1W+1S) Sludge Overflow Transfer Pump.
- x) Lifting and handling arrangements at Clear water pump house
  - a) One (1) no. electrically operated Monorail Hoists along with supporting structure monorail beam and column etc. on Clear water reservoir of suitable capacity not less than 3.0 Ton capacity.
  - b) One (1) no RCC Clear Water pump house with suitable superstructure.
- xi) All necessary sludge piping with manholes from the respective clariflocculator, pH correction chamber, feed chamber, chemical house, etc. up to the Sludge Pit of Blow Down Water Clarification Plant.
- xii) ~~Two (2) nos. (1W+1S) Feed Pumps at clear water pump house for DMF, each having rated capacity not less than 300 m<sup>3</sup>/hr along with drive Motor and all other accessories.~~
- xiii) ~~Three (3) nos. (2W+1S) Vertical Dual Media Filters (DMF) located near RO plant of carbon steel rubber lined, each having Capacity not be less than 150 m<sup>3</sup>/hr along with valves, instruments and interconnecting piping.~~
- xiv) ~~Two (2) nos. (1W+1S) Air Blowers for Filter of material of~~

construction cast iron as per IS-210, Gr. FG 260, each having rated capacity suitable for Air Scouring of one (1) no. DMF along with drive Motor and all other accessories.

xv) One (1) no. Backwash Water Storage Tank of RCC construction having effective capacity suitable for backwashing of one (1) no. DMF plus 20% margin.

xvi) Two (2) nos. (1W+1S) DMF Backwash Pumps for Backwashing of Filters of material of construction cast iron as per IS 210, Gr. FG 260, each having rated capacity suitable for Backwashing of one (1) no. DMF along with drive Motor and all other accessories.

## **II. OTHER ITEMS**

i) Two (2) nos. safety Showers with other accessories.

ii) Two (2) nos. [One (1) no. in Ground Floor and one (1) no. in First Floor] electrically operated Monorail Hoists (Travelling & Hoisting) of not less than 3.0 Ton capacity each along with monorail beams and all accessories in the Chemical House.

iii) All integral and interconnected pipe works, valves, sump, gates, all types of pipe supports, pipe and cable racks, pipe and cable bridges, etc. for the entire Plant.

## **III. ELECTRICAL**

Broad scope of design, engineering, manufacturing, supply, installation, testing, commissioning and putting into successful commercial operation of ELECTRICAL EQUIPMENT AND ACCESSORIES are specified under Electrical Sections of the technical specification.

All electrical loads related to Clarifier, DMF's, Clear water pump house and Chemical house shall be considered under new 415V RO Plant PMCC located in RO plant Electrical building as mentioned in Vol-II-F.

#### **IV. INSTRUMENTATION & CONTROL**

Broad scope of design, engineering, manufacturing, supply, installation, testing, commissioning and putting into successful commercial operation of I&C EQUIPMENT AND ACCESSORIES are specified under Instrumentation & Control Sections of the technical specification.

#### **V. CIVIL WORK**

Broad scope of design, engineering, supply, installation, testing, commissioning and putting into successful commercial operation of CIVIL EQUIPMENT AND ACCESSORIES are specified under Civil Sections of the technical specification.

#### **5.00.00 TERMINAL POINTS**

Interface Points of the package to be supplied shall be as follows. For each of all Terminal Points, scope of this Write-up shall include making the joint including supply of matching counter flanges, gaskets, bolts, nuts, etc. wherever applicable.

#### **6.00.00 NOT USED**

#### **7.00.00 SALIENT DESIGN FEATURES**

7.01.00 All pipes and cables shall be taken through pipe and cable racks only. Details of Pipe & Cable racks have been specified elsewhere in the specification.

- 7.02.00 A minimum of 300 mm freeboard (considered after overloading of the plant by a maximum of 20%) shall be provided for all the units and chemical solution tanks of the Blowdown Water Clarification Plant covered under this specification.
- 7.02.01 All the valves, gates, shutters etc. used in the complete plant shall be "rising spindle type". All motor actuated valves shall also have hand wheels for local manual operation as and when required.
- 7.02.02 All the chemicals to be used in the Blowdown Water Clarification Plant will generally conform to the requirement of technical grade as per relevant IS.
- 7.03.00 All the isolation gates used in the Blowdown Water Clarification Plant shall have necessary extended spindle, penstock, hand wheel and brass lining to have leak tight effect. All isolation gates shall conform to the requirements of AWWA. Isolation gates in corrosive services shall have rubber sealing.
- 7.04.00 Rubbers, used for rubber lining shall be natural rubber and shall have shore hardness  $65 \pm 5$  Deg. in scale 'A'.
- 7.05.00 Water temperature varies seasonally. All the equipment used in the Blowdown Water Clarification Plant shall perform satisfactorily at the minimum and maximum temperature as indicated in meteorological data provided in Vol-II-A.
- 7.06.00 All the valves used in sludge line shall have draining and flushing arrangement at valve seat. Each valve of size 200 NB and above shall have pressure equalizing bypass valves. All nuts, bolts, washers, etc. in under-water and corrosive application shall be of SS 316. Automatic flushing for lime and sludge piping shall be provided. Piping, valves and pumps used in sludge and lime service should be automatically flushed with water whenever taken out of service. Manual control of the flushing sub system shall be furnished in addition to automatic control.

- 7.06.01 The complete clarifier unit shall be above-ground to the greatest extent practical to minimize the underground routing of sludge piping. The total water loss due to sludge blow down shall be limited to 3% of the total inflow to clarifier unit. Each clarifier unit shall be suitably designed to make good of sludge blow down.
- 7.06.02 For all pipes handling lime and sludge, only flanged piping shall be used and pipe sizes shall be not less than 80 NB. Within clariflocculator, sludge pipe shall be of C.I. with socket and spigot joint with lead caulking and outside clariflocculator units, sludge piping shall be of C.I. double flanged. For all lines carrying lime and sludge, suitable slope shall be provided and no elbows shall be used and tees shall be provided instead of bends and crosses shall be used instead of tees with the remaining end blanked for flushing purpose. The blank end will serve as a maintenance port when choking occurs. For all buried piping suitable marker plates shall be provided for easy identification of pipe location.
- 7.07.00 Design of the sludge removal system should be such as to reduce loss of water during sludge blow off, within 3% of rated flow. Inlet portion of the unit shall be designed to handle excess water to make good for water loss during sludge blow off. Airline shall be provided to sludge blowdown line to get rid of sludge plugging inside the line.
- 7.08.00 Sludge blow-off shall be affected by the static head of water in the clarifier-cum-concentric flocculator unit.
- 7.09.00 All chemical dosing system shall be complete in all respects including piping, valves, fittings, interconnection, instruments, etc.
- 7.10.00 Provision shall be made for suitable flushing of lime and ferric chloride solution lines by water from overhead clear water storage tank.
- 7.11.00 All mechanical, electrical and structural items included in the scope of the



Bidder shall be suitably protected with paints and protective coatings, whether specifically mentioned or not.

7.12.00 For painting specification, Vol IIA, Section-XI shall be referred to.

## 8.00.00 **DESIGN AND CONSTRUCTION**

### 8.01.00 **Flow Control Valve**

One (1) no. 100% capacity motor operated butterfly flow control valve shall be provided to control the inflow of CW blow down water into the pH correction chamber of the clarification plant.

Suitable manually operated butterfly valves shall also be provided to bypass the main flow control valve so that the same can be removed for maintenance without taking a complete shutdown of the plant. All the motor operated valves shall be remote operable along with hand-wheels for local manual operation. All valves shall have remote as well as local % positioning indicators. All valves shall conform to the requirement of AWWA-C-504.

### 8.02.00 **pH Correction Chamber**

One (1) nos. pH correction chambers of R.C.C. construction shall be provided. The pH correction chamber shall have a minimum of 1 minute retention time with respect to the total flow to clarification plant.

Suitable draining arrangement shall be provided for the pH correction chamber and the drain lines shall be extended up to the nearest sludge well/sludge pocket for final disposal to the sludge sump.

### 8.03.00 **Feed Chamber**

One (1) nos. Feed Chamber of R.C.C. construction shall be provided.

Feed Chamber shall provide a minimum of thirty (30) seconds residence time.

8.04.00 **Clarifier (High Rate Solid Contact Reactor Type)**

One (1) no. of Clarifier shall be installed. The unit shall be capable of handling maximum designed flow rate and reducing turbidity to the extent as per specification requirement. The outlet water shall be oil free.

Hydraulic circuit of the complete clariflocculation plant shall be designed in such a way that clear water from the unit shall flow by gravity to Clear water reservoir and complete draining of clarifiers shall be possible through sludge disposal line. Hydraulics shall be such that 20% overloading of clarifier is achieved.

The clarifier shall be solid contact reactor type with integral variable speed impeller/turbine to internally recirculate sludge water at adjustable rate to produce consistent water quality at varying hydraulic load and turbidity.

Clarifiers shall be provided with following features.

The sludge blanket shall be suspended and maintained in the lower portion.

The clarifier unit shall be circular, central feed type with concentric recirculation zone (rapid mixing), reaction zone (slow mixing) and clarification zone in RCC construction.

Bridge type rake arm and suitable equipment such as turbine/impeller shall be provided for internal sludge recirculation.

The design of the turbine/impeller shall be such as not to break the flocks during recirculation.

Suitable mechanism for varying the recirculation rate shall also be provided such that the reactor clarifier shall be capable of operating at varying hydraulic load and turbidity with consistent effluent quality.

Clarifiers shall be provided with radial launders.

The bottom of clarifier shall be sloped towards the center and mechanically driven sludge scraper and collector shall be used to remove the settled sludge down the sloping bottom to the central sludge area. Rubber squeezer pads shall be provided on sludge scraper and skimmer. Sludge removal system design shall consist of central sludge area with rotating pickets and back flush arrangement for proper control of sludge accumulation at the bottom.

Suitable scum collecting arrangement shall be provided in the clarifying section for removal of floating debris, foam, etc. The scraper shall consist of blades which are inclined to the radius in the opposite direction to that of the floor scraper.

The rake bridge and agitators shall be constructed of structural steel and suitably braced to provide rigidity.

The clarifier shall be provided with a gate at the outlet for isolation of the clarifier for maintenance.

The gear boxes for the bridge drive shall be either oil free type or suitable arrangement for collecting leaked oil shall be provided so that outlet water shall be oil free.

Unit shall be designed with 90 minutes (minimum) retention time for clarification/settling. Larger retention time may be provided to meet the equipment guarantee.

The overall area of clarification zone shall be based on an average flow velocity not exceeding 3.0 Cu.m/Sq.m/hr.

Weir loading shall not exceed 300 Cu.m/m/day. For uniform overflow over weirs/saw tooth weir may be provided as necessary. Peripheral orifices may also be used. Uniform flow through orifices should be ensured.

Design of the sludge removal system should be such as to reduce loss of water during sludge blow off, within 3% of rated flow. Inlet portion of the unit shall be designed to handle excess water to make good for water loss during sludge blow off.

Sludge outlet pipe from the concentrated sludge hopper shall be branched into main sludge disposal line. Main sludge disposal line shall consist of independently manual adjustable timer operated blow-off valve with manually over-riding facility along with hand wheel to drain sludge. This is an intermittent operation. Continuous sludge disposal line consists of a telescopic stand pipe, the top of which is maintained at a desired elevation to ensure trickle flow of water or sludge water mixture. This is a continuous operation.

Sludge from each of the clarifiers, pH correction chamber and chemical house shall be led to common sludge sump as per P&I diagram enclosed with this specification.

All flushing line size shall be not less than 50 NB. Only flanged piping will be used in sludge handling line.

Suitable sampling connections from the various levels and zones of clarifier and at the outlet shall be provided for performance monitoring.

#### 8.05.00 **Chemical House**

The chemical house will be two-storied building, the ground floor of which shall be used as storage space for Ferric Chloride, lime & polyelectrolyte. The storage space with suitable partition wall in chemical house shall be adequate to accommodate at least thirty (30) days requirement of Ferric Chloride, lime & polyelectrolyte. The chemical house shall have sufficient unloading space, wide corridors, office space, toilet, etc. In the first floor of the chemical house, all chemical preparation tanks shall be located. Suitable accessibility shall be provided to have clear access from Chemical House to different units like pH

Correction Chamber, Parshall flumes, Feed Chambers, Clarifiers etc. and also various sub-systems/units of Blowdown Water Clarification plant. Eye wash and safety shower shall be provided outside of chemical house.

8.05.01.

### **Lime Solution Preparation and Dosing System**

#### **I. Lime Slaking Tanks and Transfer Pumps**

- a) Quick lime (industrial quality, 60-70% CaO) shall be dissolved in the slaking tanks and the resultant slurry (about 10% W/W) from the slaking tanks shall be transferred to the lime solution preparation tanks by non-clog centrifugal pumps (one working and one standby).
- b) The slaking tanks shall be constructed of RCC with inside PPG lining / epoxy screeding. The tanks shall be provided with dissolving baskets of epoxy painted carbon steel, wire mesh and slow speed agitators of epoxy painted carbon steel driven by electric motors through reduction gears. The tanks shall also be provided with level indicators, sampling connections, drain and overflow arrangements etc. as required.
- c) Two (2) nos. lime slaking tanks shall be provided. Each tank shall have a capacity to cater 12 hours plant demand of the entire clarification plants.

Details of the lime slaking tanks have been specified in Annexure-I to this section.

- d) Two (2) nos. non clog horizontal centrifugal pumps shall be provided to transfer lime slurry from slaking tanks to lime solution preparation tanks.

Details of the transfer pumps have been specified in Annexure-I enclosed with this specification.

## II. Lime Solution Preparation Tanks

- a) Lime slurry from the lime slaking tanks will be further diluted in the lime solution preparation tanks from 10% to 5% W/W concentration.
- b) The solution preparation shall be achieved by means of agitators.
- c) Two (2) nos. non clog centrifugal pumps shall also be installed, one (1) working & one (1) standby, for carrying out dosing in the clarifier.
- d) Two (2) nos. lime solution preparation tanks shall be provided. Each tank shall have a capacity to cater 12 hours plant demand of the entire clarification plants.

The tanks shall also be provided with agitator, level indicators, sampling connections, level switches / transmitters, drain and overflow arrangements as required.

### 08.05.02 **Ferric Chloride Solution Preparation and Dosing System**

#### I. Ferric Chloride Solution Preparation Tanks

The solution preparation shall be achieved by means of recirculation pumps.

Two (2) nos.  $\text{FeCl}_3$  solution preparation tanks shall be provided. Each tank shall have a capacity to cater 12 hours plant demand of the entire clarification plant.

The tanks shall also be provided with level indicators, sampling connections, level switches / transmitters, drain and overflow arrangements as required.



## II. Ferric Chloride Solution Dosing System

Two (2) nos.  $\text{FeCl}_3$  solution dosing pumps shall be installed at chemical house for the dosing of ferric chloride solution at clarifiers.

### 8.05.03. **Polyelectrolyte Dosing System**

#### I. Polyelectrolyte Dosing Tanks

Polyelectrolyte (Potable/edible grade) shall be taken in the Polyelectrolyte dosing tanks resulting to a concentration of 1% (W/W) for subsequent dosing.

Two (2) nos. polyelectrolyte dosing tanks of specified thickness shall be provided. Each tank shall have a capacity to cater 12 hours plant demand of the entire clarification plant.

The tanks shall be provided with level indicators, sampling connections, level switches / transmitters, drain and overflow arrangements as required.

#### II. Polyelectrolyte Dosing System

Two (2) nos. Polyelectrolyte solution dosing pumps shall be installed at chemical house for the dosing of Polyelectrolyte solution at clarifiers.

8.05.04. Water for dissolving chemicals shall be taken from the overhead clear water tank located at the roof of chemical house directly fed from the DMF feed pump discharge header.

### 8.05.05 **Sampling Rack**

A centralized sampling rack for the entire BD Water Clarification Plant shall be provided and this sampling rack shall be installed in the ground floor of the

Chemical House. Samples of water shall be taken from the following points and supplied to the sampling rack:

- a) CWBD water inlet to pH Correction Chamber - 1 no.
- b) Sludge water from clarifiers (individually) - 2 nos.
- c) Clarified water from the launders (individually) - 2 nos.
- d) DMF individual discharge – 3 no.

The water samples to be taken to the centralized sampling rack through small diameter pipes of SS-316 construction. Suitable mono block pumps, if required, for carrying the water samples at the sampling rack shall also be provided by the Bidder and shall be located near the supply source itself at suitable accessible location.

#### 8.05.06 **Overhead Clear Water Storage Tank**

One (1) no. top covered overhead clear water storage tank shall be provided by the Bidder at the roof of the chemical house. The tanks shall cater to dilution water requirement for various solution preparation tanks in the chemical house and also cater to the demand of toilets, chemical laboratory etc. located in the chemical house.

For tank capacity, material of construction, fittings and instruments etc. shall be as per data sheets enclosed with this specification.

#### 8.06.00 **Isolation Gates/Shutters**

All isolation gates/shutters shall be drop tight and suitable lining shall be provided preferably of brass in the frame of gates/shutters, wherever required, the gates shall be adjustable weir type to enable to divert water in desired proportion to different units. All gates/shutters shall be manually

operated having hand wheel and gear boxes with penstock/headstock for ease of operation.

8.07.00 Piping

a) Material of Construction of pipes as envisaged under various services are reproduced below:

SI No	Pipe Lines	MOC
1.	Filtered water, Clear Water, Service Water, Back-wash Waste Water, Non- corrosive waste water	Carbon Steel Pipe to ASTM 53 Gr. B / IS-1239, Part-I heavy grade for pipe size up to 150 mm NB and IS- 3589 for 200 mm NB and above
	a) Other Chemicals	SS 304 / CPVC

**Notes:**

1. For small diameter pipe below 50 NB, where rubber lining is difficult, stainless steel pipe instead of rubber lined steel pipe shall be used for other services.
2. For rubber lined pipe, lining thickness shall not be less than 3 mm. The lining shall conform to IS: 4682 Part-I.
3. Pipelines carrying water, chemicals, air etc. should be sized on the velocities as follows:

		Velocity in m/sec.		
		Pipe Size		
	Pipe Size	Below 50 mm	50 - 150 mm	200 mm & above
a)	Pump Suction	-	1.2 - 1.5	1.2 - 1.8

	for Water			
b)	Pump Discharge for Water	1.2 - 1.8	1.8 - 2.4	2.1 - 2.5
c)	Header for Water	-	1.5 - 2.4	2.1 - 2.4
d)	Pump suction for chemical solution	0.8 - 1.2	0.8 - 1.3	-
e)	Pump discharge for chemical solution	1.2 - 1.4	1.3 - 1.5	-
f)	Compressed air below 2 kg. /sq.cm (g)	15 - 20	20 - 30	25 - 35
g)	Compressed air [2 kg. /sq.cm (g) & above]	20 - 30	25 - 40	35 - 45

8.08.00

### VALVES

a) The valve design and testing standard shall be as follows:

	Less than 50 mm size		50 mm size and above	
	Design	Testing	Design	Testing
Gate	API - 602	API - 598	API - 600	API - 598
Globe	BS - 5352	BS - 6755	BS - 1873	BS - 6755
Check	BS - 5352	BS - 6755	BS - 1868	BS - 6755

b) For material of construction & other necessary details of the valves, refer Vol. II-I2, Section – VIII, Cl. No. 4.14.00

8.09.00

All Steel Tanks shall be designed as per ASME SEC-VIII – DIV-I / IS-2825/IS 803.

8.10.00 Design pressure for any Pressure Vessel, should be the maximum expected pressure to which the vessel may be subjected plus 5% extra margin. Maximum expected pressure for a vessel placed in the discharge line of a pump shall be based on the shut-off head of the pump plus static head at pump suction, if any.

8.11.00 General Features

- i) Minimum of 300 mm freeboard and 100 mm dead depth shall be provided for all the atmospheric tanks.
- ii) Under drain system shall be strainer on plate type. In case of strainer on plate type design, an additional manhole shall be provided to give access below the bed plate over and above two (2) manholes of 500 mm size (minimum), one at the roof top and the other at shell side. One (1) hand hole of 150 NB. Sizes shall also be provided for each Dual Media filter. Roof manhole shall be Davit type.
- iii) At least 50% free-board shall be provided over Dual Media filter for expansion during backwashing or addition of some extra media.

Sand shall conform to the following specifications:-

Bulk density	:	1400-1600 kg/m <sup>3</sup> .
Effective size	:	0.45 mm.
Uniformity co-efficient	:	1.6 to 1.65.
Particle size, Mesh (BSS)	:	8/32.
Acid solubility	:	Loss in weight after soaking in 10% HCl for 24 hours not to exceed 5%.

Silica (%), minimum : 90.

Loss on ignition (%), max. : 5.

Each pressure filter should be backwashed after every 24 hours of operation.

Blowers for air scouring of Filter-bed:-

The flow rate of air shall not be less than 50 NM<sup>3</sup> of free air/hr./m<sup>2</sup> of bed area at a head suitable for efficient air scouring of filter beds. Two (2) nos. 100% capacity blowers shall be provided. One blower shall remain as standby. Blower shall be twin lobe, oil free type electric motor driven complete with silencer and filter, duct/pipe work, damper, etc.

iv) All header pipes shall be sized considering simultaneous operations of all streams at rated conditions. Regeneration system shall be sized for regeneration of one (1) vessel at a time.

v) A minimum free board of 300 mm shall be provided in all the water/sludge/waste water/chemical retaining structures/equipment of the maximum as the case may be excluding the thickness of the slab/beam, if any.

vi) At least 300 mm free board shall be provided over the maximum liquid level of chemical preparation/dosing tanks. All tanks shall be provided with charging platform, dissolving chamber and slow speed agitators of SS 316 material. Overflow, sampling and drain connections should also be provided.

vii) Mechanical seal arrangement for shaft sealing shall be provided for all horizontal / vertical centrifugal pumps.

viii) Margin between shut-off head and operating head for all pumps shall not be less than 20%.



ix) The minimum bed depth of filtering media for all types of filters, excluding the support material (minimum 300 mm gravel support), shall be 1100 mm (minimum 750 mm Sand and minimum 350 mm Anthracite).

**9.00.00 PERFORMANCE GUARANTEE TEST PROCEDURE AND PERFORMANCE GUARANTEE**

**9.01.00 Clarification and Filtration System**

**9.01.01 Performance Test Procedure:**

- a) After water supply is established, the flow control valve at inlet to pH correction chamber should be adjusted to give desired flow.
- b) Isolation gates shall be adjusted to ensure equal flow distribution to each unit as determined by flow measuring device.
- c) Bidder shall conduct a test during the period when the turbidity is maximum. The duration of the test shall not be less than 72 hours. The actual duration, type and mode of conducting the above test shall be mutually decided upon between the Owner and the Bidder.

These tests will be carried out within a reasonable period from the date of commissioning of the plant. Basically the test shall be such as to prove beyond doubt the guaranteed performance of the plant under varying flow conditions (within the specified units) to the satisfaction of the Owner. The test procedures shall be as per relevant equivalent standards from recognized origins (where Indian Standard is not available and/or applicable).

The average turbidity in the Clarifier effluent at normal flow rate shall not exceed 10 NTU and any individual reading shall be within 10 NTU. In the event of 20% over loading, average turbidity shall not exceed 15 NTU and any individual reading shall be within 15 NTU.

- d) The test shall be deemed to be a failure when either of the limits as indicated in (d) is exceeded and retesting will have to be arranged.
- e) During this test, ferric chloride and lime dosage will be calculated by determining the concentration, level gauge readings and duration of test. The chemical consumption value shall not exceed 15% over the requirement as established from Jar test result.
- f) Sludge disposal system will be periodically checked with respect to ability and sludge consistency.
- g) Insoluble iron shall be "Not Detectable".
- i) By adjusting the control valve, flow is adjusted to 120%, 75% and 50% tests will be repeated each time. Lime and alum feed rate shall be adjusted proportional to raw water flow.
- j) The plant must meet the guarantee on turbidity, iron value, chemical consumption & ensure satisfactory performance of the chemical dosing and sludge disposal system in each test run.

**9.01.02 Performance Guarantee Parameters:**

**High Rate Solid Contact Clarifier**

- a) The unit will have rated output capacity not less than 292 m<sup>3</sup>/hr (net).
- b) Dissolved Silica concentration shall not exceed 25 ppm as SiO<sub>2</sub> in clarified treated water.

~~**Dual Media Pressure Filters**~~

- ~~a) Each Dual Media Pressure Filter will have a rated continuous treated water~~

output capacity of not less than 150 m<sup>3</sup>/hr (net) over and above the quantity of treated water required for backwash / regeneration / rinse of itself and other units of the same stream or chain it belongs to. It shall be backwashed once after every 24 hours of continuous service run.

- b) Turbidity of treated water shall not exceed 1 NTU with inlet Turbidity of 20 NTU maximum.
- c) Dissolved Silica concentration shall not exceed 25 ppm as SiO<sub>2</sub>.
- d) Backwash water requirement not to exceed 2% of the water treated between two backwashes.

#### **10.00.00 OPERATION AND CONTROL PHILOSOPHY**

Operation and control of the clarification system shall be through Remote DCS Node envisaged for RO plant and located at RO system control room. Operator Work Stations and Operator cum Engineering Work Stations envisaged in RO control room shall be used for control the operation of this system. Inputs/Outputs from field instruments/devices or local panels / MCC shall be hardwired connected to the Remote DCS Node. Necessary & suitable instrumentation as required to achieve the operation philosophy defined in this specification and as illustrated in relevant tender drawings shall be provided by the bidder as minimum requirement for the system.

Bidder shall provide all instruments accessories, junction boxes, instrumentation cables including laying and termination of cables up to termination cabinet of Remote DCS Node at RO control room, erection hardware etc. for safe, efficient and reliable operation of the plant.

For detail specification of instrumentations and systems, refer Technical Specification Volume IIE/Section -VI).

**ANNEXURE -I**

**DATA SHEETS FOR PROCESS EQUIPMENT AND ACCESSORIES  
CWBD WATER CLARIFICATION PLANT**

1.00.00 **BLOW DOWN WATER INLET PIPE AND VALVES**

<b>A)</b>	<b>INLET PIPE</b>	One (1).
i.	Size in mm	As calculated as per latest Water Balance Diagram/ As mentioned elsewhere in the specification.
ii.	Material of construction	Carbon Steel as per Specified Code.
<b>B)</b>	<b>BY PASS TO INLET PIPE</b>	One (1)
i.	Size in mm	To be suitable for 100% bypass and provided from upstream of pH Correction Chamber to inlet channel of Clear Water Reservoir.
ii.	Material of construction	Carbon Steel as per Specified Code.
<b>C)</b>	<b>INLET CONTROL VALVE</b>	
i.	Number	One (1)
ii.	Type of fluid to be handled	Blowdown Water
iii.	Design flow rate in m <sup>3</sup> /hr	As calculated as per latest Water Balance Diagram / As mentioned elsewhere in the specification.
iv.	Size	Suitable to match the Inlet Pipe.
v.	Type	Globe modulating type valve
vi.	Design Pressure in kg/cm <sup>2</sup> (g)	6.0(minimum)
vii.	Design Temperature, °C	60
viii.	Design Code	AWWA-C-504 or BS 5155
ix.	Code for Tests and Inspections	As per Technical Specification
x.	Leakage Class	Class VI (No leakage)

xi.	Material of Construction	
	a) Body	Cast Iron (IS 210 FG 260)
	b) Disc	Cast Iron (IS 210 FG 260)
	c) Shaft	AISI 316.
	d) Hand Wheel	Steel or malleable Cast Iron
xii.	Provided with accessories as follows:	
	a) Hand Wheel	To be provided for local manual operation.
	b) Gear operator	To be provided with self-locking device.
	c) Valve Actuator	To be provided pneumatic type with I/P Converter.
	d) Limit Switches	To be provided.
	e) Percentage Position Indicator	To be provided at local as well as DCS.
xiii.	Range of flow control	10 – 100%
xiv.	Type of control	Automatic based on level in Clear Water Reservoir.
xv.	Special features	Valve shall have "Auto Manual" selector switch with "Open-Close" push buttons and lamps in OWS / DCS. Under "Auto" mode, the valve shall automatically maintain the level of water in the Clear Water Reservoir i.e. the valve shall automatically close when water level in Clear Water Reservoir becomes high.
<b>D)</b>	<b>ISOLATION VALVES FOR INLET CONTROL VALVE</b>	
i.	Number	Two (2)
ii.	Type of fluid to be handled	Blow down water
iii.	Design flow rate in m <sup>3</sup> /hr for each valve	As calculated as per latest Water Balance Diagram / As mentioned elsewhere in the specification.
iv.	Size	Suitable to match the Inlet Pipe.
v.	Type	Motorized Gate valve



vi.	Design Pressure in kg/cm <sup>2</sup> (g)	6.0 (Minimum)
vii.	Design Temperature, °C	60
viii.	Design Code	AWWA-C-504 or BS 5155
ix.	Code for Tests and Inspections	As per Technical Specification
x.	Leakage Class	Class VI (No leakage)
xi.	Material of Construction	
	a) Body	Cast Iron (IS 210 FG 260)
	b) Disc	Cast Iron (IS 210 FG 260)
	c) Shaft	AISI 316.
	d) Hand Wheel	Steel or malleable Cast Iron
xii.	Provided with accessories as follows:	
	a) Hand Wheel	To be provided for local manual operation.
	b) Gear operator	To be provided with self-locking device.
<b>E)</b>	<b>ISOLATION VALVE IN BYPASS LINE OF INLET CONTROL VALVE</b>	
i.	Number	One (1).
ii.	Type of fluid to be handled	Blowdown water
iii.	Design flow rate in m <sup>3</sup> /hr for each valve	As calculated as per latest Water Balance Diagram / As mentioned elsewhere in the specification.
iv.	Size	Suitable to match the Bypass Pipe.
v.	Type	Manual Gate valve
vi.	Design Pressure in kg/cm <sup>2</sup> (g)	6.0 (minimum)
vii.	Design Temperature, °C	60

viii.	Design Code	AWWA-C-504 or BS 5155.
ix.	Code for Tests and Inspections	As per Technical Specification.
x.	Leakage Class	Class VI (No leakage)
xi.	Material of Construction	
	a) Body	Cast Iron (IS 210 FG 260).
	b) Disc	Cast Iron (IS 210 FG 260).
	c) Shaft	AISI 316.
	d) Hand Wheel	Steel or malleable Cast Iron
xii.	Provided with accessories as follows:	
	a) Hand Wheel	To be provided for local manual operation.
	b) Gear operator	To be provided with self-locking device.

#### 2.00.00 pH CORRECTION CHAMBER

<b>A)</b>	Numbers To be provided	One (1)
<b>B)</b>	Description for Unit	
i.	Type	Rectangular in cross section with baffles.
ii.	Type of fluid to be handled	Blowdown water
iii.	Design flow rate in m <sup>3</sup> /hr (each)	As calculated as per latest Water Balance Diagram / As mentioned elsewhere in the specification.
iv.	Design residence time in seconds	60 minimum.
v.	Size	Bidder to indicate.
vi.	Minimum Free Board in mm	300 mm.
vii.	Design Temperature, °C	60 (for process design only, not for civil design)
viii.	Design Code	As per Technical Specification
ix.	Code for Tests and	As per Technical Specification.

	Inspections	
x.	Material of Construction	RCC
xi.	Provided with accessories as follows:	
	a) Inlet	To be provided.
	b) Outlet	To be provided.
	c) Drain	To be provided.
	d) Sample Collection Point	To be provided.
xii.	Special features	Suitable drain line shall be extended up to nearest local sludge drain for final disposal to the BD water Sludge Pit.

### 3.00.00 INLET CHANNELS

<b>A)</b>	Numbers To be provided	One (1)
<b>B)</b>	Description for each Inlet Channel	
i.	Type	Rectangular in cross section.
ii.	Type of fluid to be handled	Blowdown water
iii.	Design flow rate in m <sup>3</sup> /hr	As calculated as per latest Water Balance Diagram / As mentioned elsewhere in the specification.
iv.	Design velocity in m/sec	0.6 (Maximum).
v.	Size	Bidder to indicate.
vi.	Minimum Free Board in mm	300 mm.
vii.	Design Temperature,	60 (for process design only, not for civil design)

	°C	
viii.	Design Code	As per Technical Specification
ix.	Code for Tests and Inspections	As per Technical Specification.
x.	Material of Construction	RCC
xi.	Special features	Both local mounted Rate of Flow Indicator as well as remote Rate of Flow Indication at OWS – (both flow rate and totalizer). Flow measurement shall be carried out through parshall flume.  Water level in the channel shall be measured using Ultrasonic Level Transmitter and the measured level shall be calibrated in terms of channel flow.

#### 4.00.00 FEED CHAMBER

A)	Numbers To be provided	One (1) no.
B)	Description for each Flash Mixer	
i.	Type	Rectangular
ii.	Type of fluid to be handled	Blowdown water
iii.	Design flow rate in m <sup>3</sup> /hr (each)	As calculated as per latest Water Balance Diagram / As mentioned elsewhere in the specification.
iv.	Design residence time in seconds	30 minimum in order to dampen out turbulence
v.	Size	Bidder to indicate.
vi.	Minimum Free Board in mm	300
vii.	Design Temperature, °C	60 (for process design only, not for civil design)

viii.	Design Code	As per Technical Specification
ix.	Code for Tests and Inspections	As per Technical Specification.
x.	Material of Construction	RCC
5.00.00	<b>REACTOR TYPE CLARIFIER</b>	
A)	Numbers To be provided	One (1) nos.
B)	Description for each Clarifier	
i.	Inlet Pipe	MS ERW as per IS 2062 with rapping and coating
ii.	Type	Solid contact reactor Type with integral variable speed impeller/turbine to internally recirculate water and sludge at adjustable rate to produce consistent water quality at varying hydraulic load and turbidity.
iii.	Type of fluid to be handled	Blowdown water
iv.	Design rated output flow rate, in m <sup>3</sup> /hr (each)	As calculated as per latest Water Balance Diagram / As mentioned elsewhere in the specification.
v.	Design residence time within clarification/settling zone, in minutes	Not less than 90.
vi.	Design average flow velocity, in m <sup>3</sup> /hr/m <sup>2</sup>	Not to exceed 3.
vii.	Design weir loading at rated capacity, in m <sup>3</sup> /day/m	Not to exceed 300.

viii.	Guaranteed quality of clarified water at design rated flow rate	Oil free clarified water with turbidity less than 10 NTU.
ix.	Size	Bidder to indicate.
x.	Material of Construction	RCC
xi.	Clarifier Reaction Turbine/recirculator	
	a) Number	One (1) no. for Clarifier
	b) Material of construction	Shaft - Mild Steel with epoxy painted Impeller – Stainless steel
xii.	Clarifier Bridge	
	a) Type	Rotary.
	b) Material of Construction	Carbon Steel.
	c) Bridge drive	Slow speed motor driven through reduction gear. Torque switch is To be provided to be provided.
	d) Salient features	Suitably braced to provide rigidity. Gear boxes for bridge drive shall be either oil free type or suitable arrangement for collecting leaked oil shall be provided so that clarified water remains oil free.
xiii.	Clarifier Scrapper Assembly	
	a) Number	One Assembly for each Clarifier.
	b) Type	Supported and suspended from Clarifier Bridge.
	c) Material of Construction	Carbon Steel with rubber inserts as squeezers and painting shall be as per painting specification.
xiv.	Overflow Weir / Peripheral Orifice	
	a) Location	To be fixed in the overflow launder of Clarifier.
	b) Type	Open type all along the periphery of Clarifier. For uniform overflow over weirs, saw tooth weir may be provided as necessary.



xv.	Sludge Disposal Arrangement	
	a) Type	<p>Disposal of sludge shall be by gravity.</p> <p>Sludge outlet pipe from the sludge hopper of the Clarifier shall be branched to a Telescopic Device for continuous bleed. The top of telescopic stand pipe shall be maintained at a desired elevation to ensure trickle flow of sludge.</p> <p>Sludge outlet pipe shall include an adjustable timer operated periodic blow-off valve (at downstream of Telescopic Device) with manual over riding facilities. The timer set point shall be independently manually adjustable. The range of the timer shall be 0-24 hrs.</p>
	b) Sludge Outlet Pipe	Cast iron as per IS-1536, Class-A
	c) Constant bleed arrangement with telescopic device	To be provided.
	d) Flushing connection	To be provided.
	e) Size of flushing connection	Shall be not less than 50 NB
	f) Operation	<p>Automatic operation through independent and adjustable timer.</p> <p>Local manual operation facility shall also be provided through extended spindle, headstock arrangement &amp; hand wheel.</p>
xvi.	Isolation Gates	Not required.
xvii.	Walkway	To be provided with handrails around launder periphery of each Clarifier. Width of the Walkway shall not be less than 1000 mm

xviii.	Access staircase, ladder, platform, handrails etc.	To be provided.
xix.	Special feature	Power supply/control of all electric drive motors on each Clarifier shall be done by a Rotary Current Collector located at the pivot point of rotation. For each Clarifier, one (1) Distribution Board to be located on Clarifier Bridge for all drives of Clarifier Bridge Assembly.

6.00.00	<b>OVERHEAD CLEAR WATER TANK</b>	
i.	Number	One (1)
ii.	Service	Storing of clarified water for supply to necessary areas.
iii.	Location	Overhead, on the roof of chemical house.
iv.	Material	R.C.C
v.	Capacity	20 Cu.m effective (minimum)
vi.	Vent , overflow, drain,	Required connection, manhole, rung, ladder, handrails
vii.	Instrumentation	
	a) Level Indicator	Mechanical float type with dial type indication.
	b) Level Switch	Two (2) nos. float type one (1) for high and one (1) for low level with alarm.
7.00.00	<b>FERRIC CHLORIDE SOLUTION PREPARATION TANK</b>	
<b>A)</b>	Numbers To be provided	Two (2) [One (1) no. to be under operation and one (1) no. under solution preparation].
<b>B)</b>	Description for each Tank	
i.	Type	Rectangular.
ii.	Type of fluid to be handled	10 % FeCl <sub>3</sub> Solution.
iii.	Available concentration	40%

iv.	Effective capacity, in m <sup>3</sup>	Not less than the quantity required (design dosage rate – 25 ppm) for twelve (12) hours of continuous operation of the entire Clarification System.
v.	Minimum Free Board, in mm	300.
vi.	Size	Bidder to indicate.
vii.	Design Pressure, Kg/Sq.cm.g	As per Technical Specification.
viii.	Design Temperature, °C	60 (for process design only, not for civil design)
ix.	Design Code	As per Technical Specification.
x.	Code for Tests and Inspections	As per Technical Specification.
xi.	Material of Construction	SS 304
xii.	Protection	
	a) Internal	Not required.
	b) External	Not required.
xiii.	Provided with accessories as follows:	
	a) Dissolving Basket	To be provided. Dissolving Basket shall be of SS-316 construction.
	b) Inlet	To be provided.
	c) Outlet	To be provided.
	d) Drain	To be provided.
	e) Overflow	To be provided.
	f) Vent	Not required.
	g) Manhole	Not required.
	h) Agitator along with drive motor and other accessories	To be provided. Agitator shall be motor driven through reduction gear. Agitator shall be of SS 316.
	i) Sample Collection Point	To be provided.

	j) Isolation Gates	Not required.
	k) Platform complete with handrails for operation	To be provided.
	l) Staircase	To be provided for access from finished floor level to Operation Platform at First Floor of Chemical House.
xiii.	Instruments	
	a) Level Gauge	
	◆ Number	One (1).
	◆ Type	Mechanical Float and Tape type.
	b) Level Switches	
	◆ Number	Two (2) [one for high and the other for low].
	◆ Type	Top Mounted Float Operated Magnetic type.
	◆ Alarm	To be provided.
	◆ Interlock	Low Level Switch needs to be interlocked with Ferric Chloride Solution Recirculation Pumps.
	c) Level Transmitters	
	◆ Number	Not required.
	◆ Type	Not required.
	◆ Alarm	Not required.
	◆ Interlock	Not required.
	d) Level Indicating Controller	
	◆ Number	Not required.
	◆ Type	Not required.
	◆ Alarm	Not required.
	◆ Interlock	Not required.
8.00.00	<b>FERRIC CHLORIDE SOLUTION DOSING PUMP</b>	
A)	Number	Two (2) [One (1) no. to be under operation and the

		other one (1) as standby]
B)	Description for each Pump	
i.	Location	Indoor.
ii.	Fluid to be handled	10 % FeCl <sub>3</sub> Solution.
iii.	Available concentration	40%
iv.	Purity of chemical	80%
v.	Service	To dose FeCl <sub>3</sub> Solution.
vi.	Duty	Continuous and to be suitable for parallel operation.
v.	Type of Pump	Electromechanical, positive displacement, constant speed, variable stroke and hydraulically operated diaphragm type.
vi.	Design standard	API 675.
vii.	Service temperature, in °C	60 maximum.
viii.	Rated Capacity, in LPH	300
ix.	Facility for Capacity Adjustment	Local manual through Micrometer Dial and remote manual from DCS
x.	Range of capacity adjustment	0 % - 100 %.
xi.	Suction Condition	Flooded.
xii.	Head to be developed at rated capacity	15 mlc minimum. If necessary, higher value needs to be considered by Bidder to meet the requirements as per Technical Specification (C shall be considered as 120 to calculate the frictional loss in pipe as per Hagen Williams Equation).
xiii.	Material of construction	
	a) Housing	Polypropylene.
	b) Pump head	Polypropylene.
	c) Valve and valve housing	Polypropylene.



	d) Diaphragm	PTFE / Teflon faced Hypalon.
	e) Connecting rod	As per manufacturer's standard
	f) Shaft	As per manufacturer's standard
	g) Worm	Manganese Bronze / Cast Iron.
	h) Worm Wheel	Manganese Bronze / Cast Iron.
	i) Nuts and bolts	SS-316
	j) Base plate	MS epoxy painted.
	k) Foundation bolts	SS-316
xiv.	Type of drive	Electrical Motor
xv.	Criteria for selection of drive motor	Minimum 15 % margin over BkW at rated duty point shall be taken and standard motor with next higher KW as available shall be selected. This shall in no way be less than the maximum power required by the Pump.
xvi.	Rated speed (RPM)	100 strokes per minutes (maximum).
xvii.	Voltage, Phase & Frequency ( $\pm$ % Variation)	415 V ( $\pm$ 10%), 3 Phase, 50 HZ (+3 to -5%).
xviii.	Type of coupling between Pump & Motor	Flexible Spacer.
xix.	Noise level (for complete set of Pump & Motor)	Not more than 85 db (At a distance of 1.0 m from the outer surface of Motor).
	Painting for complete set of Pump & Motor	
	a) Primer	As per the requirement of the Technical Specification.
	b) Finish paint	As per the requirement of the Technical Specification.
	c) Shade	As approved by Owner.
xx.	Tests and Inspection	
	a) Material Test required for	Required for Pump Head and Plunger.

	b) Hydro-test	Test Pressure - 200% of pump operating pressure or 15 kg/cm <sup>2</sup> (g) whichever is higher. Test Duration - Half an hour (minimum).
	c) Dynamic Balancing Test	Static Balancing for all rotating parts of pumps required.
xxi.	Performance Test	
	a) Test Code	Hydraulic Institute Standard and API-675.
	b) Tests to be done for determination of	Capacity, Volumetric Accuracy, Volumetric Efficiency and Power Consumption.
	c) Test to be carried out	On prototype model at rated speed.
	d) Test for satisfactory operation of pump at site	Required.
xxii.	Instruments	
	a) Pressure gauge	
	◆ Number	One (1).
	◆ Location	At discharge of each Pump.
	◆ Type	Bourdon Gauge with diaphragm seal.
xxiii.	Start and stop facility provided at local	To be provided.
xxiv.	Trip interlock	To be provided.
xxv.	Accessories to be provided	
	a) Pulsation Dampener	Required.
	b) Pressure Relief Valve	Required.
9.00.00	<b>LIMESOLUTION PREPARATION TANKS</b>	
<b>A)</b>	Numbers To be	Two (2) [One (1) no. to be under operation and other

	provided	One (1) no. under solution preparation].
<b>B)</b>	Description for each Tank	
i.	Type	Rectangular.
ii.	Type of fluid to be handled	6% Lime Solution.
iii.	Purity of chemical	80%
iv.	Effective capacity, in m <sup>3</sup>	Not less than the quantity required [design loading rate - Magnesium oxide (from Dolomitic Lime )] shall not be less than 2.5 mg/mg of SiO <sub>2</sub> adsorbed.) for twelve (12) hours of continuous operation of the entire Pretreatment Plant.
v.	Minimum Free Board, in mm	300.
vi.	Size	Bidder to indicate.
vii.	Design Pressure, Kg/cm <sup>2</sup> .g	As per Technical Specification.
viii.	Design Temperature, °C	60 (for process design only, not for civil design)
ix.	Design Code	As per Technical Specification.
x.	Code for Tests and Inspections	As per Technical Specification.
xi.	Material of Construction	SS 304
xii.	Protection	
	c) Internal	Not required.
	d) External	Not required.
xiii.	Provided with accessories as follows:	
	a) Dissolving Basket	Not required.
	b) Inlet	To be provided.
	c) Outlet	To be provided.

	d) Drain	To be provided.
	e) Overflow	To be provided.
	f) Vent	Not required.
	g) Manhole	Not required.
	h) Agitator along with drive motor and other accessories	To be provided. Agitator shall be motor driven through reduction gear. All wetted parts of the agitator shall be of SS-316 construction.
	i) Sample Collection Point	To be provided.
	j) Isolation Gates	Not required.
	k) Platform complete with handrails for operation	To be provided.
	l) Staircase	To be provided for access from finished floor level to Operation Platform at First Floor of Chemical House.
xiv.	Instruments	
	a) Level Gauge	
	◆ Number	One (1).
	◆ Type	Mechanical Float and Tape type.
	b) Level Switches	
	◆ Number	Two (2) [one for high and the other for low].
	◆ Type	Top Mounted Float Operated Magnetic type.
	◆ Alarm	To be provided.
	◆ Interlock	Low Level Switch needs to be interlocked with Lime Solution Recirculation Pumps.
	c) Level Transmitters	
	◆ Number	Not required.
	◆ Type	Not required.
	◆ Alarm	Not required.
	◆ Interlock	Not required.
	d) Level Indicating Controller	

	◆ Number	Not required.
	◆ Type	Not required.
	◆ Alarm	Not required.
	◆ Interlock	Not required.
10.00.00	<b>LIME SOLUTION DOSING PUMP</b>	
A)	Number	Two (2) [One (1) no. to be under operation and the other one (1) as standby]
B)	Description for each Pump	
vii.	Location	Indoor.
viii.	Fluid to be handled	6 % Lime Solution.
ix.	Purity of chemical	80%
x.	Service	To dose Lime Solution.
xi.	Duty	Continuous and to be suitable for parallel operation.
xxv.	Type of Pump	Electromechanical, positive displacement, constant speed, variable stroke and hydraulically operated diaphragm type.
xxvi.	Design standard	API 675.
xxvii.	Service temperature, in °C	60 maximum.
xxviii.	Rated Capacity, in LPH	To be decided by the Bidder considering design loading rate - Magnesium oxide (from Lime) 2.5 mg/mg of SiO <sub>2</sub> adsorbed.
xxix.	Facility for Capacity Adjustment	Local manual through Micrometer Dial and remote manual from DCS
xxx.	Range of capacity adjustment	0 % - 100 %.
xxxi.	Suction Condition	Flooded.

xxxii.	Head to be developed at rated capacity	15 mlc minimum. If necessary, higher value needs to be considered by Bidder to meet the requirements as per Technical Specification (C shall be considered as 120 to calculate the frictional loss in pipe as per Hagen Williams Equation).
xxxiii.	Material of construction	
	l) Housing	Polypropylene.
	m) Pump head	Polypropylene.
	n) Valve and valve housing	Polypropylene.
	o) Diaphragm	PTFE / Teflon faced Hypalon.
	p) Connecting rod	As per manufacturer's standard
	q) Shaft	As per manufacturer's standard
	r) Worm	Manganese Bronze / Cast Iron.
	s) Worm Wheel	Manganese Bronze / Cast Iron.
	t) Nuts and bolts	SS-316
	u) Base plate	MS epoxy painted.
	v) Foundation bolts	SS-316
xxxiv.	Type of drive	Electrical Motor
xxxv.	Criteria for selection of drive motor	Minimum 15 % margin over BKW at rated duty point shall be taken and standard motor with next higher KW as available shall be selected. This shall in no way be less than the maximum power required by the Pump.
xxxvi.	Rated speed (RPM)	100 strokes per minutes (maximum).
xxxvii.	Voltage, Phase & Frequency ( $\pm$ % Variation)	415 V ( $\pm$ 10%), 3 Phase, 50 HZ (+3 to -5%).
xxxviii.	Type of coupling between Pump & Motor	Flexible Spacer.



xxxix.	Noise level (for complete set of Pump & Motor)	Not more than 85 db (At a distance of 1.0 m from the outer surface of Motor).
	Painting for complete set of Pump & Motor	
	d) Primer	As per the requirement of the Technical Specification.
	e) Finish paint	As per the requirement of the Technical Specification.
	f) Shade	As approved by Owner.
xl.	Tests and Inspection	
	a) Material Test required for	Required for Pump Head and Plunger.
	b) Hydro-test	Test Pressure - 200% of pump operating pressure or 15 kg/cm <sup>2</sup> (g) whichever is higher. Test Duration - Half an hour (minimum).
	c) Dynamic Balancing Test	Static Balancing for all rotating parts of pumps required.
xli.	Performance Test	
	e) Test Code	Hydraulic Institute Standard and API-675.
	f) Tests to be done for determination of	Capacity, Volumetric Accuracy, Volumetric Efficiency and Power Consumption.
	g) Test to be carried out	On prototype model at rated speed.
	h) Test for satisfactory operation of pump at site	Required.
xlii.	Instruments	
	a) Pressure gauge	
	◆ Number	One (1).
	◆ Location	At discharge of each Pump.
	◆ Type	Bourdon Gauge with diaphragm seal.
xliii.	Start and stop facility provided at local	To be provided.

xliv.	Trip interlock	To be provided.
xxv.	Accessories to be provided	
	c) Pulsation Dampener	Required.
	d) Pressure Relief Valve	Required.
11.00.00	<b>POLYELECTROLYTE SOLUTION PREPARATION TANK</b>	
<b>A)</b>	Numbers To be provided	Two (2) [One (1) no. to be under operation and the other one (1) no. as standby].
<b>B)</b>	Description for each Tank	
i.	Type	Vertical cylindrical with flat bottom.
ii.	Type of fluid to be handled	1 % Polyelectrolyte Solution.
iii.	Effective capacity, in m <sup>3</sup>	Not less than the quantity required (design dosage rate – 1 ppm) for twelve (12) hours of continuous operation of the entire Pretreatment Plant.
iv.	Minimum Free Board, in mm	300.
v.	Size	Bidder to indicate.
vi.	Design Pressure, Kg/cm <sup>2</sup> .g	As per Technical Specification.
vii.	Design Temperature, °C	60
viii.	Design Code	As per Technical Specification.
ix.	Code for Tests and Inspections	As per Technical Specification.
x.	Material of Construction	SS 304
xi.	Thickness, in mm	Not less than 6.

xii.	Protection	
	a) Internal	Not required.
	b) External	Not required.
xiii.	Provided with accessories as follows:	
	a) Dissolving Basket	To be provided. Dissolving Basket shall be of SS-316 construction.
	b) Inlet	To be provided.
	c) Outlet	To be provided.
	d) Drain	To be provided.
	e) Overflow	To be provided.
	f) Vent	Not required.
	g) Manhole	Not required.
	h) Agitator along with drive motor and other accessories	To be provided. Agitator shall be motor driven through reduction gear. All wetted parts of the agitator shall be of SS-316 construction.
	i) Sample Collection Point	To be provided.
	j) Isolation Gates	Not required.
	k) Platform complete with handrails for operation	To be provided.
	l) Staircase	To be provided for access from finished floor level to Operation Platform at First Floor of Chemical House.
xiv.	Instruments	
	a) Level Gauge	
	◆ Number	One (1).
	◆ Type	Tubular Transparent type.
	b) Level Switches	
	◆ Number	Two (2) [one for high and the other for low].
	◆ Type	External Float Cage type with Magnetic Switch.

	◆ Alarm	To be provided.
	◆ Interlock	Low Level Switch needs to be interlocked with Polyelectrolyte Solution Injection Pumps.
	c) Level Transmitters	
	◆ Number	Not required.
	◆ Type	Not required.
	◆ Alarm	Not required.
	◆ Interlock	Not required.
	d) Level Indicating Controller	
	◆ Number	Not required.
	◆ Type	Not required.
	◆ Alarm	Not required.
	◆ Interlock	Not required.
12.00.00	<b>POLYELECTROLYTE DOSING PUMPS</b>	
<b>A)</b>	Number	Two (2) [One (1) no. to be under operation and the other one (1) as standby].
<b>B)</b>	Description for each Pump	
i.	Location	Indoor.
ii.	Fluid to be handled	1 % Polyelectrolyte Solution.
iii.	Service	To inject Polyelectrolyte Solution.
iv.	Duty	Continuous and to be suitable for parallel operation.
v.	Type of Pump	Electromechanical, positive displacement, constant speed, variable stroke and hydraulically operated diaphragm type.
vi.	Type of Casing	Foot mounted.
vii.	Design standard	API 675.
viii.	Service temperature, in °C	60 maximum.

ix.	Rated Capacity, in LPH	500
x.	Facility for Capacity Adjustment	Local manual through Micrometer Dial and remote manual from DCS
xi.	Range of Capacity Adjustment	0% - 100%.
xii.	Suction Condition	Flooded.
xiii.	Head to be developed at rated capacity	20 mlc minimum. If necessary, higher value needs to be considered by Bidder to meet the requirements as per Technical Specification (C shall be considered as 120 to calculate the frictional loss in pipe as per Hagen Williams Equation).
xiv.	Material of construction	
	a) Housing	Polypropylene.
	b) Pump head	Polypropylene.
	c) Valve and valve housing	Polypropylene.
	d) Diaphragm	PTFE / Teflon faced Hypalon.
	e) Worm	Manganese Bronze / Cast Iron.
	f) Worm Wheel	Manganese Bronze / Cast Iron.
	g) Shafts (worm)	Hardened Steel (EN 19 / ASTM A 276 Gr. 410).
	h) Base plate	MS.
	i) Foundation bolts	SS-316.
xv.	Type of drive	Electrical Motor
xvi.	Criteria for selection of drive motor	Minimum 15% margin over BKW at rated duty point shall be taken and standard motor with next higher KW as available shall be selected. This shall in no way be less than the maximum power required by the Pump.
xvii.	Rated speed (SPM)	1500 (Sync.) maximum.
xviii.	Voltage, Phase & Frequency ( $\pm$ % Variation)	415 V ( $\pm$ 10%), 3 Phase, 50 HZ

xix.	Type of coupling between Pump & Motor	Flexible Spacer.
xx.	Noise level (for complete set of Pump & Motor)	Not more than 85 db (At a distance of 1.0 m from the outer surface of Motor).
xxi.	Painting for complete set of Pump & Motor	
	i) Primer	Shall be as per technical specification.
	b) Finish paint	Shall be as per technical specification.
	c) Shade	As approved by Owner.
xxii.	Tests and Inspection	
	a) Material Test required for	Required for Pump Head and Plunger.
	b) Hydro-test	Test Pressure - 200% of pump operating pressure or 15 kg/cm <sup>2</sup> (g) whichever is higher. Test Duration - Half an hour (minimum).
	c) Dynamic Balancing Test	Static Balancing for all rotating parts of pumps required.
xxiii.	Performance Test	
	a) Test Code	Hydraulic Institute Standard and API-675.
	b) Tests to be done for determination of	Capacity, Volumetric Accuracy, Volumetric Efficiency and Power Consumption.
	c) Test to be carried out	On prototype model at rated speed.
	d) Test for satisfactory operation of pump at site	Required.
xxiv.	Instruments	
	a) Pressure gauge	
	◆ Number	One (1).



	◆ Location	At discharge of each Pump.
	◆ Type	Bourdon Gauge with diaphragm seal.
xxv.	Start and stop facility provided at local	To be provided.
xxvi.	Trip interlock	To be provided.
xxvii.	Accessories to be provided	
	a) Pulsation Dampener	Required.
	b) Pressure Relief Valve	Required.
<b>13.00.00</b>	<b>DUAL MEDIA FILTER FEED PUMP</b>	
i.	Number of pumps in the system	Two (2) [One (1) in operation and other in standby]
ii.	Type of pump	Horizontal Centrifugal / Vertical Wet Pit
iii.	Type of operation	Continuous
iv.	Pump Capacity (each), m <sup>3</sup> /hr	300 m <sup>3</sup> /hr (Minimum) + Consumption water for overhead clear water tank
v.	Rated Pump Head	Shall be minimum 60 MLC. If necessary, higher value needs to be considered by the bidder to meet the requirements as per Tender Specification (C should be considered as 120 to calculate the frictional loss in pipe as per Hagen Williams Equation).
vi.	Pump Speed, r.p.m.	1500 (maximum)
vii.	Material of construction	Casing & Impeller – 2.5% Ni-CI as per IS 210 FG 260, Shaft–Stainless Steel
viii.	Type of drive	Electrical Motor
ix.	Criteria for selection of drive motor	Minimum 15 % margin over BKW at rated duty point shall be taken and standard

		motor with next higher KW as available shall be selected. This shall in no way be less than the maximum power required by the Pump.
x.	Rated speed (RPM)	1500 (Sync.) maximum.
xi.	Painting for complete set of Pump & Motor	
	a) Primer	Shall be as per technical specification.
	b) Finish paint	Shall be as per technical specification.
	c) Shade	As approved by Owner.
xii.	Instruments	
	a) Pressure gauge	
	◆ Number	One (1).
	◆ Location	At discharge of each Pump.
	◆ Type	Bourdon Gauge with diaphragm seal.
<b>14.00.00</b>	<b>DUAL MEDIA PRESSURE FILTERS</b>	
<b>A)</b>	Number	Three (3).[2W+1S]
<b>B)</b>	Description for unit	
i.	Type	Vertical cylindrical with dished ends.
ii.	Location	Outdoor.
iii.	Design Rated Service Flow Rate (Net) in m <sup>3</sup> /hr	To be specified by the Bidder or minimum 150 m <sup>3</sup> /hr.
iv.	Time Period for each Service Cycle between two consecutive regenerations, in hrs	24
v.	Design surface flow rate in m <sup>3</sup> /m <sup>2</sup> /hr	Not more than 12.
vi.	Design Temperature in ° C	60.

vii.	Design Pressure in kg/cm <sup>2</sup> (g).	Design pressure should be the maximum expected pressure to which the vessel may be subjected plus 5% extra margin. Maximum expected pressure for a vessel placed in the discharge line of a pump shall be based on the shut-off head of the pump plus static head at pump suction, if any.
viii.	Design Inlet Turbidity, in NTU	20
ix.	Design Outlet Turbidity, in NTU	Not more than 1.
x.	Design Code	IS:2825/ASME SEC.VIII DIV.I
xi.	Code for Tests and Inspections	IS:2825/ASME SEC.VIII DIV.I
xii.	Filter Media	
	a) Type	Bed of Graded Sand and Anthracite supported over Graded Gravel.
	b) Bed depth in mm	Anthracite - minimum 350 and Sand - minimum 750 and Support Gravel - minimum 300.
	c) Percentage freeboard	50 % minimum.
i.	Details of Regeneration of Filter Media	
	a) Air Scour	Air Scour by air from Air Blowers for Dual Media Pressure Filters.
	b) Air Scour Velocity	50 Nm <sup>3</sup> /hr/m <sup>2</sup> (minimum) of filtration area at a suitable head.
	c) Backwash	Backwash water from DMF Backwash Tank.
xiii.	Material of construction	
	a) Shell	Carbon steel as per IS 2062 Gr. B.
	b) Dished ends	Carbon steel as per IS 2002.
xiv.	Protection	
	a) Internal	
	◆ Material	Epoxy painted.
	◆ Primer	Shall be as per technical specification.
	◆ Finish paint	Shall be as per technical specification.
	b) External	

	◆ Primer	Shall be as per technical specification.
	◆ Finish paint	Shall be as per technical specification.
	◆ Shade	As approved by Owner.
xv.	Manhole	Two (2) nos. minimum each of Davit type and 500 mm diameter for Header Lateral under drain system. One (1) additional manhole of 500 mm diameter shall be provided for strainer-on-plate under drain system to access the bed plate from bottom.
xvi.	Sight windows	One (1) no. in Backwash Space.
xvii.	Hand hole	One (1) no. of 150 mm dia. for removal of media inside.
xviii.	Media Trap	One (1) no. at the outlet and one (1) no. at Backwash outlet of each Filter
xix.	Instruments	
	a) Flow Transmitter	
	◆ Number	One (1).
	◆ Location	Inlet.
	b) Pressure Gauge	
	◆ Number	Two (2).
	◆ Location	Inlet and Outlet.
	◆ Type	Bourdon Gauge with diaphragm seal.
<b>15.00.00</b>	<b>AIR BLOWERS FOR DUAL MEDIA PRESSURE FILTERS</b>	
<b>A)</b>	Number	Two (2) [One (1) no. to be under operation and the other as standby] nos.
<b>B)</b>	Description for each Blower	
i.	Location	Outdoor.
ii.	Service	To scour the filter bed prior to backwash.
iii.	Type of Blower	Rotary Twin Lobe Oil Free.
iv.	Design temperature, in °C	60 maximum.
v.	Rated Capacity, in m <sup>3</sup> /hr	Bidder to indicate the rated capacity suitable

		for 100% requirement of single Dual Media Filter.
vi.	Surface velocity	Not less than 50 NM3 of free air/hf/m <sup>2</sup>
vii.	Permissible tolerance in rated capacity, in %	As per BS-1571-Part II.
viii.	Head to be developed at rated capacity	Bidder to indicate, in order to comply with the requirements of Tender Specification.
ix.	Permissible tolerance in efficiency at rated capacity, in %	As per BS-1571-Part II.
x.	Material of construction	
	a) Casing	CI as per IS-210, Gr. FG 260.
	b) Lobe	CI as per IS-210, Gr. FG 260.
	c) Shaft	EN-8 to BS-970.
xi.	Type of drive	Electrical Motor
xii.	Criteria for selection of drive motor	Minimum 15 % margin over BkW at rated duty point shall be taken and standard motor with next higher KW as available shall be selected. This shall in no be less than the maximum power required by the Blower.
xiii.	Rated speed (RPM)	1500 (Sync.) maximum.
xiv.	Painting for complete set of Blower & Motor	
	a) Primer	Shall be as per technical specification.
	b) Finish paint	Shall be as per technical specification.
	c) Shade	As approved by Owner.
xv.	Instruments	
	a) Pressure gauge	
	◆ Number	One (1).
	◆ Location	At discharge of each Blower.
	◆ Type	Bourdon Gauge.
xvi.	Start and stop facility provided at local	To be provided.

kvii.	Accessories to be provided	Common base frame, Pulley, V-Belt Guard, Suction Filter, Suction Silencer, Discharge Silencer, Anti Vibration Pad, Safety Relief Valve.
<b>16.00.00</b>	<b>FILTER BACKWASH WATER SUPPLY PUMPS</b>	
	Number of pumps in the system	Two (2) [One (1) in operation and another in standby]
	Type of pump	Horizontal Centrifugal
	Type of operation	Continuous
	Pump Capacity, m <sup>3</sup> /hr	To suit the backwash requirement of one (1) Dual Media Filter
	Rated Pump Head	To be specified by the Bidder. However, Backwash Velocity should not be less than 24 m <sup>3</sup> /m <sup>2</sup> /hr.
	Pump Speed, r.p.m.	1500 (maximum)
v.	Head to be developed at rated capacity	To be indicated by Bidder to meet the requirements as per Tender Specification (C should be considered as 120 to calculate the frictional loss in pipe as per Hagen Williams Equation).
vi.	Material of construction	Casing & Impeller – 2.5% Ni-CI as per IS 210 FG 260, Shaft–Stainless Steel
vii.	Type of drive	Electrical Motor
viii.	Criteria for selection of drive motor	Minimum 15 % margin over BKW at rated duty point shall be taken and standard motor with next higher KW as available shall be selected. This shall in no way be less than the maximum power required by the Pump.
ix.	Rated speed (RPM)	1500 (Sync.) maximum.
x.	Painting for complete set of Pump	

	& Motor	
	d) Primer	Shall be as per technical specification.
	e) Finish paint	Shall be as per technical specification.
	f) Shade	As approved by Owner.
xi.	Instruments	
	b) Pressure gauge	
	◆ Number	One (1)
	◆ Location	At discharge of each Pump.
	◆ Type	Bourdon Gauge with diaphragm seal.
<b>17.00.00</b>	<b>LIME SLAKING TANK</b>	
i.	Number	Two (2)
ii.	Material of Tank	RCC inside Plastic Polypropylene Glass (PPG) Lining (total thickness 3.5 mm, out of which 2.0 mm PPG sheet which will be fixed with suitable adhesive of 1.5 mm)
iii.	Capacity plant	Each tank shall have a capacity to cater 12 hours demand.
iv.	Solution Strength	10% W/W [Quick lime (industrial quality 60-70%) shall be dissolved to produce the resultant slurry]
v.	Agitator type and number	Motor & gear driven agitator, one (1) per tank.
vi.	Dissolving basket	Dissolving Basket shall be of SS-316 construction.
vii.	Agitator material	All wetted parts of the agitator shall be of SS-316 construction.
viii.	Instrumentation	
	Level indicator	
	a) Number	One (1) for each tank
	b) Type	Mechanical float type with dial type indication.
<b>18.00.00</b>	<b>SLAKED LIME TRANSFER PUMP</b>	
i.	Type	Horizontal Centrifugal
ii.	Number	Two (2) nos. each of 100% capacity.
iii.	Material of construction	Cast iron to IS-210 & FG-260



iv.	Capacity and head	Minimum 15 m <sup>3</sup> /hour, TDH - by Bidder [By considering C = 120 in H & W Equation]
v.	Duty	Intermittent
vi.	Rated speed	1500 RPM (Max.)
vii.		
viii.	Permissible tolerance in Rated Capacity (%)	As per IS 5639, IS 5120
ix.	Permissible Tolerance In Efficiency at Rated capacity (%)	As per IS 5639
x.	Range of operation	30% to 120% of rated capacity
xi.	Design Standard	As per IS 5639 & IS 5120
	Material of construction	
	a) Casing	SS-304.
	b) Impeller	SS-304.
	a) Shaft	EN-8 to BS-970.
xiii.	Material test required for	Casing, impeller shaft and shaft sleeve
xiv.	Hydrotest pressure, duration and procedure	As per IS 5120
xv.	Dynamic balancing test	Required
xvi.	Performance Test	
	a) Testing standard	Hydraulic Institute standard.
	b) Test to be done for	Head-capacity curve, BHP- determining capacity curve and Efficiency capacity curve
	c) Test to be carried out	On prototype at rated speed
	d) Testing for satisfactory running of pump at site required	Yes
xvii.	Motor Selection Criteria	While selecting the motor for pump, 15% (minimum) margin over BkW of Pump at rated duty point shall be taken and standard motor with next higher KW rating available shall be selected. This shall in no way be less than maximum power required by pump.

**ENGINEERING SERVICES**

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## **OWNER'S ENGINEERING SERVICES**

### **1.00.00 GENERAL**

- 1.01.0 As part of the overall project management activity, the Successful Bidder Shall be responsible for proper Owner's Engineering and co-ordination of activities during various phases of execution of the contract. The Successful Bidder shall identify a person, designated as Project Manager, with whom the Owner, the Consulting Owner's Engineer or the Review Consultant shall interact on matters related to Owner's Engineering as well as execution of the contract. The Project Manager shall be the single-point contact person on behalf of the Successful Bidder and shall be responsible for all Owner's Engineering co-ordination. The Owner /Consultant /Review Consultant shall interact with the Project Manager only on all matters of co-ordination between the Owner and the Successful Bidder or on matters involving the Successful Bidder, his manufacturing units and sub-vendors. For expediting, the Owner or his representative may sometimes interact with the manufacturing units or sub-vendors of the Successful Bidders. However such interaction will not, under any circumstance, dilute the responsibility of the Successful Bidder to provide a fully Owner's Engineered and coordinated package under this contract.
- 1.02.0 On finalization of the contract, a procedure for exchange of Owner's Engineering information will be mutually agreed and finalized between the Owner and the Successful Bidder.

### **2.00.0 DESIGN COORDINATION MEETING**

The Successful Bidder and his sub-vendors will be called upon to attend design co-ordination meetings with the Owner's Engineer, other Successful Bidders and the Consultants of the Owner during the period of execution of contract. The Successful Bidder including his sub-vendors shall attend such meetings at their own cost at Owner's or Consultant's office in Kolkata/ or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

### **3.00.00 CO-OPERATION WITH OTHER CONTRACTORS AND CONSULTING OWNER'S ENGINEERS**

The Successful Bidder shall agree to cooperate with the Owner's other Contractors and Consulting Owner's Engineers and freely exchange with them such technical information as is necessary to obtain the most efficient and economical design and to avoid unnecessary duplication of efforts. The Owner's Engineer shall be provided with copies of all

correspondences addressed by the Successful Bidder to other Sub-Vendors and Consulting Owner's Engineers in respect of such exchange of technical information.

#### **4.00.00 GUIDELINES FOR OWNER'S ENGINEERING SERVICES**

4.01.00 Prior to commencement of the Owner's Engineering work as part of design submissions, all aspects of design viz., criteria for selection and sizing of all equipment and systems, design margins etc. including that for structural steel and civil work shall be outlined and these shall form the basis for the detailed Owner's Engineering work.

4.02.00 Owner's Engineering work shall be performed on modern and proven concepts and internationally accepted good Owner's Engineering practices but fully compatible with the Indian environments. Owner shall have the right to review and approve the Owner's Engineering work by themselves and/or through consultant and ask for any clarifications and changes/modifications to the work performed by Successful Bidder.

4.03.00 At any stage during the performance of assignment, the Successful Bidder may be required to make certain changes/modification/improvements in design/drawing/other documents, which in the opinion of the Owner could result in better improved design, layout, operability, plant availability, maintainability, reliability or economy of the plant and its systems/sub-systems in view of revised and more accurate information/data available at a later date(s) or feedback(s) received during execution/operation of similar units. Such changes/modifications/improvements required could be identified by Owner and/or Consultant and mutually discussed. Owner requires the Bidder to incorporate such action in the subject assignment appropriately without any additional cost liability and time implication to the Owner and same shall be within the responsibilities and Scope of the Successful Bidder.

4.04.00 During the course of review of detailed Owner's Engineering stages, it may be essential in the opinion of Owner to obtain certain classified data for review purposes only. In case Owner so desires, the Bidder shall submit such data to Owner.

4.05.00 During the course of review of detailed Owner's Engineering, it may be essential in Owner's opinion to obtain data and the Bidder engineers information on similar equipment and plants Owner. In case, Owner so desires the Bidder shall submit such data and information to the Owner.

4.06.00 It is not the intent to give details of every single task covered in the total Owner's Engineering work to be carried out by Successful Bidder, however, all Owner's Engineering work required for the satisfactory completion of the plant/systems as specified shall be carried out by the

Successful Bidder. Broadly, the following are the minimum requirements in respect of scope of major items of work.

- 4.06.01 Preparation, updating and finalisation of scheme drawings, control and interlock diagrams, detailed and fully dimensioned layout drawings (plant layout and equipment layout detailed plan, elevation and cross-sectional drawings at different elevations/ floor levels) covering all mechanical, electrical, C&I, civil and structural items, equipment, systems and facilities. Drawings and Schedules prepared by the Successful Bidder from time to time, as detailed designs are developed, shall be submitted for Owner's/ Consultant's approval before the work is taken up. Revisions, corrections, additions to drawings and schedules shall not be considered to change the scope of work.
- 4.06.02 Preparation of detailed technical specifications including data sheets, tender drawings and bill of material for all bought out items, as also finalisation of corresponding sub-Vendors.
- 4.06.03 Review of sub-Vendor's data, drawings, design calculations, schedules, bill of materials, instruction manuals etc. for all equipment, before forwarding them to Owner/Consultant for approval.
- 4.06.04 Preparation of civil construction drawings for all equipment showing foundation details and full details regarding equipment loads, floor openings, details of embedment, etc. required for preparation of civil construction drawings and also as referred at relevant sections of Scope & Exclusions. These documents shall be preceded by appropriate design calculations, static and dynamic analysis as necessary.
- 4.06.05 Preparation and finalisation of process piping and instrumentation diagrams and schematics, complete in all respects for all systems/packages of the power plant.
- 4.06.06 Preparation of consolidated schedules and bills of materials, including line numbers, tag numbers, source of supply, service conditions, specifications, materials, types and connections details, quantities for items of the plant including dampers, steam traps, strainers, instrumentations, ducting.
- 4.06.07 Sizing of all piping and equipment as per the stipulated design criteria; carrying out of flexibility analysis/dynamic analysis as necessary; hangers & support Owner's engineering.
- 4.06.08 Final revision of all documents including preparation and compilation of Instruction Manuals for installation, commissioning, operation and maintenance for all equipment and systems. Refer clause 5.00.00 for the specific requirement in this regard.

4.06.09 Certification and submission of final as-built drawings for all areas.

4.06.10 Preparation and compilation of all drawings, schedules and instructions, which may be required at site, whether separately, mentioned or not.

4.06.11 All erection and assembly drawings, which may be required at site.

## **5.00.00 INSTRUCTION MANUALS**

5.01.00 The Bidder shall provide all necessary instruction manuals for the Owner's review, comment, and final acceptance as required in the contract. The instruction manual shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The instruction manual shall be submitted in the form of one (1) soft copy in CD and 15 hard copies.

### **5.02.00 Erection Manuals**

The erection manuals shall be submitted at least three (3) months prior to commencement of erection activities of particular equipment/system. The manuals shall contain the following as a minimum:

- a) Erection strategy.
- b) Sequence of erection.
- c) List of tools, tackles, heavy equipment like cranes, dozers etc. Required for erection.
- d) Bill of Materials.
- e) Safety precautions to be followed during erection.
- f) Erection instructions.
- g) Critical checks and permissible deviation/tolerances.
- h) Check-list for pre-commissioning activities
- i) Checklist for commissioning of the system.
- j) Procedure for initial checking, testing and acceptance norms.

### **5.03.00 Operation & Maintenance Manuals**

5.03.01 The operating and maintenance instructions together with drawings of the equipment, as completed, shall be in sufficient detail to enable the Owner to operate, maintain, dismantle, reassemble, and adjust all parts of the equipment. They shall outline a systematic procedure for all operations likely to be carried out during the life of the plant/ equipment. Each manual shall include a complete set of drawings together with performance/ rating curves of the equipment and test certificates wherever applicable.



5.03.02 If after commissioning and initial operation of the plant, the manuals require any modification/ additions in the view of the Owner or Bidder, the same shall be incorporated and the updated final manuals shall be submitted to the Owner.

5.03.03 The manuals shall include the following:

- a) List of spare parts along with their drawing, catalogue, and Performa for ordering spares.
- b) Location and identification guide for bearings of various equipment and lubrication schedule including charts showing lubrication checking, testing and replacement procedure.
- c) Wherever applicable, fault location charts shall be included to facilitate fault detection.
- d) Detailed specification for all consumables (including lubricating oils, greases, chemicals etc.) required for each equipment.

#### **6.00.00 PLANT HANDBOOK**

The Bidder shall provide the plant handbook to the Owner as per provision of the contract.

The Plant Handbook shall contain the following as a minimum:

- a) Design and performance data
- b) Process & instrumentation diagrams
- c) Single line diagrams
- d) Sequence & Protection interlock schemes
- e) Alarm and trip values
- f) Performance curves
- g) General layout plan and layout of Balance of Plant building and auxiliary buildings
- h) Important Do's and Don'ts.

#### **7.00.00 TENDER STAGE DOCUMENT SUBMISSION**

7.01.00 The Bidder shall submit along with his bid all documents/drawings as specified in RFP and respective sections of the Technical Specifications in Vol-II and Vol-III. The documents shall include but not be limited to the following:

- a) All Bid proposal sheets duly filled up.
- b) Detailed experience list and financial resources of the Prime Bidder his collaborators/associates in this bid as well as the sub-vendors proposed.
- c) Scheme drawings indicating scope of supply and service as offered by the Bidder indicating clearly exclusions, if any.
- d) List of terminal points of the package offered together with quality and quantity of various input (i.e. water, air, electricity etc.) as required from the Owner at such interfaces.

- e) Equipment GA, Layout, Design Calculations, interlock and other write-up, catalogues/literature etc. as required for clear understanding of the bid submitted.
- f) High level project schedule network indicating target dates for intermediate milestones and final commissioning of plant systems; This network shall be supplemented by a detailed write-up on proposed sequence and method of execution for project implementation, deployment schedule for Key personnel with their bio-data, schedule of construction machinery etc.

## **8.00.00 CONTRACT STAGE DOCUMENT SUBMISSION AND APPROVAL PROCEDURE**

- 8.01.00 Owner's Engineering schedule shall be submitted by the Bidder as indicated in the RFP. Owner's Engineering schedule shall be developed in format as desired by the Owner/consultant.

The documents shall be divided into two categories: a) for approval and b) for information/further Owner's Engineering and co-ordination by the Consultant.

In preparing this schedule, the Bidder shall allow one (1) week from date of receipt for review and comments by the Consultant for each submission of a document.

This document submission schedule shall require acceptance by the Owner/Consultant.

Bidder shall also develop and submit a Master drawing list to the Owner/consultant.

- 8.02.00 All contract documents shall be marked with the name of the Owner, the Project, the specification title and number and the unit designation.

All dimensions shall be in metric units.

All notes, markings etc. shall be in English.

- 8.03.00 Documents/Drawings, submitted during tender stage, shall be revalidated or revised as required and submitted as certified contract document for approval/information of the Owner/Consultant.

- 8.04.00 Unless specified otherwise, the following categories of documents/drawings would require approval of the Owner/Consultant:

- a) System scheme and Process & instrumentation Diagrams (P & IDs).

- b) Design basis documents / memoranda / calculations justifying sizing and selection of equipment, vessels, tanks, piping, valves & specialties as well as the process parameters.
- c) Equipment data sheets and general arrangement drawings.
- d) Materials of construction.
- e) General Arrangement and Layout drawings.
- f) Typical control schemes, circuit diagrams, drive/ feeder-wise control scheme showing all external interfaces.
- g) Control System Configuration
- h) Shop Inspection and Testing Procedures, Test Set-up & Instrumentation, Acceptance Criteria and Codes / Standards followed, correction curves / charts, etc.
- i) Performance Test Procedures, Instrumentation, Acceptance Criteria and Codes / Standards followed, correction curves / charts, etc.
- j) Schedules covering equipment delivery schedules, erection, testing and commissioning schedules at L1 and L2 levels.

8.05.00 Unless specified otherwise, the following categories of documents / drawings would be treated for information/further Owner's Engineering by the Owner/Consultant. The Bidder shall, however, incorporate all additional information and clarifications in these documents/ drawings as and when desired by the Owner/ Consultant.

- a) Equipment foundation drawings.
- a) Equipment cross-section drawings, product literature etc. which are of proprietary nature.
- b) Predicted performance curves of equipment.
- c) Various bills of quantity, schedules etc.
- d) Piping fabrication drawings, isometrics etc.
- e) Panel wiring diagrams.
- f) Instruction/Operation manuals.

- g) Service manuals and trouble shooting guide for C & I system including field instruments.
- h) Operation logic diagrams.
- i) Cable schedule and interconnection chart.

In essence, the Bidder is solely responsible for corrections and adequacy of design & Owner's Engineering for documents under this category.

8.06.00 Upon review, the Consultant shall put his remarks and one of the following action stamps on the drawing / document:

- a) Approved.
- b) Approved except as noted, forward final drawing
- c) Approved except as noted, resubmission required.
- d) Disapproved.
- e) For information/reference only.

For action stamps in category (c) & (d), documents must be resubmitted for review by the Owner/Consultant. For action stamp in category (b), further review by Owner/Consultant would not be necessary provided the Bidder agrees & incorporates the minor comments made on the document.

Except for action stamp under category (c) & (d), the Bidder can proceed with manufacturing and other sequential activities for those areas of a drawing/document which do not have any review comment by the Owner/Consultant.

The Consultant may accord approval in category (c) or (d) in more than one submission of a document till he is satisfied that the intent of the specification has been fully complied with. The Bidder shall be responsible for delay in such cases and no extension of time shall ordinarily be allowed on such grounds.

The Bidder's work shall be in strict accordance with the finally approved drawings and no deviation shall be permitted without written approval of the Consultant.

8.07.00 Except key plan/general yard plan, any layout drawing requiring scrutiny shall not be drawn to a scale less than 1:50.

8.08.00 For review by the Consultant, the Bidder shall furnish three (3) prints of each drawing (only for first submission). There upon all transaction of drawings including reviewed comments and stamping shall be done

in soft. All transaction of drawings shall be accompanied by a reference letter mentioning the date, revision no. and document status. Only on receiving the Approval Stamping, bidder shall distribute 6 sets of drawings (2 at WBPDCCL corporate office and 4 sets at WBPDCCL site office).. The Bidder shall furnish three (3) CDs of all as built/final drawings for Owner/Consultant site.

- 8.09.00 In case of contradiction between the stipulations above and those stated elsewhere in the specification, the stipulations herein shall prevail.



**WBPDC**

**EPC Bid Document  
Sagardighi Thermal Power Project  
1x660 MW Unit No. 5, Phase – III**

**Annexure - 13**

## **SECTION-VI**

### **PROJECT MANAGEMENT AND SITE SERVICES**



**Development Consultants Pvt. Ltd.**

**Volume : II-A  
Section : VI  
Project Management and Site Services**



**WBPDC**

**EPC Bid Document  
Sagardighi Thermal Power Project  
1x660 MW Unit No. 5, Phase – III**

## **CONTENT**

<b>CLAUSE NO.</b>	<b>DESCRIPTION</b>
1.00.00	PROJECT MANAGEMENT SERVICES
2.00.00	SITE SERVICES
3.00.00	PROTECTION & CARE
ANNEXURE-I	LIST OF SUB-VENDORS



**Development Consultants Pvt. Ltd.**

**Volume : II-A  
Section : VI  
Project Management and Site Services**





## PROJECT MANAGEMENT AND SITE SERVICES

### 1.00.00 PROJECT MANAGEMENT SERVICES

#### 1.01.00 Responsibility

The Bidder shall identify a separate and independent project management team headed by a Project Manager for the execution of this project. Responsibilities of this project Management team shall cover the areas listed below :

- a) Planning and Monitoring
- b) Owner's Engineering Management
- c) Contracts Management
- d) Quality Assurance, Inspection & Expediting
- e) Construction Management
- f) Spares Management
- g) Commissioning Management

Detailed responsibilities in the above areas are discussed below :

#### 1.02.00 Organisation

##### 1.02.01 Headquarters

The project management team shall be stationed at the organizational headquarter and headed by a senior level executive designated as the Project Manager who shall be responsible to Owner for the execution of the project. . He should have adequate financial power and authority to give decision.

Separately, designated leaders shall be identified for each of the areas mentioned under 1.01.00, who, in turn, will report to the Project Manager for all matters related to this contract.

##### 1.02.02 Central Co-ordination Cell

The central coordination/ cell shall be based in Kolkata and shall have sufficient technical personnel to coordinate technical matters and to quickly resolve day to day queries or references made by Owner and his Consultants without having the need to refer to his headquarters each time.





1.02.03 **Site Organisation**

The site should have a competent construction manager for all site operations with adequate financial power and sufficient level of authority to take site decisions. The organisation chart for site should indicate the various levels of experts to be posted for supervision in the various fields in civil construction, erection, commissioning etc.

1.02.04 **Organisation Chart**

The Bidder shall furnish a detailed organisation chart for the project management team, clearly identifying the key personnel in each of the areas mentioned at 1.01.00 above. The expected number of executives at different levels shall also be indicated, separately for headquarters, central coordination cell and site organisation.

1.03.00 **Implementation Schedule**

The following milestones shall be followed by the Contractor against each activity as detailed below:

1.	Letter of Award (LOA)	Zero Date
2.	Supply Completion	
3.	Synchronization	
4.	Completion of Trial Operation	
5.	System & Completion of all facilities as per contract and handing over	
6.	P. G. Test	To be completed within three (3) months after Completion of all facilities and handling over.
7.	Guarantee/Warranty Period	For a period of 18 months from the date of completion of the facilities or twelve (12) months from the date of operation acceptance (or any part thereof), whichever occurs first and any suitable extension of time for completion of rectified job granted by Employer
8.	Final Acceptance	After the expiry of defect liability period



1.03.01 **Owner’s Engineering Schedules**

These schedules shall cover various design submissions indicating different Owner’s Engineering activities to be performed. Such schedules shall be furnished by the Bidder for each and every plant/systems/ equipment/ item covered in the scope of this specification.

1.03.02 **Manufacturing Schedule**

The Contractor shall submit to the Owner’s Engineer his manufacturing and delivery schedules for all equipment within thirty (30) days from the date of issue of the Letter of Award (LOA). Such schedules shall be in line with the detailed network for all phases of the work of the Contractor. Such schedules shall be reviewed, updated and submitted to the Owner’s Engineer, once in every two months thereafter, by the Contractor. Schedules shall also include the materials and equipment purchased from outside suppliers.

1.03.03 **Erection Schedules**

In order to achieve the overall completion schedule, the Contractor shall provide the Owner all the information covering erection sequence, testing and commissioning activities. These schedules may be based on the recommended erection procedures and will be subject to discussions/agreements with the Owner subsequent to the award of contract.

1.03.04 The successful Bidder shall have to provide all the above schedules (i.e. 1.03.01, 1.03.02 & 1.03.03) in a tabular form in addition to that in the form of L2 & L3 networks and these shall necessarily include information not limited to the earliest and latest dates for various activities/submissions and also any related constraints. However, the Bidder shall include in his proposal a Level-1 (L-1) network showing the major activities and various milestones to achieve the above mentioned completion schedule.

1.03.05 The Contractor shall provide the Owner the original disc/software for all such schedules along with requisite no. of copies (as required by the Owner) within an agreed time schedule. This time schedule will be agreed between Owner/Bidder at the time of award of Contract. The Contractor's project management software shall be compatible with that of the Owner and the input data shall be furnished to the Owner in a manner compatible with Owner's project management software, Primavera.

1.04.00 **Detailed Responsibilities**

1.04.01 **Planning & Monitoring**

a) **Planning**

The Bidder shall prepare a Master Network Schedule in the form of PERT network consisting of at least 500 activities.





The network shall be prepared on a Work Breakdown Structure for the project which sub-divides the project into a set of manageable systems/sub-systems. The master network will identify milestones of key events for each system/package in the areas of Owner's Engineering, procurement, manufacture and despatch and erection and commissioning. The master network shall represent the Level-I plan and will form the basis for development of detailed second and third tier execution plans. The master network shall conform to the overall schedule prescribed by Owner.

The master network should be submitted along with the bid, which would be mutually discussed and finalised before the Award of Contract. This master network would clearly indicate the responsibility of the Bidder and project management team. This master network would form a part of the contract. The master network shall also identify a complete list of inputs to be furnished by the Owner which may be required for proper interfacing and tie-up. Scheduled dates for providing such inputs shall also be indicated, which will be mutually discussed and finalised.

b) **Monitoring & Progress Reporting**

The progress reports would be emanated every month, one from the head office of the Contractor and another from the site office. The progress report emanating from the head office should necessarily include the following sections:

- i) Report on key milestones.
- ii) Management summary indicating critical areas with details of actions initiated and effect of any on the project.
- iii) Action needing attention of the Owner/Consultant.
- iv) Detailed package wise status of Owner's Engineering submissions, quality plan submissions and approval, procurement manufacture and despatch.

The monthly report generated from the site office should necessarily include:

- i) Report on key milestones.
- ii) Management summary indicating critical areas with details of actions initiated and effect if any on the project.
- iii) Action needing attention of the Owner/Consultant.



- iv) This report would also cover the areas pertaining to the receipt of the equipment at the port, port clearance, transport, receipt at site, erection and commissioning.

In addition to the above, as the project execution progresses, the Contractor shall also be responsible for generating more frequent reports in the form of fax/e-mail information on progress in critical areas so that actions can be expedited. The exact format of the progress report shall be finalised after award of Contract.

#### 1.04.02 **Owner's Engineering Management**

Based on the master network for the project (L-1) the Contractor will prepare an exhaustive list of Owner's Engineering activities for the equipment/systems covered in his scope and a detailed programme of accomplishing the same within the time frame specified in the master network. This schedule will form the Level-2 (L-2) network for Owner's Engineering activities.

Based on (L-2) network, the Bidder shall further develop the Level-3 (L-3) network for Owner's Engineering activities which will indicate schedule for data availability, drawing release date and document submission dates.

Detailed (L-2) and (L-3) networks would be submitted sequentially by the Contractor within two months from the date of issue of Letter of Award and finalised within one (1) month thereafter.

All such networks shall be provided in MS PROJECT software.

The Owner's Engineering management team should also co-ordinate all interface Owner's Engineering activity between the Contractor and the equipment sub-vendors so as to ensure the correctness and completeness of related Owner's Engineering documentation before the same is submitted to the Owner.

#### 1.04.03 **Contracts Management**

Based on the master network, the Contractor shall submit L-2 programmes of manufacture and despatch. In addition, the master network shall also include periods considered for site activities viz. erection, commissioning etc. These L-2 programmes would be submitted in 2 months time from the date of award of contract and finalised within one (1) month thereafter. The Contractor will also submit site mobilisation plan. This programme would be submitted at the time of finalisation of award of contract and agreed immediately thereafter so that immediate development of the various activities at site could take place.

The Contractor should also submit L-3 programmes for the manufacturing, despatch of the various items. These networks shall also show the customer hold points (CHP) which have to be cleared by Owner or their authorised representative(s) before further manufacturing can take place. These L-3 programmes for the manufacture and despatch would clearly identify responsibilities of the Contractor, sub-Contractor and Owner. These networks



shall be submitted within one (1) month of the date of finalisation of the various sub-contracts by the Contractor.

In case all the manufacture is being done by the Contractor then the L-2 programmes would be themselves amplified to cover details of the manufacture, inspection, clearance by Owner and despatch.

The Contractor shall also submit the programme for procurement of bought out items, detailed shipping schedule and cash flow statement for Owner's approval.

**1.04.04****Quality Assurance, Inspection and Expediting**

The Contractor shall submit the list of manufacturers/sub-vendors from whom the equipment are expected to be procured and the quality assurance plans thereof for the manufacture shall be approved by the QA group of Owner before the manufacturing is commenced. The list of major suppliers would be submitted along with the bid and this shall be mutually discussed and approval will be given by the Owner during contract negotiation meeting prior to placement of Letter of Award. This approved list will be binding to the bidder. In the said list, Owner reserves the right to include reputed/reliable vendors of his own choice. Regarding the various other sub-vendors, the list would be submitted within six (6) months of the award of the contract that shall be scrutinized by the Owner to accord approval. In such list Owner reserves the right to include vendors of his own choice. No further vendor approval will be given after six (6) months. On the quality plans, the customer hold points will also be identified based on which Owner would give clearance for the manufacture to proceed further.

Quality assurance/Inspection group of Owner or its representative would issue a material despatch clearance certificate (MDCC) after the inspection clearance which will enable the Contractor to despatch the equipment and claim the payment. In the despatch programme, the Contractor shall indicate a schedule of estimated programme, tonnages specifically identifying various oversize dimensioned consignments (ODC). Further the Contractor will also be required to ensure at all stages of shipment that packing of all shipments despatched are suitable for ocean freight to India, handling at the port of entry, inland transportation and preservation at site up to erection. All despatch details & item lists shall be made available to both Owner & site immediately after shipping.

The Contractor shall also expedite all despatches from their own works/works of their sub-vendors, so as to match with the various activities mentioned at 1.04.03 above.

**1.04.05****Construction Management**

Based on the L-1 Master Network Programme, within two (2) months of the issue of Letter of Award, the Contractor shall submit a programme of construction/erection/commissioning, either in continuation with the manufacture and despatch or separately for the implementation. These



programmes would be amplified showing when the civil drawings shall be released by him and construction of civil works shall be completed by him to facilitate start of erection and subsequent activities and shall form the basis for site execution and detailed monitoring. The three monthly rolling programme with the first month's programme being tentative based on the site conditions would be prepared based on these L-3 programmes. The Contractor shall also be involved along with the Owner to tie up detailed resource mobilisation plan over the period of time of the contract matching with the performance targets.

The L-3 programme would be jointly finalised by the site in-charge of the Contractor with the Owner's project coordinator as well as the site planning representative. The erection programme will also identify the sequential erectable tonnages that are required for various equipment which should be taken care of in the despatch programmes.

Erection and commissioning of the equipment shall also be done under the supervision of experts from the respective equipment/ system supplier.

#### 1.04.06 **Spares Management**

Along with the proposal for the plant and equipment, the Contractor shall also submit proposals/schedule for the following:

- a) Mandatory spares
- b) Recommended spares

While the award for mandatory spares will be finalised at the time of the award of contract, recommended spares will be finalised within twelve (12) months thereafter.

#### 1.05.00 **Project Progress Review Meetings**

Keeping in mind the overall responsibility of the Contractor it is intended that periodic progress reviews on the entire activities of execution in respect of Sagardighi Thermal Power Plant unit #5 will be held initially at least once in two (2) months at Kolkata/site. During peak period it may be held once in a month. These meetings will be attended by reasonably higher officials of the Contractor and their leading sub- contractors and will be used as a forum for discussing all areas where progress needs to be speeded up. Actions will be placed on the concerned agencies and decisions will be taken to expedite/speed up the progress. Minutes of such meetings will be issued reflecting the major discussions and decisions taken and circulated to all concerned for reference and action. The Contractor shall be further responsible for ensuring that suitable steps are taken to meet various targets decided upon such meetings.

In addition to the above, and to streamline the construction and erection at site, a suitable frequency and forum of periodic meetings between the Contractor and the Owner will be decided upon as part of erection coordination procedure. Site co-ordination meeting may be held on weekly basis.





1.06.00 **Owner's Consultant**

The Owner would appoint a consultant to assist him in some of the areas mentioned at 1.01.00 above. The details of interaction and procedures for coordination between Owner/Owner's Consultant and Contractor/Contractor's project management team shall be finalised during contract negotiations.

1.07.00 **Commissioning Management**

1.07.01 For commissioning of the various equipment/system covered under the scope of contract, Owner will form an organisation structure which may consist of the following committees. The Contractor shall nominate his representative on one or more of the committee as decided by the Owner:

- a) Commissioning Teams.
- b) Testing Teams.

1.07.02 Commissioning documents shall be prepared by the Contractor in the following manner and submitted for Owner's approval :

- a) Paper of Principle

This document shall be prepared for the various equipment/ systems under commissioning and shall have the following objectives to fulfill and shall be submitted for Owner's approval at least six (6) months before their actual commissioning :

- i) Establish design data against which Plant Performance will be compared.
- ii) Set-out the testing objectives and proposals.
- iii) Define the documentation required.

- b) **Testing/Commissioning Schedule**

These shall be prepared for the various equipment/systems under consideration and shall contain sections like detailed testing method, programme, safety, individual responsibility and results.

- c) **Standard Check Lists**

Standard checklists are intended for use at the completion of erection to ensure correct erection, testing and to a limited extent operation for repetitive items.

**1.07.03 Test Reports**

After the completion of commissioning activity of equipment/ systems, the Contractor shall prepare the test reports which shall include all the relevant information related to various commissioning checks, tests carried out, any deviations/commissions noticed with respect to the intended design requirements, sequence of various commissioning activities as actually adopted vis-à-vis as recommended in the procedures, programme schedules achieved and any other such information as required. These test reports shall be submitted in requisite number of copies to the Owner and this should be duly signed jointly by the Owner/Consultant and the Contractor/Equipment supplier, who are involved during the commissioning activities.

**2.00.00 SITE SERVICES**

These services shall be rendered by the Bidder as part of the overall project management service. The services shall broadly include but not be limited to the following :

- 2.01.00 Arranging material despatch from the shop by rail/road and/or sea as applicable.
- 2.02.00 Monitoring movement of materials & follow-up as necessary with Railways, road transport, port clearance etc. from the time of despatch F.O.R. works/F.O.B. port of shipment by Contractor till receipt of the same at site.
- 2.03.00 Unloading of materials at Railway Station/Railway Siding inside project area, transportation to site store, assessment of lost/damaged items in transit and arranging insurance claims and replacement of lost/damaged items. The Contractor shall submit to the Owner's Engineer a report detailing all the receipts during the week.
- 2.04.00 Issuing materials from site store/open yard from time to time for erection as per the construction programme. The Contractor shall be the custodian of all the materials issued till the plant is officially taken over by the Owner after complete erection and successful trial run & commissioning.
- 2.05.00 Transportation of materials to their respective places of erection and erection of the complete plant & equipment as supplied under this specification.
- 2.06.00 Trial run and commissioning of individual equipment/sub-systems and the plant as a whole to the satisfaction of the Owner, including supply of temporary equipment & services for chemical cleaning, steam blowing as well as performance guarantee tests.

For Coal Handling Plant, satisfactory operation of the system, amongst others, shall consist of operation without spillage or choking anywhere even during monsoon.



Provision for preservation of individual equipment after trial run and commissioning e.g. Nitrogen blanketing etc. as necessary shall also be in the scope of the Bidder.

- 2.07.00 Supply and application of the final paints lubricating oils and all consumable till completion of facilities and hand over..
- 2.08.00 For the purpose of erection and commissioning the Contractor's scope of work shall include but not be limited to the following :
- 2.08.01 Deployment of all skilled and unskilled manpower required for erection, supervision of erection, watch & ward, commissioning and other services to be rendered under this specification.
- 2.08.02 Deployment of all erection tools & tackle, construction machinery, transportation vehicles and all other implements in adequate number and size, appropriate for the erection work to be handled under the scope of this specification.
- Supply of commissioning spares.
- 2.08.03 Supply of all chemicals and consumables, e.g. Regeneration chemicals, alum, lime, polyelectrolyte, resin, welding electrodes, cleaning agents, diesel oil, grease, lubricant etc. as well as materials required for temporary supports, scaffolding etc. as necessary for such erection commissioning work till completion of facilities and hand over, except those listed under exclusion elsewhere in this specification.
- 2.08.04 Construction of all civil/structural/architectural works, including construction of foundation for all equipment supplied as required, grouting of equipment on foundation after alignment, and all other incidental civil activities as detailed elsewhere.
- 2.08.05 All structural steel fabrication and erection work as detailed elsewhere in the specification.
- 2.08.06 Providing support services for the Contractor's erection staff e.g. construction of site offices, temporary stores, residential accommodation and transport to work site for erection personnel, insurance cover, watch & ward for security and safety of the materials under the Contractor's custody etc. as required.
- 2.08.07 Maintaining proper documentation of all the site activities undertaken by the Contractor as per the proforma mutually agreed with the Owner; submitting monthly progress reports as also any such document as and when desired by the Owner; taking approval of all statutory authorities e.g. Boiler Inspector, Factory Inspector, Inspector of Explosives etc. for respective portions of work under the jurisdiction of such statutes or laws.
- 2.08.08 The Contractor shall provide 'Industrial Relations' unit and 'Medical' unit to take care of his erection staff and the Owner shall have no obligation in this regard.

**2.09.00 Site Organisation**

The Contractor shall maintain a site organisation of adequate strength in respect of manpower, construction machinery and other implements at all times for smooth execution of the contract. This organisation shall be reinforced from time to time, as required, to make up for slippages from the schedule without any commercial implication to the Owner. The site organisation shall be headed by a competent construction manager having sufficient authority to take decisions at site.

On award of contract, the Contractor shall submit to the Owner a site organisation chart indicating the various levels of experts to be deployed on the job. The Owner reserves the right to reject or approve the list of personnel proposed by the Contractor. The persons, whose bio-data have been approved by the Owner, will have to be posted at site and deviations in this regard will not generally be permitted.

The Contractor shall also submit to the Owner for approval a list of construction equipment, erection tools, tackle etc. prior to commencement of site activities. These tools & tackle shall not be removed from site without written permission of the Owner.

**2.10.00 General Guidelines for Field Activities**

2.10.01 The Contractor shall execute the works in a professional manner so as to achieve the target schedule without any sacrifice on quality and maintaining highest standards of safety and cleanliness.

2.10.02 The Contractor shall co-operate with the Owner and other Contractors working in site and arrange to perform his work in a manner so as to minimise interference with other Contractors' works. The Owner's Owner's Engineer shall be notified promptly of any defect in other Contractor's works that could affect the Contractor's work. If rescheduling of Contractor's work is requested by the Owner's Owner's Engineer in the interest of overall site activities, the same shall be complied with by the Contractor. In all cases of controversy, the decision of the Owner shall be final and binding on the Contractor without any commercial implication to owner.

2.10.03 The Owner's Engineer shall hold weekly meetings of all the Contractors working at Site at a time and a place to be designated by the Owner's Engineer. The Contractor shall attend such meetings and take notes of discussions during the meeting and the decisions of the Owner's Engineer and shall strictly adhere to those decisions in performing his Work. In addition to the above weekly meeting, Owner's Engineer may call for other meetings either with individual contractors or with selected number of contractors and in such a case the Contractor, if called will also attend such meetings.

2.10.04 Time is the essence of the Contract and the Contractor shall be responsible for performance of his Work in accordance with the specified construction schedule. If at any time the Contractor is falling behind the schedule, he shall



take necessary action to make good of such delays by increasing his work force or by working overtime or otherwise accelerate the progress of the work to comply with the schedule and shall communicate such action in writing to the Owner's Engineer, satisfying that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

- 2.10.05 The Owner's Engineer shall however not be responsible for provision of additional labour and or materials or supply or any other services to the Contractor except for the co-ordination work between various Contractors as set out earlier.
- 2.10.06 The works under execution shall be open to inspection & supervision by the Owner's Owner's Engineer at all times. The Contractor shall give reasonable notice to the Owner before covering up or otherwise placing beyond the reach of inspection any work in order that same may be verified, if so desired by the Owner.
- 2.10.07 Every effort shall be made to maintain the highest quality of workmanship by stringent supervision and inspection at every stage of execution. Manufacturer's instruction manual and guidelines on sequence of erection and precautions shall be strictly followed. Should any error or ambiguity be discovered in such documents, the same shall be brought to the notice of the Owner's Owner's Engineer. Manufacturer's interpretation in such cases shall be binding on the Contractor.
- 2.10.08 The Contractor shall comply with all the rules and regulations of the local authorities, all statutory laws including Minimum Wages, Workmen Compensation etc. The contractor shall engage maximum number of local unskilled and semi skilled labours for construction works. All registration and statutory inspection fees, if any, in respect of the work executed by the Contractor shall be to his account.
- 2.10.09 All the works such as cleaning, checking, leveling, blue matching, aligning, assembling, temporary erection for alignment, opening, dismantling of certain equipments for checking and cleaning, surface preparation, edge preparation, fabrication of tubes and pipes as per general Owner's Engineering practice at site, cutting grinding, straightening, chamfering, filling, chipping, drilling, reaming, scrapping, shaping, fitting-up bolting/welding, etc., as may be applicable in such erection and are necessary to complete the work satisfactorily, are to be treated as incidental and the same shall be carried out by the Contractor as part of the work.
- 2.10.10 In case of any class of work for which there is no such specification as laid down in the contract such as, blue matching, welding of stainless steel parts, etc., the work shall be carried out in accordance with the instructions and requirements of the Owner's Engineer.
- 2.10.11 It may sometimes be necessary to remove some of the erected structural members to facilitate erection of bigger/pre-assembled equipment. In such cases, the removal and re-erection of such members, which are essential, and if so agreed by the Owner's Engineer, will have to be done by the Contractor.



- 2.10.12 Attachment welding of necessary instrumentation tapping points, thermocouple pads, root valves, condensing vessels, flow nozzles and control valves etc., both for regular measurement and performance testing to be provided on equipment, its auxiliaries or pipelines covered within the scope of this tender, will also be the responsibility of the Contractor and the same will be done as per the instructions of Owner's Engineer. The erection and welding of all above items will be the Contractor's responsibility, even if :
- a) Product groups under which these items are re-leased are not covered in the scope of this tender.
  - b) Items are supplied by an agency other than the Contractor.
- 2.10.13 Preservation of all materials/equipment under custody of the Contractor during storage, pre-assembly & erection, commissioning etc., shall be the responsibility of the Contractor. All necessary preservatives and consumables like paints, etc., shall be arranged by the Contractor. Necessary touch up painting, periodic application of preservatives/paints on pressure parts/other equipment even after erection until completion of work shall be carried out by the Contractor. The Contractor shall fabricate piping, install lub oil systems and carry out the acid cleaning of fabricated piping. The Contractor shall also service the lub oil system, carryout the hydraulic test of oil coolers, etc.
- 2.10.14 It is responsibility of the Contractor to do the alignment etc. if necessary, repeatedly to satisfy Owner's Engineer, with all the necessary tools & tackles, manpower, etc. The alignment will be complete only when jointly certified so, by the Contractor's Owner's Engineer & Owner. Also the Contractor should ensure that the alignment is not disturbed afterwards.
- 2.10.15 Additional platforms for approaching different equipment as per site requirement, which may not be indicated in drawings, shall be fabricated and erected by the Contractor. The materials required for these works shall be supplied by the Contractor and he will have to fabricate them to suit the requirement.
- 2.10.16 Equipment and material, which are wrongly installed, shall be removed and reinstalled to comply with the design requirement at the Contractor's expense, to the satisfaction of the Owner/ Consultant.
- 2.10.17 Before erection of any equipment on a foundation, the Contractor shall check and undertake if necessary rectification of foundation bolts, reaming of holes, drilling of dowels, matching of bolts and nuts, making new dowel pin, etc.
- 2.10.18 Assistance for calibrating/testing the power cylinders, valves, gauges, instruments, etc., and setting of actuators coming under various groups shall be provided by Contractor.
- 2.10.19 It shall be the responsibility of the Contractor to provide ladders on columns for initial works till such time stairways are completed. For this, the ladder should not be welded on the column and should be prefabricated clamping type. No





temporary welding on any structural member is permitted except under special circumstances with the approval of Owner.

- 2.10.20 Structural materials required for the supporting/operating platforms required for the valves at various levels for the safe operation of valves will be arranged by the Contractor.
- 2.10.21 For civil, structural and architectural works, volume IIG/1 & IIG/2 may be referred. For Instrumentation and Electrical works Vol. IIE and Vol. IIF1 & F2 may be referred.
- 2.11.00 Safety
- 2.11.01 Safety and overall cleanliness of work site shall be given top priority. The Contractor shall ensure the safety of all workmen, materials and equipment either belonging to him or to others working at site. He shall observe safety rules & codes applied by the Owner at site without exception.
- 2.11.02 The Contractor shall notify the Owner of his intention to bring to site any equipment or material which may create hazard. The Owner shall have the right to prescribe the conditions under which such equipment or material may be handled and the Contractor shall adhere to such instructions. The Owner may prohibit the use of any construction machinery, which according to him is unsafe. No claim for compensation due to such prohibition will be entertained by the Owner.
- 2.11.03 Storage of petroleum products & explosives for construction work shall be as per rules and regulation laid down in Petroleum Act, Explosive Act and Petroleum and Carbide of Calcium Manual. Approvals as necessary from Chief Inspector of Explosives or other statutory authorities shall be the responsibility of the Contractor.
- 2.11.04 The Contractor shall be responsible for safe storage of his and his sub-contractor's radioactive sources.
- 2.11.05 All requisite tests & inspection of handling equipment, lifting tools & tackle shall be periodically done by the Contractor. Defective equipment shall be removed from service. Any equipment shall not be loaded in excess of its recommended safe working load.
- 2.11.06 All combustible waste and rubbish shall be collected and removed from the worksite at least once each day. Use of undercoated canvas paper, corrugated paper, fabricated carton, plastic or other flammable materials shall be restricted to the minimum and promptly removed.
- 2.11.07 The Contractor shall provide adequate number of fire protection equipment of the required types for his stores, office, temporary structures, labour colony etc. Personnel trained for fire-fighting shall be made available by the Contractor at site during the entire period of the Contract.





- 2.11.08 All electrical appliances used in the work shall be in good working condition and shall be properly earthed. No maintenance work shall be carried out on live equipment. The Contractor shall maintain adequate number of qualified electricians to maintain his temporary electrical installation.
- 2.11.09 All workmen of the Contractor working in construction site shall wear safety helmets, safety boots and safety belts. The Contractor shall take appropriate insurance cover against accidents for his workmen as well as third party.
- 2.11.10 All the worksites shall be provided with adequate lighting facilities e.g. flood lighting, hand lamps, area lighting etc. by the Contractor for proper working environment during night times.
- 2.11.11 Adequate number of temporary toilets/urinals (men & women separate) shall be provided at work places with soak pits. Adequate drinking water facilities and rest rooms shall be provided for workers to take food and rest.
- 2.11.12 All safety precautions shall be taken for welding and cutting operations as per IS-818.
- 2.11.13 All safety precautions shall be taken for foundation and other excavation marks as per IS-3764.
- 2.12.00 Taking Delivery & Storage
  - 2.12.01 The Contractor shall arrange issue of all equipment and materials to be erected under the contract from the stores/open yard at site by signing on standard indent forms. After completion of work, detailed auditing of the materials so issued shall be submitted to the Owner.
  - 2.12.02 The Contractor shall arrange for proper and safe storage of materials till the same are taken over by the Owner as per terms of the contract. Manufacturer's instructions for preservation shall be strictly followed.
  - 2.12.03 All empty containers, packing materials, gunny bags, transport frames and also surplus and unused materials reconciliation prior to completion of contract shall be the property of the Owner and returned to the Owner by the Contractor.
- 2.13.00 Site Welding & Heat Treatment
  - 2.13.01 Welding shall be done in accordance with IS-813, IS-816, IS-9595 & other relevant IS/International standards and as per instructions of Contractor. Only those welders, who are qualified as per IS-817 for ordinary welds and as per IBR/ASME Section-IX for high pressure welds, shall be employed in the job.
  - 2.13.02 All welders shall be tested and approved by Owner's Engineer before they are actually engaged on the work even though they may possess the requisite certificates. The Owner reserves the right to reject any welder without assigning any reason. The welder identification code as approved by the Owner's Engineer shall be stamped by the welder on each joint done by them. The



Contractor will be responsible for the periodic renewal, re-testing of the welders as demanded by Owner.

- 2.13.03 The Owner's Engineer is entitled to stop Contractor's any welder from his work if his work is unsatisfactory for any technical reason or there is a high percentage of the rejection of joints welded by him, which in the opinion of Owner's Engineer will adversely affect the quality of welding even though the welder has earlier passed the tests. The welders having passed the tests do not relieve the Contractor from his contractual obligations, to check the performance of the welders.
- 2.13.04 All charges for testing of welders including destructive and non- destructive tests if conducted by Owner or by the inspection authority at site shall have to be borne by the Contractor. The necessary test materials and consumables will have to be arranged by the Contractor and all testing facility made available, as required.
- 2.13.05 All welded joints shall be subject to acceptance by Owner's Engineer. Inspection of welds shall be in accordance with IS-822 or equivalent code.
- 2.13.06 Preheating/post-heating and stress relieving after welding are part of fabrication and erection work and shall be performed by the Contractor in accordance with the instruction of Owner's Engineer. Contractor shall arrange to supply heating equipment with automatic recording devices. Also the Contractor shall have to arrange for the labour, heating elements, thermocouples, compensating cables, insulation materials like mineral wools, asbestos cloth, ceramic beads, asbestos rope, etc. required for the heat-treatment and stress relieving works. During pre- heat/stress relieving operations, the temperature shall be measured at one or more points as required by attaching thermocouples and recorded on a continuous printing type recorder. All the record graphs for the heat treatment works carried out shall be got signed by the Owner's Engineer prior to the commencement of each cycle and handed over to Owner's Engineer on completion. The graphs will be the property of Owner. The Contractor has to provide thermo-chalks temperature recorders, thermocouple attachments, units, graph sheets, etc. required for the job and maintain them in good condition.
- 2.13.07 All electrodes shall be baked and dried in the electric/electrode drying oven to the required temperature and for the period specified by the Owner's Engineer before they are used in erection work. The electrodes used shall be as per IS-814, IS-815, IS-1442, IS-7280 and other codes as applicable, and shall be of approved reputed manufacture. The electrodes shall meet the requirement of the pipe material. No electrode manufactured more than 12 months ago and the type covered under certificate issued after conducting tests more than 6 months ago shall be used. All electrodes shall be preserved at works and at site as per manufacturer's recommendations.
- 2.13.08 Oxy-acetylene flame or Exothermic chemical heating for stress relieving is not permitted. Heating shall be by means, of electric induction coil or electric resistance coil.



- 2.13.09 It may become necessary to adopt inter layer radiography/MPT/UT depending upon the site/technical requirement necessitating interruptions in continuation of the work and making necessary arrangement for carrying out the above work.
- 2.13.10 Gas tungsten arc welding process (TIG) shall be adopted for all root pass welds except for structural works until 4.75 mm thickness is deposited. Subsequent welding after root pass can be carried out by manual metal arc welding with coated electrodes. For pipes of thickness less than 6 mm the entire welding has to be carried out by TIG welding.
- Fillet weld shall be made by shielded metal arc process as per applicable codes.
- However, the Owner's Engineer will have the option of changing the method of welding as per site requirement. The method adopted for manual arc welding shall be weaving technique and the width of weaving shall not exceed 1.5 times of the dia. of the electrode.
- In case of deviation from welding process and electrodes, the Contractor shall take approval of the Owner prior to adoption of same.
- 2.13.11 The root pass for butt joints shall be such as to achieve full penetration with complete fusion of root edges.
- 2.13.12 Each pass shall be cleared and freed of slag before the next pass is deposited.
- 2.13.13 On completion of each run, craters, weld irregularities, slag etc. shall be removed by grinding or chipping.
- 2.13.14 Each layer of welding shall have an even and smooth appearance.
- 2.13.15 Welding sequence shall be adjusted in such a way that distortion due to welding shrinkage is minimised. Further any movement, shock or vibration during welding shall be avoided to prevent weld cracks.
- 2.13.16 Proper protection of welders and the work shall be taken during periods of rain. No welding shall be carried out when surfaced to be welded are wet from any cause.
- 2.13.17 Following will be stages of inspection during welding:
- a) Two pieces to be joined shall be individually checked for the weld edge preparation and profile dimensionally and to the template. Dye penetrant check shall be carried out on edge prepared surfaces at random. The percentage will depend upon on criticality as specified by Owner's Engineer.
  - b) Joint fit up will be a stage of inspection. Misalignment after fit up may vary from 0.3 mm to 1.6 mm depending on outside diameter and thickness.



- c) All joints shall be offered for visual inspection after root run. Subsequent welding should be made only after the approval of root run.

2.13.18 All welded joints shall be painted with anti-corrosive paint immediately on completion of radiography and stress-relieving.

2.14.00 For further details on procedures of work at site on civil, architectural, electrical and instrumentation & control services, refer Volume: II-E, II-F1 & F2 and II-G/1 G/2 & G/3 of this specification.

3.00.00 **PROTECTION AND CARE**

3.01.00 All construction and erection activities for this project are to be carried out in the plant premises.

3.02.00 Generator Stator Lifting may be considered by either of the two options as mentioned below:

- a) With the help of two (2) nos. turbine room cranes.
- b) With the help of separate lifting arrangement to be provided by the Bidder from outside the TG building A-row column before the construction of A-row building wall.

**REQUIREMENTS OF SPARES, TOOLS & TACKLE,  
LUBRICANTS/OIL/CONSUMABLES**

**1.00.00 TOOLS & TACKLE**

The Contractor shall supply with the equipment one complete set of special tools and tackle as required for the erection, assembly, dismantling & maintenance of the equipment. These special tools will also include special material handling equipment, jigs & fixtures for maintenance and calibration/readjustment, checking & measurement aids etc. A list of such tools & tackle shall be submitted by the Bidder along with the offer. Detailed description of each tools/tackle, its function along with the equipment/part for which it is meant for and the price of each tools/tackle shall also be indicated in the offer. These tools & tackle shall be separately packed and sent to site before the first unit commissioning. The Bidder shall also ensure that these tools are not used for erection purpose.

**2.00.00 SPARES**

**2.01.00 General**

The Bidder shall indicate and include in his scope of supply all the necessary start-up, commissioning and recommended spares in addition to mandatory spares as specified elsewhere in the specification. The Owner reserves the right to buy any or all mandatory and recommended spares. The Contractor shall also state for each item of spares both mandatory and recommended, the normal expected service life.

2.01.01 All spares supplied under this contract shall be strictly interchangeable with the parts for which they are intended to replace. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site, e.g. small items shall be packed in sealed transparent plastic bags with dessicator packs as necessary.

2.01.02 Each spare part shall be clearly marked or labelled on the outside of the packing with the description. When more than one spare part is packed in a single case, a general description of the contents shall be shown on the outside and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purposes of identification.

2.01.03 All cases, containers or other packages are liable to be opened for examination as may be considered necessary by the Engineer.

2.01.04 All mandatory spares shall be delivered to site within one to three months prior to the scheduled date of the trial operation of the plant. However, they shall not be despatched before the despatch of the associated main equipment.

- 2.01.05 The Bidder shall also guarantee supply of spare parts, which will be made, based on manufacturer's drawings on special order from the Purchaser for 30 years after commissioning of the plant.
- 2.01.06 Warranty period for all kinds of spares shall be six thousand (6000) hours of operation, except normal wear or eighteen (18) months from the date of receipt at site, whichever is earlier. In case of failure or non-conformance to specifications, the Contractor shall replace them free of cost.
- 2.02.00 **Recommended Spares**
- 2.02.01 The Contractor shall provide a list of recommended spares giving unit prices and total prices for 2 years of normal operation of the plant for spares of indigenous origin, and for 5 years of normal operation for spares of non-indigenous origin. This list shall take into consideration the mandatory spares specified elsewhere in the specification and should be a separate list.
- 2.02.02 The price of recommended spares will not be used for the evaluation of bids. The price of these spares shall remain valid for a period as specified elsewhere in the specification from the date of Award of the Contract. Where the recommended spares are the same as mandatory spares, the prices shall be the same. The prices of any recommended spares, which are not common with mandatory spares, shall be subject to review by the Owner, and shall be finalised after mutual discussion.
- 2.03.00 **Start-up Commissioning Spares**
- 2.03.01 Start-up commissioning spares are those spares which may be required during the start-up and commissioning of the equipment/system. All spares used until the plant is handed over to the Owner shall come under this category. Said spares, properly marked, shall be supplied together with the main equipment and shall be used by the Contractor, if needed, during erection & commissioning stage. All such spares which remain unused till issuance of Taking Over Certificate by the Owner, along with an equipment-wise quantitative consumption report shall be returned to the Owner during time of handover. The list of commissioning spares to be brought by the Contractor to ensure smooth commissioning of the plant shall be subject to the Engineer's approval.
- 2.03.02 The Contractor shall submit a complete BBU list inclusive of recommended, mandatory, initial start-up and commissioning spares. Costs of the above spares, which are consumed before the handing-over of the plant, shall be deemed to have been included in the lump sum proposal price of the package, and the Contractor shall have no claim on this account to the Owner.



**THE WEST BENGAL POWER DEVELOPMENT  
CORPORATION LIMITED**

**SAGARDIGHI THERMAL POWER PROJECT  
1 x 660 MW Unit No. 5, PHASE – III**

**EPC BID DOCUMENT**

**DOCUMENT NO. 12A05-SPC-G-001**

**VOLUME: II-G/1**

**GENERAL SPECIFICATIONS AND DESIGN CRITERIA  
FOR  
CIVIL AND STRUCTURAL WORKS**



**DEVELOPMENT CONSULTANTS PRIVATE LIMITED  
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**SEPTEMBER, 2017**





**WBPDCL**

**EPC Bid Document  
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**Development Consultants Pvt. Ltd.**

**Volume : II-G/1  
General Specification And Design Criteria  
For Civil And Structural Work**



**WBPDCL**

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# **SECTION-I GENERAL**



**Development Consultants Pvt. Ltd.**

**Volume : II-G/1  
Section : I  
General**



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**SECTION - I****GENERAL****1.00.00 INTRODUCTION**

Volume: II-G/1 of this specification cover site survey, soil investigation, site development works, design and construction of Civil & Structural works. The scope of works covers complete Civil & Structural Works including supply of all materials, labour, tools and plants as required for successful execution of the turnkey package.

This section-I of Volume: II-G/1 lists Codes and Standards to be adopted and the principal structures of the plant, and briefly describes the basic concept, requirements and features pertinent to each. Documents to be submitted have also been brought out in this section along with the procedure to be followed for the same.

In case of any contradiction between any part of the Bid Document with the other, requirement of most stringent one shall be applicable.

**2.00.00 CODES AND STANDARDS**

Following is a general listing of Codes and Standards to be used in the design of the Plant. Specific applicable codes and standards will be identified in System Design Descriptions as appropriate.

The latest editions/revisions of following codes and standards along with addendums/amendments, if any, shall be followed:

**2.01.00 General**

- a) Internationally accepted design Codes and Standards which are equivalent or more stringent than corresponding Indian Standards.
- b) National Building Code of India.
- c) "Accepted Standards" and "Good Practice" listed in the appendix to National Building Code of India.
- d) IS-1200 : Method of measurement of Building and Civil Engineering Works.
- e) IS-1256 : Code of Practice for Building Byelaws.

**2.01.01 Earthwork**

- a) IS-1498 : Classification and identification of soils for General Engineering purposes.
- b) IS-3764 : Safety Code for excavation work.
- c) IS-7293 : Safety Code for working with construction machinery.





2.01.02	Concrete
IS-269	: Ordinary and low heat Portland cement.
IS-383	: Coarse and fine aggregate from natural sources for concrete.
IS-432	: Mild Steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
IS-455	: Portland Slag Cement.
IS-456	: Code of Practice for Plain and reinforced concrete.
IS-460	: Test Sieves (all parts).
IS-516	: Methods of test for strength of concrete.
IS-1199	: Methods of sampling & analysis of concrete.
IS-1566	: Hard drawn steel wire fabric for concrete Reinforcement.
IS-1786	: High strength deformed steel bars and wires for concrete reinforcement.
IS-1834	: Hot applied sealing compounds for joints in concrete.
IS-2386	: Methods of test for aggregates for concrete (all parts).
IS-2502	: Code of practice for bending and fixing of bars for concrete reinforcement.
IS-3370	: Code of practice for concrete structures for storage of liquids (all parts).
IS-3414	: Code of practice for design and installation of joints in buildings.
IS-4948	: Welded steel wire fabrics for general use.
IS-6452	: High Alumina Cement for Structural use.
IS-7320	: Concrete slump test apparatus.
IS-7861	: Code of practice for extreme weather concreting (all parts).
IS-8041	: Rapid Hardening Portland cement.
IS-8112	: High Strength Ordinary Portland Cement
IS-10262	: Recommended guidelines for concrete mix design.
IS-13920	: Ductile detailing of RCC structure subjected to seismic loads





- SP- 34 : Handbook on concrete reinforcement and detailing
- IS- 216 : Indian Standard Specification for Coal Tar Pitch
- IS- 226 : Indian Standard Specification for Structural Steel [Standard quality]
- IS-1139 : Indian Standard Specification for Hot Rolled Mild Steel and Medium Tensile Steel and High Yield Strength Steel Deformed Bars for concrete Reinforcement
- IS-1200 : Indian Standard Specification for Method of measurement Cement Concrete Works. Part-II
- IS-1200 : Indian Standard Specification for Method of measurement Part-V Formwork.
- IS-1609 : Code of Practice for Laying Damp proof Treatment using Bitumen felts
- IS-1791: Indian Standard Specification for Batch Type Concrete Mixers
- IS-2210 : Indian Standard Specification FOR Design of Reinforced Concrete Shell Structures and Folded Plates
- IS-2505 : Indian Standard Specification for Concrete Vibrators, Immersion Type
- IS-2506 : Indian Standard Specification for Screed Board Concrete Vibrators
- IS-2514 : Indian Standard Specification for Concrete Vibrating Tables
- IS-2722 : Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)
- IS- 2751 : Code of Practice for Welding of Mild Steel Bars used for reinforced concrete construction
- IS- 2770 : Indian Standard Specification for Method of Testing Bond in Reinforced Concrete.
- IS- 3025 : Indian Standard Specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry
- IS- 3201 : Indian Standard Specification for Design and construction of Precast Concrete Trusses
- IS- 3370 : Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids
- IS- 3550 : Indian Standard Specification for Method of Test for Routine Control for Water used in Industry



- IS- 3558 : Code of Practice for use of Immersion Vibrators for Consolidating Concrete
- IS- 3590 : Indian Standard Specification for Load Bearing Light Weight Concrete Blocks
- IS- 3696 : Safety Code for Scaffolding and Ladders
- IS- 3812 : Indian Standard Specification for Fly Ash for use as Admixture for Concrete.
- IS- 4031 : Indian Standard Specification for Method of Tests for Hydraulic Cement
- IS- 4082 : Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site.
- IS- 4634 : Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes.
- IS- 4656 : Indian Standard Specification for Form Vibrators for Concrete
- IS- 4925 : Indian Standard Specification for Concrete Batching and Mixing Plant
- IS- 4926 : Indian Standard Specification for Ready Mixed Concrete
- IS- 4990 : Indian Standard Specification for Plywood for Concrete Shuttering work
- IS- 4995 : Indian Standard Specification for Design of Reinforced Concrete Bins for the Storage of Granular and Powdery Materials (Part-I&II)
- IS- 5512 : Indian Standard Specification for Flow Table for use in Tests of Hydraulic Cement and Pozzolanic Materials
- IS- 5513 : Indian Standard Specification for Vicat Apparatus
- IS- 5515 : Indian Standard Specification for Compaction Factor Apparatus
- IS- 5751 : Indian Standard Specification for Precast Concrete Coping Blocks
- IS- 5816 : Indian Standard Specification for Method of Test for Splitting Tensile Strength of Concrete Cylinders
- IS- 5891 : Indian Standard Specification for Hand Operated Concrete Mixers
- IS- 6909 : Indian Standard Specification for Super sulphated Cement





- IS- 6923 : Indian Standard Specification for Method of Test for Performance of Screed Board Concrete Vibrators
- IS- 6925 : Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures
- IS- 7242 : Indian Standard Specification for Concrete Spreaders
- IS- 7246 : Indian Standard Specification for Table Vibrators for Consolidating Concrete
- IS- 7251 : Indian Standard Specification for Concrete Finishers
- IS- 7969 : Safety Code for Storage and Handling of Building Materials
- IS- 8142 : Indian Standard Specification for Determining Setting time of Concrete by Penetration Resistance
- IS- 8989 : Safety Code for erection of Concrete Framed Structures
- IS- 9013 : Indian Standard Specification for Method of Making, Curing and Determining Compressive Strength of Accelerated-cured Concrete Test Specimens
- IS- 9077 : Code of Practice for Corrosion Protection of Steel Rails in RB and RCC Construction
- IS – 9103 : Indian Standard Specification for Admixtures for concrete.
- IS- 1489 : Part-1 : 1991 - Specification for Portland pozzolana cement Fly ash based.

**2.01.03****Foundations**

- a) IS-1904 : Code of practice for structural safety of buildings : Shallow foundations.
- b) IS-2950 : Code of practice for design and construction of raft foundations.
- c) IS-2974 : Code of practice for design and construction of Machine foundations (all parts).
- d) IS-2911 : Code of practice for design and construction of pile foundation.
- e) IS-9716 : Lateral dynamic load test on pile
- f) IS-6313 : Code of Practice for anti-termite measures and treatment.  
(Part-1 & 2)



**2.01.04 Loading**

- a) IS-875 : Code of practice for Structural safety of buildings - loading standards.
- b) : Bridge Rules of Government of India, Ministry of Railways (Railway Board).

**2.01.05 Masonry**

- a) IS-712 : Building limes.
- b) IS-1077 : Common Burnt Clay Building Bricks.
- c) IS-1127 : Recommendations for dimensions and workmanship of natural building stones for masonry work.
- d) IS-1528 : Methods of sampling and physical tests for refractory materials.
- e) IS-1597 : Code of practice for construction of stone masonry (all parts).
- f) IS-2212 : Code of practice for brickwork.
- g) IS-2116 : Sand for masonry mortars
- h) IS-2185 : Concrete masonry units.  
(all parts - Hollow and Solid concrete blocks).
- i) IS-2250 : Code of practice for preparation and use of masonry mortars.
- j) IS-2572 : Code of practice for construction of hollow concrete block masonry.
- k) IS-2691 : Burnt clay facing bricks.
- l) IS-3414 : Code of practice for design and installation of joints in buildings.
- m) IS-3495 : Methods of tests of burnt clay building bricks.
- n) IS-4441 : Code of practice for use of Silicate type chemical resistant mortars.
- o) IS-4860 : Acid Resistant Bricks.

**2.01.06 Doors, Windows and Ventilators**

- a) IS-399 : Classification of commercial timbers and their zonal distribution.





- b) IS-883 : Code of practice for design of structural timber in building.
- c) IS-1003 : Timber panelled and glazed shutters (all parts).
- d) IS-1038 : Steel doors, windows and ventilators.
- e) IS-1081 : Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.
- f) IS-1361 : Steel windows for industrial buildings.
- g) IS-2835 : Transparent sheet glass for glazing and framing purposes.
- h) IS-1948 : Aluminium doors windows and ventilators.
- i) IS-1949 : Aluminium windows for industrial building.
- j) IS-2191 : Wooden flush door shutters (Cellular and hollow core type).
- k) IS-2202 : Wooden flush door shutters (solid core type).
- l) IS-3103 : Code of practice for Industrial ventilation.
- m) IS-3548 : Code of practice for glazing in buildings.
- n) IS-3614 : Fire check doors.
- o) IS-4021 : Timber door, windows and ventilator frames.
- p) IS-4351 : Steel door frames.
- q) IS-6248 : Metal rolling shutters and rolling grills.

**2.01.07 Roof and Flooring**

- a) IS-2204 : Code of practice for construction of reinforced concrete shell roof.
- b) IS-3201 : Criteria for the design and construction of precast concrete trusses.
- c) IS-2210 : Criteria for Design of R.C. shell structures and folded plates.
- d) IS-809 : Rubber flooring materials for general purposes.
- e) IS-1195 : Bitumen mastic for flooring.
- f) IS-1196 : Code of practice for laying bitumen mastic flooring.





- g) IS-1198 : Code of practice for laying, fixing and maintenance of linoleum floors.
- h) IS-1237 : Cement concrete flooring tiles.
- i) IS-1443 : Code of practice for laying and finishing of cement concrete flooring tiles.
- j) IS-2114 : Code of practice for laying in situ terrazzo floor finish.
- k) IS-2571 : Code of practice for laying in situ cement concrete flooring.
- l) IS-5491 : Code of practice for laying in situ granolithic concrete floor topping.
- m) IS-5766 : Code of practice for laying burnt clay brick flooring.
- n) IS-1197 : Code of practice for laying of rubber floors.
- o) IS-2441 : Code of practice for fixing ceiling coverings.

**2.01.08 Waterproofing**

- a) IS-1322 : Bitumen felts for waterproofing and damp proofing.
- b) IS-1346 : Code of practice for waterproofing of roofs with bitumen felts.
- c) IS-1609 : Code of practice for laying damp proof treatment using bituminous felts.
- d) IS-3036 : Code of practice for laying lime concrete for a waterproofed roof finish.
- e) IS-3037 : Bitumen mastic for use in waterproofing of roofs.
- f) IS-3067 : Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings.
- g) IS-3384 : Bitumen primer for use in water proofing and damp proofing.
- h) IS-4365 : Code of practice for application of bitumen mastic for waterproofing of roofs.

**2.01.09 Soil Engineering**

- a) IS-1498 : Classification and identification of soils for general engineering purposes.





- b) IS-1892 : Code of practice for sub-surface investigation for foundations.
- c) IS-2131 : Method for standard penetration test for soils.
- d) IS-2720 : Methods of test for soils (all parts).
- e) IS-10379 : Field Control of moisture and compaction of soil for embankment and subgrade.

**2.01.10 Water Supply, Drainage and Sewerage**

- a) IS-404 : Lead pipes
- b) IS-458 : Concrete pipes
- c) IS-651 : Salt glazed stoneware pipes and fittings.
- d) IS-771 : Glazed fire-clay sanitary appliances (all parts).
- e) IS-774 : Flushing cisterns for water closets and urinals other than plastic cisterns.
- f) IS-783 : Code of practice for laying of concrete pipes.
- g) IS-1172 : Code of basic requirements for water supply, drainage and sanitation.
- h) IS-1626 : Asbestos cement building pipes, gutters and fittings (all parts).
- i) IS-1742 : Code of practice for building drainage.
- j) IS-2064 : Code of practice for selection, installation and maintenance of sanitary appliances.
- k) IS-2065 : Code of practice for water supply in buildings.
- l) IS-2470 : Code of practice for installation of septic tanks (all parts).
- m) IS-3114 : Code of practice for laying of Cast Iron pipes.
- n) IS-4127 : Code of practice for laying of glazed stoneware pipes.
- o) IS-12251 : Code of practice for Drainage of Building Basement.
- p) IS-1200 : Method of measurement : Laying of water and [Part XVI] sewer lines including appurtenant items.
- q) IS-1536 : Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.



- r) IS-1537 : Vertically cast iron pressure pipe for water, gas and sewage.
- s) IS-3486 : Cast iron spigot and socket drain pipes .
- t) IS-5329 : Code of practice for sanitary pipe work above ground for buildings.
- u) IS-3076 : Low density polyethylene pipes for potable water supplies.
- v) IS-1538 : Cast iron fittings for pressure pipes for water, gas and sewage.
- w) IS-1230 : Cast iron rainwater pipes and fittings.
- x) IS-1729 : Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
- y) IS-784 : Prestressed concrete pipes.
- z) IS-1726 : Cast iron manhole covers and frames.
- aa) IS-5961 : Cast iron grating for drainage purposes.
- bb) IS-5219 : "P" and "S" traps. [Part-I]
- cc) IS-772 : General requirements for enamelled cast iron sanitary appliances.
- dd) IS-775 : Cast iron brackets and supports for wash basins and sinks.
- ee) IS-777 : Glazed earthenware wall tiles.
- ff) IS-2548 : Plastic water closet seats and covers (all parts).
- gg) IS-2527 : Code of practice for fixing rainwater gutters and downpipes for roof drainage.

**2.01.11 Paving and Roadworks**

- a) IS-73 : Paving bitumen
- b) IS-702 : Industrial Bitumen
- c) IS-1201 : Method of testing tar and bituminous materials. thru' 1220
- d) IRC-15 : Standard Spec. and code of practice for construction of concrete roads
- e) IRC-58 : Guidelines for the design of plain jointed rigid pavement for highways





2.01.12 Earthquake Resistant Design

- a) IS-1893 (Part 1, 2, 4) : Criteria for earthquake resistant design of structures.
- b) IS-4326 : Code of practice for earthquake resistant design and construction of buildings.

2.01.13 NOT USED.

2.01.14 Structural Steelwork

- a) IS-800 : Code of practice for general construction in steel.
- b) IS-802 : Code of practice for use of structural steel in Overhead Transmission Line.  
  
Part-I : Load and permissible stresses.  
  
Part-II: Fabrication, Galvanizing, Inspection and Packing.
- c) IS-806 : Code of practice for use of steel tubes in general building construction.
- d) IS-808 : Rolled steel beams, channels and angle sections.
- e) IS-813 : Scheme of symbols for welding.
- f) IS-814 : Covered electrodes for manual metal arc welding of carbon and carbon manganese steel.
- g) IS-816 : Code of practice for use of metal arc welding for general construction in mild steel.
- h) IS-817 : Code of practice for training and testing of metal arc welders.
- i) IS-818 : Code of practice for safety and health requirements in electric and gas welding and cutting operation.
- j) IS-819 : Code of practice for Resistance spot welding for light assemblies in Mild Steel.
- k) IS-919 : Recommendations for limits and fits for engineering.
- l) IS-1024 : Code of practice for use of welding in Bridges and Structures subjected to Dynamic loading.
- m) IS-1161 : Steel tubes for structural purposes.
- n) IS-1182 : Recommended practice for Radiographic Examination of Fusion Welded Butt joints in steel plates.







- o) IS-1200 : Method of measurement of steelwork and ironwork. [Part-VIII]
- p) IS-1239 : Mild steel tubes, tubular and other wrought steel fittings (all parts).
- q) IS-1363 : Black hexagonal bolts, nuts and locknuts (dia.6 to 39 mm) and black hexagon screws (dia.6 to 24 mm). [all parts]
- r) IS-1364 : Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia. range 6 to 39 mm). [all parts]
- s) IS-1365 : Slotted counter sunk head screws (dia range 1.6 to 20 mm).
- t) IS-1367 : Technical supply conditions for threaded steel fasteners.
- u) IS-1443 : Code of practice for laying and finishing of cement concrete flooring tiles.
- v) IS-1608 : Method for tensile testing of steel products.
- w) IS-1730 : Dimensions for steel plate, sheet and strip for structural and general engineering purpose.
- x) IS-1731 : Dimensions for steel flats for structural and general engineering purposes.
- y) IS-1852 : Rolling and cutting tolerances for hot rolled steel products.
- z) IS-1977 : Structural steel (Ordinary quality)
- aa) IS-2016 : Plain Washers
- bb) IS-2062 : Steel for General structural purposes.
- cc) IS-2074 : Ready mixed paint, air drying, red oxide zinc-chrome, priming.
- dd) IS-2633 : Methods of testing uniformity of coating of zinc coated articles.
- ee) IS-3613 : Acceptance tests for wire-flux combinations for submerged-arc welding of structural steels.
- ff) IS-3664 : Code of practice for Ultrasonic Pulse echo testing by contact and immersions methods.
- gg) IS-3757 : High strength structural bolts.



- hh) IS-4000 : High strength bolts in steel structures.
- ii) IS-4759 : Hot dip zinc coatings on structural steel and other allied products.
- jj) IS-5334 : Code of practice for Magnetic Particle Flaw detection of welds.
- kk) IS-7215 : Tolerances for fabrication of steel structures.
- ll) IS-7280 : Base-wire electrodes for sub-merged arc welding of structural steels.
- mm) IS-7318 : Approval test for welders when welding [Part-I] procedure approval is not required.
- nn) IS-8500 : Structural steel - microalloyed (medium and high strength qualities).
- oo) IS-9595 : Recommendation for metal arc welding of carbon and carbon manganese steels.
- pp) AWS D.1.1 : Structural Welding Code.

**2.01.15****Painting**

- a) IS-348 : Specification for French Polish.
- b) IS-427 : Specification for Distemper, dry colour as required.
- c) IS-428 : Specification for Distemper, oil emulsion, colour as required.
- d) IS-1477 : Code of practice for painting offerrous metal [I & II] in buildings.
- e) IS-2338 : Code of practice for finishing of wood and [I & II] wood based materials.
- f) IS-2339 : Specification for Aluminium Paints for general purposes in dual containers.
- g) IS-2395 : Code of practice for painting concrete, masonry and plaster surface.
- h) IS-2932 : Specification for enamel, synthetic, exterior -
  - a) undercoating,
  - b) finishing.
- i) IS-2933 : Specification for enamel, exterior -
  - a) undercoating,
  - b) finishing.
- j) IS-5410 : Specification for cement paint.





- 2.01.16 a) Indian Road Congress (IRC) Bridge Codes  
b) Indian Railway Standard Bridge Rules

2.01.17 Environmental Protection

Charter on Corporate Responsibility for Environmental Protection (CREP) published in Gazette of India dated 27.08.2003.

- 2.01.18 CEA guide lines for Civil works for Power Plants of 500 MW and above shall also be followed.

**3.00.00 SCOPE OF CIVIL WORKS**

The scope of civil work comprises all necessary investigations, survey, foundations, building, superstructures and infrastructure required for the complete operating power station.

The work under this Section consists of all Civil and Structural works, but not limited to items mentioned below.

- Topographical Survey
- Area Grading, leveling & dressing (finished grade levels shall be as mentioned elsewhere in this Section)
- Geo-Technical investigation
- Demolition of existing structures / facilities, if any, and site clearance
- Piling work.
- Main plant Roads and Culverts within the Battery limit of this Specification and as shown in the Plot Plan.
- Boundary walls in buildings, if required from statutory point of view
- Provide a connection of at least 3m wide at operating floor level between existing Unit 3&4( 2X 500MW) and new Unit#5 (1X660MW).
- Roads along ash pipe line corridor from plant boundary to ash pond including all structures and foundation necessary for canal / drain and pipe crossings, if applicable.
- Storm Drainage network within the battery limit of the Main Plant area and terminating the same to arterial Road side drains or existing drains of Stage-II as practicable.

Major building and facilities

- Power House Building sub structure and super structure with E.O.T crane.





- Foundation for TG and auxiliaries
- Vibration isolation system: Steel spring / viscous dampers for Steam Turbine Generator (STG), Condenser, Boiler Feed Pumps, ID, FD, PA fans and Coal mills.
- Transformer yard including transformer foundations, Fire walls, Rail track (embedded in concrete), transformer oil collection drain pit with sump pump and intermediate pits as required.
- Electrical Grounding mat for all equipment foundations.
- Mill building including bunker and bunker stainless steel lining.
- Civil work & foundations for all electrical auxiliaries in main plant package.
- Boiler & Boiler Auxiliary foundations and super structure.
- ESP foundations and super structure.
- BFP, mill, fan (PA, FD, ID, SA) foundations.
- Cable Racks, Pipe racks, Pipe & Cable racks trenches, duct-banks etc.
- Main plant paving including plinth protection & surrounding drains of all buildings.
- 400 KV Switchyard structures & foundations, Extension of switchyard control building in line with existing Control room building, switchyard maintenance building
- CW & ACW Pump House (CW pumps are concrete volute type) including Fire water pump house, common fire- fighting control room (for PH-II & PH-III), Electrical Annex Building & forebay basin
- CW RCC Channel / Duct from Cooling Tower to CW/ACW Pump House
- CW treatment cum chlorination building structure & foundation
- Self Cleaning Strainer Shed
- Ash handling and disposal system
- Coal handling plant structures and foundations as required
- Mill reject storage bins or silos (Capacity mentioned elsewhere in this specification)
- Vacuum Pump-cum-AHP compressor house
- CPU Regeneration Building.
- FGD Control Building and other buildings / structures as required.



- Condensate Storage Tank foundation.
- ESP Control Building
- Wagon Tippler Complex
- Crusher House
- Crusher House Substation
- CHP utility building
- DG building
- Transfer Points (TPs) for CHP
- WT Control Building and Substation
- Ash Silo Electrical Building
- Expansion of LT Swgr Room (Phase-II) for accommodating new set of battery requirement for Phase-I, II and III.
- Extension of CST Pump House.
- Other auxiliary buildings / structures as required.
- All other civil items not covered above but required for completion and proper functioning of the plant (Unit 5, Phase-III) shall form part of the scope.

Above list of Plant & Non Plant Buildings is not exhaustive. Buildings necessary for the smooth operation of the plant shall be within this scope of work. In case the equipment parameters considered by bidders for Phase-III differs from that of Phase-II, separate buildings may be required to accommodate such equipment and its stand-by units.

The scope shall also include all necessary civil work (mainly civil fdn.) pertaining to erection of stator/ any other equipment (if reqd.).

The civil, structural and Architectural works pertaining to above facilities include supply of all materials, design, engineering and construction of all sub and super structures, erection and installation of equipment and providing finishes including flooring, paving, Side cladding with sheeting/brick masonry, walls, plastering, painting, false ceiling, doors & windows, plumbing, roof treatment, etc. complete in all respect to render the premises functional to the satisfaction of the Owner.

The scope shall also include setting up by the successful bidder a complete testing laboratory in the field to carry out all relevant tests required for the civil works for the project.



Slope protection work shall be done with stone pitching & grouting with cement mortar (1:4). RCC retaining wall shall be provided as per requirement.

Entire BTG area is graded at a level of R.L. 34.2M.

Water will be supplied by the Owner at two points within the plant battery limit and the Bidder shall arrange distribution of the same beyond the above point.

A list of Civil Field Quality Assurance Laboratory Apparatus is enclosed in Annexure-I of this Section.

The Bidder shall visit the site and assess the involvement of demolition and site clearance, if required, within the plant area to construct the project & accordingly the cost is to be considered in his offer.

The work shall have to be carried out both below and above the ground level. The work shall be executed accordance to the relevant Indian Standard Code, and in its absence, the work shall be executed according to the best prevailing local Public Work Department (PWD) practices or to the recommendations of relevant American and British Standards or to the instructions of the Owner's Engineer. This shall prevail in respect of civil works for which no specification has been prescribed in this section.

The work shall be carried out according to the design / drawings to be developed by the successful bidder and approved by the Owner / Owner's authorised Consultant. For all building, structures, foundations, etc., necessary terraced layout and details are to be developed by the successful bidder keeping in view the statutory & functional requirement of the plant & facilities and providing enough space & access for operation, use and maintenance.

The land will be given to the successful bidder by the Owner as is where basis. All site investigations, surveys, grading and levelling and other additional works shall be carried out by the successful bidder if necessary.

Setting-up of grid pillars with respect to phase-II general grid, the layout and levels of all structures shall be made by the successful bidder at his own cost from the general grid of the plot and the nearest GSI bench mark or other acceptable bench mark of Govt. Dept. The successful bidder shall be solely responsible for the correctness of the layout and levels.

All necessary statutory clearances shall be obtained by the Bidder prior to execution of work under scope of this specification.

All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to by the successful bidder.

**4.00.00****MAIN PLANT STRUCTURES / COMPONENTS**

The description of some of the major structures/utilities covered under the Package are given below:

1.0 Power House Building



**i) Turbine Hall**

The turbine building is an enclosed insulated, weather- tight steel framed structure which houses the turbine generator and related equipment including the feed water heaters. The building consists of an operating floor, mezzanine floors and a ground floor. The roof is supported by steel trusses. The structure is braced in the direction of the crane travel but provided with rigid joints at roof level and framing at other floor levels with the electrical and mill bays in the transverse direction.

One E.O.T Crane (capacity shall be as specified elsewhere in this specification) will operate in the Turbine Hall for handling all parts of boiler feed pumps and turbine generator including generator stators. The generator stators will be erected with the help of the E.O.T. cranes. For rigging and positioning of the condensers, building frame shall not be of any hindrance and temporary openings in the building walls and wall supporting structures shall be maintained till completion of the rigging and positioning of the condensers.

Within the building, the concrete pedestal for supporting the turbine generator will be completely isolated from the building floors for vibration control. The foundation for Turbogenerator and Boiler Feed Pumps/motors shall rest on suitable vibration isolation system consisting of springs and viscodampers (supplied by M/s GERB, Germany or equivalent). The fundamental frequency shall be at least  $\pm 30\%$  away from operating frequency. Resonance at other possible frequencies (half and twice operating speed) shall also be checked. The concrete operating floor will be designed for construction and maintenance loadings of TG. Hatchways with removable chequered plates or grating floor covers will provide access to equipment on lower floor and will be within turbine hall crane access. The intermediate floors will be of concrete with hatchways as necessary.

Windows, doors, exterior walls, internal finish and external finish shall be as laid down in Vol: II-G/2 of this specification.

The roof shall be flat with a gentle slope of about 1 in 100 towards the transformer yard. The roofing will be done by cast-in- situ RCC slab over metal decking supported by steel purlins which are spanning between two adjacent roof trusses. The roof will be insulated by providing 75 mm thick foam concrete. The roof will be provided with membrane water proofing as per architectural specification for making the roof waterproofed. Roof finishes will be as per architectural specification mentioned in Vol: II-G/2 of this specification.

Lighting, ventilation will be provided as described in other sections of this specification.

**ii) Electrical and Deaerator Bay**

This bay is continuous with the turbine building on the boiler side. This bay houses the electrical switchgears, deaerator heaters, control panels







and provides space for major pipe lines and electrical cables.

All floors with hatchways as required & roof will be of cast-in- situ concrete and the sides will be claded with 250 mm thick brick masonry. Deareator floor shall be properly sloped for draining water to nearby catch pits or drains.

Stairs and platforms shall be provided as required for maximum utility and safety.

Provision of Visitor Lounge/ Gallery in Control Room to be kept.

Connecting Passage, enclosure with control room of Phase – II to be provided.

## 2.0 Mill Building

This building houses coal pulverisers, coal bunkers, tripper conveyors, vibro feeders, ducts and piping.

### Features of Raw Coal Bunkers

- o Shape of Bunker : Cylindrical
- o Bunker capacity (cumulative) : Minimum 14 hours storage capacity considering BMCR operation with worst coal.
- o Valley angle of Hopper : 65 Deg. (minimum).
- o Gap between hopper outlet and coal feeder inlet : 3 M (min.)
- o Hopper Liner : 6 mm thick austenitic 316L plates all over fitted without allowing any projections in coal flow path.
- o Density of Coal : 800 Kg/cum (For volume calculation)  
1200 Kg/cum (For weight calculation)

All floors will be concrete with hatchways as required. Ground floor slab will have drainage trenches covered with grating.

Building roof will be of Cast-in-situ concrete and the sides will be claded with 250 mm thick brick masonry.

Stairs and platforms shall be provided as required for maximum utility and safety.



### 3.0 Flue Gas Draught System Structures

Flue gas draught system structures include De-NO<sub>x</sub> system, electrostatic precipitators, ID fans, Flue Gas Desulphurisation (FGD) plant, ductwork and chimney. The equipment structures are outdoor construction type supported by exposed steel structures consisting of beams, columns and bracings.

The precipitators will be elevated to allow a good arrangement of gas ducts from the air heaters and to facilitate removal of fly ash in the event of equipment breakdown. Precipitator control room (ESP Control Building) will be housed in a masonry building with R.C. column and beam framing.

At the paved ground level, drainage trenches covered with grating at intervals shall be provided for final discharge into the drainage system/sump pit.

Ducts and precipitators will be covered with thermal insulation.

### 3.1 NOT USED

### 4.0 Main and Aux Cooling water system

Miscellaneous Yard Buildings will be all concrete construction, excepting for buildings of more than 12M span where steel roof truss/girders will be provided to support the concrete roof over concrete columns. Gable and side cladding will be constructed with brick masonry.

The following miscellaneous plant buildings/structures will be required under this Main Plant Package :

#### 4.1 CW Pump house and fore bay

The CW /ACW Pump house shall be adjacent to Forebay / feed pool suitably designed based on Hydraulic Institute to ensure efficient pump operation and provided with stop log gates and screen to isolate individual pump sump for maintenance. CW sump shall be of water tight RCC construction. The pumps shall be mounted on RCC floor slab. The superstructure of the building shall have RCC/ Steel framing with RCC roof slab laid over metal decking and brick masonry side cladding. The provision of sludge pit in the forebay base slab shall be provided for periodic sludge removal. The building shall have EOT crane for maintenance and handling of pumps and gates.

#### 4.2 Chlorination building

Adjacent to pump house, chlorination building with RCC/ steel framing superstructure will be located to house chlorine toner and or chlorine / chemical dosing pump and auxiliaries. The side cladding and other finishes shall comply with Architectural specification.



#### 4.3 CW Tunnels/ duct

The underground tunnels / piping from CW pump house to cooling tower basin for circulating cooling water to condenser shall be of watertight RCC construction. The layout and depth of tunnels shall be made suitably so that plant drainage network shall not be affected.

#### 5.0 Switchyard structures and foundations

Substation structures comprise of all towers, gantries, lighting towers, lightning towers/masts, chain link fencing with gates, equipment supports and other structure - all of galvanized steel and with bolted type joints. Foundations for above structures will be reinforced cement concrete. Cable trenches with precast RCC covers of removable type, sump pits, oil pits, cable tray supports, grounding etc. will be constructed in Switchyard areas. Foundations for jacking transformers, oil drainage piping etc. will also be provided. Baffle walls shall be arranged based on layout of transformers and statutory requirement. Additional protection for buried cables need be provided under road/railway track in form of RCC/galvanised iron pipes/RCC box culvert.

Lighting towers shall be provided with a structural steel ladder from its base up to the top of tower. The ladder shall be provided with protection guards in the form of rings. Platforms with protection hand-railing shall be provided at suitable heights for mounting of lighting fixtures. Road inside the switchyard area shall be of 4m (one lane)wide ,water bound Macadam with bituminous topping on prepared sub –grade alongwith 1.0 m wide shoulder on either side.

#### 6.0 Pipe/Cable Trestles and Foundations

No cable/pipe trench is envisaged in the plant area. All cables & pipes in outdoor area shall run above ground over steel trestles or other supporting structures for easy inspection & maintenance except in Transformer Yard area, GIS Substation area and some other localized area where the same can run in R.C.C. trenches. In case overground routing is not feasible due to site constraints, the pipe/cable to be routed through duct-banks.

A minimum clearance (clear head room) of 8.0m shall be kept for all overground pipe/cable trestles for all road/rail crossings. In other areas the clear height shall be 3.0m (minimum) from ground/grade level except in pipe corridor between main plant and plant water system which shall be 5.0m (minimum) from ground/grade level. All trestles shall be provided with continuous walkway of minimum 600mm width with handrail and toe-guards all along the length of the trestle along with approach ladder near roads, passageways etc.

Before and after the rail/road crossing, a barrier of suitable height shall be constructed so as to prevent the approach of cranes (having height more than 8.0m) etc. up to the pipe/cable rack trestles.



Four-legged trestles & foundations are to be provided for supporting the pipe/cables at suitable intervals. Four legged trestles are to be provided mainly at intercepting location of branch pipe rack (maximum distance 100 m) Crossover, operating platform & necessary trussed resisting arrangement at pipe bend shall be provided as required.

## 7.0 Surface Treatment

### Boiler Area

The entire area beneath the Boilers, Precipitator Hoppers, around FD and ID fans upto the stack (From Transformer yard to outer edge of plinth protection of chimney) will be paved with reinforced cement concrete with and sloped to drains. Immediately adjacent to these areas water bound macadam roads with bituminous topping will be provided as required for access to equipment.

### Transformer Areas and Switchyard

Oil cooled equipment, such as transformers, will be located within concrete basins filled with gravel. The individual basins will be connected by pipeline to a separate chamber/oil pit for collection and further reclamation of oil through oil water separators, if necessary.

Drains will be adequate to remove full discharge from deluge system used for fire control. Transformer Yard will be paved with reinforced cement concrete. Switchyard area shall be filled with 150 mm thick layer of 20 mm to 40 mm size gravel over a layer of 100 mm thick lean concrete (M10).

### Oil Storage Areas

Oil storage area, with dykes to contain oil spills in accordance with Govt. Acts and Regulation on the oil pollution prevention shall be constructed.

## 8.0 Ash Handling and disposal system

The civil and structural works related to the ash handling system are as follows. For detailed specification of ash handling system Volume-II-H2 shall be referred to.

### 8.1 Ash slurry pipe trenches/ pedestals

Ash slurry pipes shall be pipes shall be routed in the plant in such a way to cause least disturbance with plant drainage networks. Generally over ground RCC pipe sleepers/pedestals shall be provided for conveying pipes. For road / rail /nallah crossings, RCC box culverts/ trenches with pipe supports inside shall be provided. Drainage provision inside trench shall be provided.



## 8.2 Fly Ash silo

Fly ash silo shall be of circular RCC structures supported on RCC pedestals on Pile foundation. The bottom height shall be decided based on truck unloading. The silo shall be provided with access ladder to roof.

## 9.0 Coal Handling Plant

The various structures in the coal handling plant are described below. For detailed specifications of coal handling system, Volume II- H1 shall be referred to.

### 9.1 Over Ground Transfer Points (TPs)

Over ground TPs shall have RCC foundations and pedestals at (+) 500 mm above ground level. The super structure for TPs shall be of steel framed structure with adequate bracing arrangement. The ground floor and all intermediate floors shall be of RCC and will be finished with IPS and metallic hardener having proper slopes for drainage. The roofs shall be of flat RCC slab with water proof treatment and drainage slope. The cladding shall be of 230 mm thick brick work or of coated steel sheet.

TPs shall be provided with independent steel staircase with steps of MS grating from ground of highest operating floor level. The clear width of the stair shall be minimum 1.0 M. The tread shall be at least 250 mm and riser shall be uniform throughout the height and shall not exceed 190 mm. However the codal regulations shall also be complied with. Continuous handrails shall be provided for the staircases.

Drive units shall be directly supported on floor beams from suitable structural steel stools and not on concrete floors. All transfer houses shall be provided with adequate no windows and doors. The window area shall not be less than 10 percent of total wall area. Maintenance platform inside /outside of transfer house may have chequered plate floors with horizontal floor bracing.

Transfer points / crusher house with metal sheeting as cladding shall have 1.0 m high 230 mm brick enclosure from finished ground floor around the building. Brick wall shall be inside face of sheeting with a lapping of 150 mm.

Adequate floor washing arrangement shall be made for all TPS.

Provision of floor dust collection and removal by chute shall be made.

TP at BTG area i.e TPs between boiler and chimney area must be on pile foundation.



## 9.2 Overground Galleries and Trestles

On grade and over ground galleries shall be of enclosed type for adequate weather protection. The walkways for on-grade galleries shall be raised and they shall be made of concrete with skid proof finish or with metal bar grating. Overhead conveyor galleries shall be structural steel consisting of two girders braced at top and bottom and supported on trestles.

Walkway portion of over ground conveyor galleries shall be of chequered plate with antiskid bar or expanded metal grating. The maximum span of standard gallery shall be 30 m. The galleries for double stream conveyors shall have one central walkway and two side walkways and single stream conveyors shall have two side walkways. Hand railings shall be provided as required. At crossing points for roads, buildings and railway lines and other important locations seal plate of minimum 3 mm thickness shall be provided. The over ground conveyor galleries shall be designed for adequate ventilation and natural lighting.

Conveyor gallery having slopes greater than 8 degree, stepped walkways of tread 250 mm of chequered plates with nosing and toe guard shall be provided all along the conveyor. 10mm dia Tor anti-skid steel bars shall be provided @ 500 mm for inclined walkways below 8 degrees.

Suitable floor washing arrangement shall be made in the conveyor gallery with down comers.

In between transfer house / buildings four legged trestles shall be place at a maximum interval of 100 m. The arrangement shall be such as to ensure that force in the longitudinal direction of conveyor gallery of length not more than 100 m will be transferred to four legged trestle. Two legged trestles at regular interval may be placed between four legged trestles. The end supports resting on the four legged trestles can have either ends hinged or one hinged and the other on slide type. Slide type support shall be with PTFE bearing to allow both rotation and movement.

End of conveyor gallery which will be supported over transfer points, shall be so detailed that only vertical reaction is transferred from gallery and no horizontal force in longitudinal direction is transferred from gallery to transfer points and vice-versa.

All RC trestle pedestals should be raised to (+) 1.0 m above FGL.

Trestles shall be of structural steel braced adequately and provided at suitable locations. Location of trestles shall be decided carefully so that there is no interference with underground and over ground structures, tunnels, trenches, drains, etc. The minimum clearance over road and railway crossing should be 8.0 meters.



**9.3 Drainage of CHP area**

Suitable drainage arrangement shall be provided for all under-ground structures and tunnels with sump pumps. Coal stockyards and surrounding areas also shall have suitable surface drainage facilities.

**9.4 Wagon Tippler Complex**

a) One (1) Rotaside Wagon Tippler complete with all accessories including driving accessories, rack & pinion, wagon tippler table complete with rails, rail fixture, integrated weigh bridge, cradle, sustaining beam, clamping arrangement etc. as required for safe, reliable and trouble free operation. The height of the roof shall be decided based on the provision for H.T. electrical overhead wire for Electric Loco and the clearance required for Wagon Tippler during unloading.

b) One (1) Side Arm Charger with the Wagon Tippler complete with the carriage, coupling for disengaging the front wagon, drive, drive pinion, chain, necessary rail, rail fixtures, cable for the travel of the machines, limit switches, brakes, necessary stops with buffer etc. as required for safe, reliable and trouble free operation of the plant.

c) One (1) local control room with wagon tippler for controlling the operation of Wagon Tippler in conjunction with side arm charger.

d) Steel Grating (heavy duty) of 300 mm square openings over wagon tippler hopper. The grating shall be fabricated from structural flats and round bars of suitable sections and complete with all necessary fixtures. The gratings shall be suitable to pass coal of size 300mm and below. The grating design shall be adequate for manual/mechanized hammering for breaking oversize coal lumps.

e) One (1) set of Apron Feeder below the Wagon Tippler Hopper complete with dribble feeder, skirt, flow control arrangement, drives and supports for evacuating ROM Coal at the rate of 1650 / 1500 TPH (Designed / Rated) from Wagon Tippler Hopper.

f) One (1) R.C.C. Wagon Tippler Hoppers of 375 M3 capacity minimum along with accessories. 16 mm thick TISCERAL / Equivalent liner on all internal walls of the hopper and other areas inside the hopper coming in contact with coal.

Wagon tippler pit shall be of RCC construction. This structure shall be designed as a water retaining structure with limited crack width of 0.1mm. Proper provision shall be made while constructing to provide structural water proofing after the concreting of the pit is complete. Sump shall be provided to collect and pump out water which enters through coal/tunnels etc. RCC access shaft accommodating staircase as well as monorail for handling of machinery shall be provided. Control and switchgear room shall be of RCC framed construction with brick cladding. Control room shall be provided with fixed glazing in aluminium framework on front side. Steel glazed windows with 6 mm





thick wired glass shall be provided for other walls. RCC staircase shall be provided for access to the control room.

Hoppers shall be of RCC construction. The pit shall accommodate the hoppers along with feeder and conveyors below. The hopper pit shall be of RCC construction and designed as water retaining structure. During construction proper provision shall be made to make the pit completely water proof. For Reclaim hopper sloping surfaces 5mm thick stainless steel liner of SS 409M shall be provided. For Wagon tippler sloping surface including grizzly supported RCC beams & all other surfaces where coal is to strike 16mm thick TISCERAL / equivalent plate shall be provided. Suitable sump shall be provided in the pit to effect surface water drainage. RCC access shaft shall be provided with staircase to the bottom of the pit. Monorail for taking machinery into the pit shall be provided in the access shaft projecting through two leaf steel sliding door. Plinth level of the pit shall be kept at least 500 mm above graded level with RCC sloped paving all round to enable bulldozer movement. Shed above hopper pit shall be of structural steel construction.

Wagon tippler shed shall be steel framed structure with rigid framing in the transverse direction and bracing in the longitudinal direction. Roofing shall be of colour coated galvanised sheet of minimum thickness 0.8 mm and side cladding shall be of similar sheet but with 0.6 mm thickness above 3 metres high brick wall. Roof shall be given a minimum slope of 1 vertical : 4 horizontal. Rain water gutters of matching colour shall be provided to convey the rain water through Pipes as specified elsewhere. RCC drains shall be given on either side along with plinth protection all round.

#### 9.5 Crusher House

Crusher house shall be of steel structure of framed / braced design. Floors and roofs shall be RCC over structural steel beam. Side cladding shall be as specified elsewhere above wall (height as specified elsewhere) on ground floor. Roof shall be given adequate slope for drainage. Roof shall be given with proper water proofing, for description mentioned elsewhere in this specification. Proper arrangement shall be provided to convey the rain water through gutter of matching colour and down comers as specified elsewhere. Adequate windows shall be provided with steel glazed side hung windows using wired glass. Wherever monorails are projecting outside for lifting of equipment, steel sliding doors shall be provided. Main entrance doors shall be rolling shutter adequately sized to carry equipment inside. Other doors shall be of flush welded steel construction. Ramps shall be provided in front of main door. Grade slab as well as intermediate floors shall be of RCC. Intermediate floor shall be supported on steel beams. Crusher shall be mounted on the floor framing using Vibration Isolator system. Handrail shall be provided around all big openings and kerb plates shall be provided around all small openings.



Two staircases shall be provided one inside and one outside, both of structural steel. Rack and pinion elevator shall be provided. Machine room of elevator floor and roof shall be of RCC. Side cladding of M/C room shall be of colour coated sandwiched cladding system. An RCC kerb wall of 300 mm shall be given around the floor. M/C room shall be given adequate slope for drainage purposes. Roof shall be given with proper water proofing, for description mentioned elsewhere in this specification with down comers as specified elsewhere. Main door to M/C room shall be of steel of flush welded construction. Adequate ventilation shall be given using steel glazed window. Toilet shall be provided in the Crusher house.

Foundation of the building columns shall be of RCC. Foundation design criteria are given elsewhere. All the foundations shall be connected together by tie / plinth beams. Top of the pedestals for the columns shall be above finished ground floor level as specified elsewhere.

#### 10.0 Area Grading

Site leveling and grading for the plant area within this phase shall be within scope of this contract. Work shall have to be carried out as per grading layout plan approved by the Owner/ Owner's Engineer. All existing drains/channels in the plant and other areas associated with the plant shall be suitably diverted before taking up any construction. These diversions shall be so designed as to ensure effective disposal of water without any accumulation or flooding in adjoining areas.

#### 11.0 Roads

All plant service roads will be 8M (for double lane) or 4M (for single lane) wide, water bound macadam with bituminous topping on prepared sub grade, providing access to all truck sized building doors and all structures requiring maintenance by vehicles. Water bound macadam with bituminous topping will be provided at areas requiring parking facilities. Bituminous topping of all plant roads and parking areas shall be done after completion of plant construction & maintenance of road till such time shall be in scope of successful bidder.

All Roads shall be designed in accordance with the provision of the latest edition of the relevant I.R.C. codes of practice.

The subgrade shall be prepared with well compacted selected soil/earth. Subbase shall be 300 thick (consolidated thickness) granular subbase with crushed stone (grading-1), morum and sand. The wearing coarse shall be 75 mm thick bituminous macadam binder course with 20 mm open graded premix carpet with seal coat on top, laid on 225 mm (compacted thickness) water bound macadam course.



## 12 0 Miscellaneous plant building

The following plant buildings / facilities are generally required for plant operation.

- Condensate Storage Tank Foundation.
- ESP Control Room and intermediate surge hopper.
- RCC Fly Ash Silo.
- Switchyard.
- FAE tower
- Cable Rack, Pipe rack, Cable & Pipe Rack & Trenches.
- **C.W. Chlorination Plant Building.**
- FGD Control Building and other buildings / structures as required.
- CPU Regeneration Building.
- Vacuum-Cum-AHP Compressor house.
- Wagon Tippler Complex
- Crusher House
- DG Building
- **WT Control Building**
- CHP utility building
- Expansion of LT Swgr Room (Phase-II) for accommodating new set of battery requirement for Phase-I, II and III.
- Extension of CST Pump House.
- Ash Silo Electrical Building
- Pipe rack, Cable rack, Pipe & Cable Rack, Trenches
- Junction Towers (TPs)

The buildings are **RCC / steel framed building with brick / colour coated metal sheeting as side cladding.** Architectural requirements shall be as per Vol:II-G/2.



Other non-plant buildings / facilities not specifically mentioned above or in Vol-II:G/2, but required for operation of the plant shall be constructed by the Bidder.

The EPC Bidder may add extra facilities / buildings as may be required for operation of plant subject to prior approval of Owner / Consultant.

### 13.0 Auxiliary and Non-plant Building

Auxiliary and non-plant buildings those are required for the plant to be prepared.

Above list of Plant & Non Plant Buildings is not exhaustive. Buildings necessary for the smooth operation of the plant shall be within this scope of work. In case the equipment parameters considered by bidders for Phase-III differs from that of Phase-II, separate buildings may be required to accommodate such equipment and its stand-by units.

### 14.0 Drainage System

Drains shall be designed as a network covering the plant area within the battery-limit of this specification. This plant area drainage has to be terminated up to surrounding Road side drains constructed by other agency. Attempts will be made to convert construction drains into main drain as far as practicable.

Auxiliary/Branch drains shall cover individual grades to terrains; collect storm water and other non-contaminated discharge from plant buildings and then be connected to Main drain/existing phase I drain at suitable locations as practicable. The invert of the in-plant peripheral drains shall be kept such that water can be discharged by gravity to the drain under all condition. RCC pipe culverts/box culverts will carry drainage under intercepting roads and railway tracks. Effluent drains shall completely be separated from storm water drain. Effluent drain within the main plant battery limit will not be the scope of this contract. Suitably designed underground storm water RCC piping on the basis of design loads specified elsewhere in this specification shall be limited to required areas where surface drainage ways are not desirable or practicable from other functional point of view. Class of RCC pipes shall be decided by Bidder as per design requirement. For pipe drains, concrete pipes of minimum grade – Class NP2 will be used. However, for road concrete pipes of Class NP3 will be used and for rail crossing, railway norms shall be followed. R.C.C. Manholes will be provided at maximum 30m intervals along the length, at connection points and every change of alignment, gradient or diameter of pipeline. The drains shall generally be of open type RCC rectangular construction. R.C.C. drains shall be covered with perforated R.C.C. pre-cast slab (M-25) of minimum 50mm thickness with provision of openable galvanized steel grating covers at every 4.0m intervals. Similarly, all drains along the periphery of buildings shall also have perforated R.C.C. pre-cast slab (M-25) of minimum 50mm thickness





with provision of openable galvanized steel grating covers at every 4.0m intervals. Design of such drain covers shall be done considering loading as specified elsewhere. In areas where vehicular loads would come, pre-cast RCC covers/box culverts of suitable thickness without perforations and designed for the vehicular loads shall be provided.

The drainage system shall be designed for precipitation intensity of 60 mm per hour (maximum hourly intensity of rainfall). Run-off coefficient for open ground area (unpaved) shall be minimum 0.80 and for paved area and other covered surface including roads the same shall be considered as 1.0.

Surface drains will normally have a slope of 1 IN 1000 along longitudinal direction and RCC pipes to have such slopes such as to have effective discharge. RCC or masonry structures will be provided at drops/falls to prevent scouring. Drops/falls shall be provided on both sides of box/pipe culverts. Minimum self-cleansing velocity should be adopted as 0.7m/sec but the velocity of flow should not be more than 2.4 m/sec for concrete drain, however, it is recommended to maintain the maximum velocity within 1.2 m/sec.

#### 15.0 Pavements

- Boiler Area

The entire area encompassing both the units from Power House to Chimney will be paved with reinforced cement concrete with and sloped to drains. Immediately adjacent to these areas water bound macadam roads with bituminous topping will be provided as required for access to equipment.

- Transformer Areas and Switchyard

Oil cooled equipment, such as transformers, will be located within concrete basins filled with gravel. The individual basins will be connected by pipeline to a separate chamber/oil pit for collection and further reclamation of oil through oil water separators, if necessary.

Drains will be adequate to remove full discharge from deluge system used for fire control. Transformer Yard will be paved with reinforced cement concrete. Switchyard area shall be filled with 150 mm thick layer of 20 mm to 40 mm size gravel over a layer of 100 mm thick lean concrete (M10).

#### 16.0 Waste water Treatment and Drainage system

The description of some of the major structures/components covered under the Waste Water System Package is given below :

Coal pile area run-off will be led to settling pond. Earthen settling pond with two (2) compartments will be provided. Top of earthen dyke shall be 500mm above surrounding finished grade level to restrict ingress of



storm water from adjacent areas. Capacity of pond shall be determined on the basis of inlet drain invert. The side slopes and bottom will be protected with PCC blocks of minimum 75mm thickness with suitable underbed having interstices filled with cement-sand mortar. At the downstream of pond RCC overflow weir and sump shall be provided. Design and detailing of pond shall be as per good engineering practice so as to satisfy functional requirement as specified in Section-IIH of this specification. Necessary sluice gates with hoisting arrangement shall be provided in inlet drain (battery limit for drain shall be as shown in tender drawings) carrying coal pile area run-off so that one settling pond can be operative while the other one under excavation.

The Power House and Boiler area service water waste shall be collected in a RCC underground oily waste retention pit. Necessary pumps and supporting floor/maintenance area shall be provided. This effluent will finally be treated in CPI. Foundation for CPI shall be designed as per IS:456.

Oil storage and handling area run-off will be collected to a conventional baffled oil water separator (battery limit shall be as shown in tender drawings). This oil water separator will be an underground RCC structure having RCC baffle wall and overflow sump for collecting water at outlet end. An oil collection pit shall be provided on sidewall of oil water separator. This structure shall be designed as uncracked section as per IS:3370. The structure shall project at least 300mm above finished grade level. Handrail shall also be provided around the pit. The overflow sump shall be covered at top over which pumps will be installed.

RCC sump for collecting boiler blow down and ESP area floor washing shall be under scope of other package. However, civil work for outlet of this effluent shall be under scope of this package.

Effluent from plant sanitary sewage shall be treated in Up-flow filter and finally discharged to soak pits. Outlet of septic tanks shall be the inlet of Civil Work for Effluent Treatment Work under this package. Design and construction of Up-flow filter and soak pit along with other necessary civil work shall be under scope of this package.

There will be a Guard Pond (effluent monitoring pond and equalization basin) sized for holding wastewater more than 24 hours before final discharge to storm water drainage system. The guard pond (earthen) shall have adequate capacity as per design requirement with 750 mm free board. Top of earthen dyke shall be 500mm above finished grade level. The pond shall be of such construction as to prevent pollution of ground water by seepage of any wastewater having side slopes and bottom lined with minimum 1.0mm HDPE for minimizing seepage loss. Over the LDPE lining, PCC blocks of minimum 75mm thickness having interstices filled with cement-sand mortar shall be provided. Filter media shall be suitably designed & provided below liner.





All other civil works including drains / MS pipe with fitting / RCC pipes / pipe racks including foundations etc. for successful completion and operation of waste water treatment plant shall as mentioned elsewhere in this specification.

#### 17.0 Sanitary Sewerage System

The scope of foul water from toilet shall include layout and laying of sewers up to the septic tank, up-flow filter with soak pit for individual building for sewerage system together with all fittings and fixture and inclusive of ancillary works such as connections, installation of man-hole and inspection chambers. Sanitary outlet can be discharged to surface drain after treatment.

#### 18.0 Construction Facilities for early works

The Bidder shall develop and construct all necessary facilities like Batching plant, Chilling plant, Construction store, Fabrication yard and Raw material storage area and Canteen for site personnel at no extra cost to the Owner. The associated roads and drains connecting these facilities shall also be constructed by the Bidder. The Bidder shall visit the site and locate suitable areas for these facilities.

### 5.00.00 DOCUMENT SUBMISSION

Design and Construction documents pertaining to all Civil, Structural and Architectural works that will be required to be submitted to Owner/ Owner's Consultant/Review Consultant for their approval have been brought out under following clauses. Approval of these documents by the Owner/Consultant shall not relieve the successful bidder of his responsibility for any errors and fulfillment of Contract requirements.

#### 5.01.00 Design Document

Design Document shall comprise Mechanical/Electrical assignment Drawings, design data, design assumptions & references, detailed structural analysis (including computer output, if any) & design calculations and design drawings.

Design calculations and drawings shall be submitted and reviewed only after approval of corresponding Mechanical/Electrical/System general arrangement drawings. The contractor shall submit approved GA drawings along with three (3) copies of design documents (except design drawings), four (4) copies of design drawings for comments/approval of the Owner/Consultants. On final approval of the drawing and design, Contractor shall submit eight (8) copies of the drawing with one soft copy in CD each to the Owner and consultant for distribution.

#### 5.02.00 Construction Document

Based on approved design drawing, detailed drawings for construction will be prepared by the successful bidder. For reinforced concrete structures and foundations detailed bar bending schedules in approved format shall







accompany each detailed drawing. For structural steel work the successful bidder will prepare detailed fabrication drawing along with bill of materials.

Six (6) copies each of selected or all detailed drawings/ fabrication drawings as decided by Engineer for all structures along with bar bending schedule/bill of materials need be furnished to Owner/Consultants for their review and approval.

Upon approval, eight (8) copies of each drawing along with one soft copy in CD shall be submitted to the Owner and Consultant for their distribution. Procedures for submission and approval of Construction Documents other than stated above have been mentioned elsewhere in this specification.

**5.03.00 As Built Drawings**

"As-built" drawings shall be prepared by the Contractor after completion of construction / erection incorporating all the changes, if any, done on Engineer's instruction/approval. In case of any discrepancy in the number of prints and CD to be submitted for Design, Construction documents and As-Built drawings mentioned elsewhere in the specification, stipulations made here shall prevail.

**6.00.00 LAYOUT**

Before starting the work, the successful bidder shall carry out the setting out of foundation and structures and provide levels, with reference to general existing grid and benchmark. If the successful bidder uses the grid, benchmark and reference pillar made by other Contractors, he shall coordinate with the Contractor and shall satisfy himself of the accuracy of the reference marks. If he is required to set out the foundation afresh, he shall do so independently with reference to the one existing grid and benchmark, which has been followed by other agency at the instruction of the Engineer. In case any discrepancy is found, it shall be immediately brought to the notice of the Engineer for any rectification / modification necessary. No complaint shall be entertained at a later stage. The successful bidder shall accurately set out the position for holding down bolts and inserts.

If required, in the option of the Engineer, he shall construct and maintain pillars for grid, references and benchmarks and maintain them till the completion of the construction. He shall also help the Engineer with instruments, materials and labours for checking the detailed layouts and levels. The successful bidder shall be solely responsible for the correctness of the layout and levels, and Engineer's approval shall not be deemed to imply any warranty in carrying out the works correctly. The Tenderers shall take into account the cost of these in quoting their price.

**7.00.00 WORKSMANSHIP**

Workmanship shall be of the best possible quality and all work shall be carried out by skilled workmen except for those, which normally require unskilled persons. Welding shall be done by experienced and certified welders in proper sequence using necessary jigs and fixtures. Fabrication shall be done in shops having proper equipment for accurate edge lining and milling of column shaft ends, base plate surfaces etc., and shaping and dimensioning of anchor bolt





assembly, inserts and other misc. items. In addition to the requirement specified above, if the bye- laws of the local Govt., Municipal or other authorities require the employment of licensed or registered workmen for various trades, the successful bidder shall arrange to have the work done by such registered or licensed personnel. In case of manufactured materials, the successful bidder shall have, with no additional cost to the Owner, the services of the supervisors of the manufacturers to ensure that the work is being done according to the manufacturer's specifications.

**8.00.00 TEMPORARY WORK**

All scaffoldings, staging, temporary bracing and other necessary temporary work required for proper execution of the Contract shall be provided by the successful bidder at his own cost and inclusive of all materials, labour, supervision and other facilities.

The layout and details of such Temporary work shall have the prior approval of the Engineer, but the successful bidder shall be responsible for proper strength and safety of the same. All Temporary work shall be so constructed as not to interfere with any permanent work or with the work by other agencies. If it is necessary to remove any of the temporary work at any time to facilitate execution of the work or with the work of other agencies, such removal and re-erection, if required, shall be carried out by the successful bidder at the direction of the Engineer without any delay and any extra cost on this account shall be borne by the successful bidder.

**9.00.00 INTERFACE WITH STRUCTURES UNDER OTHER'S SCOPE**

Modification in layout of foundation/structure during detail engineering stage may be necessary to avoid fouling with those under other's scope. Necessary changes on this account will be made without any extra cost to Owner.

**10.00.00 SEQUENCE OF WORK AND PROGRESS REPORT**

The sequence in which the works are to be carried out shall be as approved by the Engineer in accordance with the construction method accepted by the Engineer and to be followed by the successful bidder. A programme of work is to be submitted for the Engineer's review and approval and this has to be periodically updated and modified as per actual progress to enable timely completion.

The successful bidder shall regularly submit to the Engineer progress reports for periods of working as specified by the Engineer showing up to date progress on all-important items of work.

**11.00.00 CIVIL FOUNDATION OF THE FUTURE EQUIPMENT ALREADY DONE**

A few civil foundations have already been constructed for future equipments. Such existing foundation details including bolts, inserts etc to be studied in detail before procurement of specific equipments for respective purposes so that the same can safely be placed over the existing foundations complying all technical compatibility. In case this is not at all possible, new foundations need to be constructed after complete demolition of existing foundations.





## ANNEXURE-I

## LIST OF CIVIL FIELD QUALITY ASSURANCE LABORATORY APPARATUS

SL #	DESCRIPTION	QUANTITY
1	Cube moulds - 150 mm (ISI marked)	144
2	Cube moulds - 70.6 mm	18
3	Cube moulds - 50 mm	9
4	Cylindrical moulds - 300 long 150 dia	18
5	Beam mould – 700X150X150	18
6	Cube testing machine with two dial gauge and brick plate attachment	1
7	Digital thermometer - 200°C	6
8	Electrical oven	1
9	IS sieve set – 75 $\mu$ , 150 $\mu$ , 300 $\mu$ , 600 $\mu$ , 1.18 mm, 2.36 mm, 4.75 mm, 6.3 mm, 10 mm, 12.5 mm, 16 mm, 20 mm, 22.4 mm, 25 mm, 31.5 mm, 40 mm, 50 mm, 53 mm, 63 mm, 80 mm, 90 mm, 120 mm, 125 mm, pan (24 nos. per set)	1 Set
10	Measuring cylinder (glass) 50 ml, 200 ml, 500 ml	2 each
11	Physical balance Digital 10 kg capacity L.C. – 1 gm	1
12	Platform balance – Digital: 200 kg capacity	1
13	Pycnometer	2
14	Slump cone with tamping rod	8
15	Specific gravity bottle – 50 ml	2
16	Air entrainment meter capacity – 0.005 cum	2
17	Casegrande apparatus	1
18	Core cutter with collar and rammer	16
19	English type trowel	12
20	Hygrometer with thermometer	1
21	Impact testing machine	1
22	Le-Chatelier apparatus with water bath	1
23	Measuring cylinder (plastic) 50 ml, 100 ml, 200 ml, 500 ml	1
24	Modified Proctor test apparatus	1
25	Length gauge	1
26	Penetrometer for mortar test	1
27	Moisture meter	1
28	pH meter	1
29	Sand replacement method apparatus	2
30	Screw gauge	2
31	Spatula	8
32	Standard Proctor test apparatus	1
33	Standard sand grade 1, 2, 3	500 kg each
34	Stop watch - Digital	1
35	Thermometer ordinary 50°C	10
36	Thickness gauge apparatus	1
37	Vernier calipers - Digital	1
38	Vicat apparatus	2
39	Weigh Boxes	4
40	Cylindrical measures: - capacity 0.01 cum, Dia (I) – 250 mm, Height – 280 mm, (I) with tamping rod as per IS 1199.	1



**WBPDC**

**EPC Bid Document  
Sagardighi Thermal Power Project  
1x660 MW Unit No. 5, Phase - III**

**VOLUME: II-G/1**

**SECTION-II**

**SPECIFIC DESIGN CRITERIA - CIVIL**



**Development Consultants Pvt. Ltd.**

**Volume : II-G/1  
Section : II  
Specific Design Criteria - Civil**



**WBPDC**

**EPC Bid Document  
Sagardighi Thermal Power Project  
1x660 MW Unit No. 5, Phase - III**

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## **ATTACHMENT**

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**Development Consultants Pvt. Ltd.**

**Volume : II-G/1  
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## SECTION - II

### SPECIFIC DESIGN CRITERIA - CIVIL

#### 1.00.00 INTRODUCTION

This section outlines the followings:

- a) A brief description of Soil Characteristics.
- b) Design considerations for Reinforced Concrete Structures.
- c) Design considerations for Foundations.
- d) Roads.

#### 2.00.00 SOIL CHARACTERISTICS

Previous Soil investigation Report for the adjacent units (3 & 4) may be referred for preliminary information. However, detail soil investigation, as required, to be carried out for foundation design of various facilities.

Soil characteristics and parameters to be adopted in final design, the successful bidder is required to do detail geotechnical investigation work as part of the contract to verify/generate data so required.

It should be noted that nothing extra whatsoever on account of variation between soil data annexed in this specification and that found by detailed geotechnical investigation to be carried out by bidder shall be payable.

#### 3.00.00 LOADS

All structures and portions thereof shall conform to the latest revision of relevant Indian Standard specifications and also to the various other technical requirements. Any structure, which carries Indian Railway Loading or is situated in the vicinity of Railway Lines, the design has to conform to the Indian Railway Standard Specifications and approval must be obtained from Railway Authority including the clearance etc. All structures shall be designed to sustain within the stress limitation as specified in the Code, all dead loads plus assigned live, equipment, wind, seismic or other design loads.

##### a) **Dead Loads**

Dead load shall include the weight of all structural components and architectural appurtenances incorporated in the structures plus hung loads and any other permanent, externally applied load. This should also include equipment dead load. The content of tanks, silo, bins and hoppers shall be measured at full capacity for this purpose. Hung loads





and the contents of tanks, silo, bins and hoppers shall be listed separately so that they can be excluded from dead load when dead loads are acting as stabilizing loads for uplift.

The following unit weight of material shall be considered for computation of loads. Loads given in IS:875 (part-I) shall be made use of for material not listed below.

Materials	Unit weight
Plain cement concrete	: 24.0 kN/cum
Reinforced cement concrete	: 25.0 kN /cum
Structural steel	: 78.5 kN /cum
Brick work	: 19.0 kN /cum
Cement plaster	: 21.0 kN /cum
Floor Finish	: 24.0 kN /cum
Coal	: 12.0 kN /cum
Fly Ash	: 16.0 kN /cum
Bottom Ash	: 16.0 kN /cum

**b) Live Loads**

Live loads in different areas shall include dust loads, minor equipment loads, cable trays, small pipe racks/hangers, operation/maintenance loads etc. The loads considered shall not be less than those specified in IS: 875 (Part II).

The loads listed hereunder are minimum loads for the areas involved. Special use areas shall be investigated and loading revised upward as necessary.

Hung loads shall be based on minimum loading equivalents of 1.0 kN/Sq.m for piping and 0.5 kN/Sq.m for electrical, ventilation and air conditioning. Loadings resulting from concentrations of facilities in specific areas shall be substituted where listed base loading is excluded.

**i) All Buildings****a) Roofs :**

Inaccessible roof (Flat) : 1.5 kN/Sq.m + hung loads,  
if any + 0.5  
kN/Sq.m (dust load).

Accessible roof where  
equipments are placed : 5 kN/Sq.m + hung loads,  
if any + 0.5 kN/Sq.m (dust load).

Accessible roof  
without equipments : 1.5 kN/Sq.m + hung loads,







if any + 0.5 kN/Sq.m (dust load).

- Inclined roof : As per IS : 875 (Part 2).
- b) Stairs & Platforms : 5.0 kN/Sq.m
- c) Corridors : 5.0 kN/Sq.m
- d) Removable gratings, chequered plates, walkways etc. : 5.0 kN/Sq.m
- e) Office, Laboratory, Conference rooms and other non-plant areas etc. : 5.0 kN/Sq.m

ii) **Power House Building**

- a) Ground Floor
- Unloading Bay : 50 kN/Sq.m
- Other areas : 25 kN/Sq.m
- b) Mezzanine Floor : 15 kN/Sq.m plus hung loads.
- c) Operating Floor
- Equipment Lay-down Area : 35 kN/Sq.m plus hung loads or actual load furnished by equipment supplier whichever is higher
- Rotor Removal Area : 50 kN/Sq.m plus hung loads or actual load furnished by equipment supplier whichever is higher
- : Rotor removal area beams shall also be checked for half the rotor load at the center of the beam
- Other Areas in Turbine Hall : 25 kN/Sq.m plus hung loads
- All other Areas in Operating Floor except Turbine Hall : 15 kN/Sq.m plus hung loads
- d) Cable Spreader Floor : 7.5 kN/Sq.m plus hung loads





- e) All other floors : 10 kN/Sq.m plus hung loads
- f) Due to anchoring of conductors on any "A" row column : 2 x 20 = 40 kN (Twin ACSR Moose Conductor) and 10 kN (Shielding Wires)  
OR  
actual load furnished by equipment supplier, whichever is higher
- iii) Mill Building
- a) Ground Floor : 25 kN/Sq.m
- b) Feeder Floor : 15 kN/Sq.m + hung loads + 0.5 kN/Sq.m (dust load).
- c) Tripper Floor : 15 kN/Sq.m + hung loads + 0.5 kN/Sq.m (dust load).
- iv) Auxiliary Buildings
- a) Ground Floor : 10 kN/Sq.m
- b) Cable Spreader Floor : 7.5 kN/Sq.m
- c) Pump House Operating Floor : 15 kN/Sq.m / As supplied by pump manufacturer, whichever is higher
- d) Office Floor : 5 kN/Sq.m
- e) Switchgear room : 15 kN/Sq.m
- f) All other Floors : 10 kN/Sq.m
- v) Non Plant Buildings
- a) Floors with equipment: 10 kN/Sq.m
- b) All other floors : 5 kN/Sq.m
- vi) Coal handling structures :
- 1) Flat accessible roofs : 1.5 kn/sq.m + 1 KN/sq.m dust load.
- 2) Flat accessible roofs : 0.75 kn/sq.m + 1 KN/sq.m dust load



- 3) Inclined roof : In accordance with IS 875  
For live load + 0.25 KN/sq.m  
For dust load.
- 4) All TPS and Crusher  
house floors : 7.5 KN/sq.m
- 5) Switch gear and  
MCC floor : 10 KN/sq.m
- 6) Walkways of Gallery : 3 kn/sq.m or a concentrated  
load of 2 KN at center +  
dust load of 1 KN/sq.m
- 7) Wagon Tippler:

Grizzly over the Wagon tippler hopper shall be designed for JCB/Hydraulic excavator loads. Also hopper and grizzly shall be designed for loads transmitted by coal heap equivalent to 5m.

Coal density shall be considered as 1200 kg /cum for design of wagon tippler hopper.

Wagon tippler structure shall be analysed for the worst load combination. However it shall be analysed for the following load combination also.

1. Combination-1

- i. Hopper full
- ii. Equipment load
- iii. Maximum load from railway track
- iv. Earth pressure without surcharge and sub soil water pressure
- v. Maximum load from steel column for shed
- vi. Maximum load from paddle feeder support
- vii. Maximum load from coal tray

2. Combination-2

- i. Hopper full
- ii. Equipment load
- iii. Maximum load from railway track
- iv. Earth pressure with surcharge and subsoil water pressure
- v. Maximum load from steel column for shed
- vi. Maximum load from paddle feeder support
- vii. Maximum load from coal tray

vii) Underground Structures/Trenches/pits

Minimum surcharge shall be 20 kN/Sq.m. For structures in vicinity of roads and heavy vehicular movement surcharge shall be considered as applicable as per loading specified elsewhere in this specification.





Trenches/pits inside building shall be designed for a surcharge equal to Live Load intensity of Ground Floor or 15 kN/Sq.m whichever is greater. In Boiler area and other outdoor areas within Power Block, the minimum surcharge shall be 20 kN/Sqm.

viii) Covers for Trenches / Channels

Self-weight of top slab and a uniformly distributed load of 4.0 kN/Sqm on each panel or one 0.75 kN central point load, whichever is critical, shall considered. At road crossings, the covers shall be designed for vehicular movements as per IRC standards

ix) Roads

Design of roads shall be in accordance with Indian Road Congress standard IRC 37.

x) Road Culverts and its allied structures including R.C.C. Pipe Crossings & Road Crossing of Trenches

Road culverts and its allied structures including R.C.C. Pipe Crossings & Road Crossing of Trenches shall be designed for Class `AA` loading (wheeled and tracked both) and to be checked for Class `A` loading as per IRC standards.

xi) Railway Supporting Structures, Rail Culverts

Railway supporting structures and rail culverts shall be designed as per Railway Bridge Rules.

Reduction in Live load as per provision of IS:875 shall not be permitted.

The areas covered with equipment shall be designed on the basis of weight of equipment (flooded/operating) in addition to an uniform live load of 5.0 kN/Sqm or specifically defined live load whichever is greater.

Foundations and fixing arrangements for items of equipment, which generates vibration, will be designed to prevent transfer of such vibrations to the adjoining structures.

For loads caused by moving equipment over the floor for installation, consideration shall be given to the shoring of beams and floor, from floors below.

c) Equipment Loads

i) Loadings (both static and dynamic) of major equipments, including boiler, turbine-generator, boiler feed pumps, feed water heaters, de-aerator, PA, FD & ID fans, Coal Mill obtained from the manufacturer's certified drawings of the specified





equipment to be furnished. Where design of structures supporting minor equipment other than those included above has to proceed, the loadings will be estimated from similar jobs or catalog data.

- ii) All equipment, tank and piping design loadings will include Hydraulic Testing loads.
- iii) Air and gas duct loadings will include weight of insulation, duct attachments, dust accumulation loads, seismic, wind and other loads as applicable.
- iv) Crane girders and supporting columns will be designed for vertical and horizontal forces (including impact forces) as developed from the crane weights and wheel loads. Unless otherwise specified, the vertical and horizontal loadings will conform to the applicable sections of the IS specifications.
- v) Weight of equipments, ducts, tanks, pipes, conduits etc. supported by structure shall include maximum possible loading conditions i.e. flooded material contents and associated impacts, test loadings, anchorage and constraint effects.
- vi) All structural components shall be designed to accommodate anticipated concentrated loads which will or may be applied during the life of the plant.

Where both concentrated and uniform loads cannot act simultaneously, the structure or component shall be analyzed for both conditions of loading and shall be designed for most critical condition.

- vii) Jet forces resulting from guillotine type pipe ruptures shall be considered in the design, if it is of high magnitude. Jet force to be considered shall be equal to the product of the pipe cross section and the internal design pressure applied on an area equal to the pipe cross section.
- viii) Lay down areas in the Turbine Hall shall be investigated for concentrated loads resulting from equipment components to be stored during erection and maintenance operation. Where live load allowance is inadequate to permit storing of such equipment components, the design live load shall be increased to permit such use or the area shall be restricted by identifying lay down areas for specific components, each area to be identified by permanent marking.

d) Wind Loading

Wind loading will be in accordance with Indian Standard Code IS:875





(Part 3, Latest Revision) for a basic wind speed of 47 m/sec. upto a height of 10 metres above mean ground level. Terrain Category-2 shall be considered for all structures.

Risk coefficient ( $k_1$ ) shall be considered as 1.07 for all structures.

Notwithstanding the design wind forces calculated based on above parameters, the structures shall not be designed with a wind pressure less than 1.5 Kn/ sq.m.

e) Seismic Loading

The lateral forces will be established in accordance with the recommendations of IS:1893 (Latest Version only). The site falls in Zone-III as identified in the map in IS:1893. Importance factor shall be taken as per latest versions of IS:1893 parts.

Response spectrum method shall be used for seismic analysis as per IS : 1893 for tall and irregular buildings / structures like Boiler structures, Power House building, Mill building, TG foundation, ESP structure, Stack, all Transfer points, Ash Silo etc.

f) Temperature Loads

The structures shall be designed to withstand stresses due to fifty (50) percent of the total temperature variation. The total temperature variation for temperature loading should be taken as two thirds (2/3) of the average annual variation in temperature. The average maximum annual variation for this purpose will be taken as the difference between the mean daily minimum temperature during the coldest month of the year and mean daily maximum temperature during the hottest month of the year.

Mean Daily minimum ambient temperature during coldest month of the year = 5° C

Mean Daily maximum ambient temperature during hottest month of the year = 50° C

Expansion and contraction due to changes of temperature of materials of a structure shall be considered and adequate provision shall be made for the effects produced as per provision in the relevant IS codes.

g) Steam Piping Load

Minimum intensity of steam piping load shall be 6.0 kN/Sqm for the areas at different levels through which steam piping is routed. However, the bidder shall check the loading as per static/dynamic analysis for steam piping or load data supplied by piping vendor and the worst loading shall be considered in design. Horizontal anchor loads, if any,





shall also have to be considered in design.

h) Earth Pressure Load

Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable). However, for design of substructure of pump house and underground liquid storage tanks earth pressure at rest shall be considered with coefficient of earth pressure at rest shall not be less than 0.50.

In addition to earth pressure and ground water pressure, etc., surcharge load shall also be considered for the design of all underground structures including channels, sumps, cable & pipe trenches, etc., to take into account the vehicular traffic in the vicinity of the structure. Intensity of Surcharge Load shall be as described elsewhere in this specification.

i) Crane, Monorail & Elevator Loads

Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as per crane vender's data. All lifting beams and monorails shall have their design loads increased for impact factor as mentioned hereinafter.

Impact Factor

Loads for cranes, hoists and elevators shall be taken as per IS:875. The minimum impact factor to be used in design shall be as follows:

Crane loads

- a) For vertical force, an impact factor of 25% of the maximum crane wheel load
  - b) A lateral crane surge of 10% of the weight of the trolley plus lifted load applied at the top of each rail
  - c) A horizontal surge of 5% of the maximum static wheel loads of the crane applied at the top of the rail in longitudinal direction.
- Monorail loads
- a) Impact factor of 10% of lifted load of hoist for monorail and support design
  - b) Impact factor of 25% of the lifted load for electrical pulley and support design

Elevator

A 100% of the lifted load including elevator live load plus the cab weight for the elevator support beams.





**j) Construction Loads**

The integrity of the structures shall be maintained without use of temporary framing struts or ties and bracing so far as possible. However, construction or crane access considerations may dictate the use of temporary structural systems. Special studies shall be made and documented by bidder to ensure stability and integrity of the structures during any periods involving use of temporary bracing systems.

**k) Other Loads**

Stresses imparted to structures due to differential settlements, variation of water table, erection and maintenance load, creep and shrinkage shall also be considered in design of all structures.

All Power House columns adjacent to first row of Boiler columns shall be designed for an additional load of 500 kN to account for piping/cable rack loads.

All structures situated in the vicinity of railway lines shall be designed conforming to the Indian Railway Standard Specification.

**l) Thrust Load**

Thrust blocks will be designed against the thrust load from pipe lines considering the test pressure in the pipe lines.

**m) Ash Silo**

The following densities shall be considered for design of ash silo / buffer hopper / bottom ash extraction hopper etc.

- a) For volume calculation of bottom ash silo : 6.5 kN/cum
- b) For volume calculation of fly ash silo : 7.5 kN/cum
- c) For load calculation of both types of silos : 16.0 kN/cum

The ash silo shall be designed generally as per the criteria laid down in IS:4995 (Part I&II). The static pressure calculated at rest shall be multiplied by an over pressure factor of 1.35 for the top 1/3 rd portion and by a factor of 1.75 for the bottom 2/3 rd portion. Special attention shall be given in assessing the effect of hot temperature of ash on the wall. Temperature of ash shall be considered in design.

**3.01.00 Stability of Structures**

Design shall be checked against buoyancy due to the ground water during construction and maintenance stages for structures like underground tanks, pits





trenches, basements, etc. Minimum factor of safety of 1.25 against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loading. For purpose of calculating downward load due to any overburden, only the mass located vertically above the projected area shall be taken into consideration.

All building sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads. Factor of safety for these cases shall be taken as mentioned in IS:456 and other relevant IS Codes, subject to the following minimum values.

- a) Factor of safety against overturning due to wind, seismic or other lateral load shall be 1.5 minimum.
- b) Factor of safety against sliding shall be 1.5 minimum.
- c) Factor of safety against uplift due to hydrostatic forces shall be 1.25 and due to any other loads shall be 1.5.

Stability of the structure shall also be investigated for loading conditions during construction, repair or other temporary measures. Lower factor of safety may be used for such loading conditions as per relevant IS codes.

In case where dead load provides the restoring force, only 0.90 times characteristic dead load shall be considered. Imposed loads shall not be considered as restoring force.

Ground water table shall be considered at Plant Finished Grade Level for design of foundations and all underground structures.

### 3.02.00 Load Combinations

While designing consideration shall be given to the following load combinations:

- i) DL + LL
- ii) DL + LL + PL + Equip  $\pm$  TL
- iii) DL + LL + PL + Equip + Cb + CtLA $\pm$  CS  $\pm$  TL
- iv) DL + LL + PL + Equip + Cb + CtLB $\pm$  CS  $\pm$  TL
- v) 0.9DL  $\pm$  EL (for DL only)  $\pm$  TL
- vi) 0.9DL  $\pm$  WL1  $\pm$  TL
- vii) 0.9DL  $\pm$  WL2  $\pm$  TL





- viii)  $DL + *LL + PL + Equip + Cb + Ct \pm EL \pm TL$   
(\* Appropriate portion of LL which is considered for working out EL shall only be taken)
- ix)  $DL + LL + PL + Equip + Cb + CtL1 \pm (CS1+WL1) \pm TL$
- x)  $DL + LL + PL + Equip + Cb + CtL1 \pm (CS1+WL2) \pm TL$

Where the above loads are :

- DL = Dead load of structures, floors, walls etc.
- LL = General live load on floors
- PL = Pipe Load
- Equip = Equipment loads
- Cb = Crane Bridge
- Ct = Crane trolley positioned at middle of bridge
- CtLA = Crane trolley + Load near one row
- CtLB = Crane trolley + Load near other row
- CtL1 = Crane trolley + Half load lifted at centre of bridge
- CS = Crane surge for full load
- CS1 = Crane surge for half load lifted
- WL1 = Wind load from left to right
- WL2 = Wind load from right to left
- EL = Earthquake load
- TL = Temperature load

Appropriate impact factor shall be considered as per IS:875 (Part 2) while calculating crane loads.

In calculating wind loads, appropriate internal thrust / suction shall be considered along with external pressures as per IS:875 (Part 3). All possible load conditions considering external and internal pressures shall be considered in analysis and design for each combination number (vi), (vii), (ix) & (x) above to assess worst effect on whole structure as well as its components.





Appropriate allowable increase in permissible stresses as per IS codes, may be taken only under normal loads along with wind and seismic conditions. However, members which are designed primarily to resist wind, no increase in permissible stresses will be permitted.

Applicable load factors to be used for design of RCC structures by Limit State Method as per IS:456.

#### Load Combinations for Underground Structures

Following loading conditions shall be considered in addition to the loading from super structure for the design of sub-structure of pump house, channels, sumps, tanks, reservoirs, trenches and other under-ground structures.

Only liquid pressure from inside and no earth pressure and ground water pressure, and surcharge pressure from outside (applicable only to the structures which are liable to be filled with water or any other liquid).

Earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

Base slab of the pump house shall be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum ground water table. Intermediate dividing piers of pump sumps and partition walls in channel shall be designed considering water on one side only and the other side being empty for maintenance.

Design shall also be checked against buoyancy due to ground water during construction and operation stage. Minimum factor of safety as per IS:3370 against buoyancy shall be ensured considering empty condition ignoring superimposed loads.

### 3.03.00 Design Concepts

Wind and seismic forces shall not be considered to act simultaneously.

For the design of main plant structures during seismic condition, the Deaerator Feed Water Tank shall be considered full up to operating level. However, for other load combinations, Deaerator Feed Water Tank in flooded condition shall be considered.

'Lifted Load' of crane shall not be considered during seismic condition.

For design of all underground structures/foundations, ground water table shall be considered at the Finished Ground Level.

If R.C.C. floors and roofs except those cast over metal decking are assumed to act as diaphragm transmitting lateral loads to braced bays then main beams/girders shall be provided with shear connectors. However, whenever large/more number of cutouts is provided in the floor slab, horizontal floor





bracings shall be provided below slab to transfer horizontal force to columns without considering diaphragm action from slab. Shear connectors shall also be provided over beams having R.C.C. slab on one side and opening /chequered plate / grating on other side.

For R.C.C. roofs cast over metal decking, horizontal bracings must be provided below slab to transfer horizontal force to columns.

In Turbine Bay, horizontal wind girders between A-row and B-row columns must be provided below Mezzanine and Operating floor at gable ends to transmit wind load from gable columns.

PTFE bearing shall be provided where horizontal loads not to be transferred.

For calculation of seismic load, equipment load shall be considered as Dead Load.

Ultrasonic pulse velocity tests shall be carried out for the top decks of all machine foundations viz. TG substructures, BFP Foundation, ID fan, FD fan, PA fan and Mill foundations to ascertain the homogeneity & integrity of concrete.

Whenever any structure under this contract will carry or receive additional load from the work of any other contract, the structures under this contract shall be provided with sufficient margin to carry the above load (like Mill Bay structure, Trestles etc.) details of which shall be finalized during detail engineering.

Gratings / chequered plates shall not be considered as restraining members for compression flange of beams/girders. Diaphragm action shall also be not considered in design. Adequate horizontal bracings to be provided.

#### **4.00.00 DESIGN OF REINFORCED CONCRETE STRUCTURES**

- a) Reinforced Concrete Structures shall be designed in accordance with the requirements of IS-456 & IS-875 subject to the minimum Grades as specified in this specification for all possible combination of loads, e.g. dead load, live load, crane loads, wind or seismic loads, soil loads and surcharge loads.

The following minimum grades of concrete as per IS-456 shall generally be used.





Sl. No.	Class	Grade of conc.	Min. cement content Kg/Cum	Max. free water cement ratio
1.	i) Plain cement concrete used for screeds and backfill	M10	-	-
	ii) Lean concrete	M10	-	-
2.	Paving in main plant area/Grade Slab	M20	300	0.55
3.	i) Reinforced concrete for super structure and foundation	M25	300	0.5
	ii) Reinforced concrete for water retaining structure	M25	300	0.5
4.	Pre-cast concrete	M25	300	0.5
5.	Reinforced concrete for foundation of TG, Mill & Fan foundations	M30	320	0.45
6.	TG top deck	M35	340	0.45
7.	Piles	M25	400	0.5

- b) Reinforcing bars will be TMT bars of grade Fe500 conforming to IS-1786 and Mild Steel bars conforming to IS : 432 (Grade I) of main producer such as "SAIL" or "TATA STEEL" or "RINL" or vendor approved by WBPDC.
- c) For equipment (supported on VIS) foundations including top deck, Coal Mill foundation, Ordinary Portland Cement (grade 43) shall be used. For all other concrete work included in the scope of this specification shall be either with Ordinary Portland cement or Portland Slag Cement Or Portland Prozzolana cement.
- d) The design of R.C. Structures shall be carried out by limit state or working stress method as per the provisions of IS-456.
- e) Concrete tanks/water retaining structures will be designed in accordance with the recommendation of IS-3370.
- f) Grouting material :

Grouting shall be done with Conbextra GPX-2 of 'Fosroc' or or 'SIKA' or equivalent for Equipment foundations and Conbextra GP-1 or equivalent for





all structural column bases. For pipe-supports grouting shall be done with 1:1:2 cement-sand - 6mm down stone chips.

- g) RCC silos shall be designed as per IS:4995 (part 1 & 2).
- h) For reinforcement detailing IS:5525 and SP:34 shall be followed.
- i) The walls shall be provided with reinforcement on both faces for sections 150 mm or more, even if not required from design consideration.
- j) Liquid Retaining Structures

RCC water retaining structure like storage tanks, reservoirs etc., shall be leak proof and designed as uncracked section in accordance with IS:3370 (part I to IV) by working stress method.

Substructure of pump houses shall be designed as cracked section with limiting crack width of 0.1 mm and limiting steel stresses as per IS:3370 (Part I to IV) by working stress method for concrete face away from water/liquid. For faces in contact with water/liquid the structure shall be designed as uncracked section in accordance with IS:3370 (part I to IV) by working stress method.

All water retaining / storage structures shall be designed assuming liquid up to the height of wall irrespective of provision of any over flow arrangement. Pressure release valve may be used in fore bay and 50% release in water uplift pressure through pressure release valves may be considered in design. Properly designed filtering medium below total area of base slab is to be provided as per approved design.

In all liquid retaining structures leak-tightness shall be ensured and guaranteed. To achieve the same, methodology in design and construction in the way of providing PVC water bars at construction/expansion joints and/or injection grouting, usage of admixture in concrete or any such method should be adopted.

All underground water retaining/conveying system structures shall have plasticiser cum waterproofing cement additives conforming to IS:9103 of 'SIKA', 'FOSROC' make. In addition, limits on permeability as given in IS:2545 shall also be met with. The concrete surface of these structures in contact with soil shall be provided with minimum two coats of bituminous painting of grade 85/25 conforming to IS:702 @ 1.7 kg/sqm (minimum) for water / damp proofing. Storm water drains shall not be provided with bituminous paint and weep holes also shall not be provided in storm water drains.





**5.00.00 FOUNDATION DESIGN**

The design of foundation shall be carried out by Limit State or working stress method as per the provisions of IS-456 : 2000 and on the basis of the soil investigation Report done by the Bidder.

Structural concrete for foundation work shall be M-25, unless a higher grade is specified elsewhere in this specification.

**5.01.00 Foundations (For Main Plant Structures)**

Foundations for the main plant structures are those for Power House building columns, Boiler House columns, Mill and Bunker bay columns, ESP columns, etc. Top of RCC foundation for the steel columns shall generally be kept at a lower level so that the column base plates together with gussets and stiffeners remain below the finished floor level. Foundation levels of some columns will have to be suitably lowered to accommodate underground services, pits, trenches, etc.

Common foundation should be provided for columns both side of the expansion joint and shall be designed for loading on both columns.

Foundations for Buildings and structures shall be designed to resist forces and moments, caused by vertical loads and by wind or seismic loads, based on static and dynamic analysis done for those structures. The foundation sections shall be sized and reinforced adequately for moments and shear stresses.

**5.02.00 Heavy and rotating Equipment Foundations**

Loadings (both static and dynamic) of major equipments such as turbine-generator, boiler feed pumps, P.A., FD & ID fans, Coal Mill etc. shall be obtained from the manufacturer's certified drawings of the specified equipment. Where design of structures supporting minor equipment other than those included above must proceed but the exact load data is not available, the loadings will be estimated from similar jobs or catalog data. The foundations for Turbo generator, Boiler Feed Pumps, PA fans, FD fans and ID fans and Mill shall rest on suitable vibration isolation system consisting of springs and damper (M/s. GERB). However, Coal Pulverisers shall be supported on conventional block foundations.

Technical Specification for Vibration Isolation System is attached in Annexure-I of this Section.

For static and dynamic analysis of machine foundation following data will be furnished by the equipment manufacturer.

- a) Loading diagram showing static and dynamic loads and points of application of loads.





- b) Operating speed of m/c; Critical speed of m/c.
- c) Weight of rotating parts; maximum eccentricity of rotating mass from the geometric axis of rotation.
- d) Location of C.G. of machines in all three axes.
- e) Mass Moment of Inertia.
- f) Allowable amplitude/velocity of vibration at machine bearing points.
- g) Temperatures in various areas during operation.

Design of foundations for major equipments shall be done in accordance with relevant parts of IS-2974. Unbalanced loads for normal operating condition as given by machine manufacturer and/or VDI 2060 whichever is more shall be used for calculating dynamic response. The dynamic analysis will consist of free vibration analysis and forced vibration analysis. While designing following aspects shall also be taken care of.

- i) The turbine generator, pulverizer and large fan foundations will be isolated from adjacent structures for vibration control.
- ii) The turbine generator pedestals will be designed to meet the manufacturer's deflection criteria and other recommendations.
- iii) Natural frequencies of structures and components shall be away from the running speed of equipment by at least 20% generally but for important ones it shall be away by at least 30%. However, frequency separation criteria and amplitude criteria as laid down in IS:2974 and/or DIN 4024 and/or VDI 2056 and/or as required by the machine manufacturer, whichever is more stringent shall also be satisfied. A fatigue factor of 2.0 shall be considered for dynamic forces / due to normal unbalance. For design of foundation of large fans etc. provision shall be kept in the foundation for addition of mass/area for retuning of the foundations, if required at a later date.

All block foundations resting on soil shall be designed using the elastic half space theory or Barkan's theory. The mass of the RCC block shall not be less than three times mass of the machine and the CG of the combined mass of foundation and equipment should pass through the CG of the base area with tolerance not more than 5%.

For the foundations supporting minor equipment weighing less than one ton or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structures, floors, etc. suitable vibration isolation shall be provided by means of springs, neoprene pads, etc. and such vibration isolation system (VIS) shall be designed suitably.

Analysis and design of the Steam Turbine-Generator (STG) foundation shall be





carried out in accordance with relevant codes IS: 2974 Part-3 and IS: 456 and/or manufacturer's requirements. The loads to be considered for static analysis and design shall consist of dead weight of the machine and foundation, machine power torque, condenser loads under normal operating condition, Equivalent static load due to machine unbalance, thermal elongation forces, forces due to one sided operation of the condenser, forces due to condensate pump failure, vacuum loads, forces due to piping, frictional forces at machine sole plate level for turbine, generator and condenser, temperature distribution under operating condition, failure loads of turbine (blade unbalance/loss of blade/bowed rotor), failure loads of generator (short circuit loads), seismic loads due to generator, turbine and condenser and erection loads.

In case of machines supported on VIS with springs and viscous dampers it shall be ensured that not more than 5% of the dynamic loads are transmitted to the substructure. Necessary provisions of DIN 4024 shall be adhered to while designing the substructure. Substructure shall be designed for static loads. The vibration isolation system shall consist of helical spring units and viscous dampers supporting the RCC inertia block which support the machine. The spring units shall conform to DIN 2089 and DIN 2096.

For all equipment foundations supported on VIS system, the stiffness of the supporting substructure shall be at least ten (10) times that of spring elements as per DIN 4024.

While performing dynamic analysis of TG and BFP foundation, effect of soil contributing to dynamic properties shall be considered.

Tension in piles shall not be allowed for any combination of loads.

#### Crusher Foundation

Detailed dynamic analysis shall be done for the top deck together with springs and dampers and the natural frequencies and amplitudes of vibration shall be determined. A mathematical model of the top deck shall be formulated with three – dimensional beam / plate finite elements for the purpose of analysis with the spring idealized with vertical and horizontal stiffnesses. The mass of the machine together with that of the top deck shall be considered for the analysis.

Natural frequencies up to at least 10% above the operating speed shall be determined and three frequencies shall be checked against the design criteria. Forced response dynamic analysis shall be carried out for the operating condition unbalance forces using a sinusoidal forcing function. Unbalance forces as given by this specification shall be used for his purpose.

#### Isolation Efficiency

The vibration isolation system shall be designed for about 90% isolation efficiency.





### De-coupling

A ratio of the least 10 (ten) shall be ensured between the stiffness of the supporting structure and the stiffness of the spring system in the vertical direction to achieve de-coupling between the two (the stiffness of the spring system being lower). This ensures that dynamic analysis of the supporting structure need not be carried out.

### Frequency Criteria

The frequency criterion has already been laid down implicitly Foundation isolation efficiency criteria and de-coupling required. The bending mode frequency of the top deck shall be at least 20% above the operating speed.

### Unbalance Forces

Unbalance forces arising out of all the following cases shall be considered for checking the design and amplitudes.

Balance quality grade Q 40 as per VDI 2060 – 1966.

One hammer broken condition. The missing hammer shall be assumed to be closest to the crusher non – drive end of the crusher.

Three hammers broken condition. All the three hammers broken shall be assumed to be from the same suspension bar and located at the non – drive end of the crusher.

### Amplitude Criteria

The calculated amplitudes (mean to peak values) shall not exceed following limits under the specified conditions.

Operating speed of 750 RPM.

150 microns for an unbalance force arising out of balance quality grade Q 40 as per VDI 2060 – 1966.

300 microns in case of a one hammer broken condition.

Amplitudes need not be checked for a three hammer broken condition.

Operating speed of 450 RPM.

200 microns for an imbalance force arising out of balance quality grade Q-40 as per VDI – 2060 – 1966.

400 microns in case of a one hammers broken condition.





Amplitude need not be checked for a three hammer broken condition.

For intermediate operating speed between 450 to 750 RPM the amplitude limits can be linearly interpolated.

The amplitude limits mentioned above are in both vertical and horizontal directions. The amplitude shall be calculated at critical points on the top surface of the R.C.C. deck. The amplitudes shall be checked for the most unfavourable superposition of modes in any direction. However, phase difference between the maximum amplitude occurring in different directions due to the rotating vector may be considered while superimposing the modes.

#### Transient Resonance

Transient resonance, which may occur during the start – up or coasting down condition of the crusher, shall be checked and the amplitudes in such a condition should not exceed one – and – half times those at operating speed for each design condition.

#### Strength Criteria

The following criteria shall apply for the design of top deck :

Dead loads, live loads, Seismic loads and dynamic loads shall be considered for the design. The most unfavourable combination shall considered for design.

Seismic loads shall be assumed to act together with dynamic loads for a one-millimeter eccentricity in the rotor. However, seismic loads and dynamic loads arising out of hammer breakage need not be considered together.

Fatigue shall be considered while designing for dynamic forces. A fatigue factor of 2.0 shall be used on all dynamic forces to arrive at the equivalent static force for the purpose of design.

Working stress method shall be used for the design of R.C.C. deck. In survival condition, 10% overstressing may be permitted.

The R.C.C. top deck shall be at least of M25 grade of concrete as per IS : 456.

Fatigue need not be considered for the three hammer broken condition.

For calculating unbalance forces, the heaviest hammer (plain or toothed) shall be considered.

The static deflection of the crusher supporting beams at the points of spring attachments shall not exceed the value specified by the manufacturer.

Loss of contact of foundations at founding level shall not be allowed for any combination of loads.

#### 5.03.00 Switchyard Foundations

Foundations shall be designed for the worst combinations of dead loads, live loads, forces due to wind/seismic, other relevant loading from service





conditions, forces and moments caused by broken wire condition and loadings, due to thermal effects wherever applicable. The design of foundations and all R.C.C. trenches shall be carried out in accordance with the latest relevant IS codes and specifications.

Factor of safety in the design of foundations shall be 2.2 for normal and broken wire conditions and 1.65 for short circuit conditions. Design of foundation shall be carried out as per IS:4091.

Loss of contact of foundations at founding level shall not be allowed for any combination of loads.

#### 5.04.00 Open Foundations

In case open foundations are adopted, the following shall be adhered to:

- a) Minimum width of foundation shall be 1.0 m.
- b) Minimum depth of foundation shall be 1.0 m below NGL.
- c) It shall be ensured that all foundations of a particular structure/buildings/facility shall rest on one bearing stratum, i.e. either overburden or rock.
- d) Wherever the intended bearing structure is weathered rock but the actual stratum encountered during foundation excavation consists of both overburden soil and weathered rock at founding level, under such cases either the foundation shall be lowered completely into the weathered rock or the overburden soil upto the weathered rock level shall be removed and built up through PCC up to designed foundation level.
- e) The net allowable bearing pressure values to be adopted for design upon Owner's approval shall correspond to total permissible settlement as mentioned under para "permissible settlement of foundations" or the permissible settlement from functional requirement, whichever is more stringent.
- f) Permissible settlement of foundations: The total permissible settlement and differential settlement shall be governed by IS: 1904 and IS: 13063 and from functional requirements, whichever is more stringent. However, total settlement shall be restricted to the following :
  - i) All facilities in Main Plant area, ducts, Equipment foundation - 25 mm
  - ii) All foundations in switchyard, control room Building including, isolated/strip continuous/ Raft foundation - 40 mm





- iii) Other footings of width upto 6m - 40 mm
- iv) Other footings of width greater than 6.0 m (raft) - 75 mm
- v) Footings on rock - 12 mm

In case the total permissible settlement is to be restricted to less than as above specified from functional requirements, then the net allowable bearing pressure shall be reduced / reviewed accordingly in consultation with Owner.

**5.04.00 Pile Foundations**

In case piles are adopted, following shall be adhered to:

- a) The pile foundation shall be of RCC, Cast-in-situ bored, precast/cast-in-situ driven pile as per IS: 2911. Bored piles shall be installed by using rotary hydraulic rig. Three-stage flushing of pile bore shall be ensured, by airlift technique or any other internationally accepted method duly approved by the Owner.
- b) The minimum diameter of pile shall be 450mm for cast-in-situ and 300mm for precast piles. The uplift and lateral load capacity shall be established by field test.
- c) Only straight shaft piles shall be used. Minimum cast length of pile above cut-off level shall be 1.0 m.
- d) The bidder shall furnish design of piles (in terms of rated capacity, length, diameter, termination criteria to locate the founding level for construction of pile in terms of measurable parameter like (SPT & SCPT value, set criteria etc.), reinforcement for job as well as test piles, etc.) for Owner’s approval.
- e) The piling work shall be carried out in accordance with IS: 2911 (Relevant part) and accepted construction methodology. The construction methodology shall be submitted by the Bidder for Owner’s approval.
- f) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be as under:

Vertical Lateral Uplift	}	Minimum of 3 Nos. in each mode.
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The initial pile load test shall be conducted with test load upto three times the estimated pile capacity. In case of compression test the method of loading shall be cyclic as per IS: 2911 (relevant part).







g) Number of routine pile load tests to be performed for each diameter/allowable capacity of pile shall be as under:

- i) Vertical-1.0 % of the total number of piles provided.
- ii) Lateral -1.0 % of the total number of piles provided.

The routine tests on piles shall be conducted upto test load of one and half times the allowable pile capacity. The Owner shall approve piles for routine load tests. Routine load tests may be done by conventional method as per IS: 2911 (Part-4).

In case, routine pile load test shows that the pile has not achieved the desired capacity or pile(s) have been rejected due to any other reason, then the Bidder shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required, without additional cost to the Owner.

- h) Testing of piles and interpretation of pile load test results shall be carried out as per IS: 2911 (Part-4). Bidder shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory/ institute prior to their use. Additional measurement for pile movement shall also be done.
- i) Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the piles for routine load test and not intended to replace the use of static load testing.

**5.06.00****Other Requirements**

- i) In case of high ground water table, for excavations comprehensive dewatering arrangement shall be required. Scheme for dewatering and design with all computations and back-up data of dewatering and sheet piling shall be submitted for Owner's information.
- ii) The founding level for trenches/channels shall be decided as per functional requirement. The bottom of excavation shall be properly compacted prior to casting of bottom slab of trenches/channels.
- iii) Excavation for open foundations shall be covered with PCC immediately after reaching the founding level. In case of any local loosening of soil at founding level during excavation, the same shall be removed and compensated by PCC of Grade M15. The foundation pits shall be maintained dry during the complete construction period by means of suitable dewatering systems.
- iv) Backfilling, around foundations and bottom of pipes, thrust blocks, etc. shall be carried out with approved material in layers not exceeding 30 cm thickness and each layer shall be compacted to 90% standard proctor density for cohesive soil and to 75% of relative density for non-cohesive soils.





- v) Excess/surplus excavated material shall be disposed off by the Bidder as per the instructions of the Owner upto a lead of about 5 km.
- vi) CBR tests for flexible pavement design shall be carried out by Bidder after earth filling has been completed, if applicable.
- vii) The storage tanks shall rest on flexible tank pad resting on an open/shallow foundation or pile foundation. The tank pad shall be made of two layers. The first layer shall be thoroughly compacted fill of gravel, coarse sand or other suitable material topped with minimum 75mm thick compacted crushed stone, screenings, fine gravel, clean sand or similar material mixed in hot asphalt (80 / 100 bitumen or equivalent 8 to 10% by volume), rolled and compacted. The second layer shall be with minimum 25 thick premix carpet with 12 mm and down broken stone chips and 80/100 grade hot bitumen. The tank pad shall be laid by an expert agency having wide experience in execution of similar works. The tank pad shall be made up from founding level to the required level by controlled compaction in layers of 200 mm to achieve a relative density of 85% using suitable compaction equipment approved by the Owner. In addition to the above, in case of an open/shallow foundation, a ring wall shall be provided adjacent to the tank wall for retaining the fill below tank. The foundation system shall be designed as per the provisions of IS: 803. The tank shall have a flexible bottom plate, which shall establish complete bearing with the foundation fill.

After the tanks have been erected, hydro testing shall be done.

**6.00.00 GENERAL REQUIREMENTS**

**6.01.00 Minimum Thickness of Structural Elements**

The following minimum thickness shall be followed :

Pile caps	900 mm
Suspended floor / slab / walkways / canopy slabs, etc	150 mm
Ground floor slab (non-suspended)	150 mm
Water Retaining slabs / walls	200 mm
Cable / pipe trenches / underground pits / Lauder walls and base slab	125 mm
All footings (including raft foundations)	300 mm
Parapets	125 mm





Sunshades at edge	75 mm
Pre-cast louvers / fins	50 mm
Pre-cast trench cover slabs / floor slabs / louvers	75 mm
Paving	150 mm
Basement walls and base slab	200 mm
Silo / bin walls	150 mm
Underground reservoir	
Below ground	200 mm
Above ground	150 mm

From fire resistance point of view minimum thickness of reinforced concrete members shall be as per fig 1 or table 16a of IS 456 or specified above, whichever is higher.

**6.02.00 Minimum Heights For Pedestals/Encasements of Steel Columns**

**Pedestals to Steel Columns for building structures**

In case the top of pedestal is kept at a lower level so that the column base plate together with gussets and stiffeners remain below finished floor level (FFL) the column bases as well as the column sections shall be encased in concrete above FFL as per following.

- a) Open area : 300 mm above paved level
- b) Covered area : 300 mm above FFL

Stair and ladder pedestal shall be kept 200 mm above the finished floor level.

**Pedestals to Steel Columns for Equipment structure :**

- a) Equipment in open area : as required (300mm min)
- b) Equipment in covered area : as required (150 mm min)
- c) Structures and equipment supplied by vendor : as per vendor's data subject to minimum as specified above

**6.03.00 Ground floor slab-on-grade**





Ground floor slab-on-grade shall be minimum M-25 grade RCC construction laid over minimum 75mm thick lean concrete. Minimum 250mm thick graded stone (63mm down size) soling with interstices filled with sand and compacted mechanically, shall be provided as sub-base below lean concrete. The sub-base shall be laid over rammed and well-compacted earth fill or hydraulically compacted sand fill as specified elsewhere in this specification unless the thickness required from design consideration is more.

The ground floor slab shall be of minimum 150 mm thick with double layer reinforcement of 8 dia at the rate of 200 c/c both ways.

#### 6.04.00 Stairs, Platforms, Handrails

All internal stairs, platforms and walkways shall either be of RCC or minimum 6mm thick chequered plate construction. All outdoor stairs, platforms and walkways shall either be of RCC or minimum 40mm thick grating.

All handrails and posts shall be of 32NB medium duty Galvanised M.S. pipes as per IS:1239 (Part I) and for stainless steel handrail as specified elsewhere in this specification.

#### 7.00.00 ROADS

Geometric design of road shall be done in accordance with Indian Road Congress Standard IRC-37. The ruling gradient for roads in longitudinal direction shall be 1 in 30. Normally roads shall have much flatter gradient. Transverse camber of 1 in 40 shall be provided.

A detailed CBR test, shall be carried out as per the procedure outlined in IS-2720 (Part-XVI). CBR test shall be carried out in remoulded soil samples under soaked condition.

All roads shall have minimum 1.5m wide shoulder on either side of carriageway. Shoulders shall have sufficient load bearing capacity to support loaded trucks. A flatter slope of 1 in 80 shall be provided on shoulders.

Pipe, slab culverts, or RCC box culverts, as suitable, shall be provided at road crossings for drainage, LP pipes, Ash pipes, cable trenches etc. Level crossings shall be provided where a Railway siding line crosses the road. All culverts shall be designed for IRC class "AA" loading and checked for class A loading.

#### 8.00.00 DRAINAGE

Open RCC rectangular drains shall be provided for storm water. The thickness of sides & bottom shall be minimum 100 mm or as per design considerations whichever is higher. RCC culverts shall be provided for road and rail crossing. Drains shall be provided on both sides of the roads.





Inside surface of the drain will have smooth neat cement finish over with screed concrete. Invert of the drain shall be decided in such a way that the water can easily be discharged to the recommended nearest outfall outside the plant boundary. The minimum slope of the drain shall be 1:1000 longitudinally to take care of the silting problems. It is recommended to maintain the maximum velocity within 1.2 m/sec.

**9.00.00 TRANSFORMER TRACK & JACKING PAD**

Lay out of transformer track and jacking pads shall be as shown in appropriate drawing.

Transformer track shall be designed as beam on elastic foundation. For this appropriate soil investigation / test shall be carried out to establish design parameters. Grade of concrete, reinforcement etc shall be as specified earlier.

**10.00.00 MISCELLANEOUS DESIGN / CONSTRUCTION CRITERIA**

- 1) All masonry walls from ground floor shall be placed on reinforced concrete grade beams. However, light internal partitions may be placed on ground floor slab. Minimum embedment of the grade beam below grade level shall be 300 mm.
- 2) The steel column base plate along with stiffening gusset plates shall not be protruded above floor level.
- 3) The steel columns below ground floors and up to minimum 100mm above finished floor level shall be encased in concrete.
- 4) Ramps for building entrance shall be cast in situ RCC slab and the slope of ramps shall not be more than 1 (vertical) to 6 (horizontal).
- 5) Minimum 75 mm thick lean concrete M-7.5 shall be provided below all underground structure, trenches etc., to provide a base for construction.
- 6) All buildings shall have RCC/steel framed super structure. All walls shall be non-load bearing infilled panel walls.
- 7) Duct banks consisting of PVC/GI conduits for cables shall be provided with reinforced concrete encasing of M20 grade. The minimum depth of top of duct bank from grade level shall be 500mm.
- 8) Angles 50 x 50 x 6 mm (min.) with lugs shall be provided for edge protection all round of cut-outs/opening in floors, edge of drains





supporting grating covers, edges of RCC cable/pipe trenches, manholes supporting covers, supporting edges of pre-cast covers and any other places where breakage of corners of concrete is expected.

- 9) Trenches located outside building shall project at least 100mm above the finished formation level so that no storm water shall enter into the trench. The bottom of the trench shall be sloped suitably for draining out the collected water into the sump pit. The pre-cast covers shall be of minimum M-20 grade and shall not weight more than 65 kg. Lifting hooks shall be provided in the pre-cast covers. The minimum drainage slope along line shall be 1 in 500.
- 10) For open drains concrete lining of minimum M20 grade on sides & bottom shall be provided. The thickness of lining shall be minimum 100mm or as per design consideration whichever is higher.
- 11) Raw water reservoir shall be imperviously lined using HDPE/Geotextile liner and covered with pre-cast concrete tiles/brick work.
- 12) All underground concrete structure such as basement, sumps water-retaining structure shall be designed for water tightness.
- 13) All underground concrete structure like basements, sumps, water retaining structure etc., shall have plasticizer cum water-proofing cement additive conforming to IS-9103. In addition limit on permeability as given in IS-2645 shall also be met with. The concrete surface of these structures in contact with earth shall also be provided with two coats of bituminous painting for water/damp proofing. In case of water leakage in the above structures, injection method shall be applied for repairing the leakage.
- 14) All joints, including construction and expansion joints for the water retaining structure and others below subsoil water level shall be made water tight by using PVC ribbed water stops with central bulb. The minimum thickness of PVC water stops shall be 6 mm and minimum width shall be 230mm.
- 15) All mild steel parts used in the water retaining structures shall have anticorrosive epoxy based paint or equivalent.
- 16) Anti termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors, switchyard area etc., as per IS-6313 and other relevant standards.
- 17) Concrete hume pipes for under ground service shall of class NP3/NP2 as per IS-458.
- 18) For all buildings suitable arrangements for draining out of water collected from equipments, blowdowns, leakages, floor washing, fire-fighting etc., shall be provided for each floor.





- 19) All walls and slabs shall have two layers of reinforcement for section having thickness 150 mm and above.
- 20) All gratings shall have bearing bars 32mm x 5mm spaced at 30mm with cross bars at 100 mm on centers. Stairs treads made of grating shall be provided with non-skid abrasive nosing.
- 21) Unless stated specifically elsewhere in this specification, the clear height of roof/beam from finished floor shall not be less than 4.5 M for plant building and 3.5 M for non-plant building.
- 22) Unless stated elsewhere specifically in this specification, the finished floor level of any building shall be at least 300 MM from finished grade level.
- 23) For RCC buildings of more than 15M span steel roof truss/girders will be provided to support the concrete roof on permanently colour coated (on exposed face) galvanized M.S. troughed metal decking over concrete columns. Gable and side cladding will be constructed with brick masonry.
- 24) Sealing of joints shall be done by two part polysulphide sealant and shall be from approved manufacturer conforming to IS: 12118. Material shall consist of polysulphide polymer and a curing agent.

If any similar design criteria mentioned elsewhere in this specification contradict the above, the stringent of the criteria shall be adopted for design.

## **ANNEXURE – I**

### **VIBRATION ISOLATION SPRING FOUNDATIONS**

#### **1.0 General Requirement**

Steel helical springs and viscous dampers shall be provided for equipments requiring foundations with vibration isolation system by the supplier with requisite experience and proven track record of similar installation in power plants of Unit capacity not less than 500 MW.

“Complete Vibration Isolation System with Steel Helical Springs and Viscous Dampers shall be provided for the foundations of Turbo-generator, Boiler Feed Pump, ID, Fan, FD Fan and PA Fan.”

#### **2.0 Material (Design & Supply)**

##### **2.1 Steel helical springs and viscous dampers shall consist of**







- i) Steel helical spring units and viscous dampers along with viscous liquid including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads etc.
- ii) Frames for pre-stressing of spring elements.
- iii) Suitable hydraulic jack system including electric pumps, high-pressure tubes etc. required for the erection, alignment etc. of the spring units. One set of extra hydraulic jacks and hand operated pumps shall also be provided.
- iv) Any other items which may be required for the pre-stressing, erection, release of pre-stress, alignment and commissioning of the steel helical springs.

2.2. The objective of designing the supporting arrangement for any rotating equipment shall be so that the vibration level is maintained as minimum as possible under all operating conditions. Accordingly, respective rotating equipment shall be supported on RCC deck slab which in turn shall rest on vibration isolation unit consisting of steel helical springs and viscous dampers, which in turn shall be supported on RCC supporting structure. The above design shall form part of this specification.

2.3. The spring units shall have definite stiffness in both vertical and horizontal directions with the horizontal stiffness not less than 30% of vertical stiffness. The stiffness shall be such that the vertical natural frequency of any spring unit at its rated load carrying capacity is not more than 3 to 5 Hz.

2.4. The damper units or spring-cum-damper units shall be of viscous type offering velocity proportional damping. The damper units shall be suitable for temperatures ranging from 0 to 50 deg. C. The damping resistance of individual damper units shall be such that the designed damping is provided using reasonable number of units. Damper shall have damping resistance ranging from 40 kN sec/m to 750 kN sec/m.

2.5. The sizes of the spring units, damper units and spring-cum-damper units shall be such that groups of such units can be accommodated on column heads in case of elevated foundations and on pedestals/walls in case of foundations at ground level.

2.6. The steel helical springs and viscous dampers shall be designed for ensuring "fit and forget" guarantee.

3.0. Manufacturing & Testing

3.1. Complete manufacturing and testing of the steel helical springs and viscous dampers shall be done at the manufacturing shop of the approved sub-vendor/supplier. For this purpose, the successful bidder/sub vendor shall submit the detail program for approval of engineer and take up the manufacturing/testing after approval of such program. The program shall





include :

- i) Manufacturing schedule and quality check exercised during manufacturing.
- ii) Detail of test to be carried out at the manufacturing shop with their schedule.
- iii) Special requirements, if any, regarding concreting of top deck.
- iv) Complete step-by-step procedure covering the installation and commissioning of the spring system.
- v) Manuals for erection, commissioning, testing and maintenance of the steel helical springs and viscous dampers.
- vi) A checklist for confirming the readiness of the civil fronts for erection of steel helical springs and viscous dampers.
- vii) Checklist for equipment required at each stage of erection.
- viii) Bill of materials (data sheet) of various elements such as spring units, viscous dampers, with their rating, stiffness etc. included in the supply.
- ix) Bill of materials (data sheet) for frames for pre stressing, hydraulic jack including electric pump, high pressure tubes, hand operated pump etc. with their rating and numbers.
- x) Any other details which may be necessary to facilitate design and construction of the foundations/structures.

3.2 The springs shall conform to codes DIN 2089 and DIN 2096. The quality assurance and inspection procedures shall be finalized on the basis of the above codes and the quality plans be drawn accordingly.

4.0 Erection, Commissioning and Supervision

4.1 Complete erection and commissioning of the steel helical springs and viscous dampers including pre-stressing of elements, placing of elements in position, checking clearances on the shuttering of the RCC top deck, releasing of pre stress in spring elements, making final adjustments and alignments etc. all shall be done a specialist supervisor of supplier/sub vendor trained for this purpose.

4.2 The scope of work shall be deemed to include all activities, which may not have been explicitly mentioned but are reasonably implied for the successful commissioning of steel helical springs and viscous dampers.





4.3. The successful bidder shall guarantee the performance of the steel helical springs and viscous dampers for 24 months from the date of commissioning of each machine which shall be termed as "Guarantee Period".

5.0. Realignment of Spring System

If any realignment of the steel helical springs and viscous dampers is required to be done for aligning the shaft or for any other reasons during the first one year of operation from the date of Commercial Operation of the machine, the same shall be done by the successful bidder as and when asked for at no extra cost of the Owner.

6.0. Acceptance Criteria

Stiffness values shall be checked. The permissible deviations shall be as per DIN 2096. Following acceptance criteria shall be followed :

- i) General workmanship is being good and as recommended by the manufacturer are approved by the Engineer.
- ii) Tolerances are within the specified limit
- iii) Material test certificate (MTC) is in compliance with the applicable codes/standards.
- iv) Bought out material is from the approved manufacturer/vendor
- v) Bought out material is matching with the approved sample

7.0. Codes and Standards

Latest revision of following codes shall be used for the design of the spring supported foundations :

- IS: 456 Code of practice for plain and reinforced concrete.
- IS: 2974 Code of practice for design and construction of machine foundations.
- IS: 1893 Criteria for earthquake resistant design of structures
- DIN: 4024 Machine foundations; Flexible supporting structures for machine with rotating masses
- DIN: 2089 Helical compression springs out of round wire and rod : calculation & design
- DIN: 2096 Helical compression springs out of round wire and rod : quality





**WBPDC**

**EPC Bid Document  
Sagardighi Thermal Power Project  
1x660 MW Unit No. 5, Phase - III**

requirements for hot formed compression springs.

- VDI: 2056 Criteria for assessing mechanical vibrations of machine.
- VDI: 2060 Criteria for assessing the state of balance of rotating rigid bodies.





**WBPDCL**

**EPC Bid Document  
Sagardighi Thermal Power Project  
1x660 MW Unit No. 5, Phase - III**

**VOLUME: II-G/1**

**SECTION-III**

**SPECIFIC DESIGN CRITERIA - STRUCTURAL**



**Development Consultants Pvt. Ltd.**

**Volume : II-G/1  
Section : III  
Specific Design Criteria - Structural**



**WBPDC**

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1x660 MW Unit No. 5, Phase - III**

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**Development Consultants Pvt. Ltd.**

**Volume : II-G/1  
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Specific Design Criteria - Structural**

**SECTION - III****SPECIFIC DESIGN CRITERIA - STRUCTURAL****1.00.00 STRUCTURAL STEEL DESIGN**

- a) Structural steel design will be carried out as per the National Building Code with specific consultation to IS-800 unless noted otherwise. Design of structures in electrical substation will be as per IS-802.
- b) Lateral forces along the length of the building will be resisted by bracings in horizontal and vertical frames. The transverse lateral load will be resisted by stiff jointed frame action. Additional bracing or moment connection will be used to assure stability of the structures.
- c) Structural steel shall conform to Grade A of IS:2062 for rolled steel members or plates up to 20 mm thickness. For plates above 20 mm thickness and welded construction, steel conforming to Grade B (Killed and normalised) of IS:2062 shall be used except for crane girders where Grade C (Killed and normalized) (IS:2062) steel shall be used. All structural steel plates and sections shall be either of "SAIL" or "TATA STEEL" or "RINL" or "JINDAL" make or vendor approved by WBPDCCL.
- d) Shop connections will be all welded and field connections will generally be bolted unless specified otherwise. Field bolts, wherever provided shall be high tensile of 20 mm dia. or of higher diameter and of property class 8.8 as per IS-1367 for all major connections. The bolted joints shall be designed for friction type connection and the H.T. bolts shall be tightened to develop the required pretension during their installation. However, the nominal connections in the field like purlins, stairs, wall beams etc. will be done by 16 mm dia. M.S. black bolts (minimum 4.6 grade) conforming to IS-1363 unless specified otherwise.
- e) Welding shall be in accordance with the recommendations of IS-816 - Code of Practice for use of metal arc welding for general construction in mild steel and IS-9595 - Recommendation for Metal Arc Welding of Carbon and Carbon Manganese Steels. Built-up members will be fabricated using submerged arc welding procedure unless manual arc welding is specifically required. All butt welds in plate girders and columns will be full penetration. All butt welds will be radiographically or ultrasonically tested as per relevant IS codes and standard practice. The bare wire electrodes for submerged arc welding shall be as follows:

Filler wire : AWS-A-5.17-EH14

Flux will be agglomerated type of classification  
AWS-A-5.17-F7A2EH14







- f) All structural steel members for GIS substation shall be hot dip galvanized in accordance with IS-4759. The fasteners shall also be galvanized in terms of IS-5358. Galvanizing of steel structure shall be done after all fabrication work is completed. Zinc coating over galvanized surface of structural members and threaded fasteners shall not be less than 610 gm/sqm and 375 gm/sqm of surface area respectively. However, fasteners may be tapped or re-run after galvanizing. Threads of bolts and nuts shall be capable of developing the full strength of the bolt. The spring washers shall be electro-galvanized as per IS-1573. All galvanizing shall be uniform and of standard quality and shall withstand tests in accordance with IS-2633.
- g) Shop primer paint will be single coat of red oxide zinc- chromate primer conform to IS-2074. The surface preparation will be done in accordance with IS : 1477 (Part I & II) – Code of Practice for Finishing of Ferrous Metals in Buildings. Second coat of primer shall be applied after erection and final alignment of the erected structures. Two or more coats of synthetic enamel paint conforming to IS:2932 of approved shade and quality shall also be applied after erection. Total Dry film thickness of the finished paint shall not be less than 110 microns.
- h) All welding electrodes shall be of Low Hydrogen type conforming to IS:814 and shall be EB5426H3JX type. All electrodes, flux, wire etc. shall be of ADOR Welding Ltd., ESAB India Ltd., D & H Secheron Electrodes Pvt. Ltd. , Modi electrodes or equivalent as approved by WBPDCL.

Alternatively, flux coated arc welding (FCAW) conforming to AWS-E70T-5 which is a modified procedure of MIG/CO<sub>2</sub> (solid wire) can be used.

If submerged arc welding is used, the bare wire electrodes shall be as follows:

Filler wire	:	AWS-A-5.17-EH14
Flux	:	agglomerated type of classification AWS-A-5.17-F7A2EH14

- i) Minimum preheat & inter pass temperatures for welding over 40mm to 63mm (thickness of the thicker part at the point of welding) will be 66°C and for over 63mm, it will be 110°C. However, higher preheat & inter pass temperatures may be required due to joint restraint etc. and will be followed as per approved welding procedure.



- j) Minimum tests to be carried out during fabrication and erection of structural steel shall be as follows :

Steel

Ultrasonic Test : Plates above 25mm thick will be subjected to ultrasonic test as per ASTM-A435 or equivalent to check the presence of lamination.

Fillet weld

Dye Penetration Test : 5% of the total length, Dye penetration will be carried out to the root run.

Butt weld

Dye Penetration Test : 10% of the total length, Dye penetration will be carried out to the root run after back gouging

Radiographic Test : Splicing should not be provided in tension flange of Bunker Girders and crane girders. Spot radiography shall be carried out on 100% joints in tension zone and 10% joints in compression zone. Minimum 300mm length will be spot radiographed. When radiograph is not possible ultrasonic test will be carried out after grinding the surface.

Ultrasonic Test : 10% of all other Butt welds except crane girder and bunker girder shall be subject to spot radiographic test and the entire balance butt weld for ultrasonic test.

- k) Connections

Connection of vertical bracings with connecting members and diagonal truss members shall be designed for full tensile capacity of the bracings.

Size of fillet weld for flange to web connection for built up column section will be as follows:

Full shear capacity for box section.

80% of full shear capacity or actual shear (if indicated in drawings) or 0.5 times of the web thickness whichever is more for I section. Weld will be double fillet.

All welds will be continuous. The minimum size of fillet weld will be as per relevant IS code.



Shear connections shall be designed for 75% of section strength for rolled sections and 80% of section strength for built up section or rolled section with cover plates. Design shear force should be more than actual shear.

Moment connections between beam and column will be designed for 100% of moment capacity of the beam section.

All butt welds shall be full penetration butt welds.

Connection of base plate & gusset members with the columns will be done considering that total load gets transferred through weld.

All splicing work shall be of full strength. Shop splicing for all sections other than rolled sections shall be carried out by full penetration butt welds. Shop splicing of all rolled sections shall be carried out using web and flange cover plate.

Following connections will be provided during erection :

#### Welded Connection

- Connection of secondary beam to main beam
- Connection of bracing to column
- Connection of bracing to longitudinal tie beam
- Connection of longitudinal tie beam to column
- Connection of spandrel beam to column
- Connection of other secondary structures

#### HSFG Connection (Grade 8.8 bolts)

- Splicing of column / transverse frame beam / longitudinal tie beam
- Connection of frame beam to column
- Connection of Crane Girder to column
- Connection between crane girders
- Other major connections

#### Bearing Type Connection (HT bolts Grade 8.8)

All removable type connections

M.S. bolts (Grade 4.6)

Purlins, stairs, wall beams etc.

**2.00.00 LOADS**

Loads as defined under Clause 3.00.00 Section-II will be applicable.

In addition following should be considered.

a) Elevator Loads

Elevator support systems shall be designed to accommodate the capacity load of the elevator plus the weight of the cab and accessories.

b) Coal and Coal Bunker Loads

Coal Weight : 8.0 kN/Cu.M for storage volume calculation

: 12.0 kN/Cu.M for load calculation

Angle of internal friction = 31 Deg. (as per IS-9178 Part-I)

**3.00.00 LOAD COMBINATIONS**

While designing consideration shall be given to the following load combinations:

- i) DL + LL
- ii) DL + LL + PL + Equip  $\pm$  TL
- iii) DL + LL + PL + Equip + Cb + CtLA $\pm$  CS  $\pm$  TL
- iv) DL + LL + PL + Equip + Cb + CtLB $\pm$  CS  $\pm$  TL
- v) 0.9DL  $\pm$  EL (for DL only)
- vi) 0.9DL  $\pm$  WL1  $\pm$  TL
- vii) 0.9DL  $\pm$  WL2  $\pm$  TL
- viii) 0.75 (DL +\* LL + PL + Equip + Cb + Ct  $\pm$  EL  $\pm$  TL)  
(\* Appropriate portion of LL which is considered for working out EL shall only be taken)
- ix) 0.75 [ DL+LL+ PL + Equip + Cb + CtL1  $\pm$  (CS1+WL1)  $\pm$  TL ]
- x) 0.75 [ DL+LL+ PL + Equip + Cb + CtL1  $\pm$  (CS1+WL2)  $\pm$  TL ]





Where the above loads are :

- DL = Dead load of structures, floors, walls etc.
- LL = General live load on floors
- PL = Pipe load
- Equip = Equipment loads
- Cb = Crane Bridge
- Ct = Crane trolley positioned at middle of bridge
- CtLA = Crane trolley + Load near one row
- CtLB = Crane trolley + Load near other row
- CtL1 = Crane trolley + Half load lifted at centre of bridge
- CS = Crane surge for full load
- CS1 = Crane surge for half load lifted
- WL1 = Wind load with internal suction of 0.2P, left to right
- WL2 = Wind load with internal suction of 0.2P, right to left
- EL = Earthquake load
- TL = Temperature load

Appropriate allowable increase in permissible stresses as per IS codes, may be taken except where as per above load combinations load factors are used in combinations (vii) to (ix) above.

Appropriate impact factor shall be considered as per IS:875 (Part 2) while calculating crane loads.

In calculating wind loads, appropriate internal thrust / suction shall be considered along with external pressures as per IS:875 (Part 3). All possible load conditions considering external and internal pressures shall be considered in analysis and design for each combination number (vi), (vii), (ix) & (x) above to assess worst effect on whole structure as well as its components.

**4.00.00 SWITCHYARD STRUCTURES**

Structures shall be provided to carry all conductors, insulators, isolating switches, circuit breakers and other items of switchyard included in the contract. Facilities shall also be provided for the termination of the incoming overhead transmission lines.

All switchyard structures shall be of galvanised steel. The structures shall be designed to ensure that the specified minimum phase, earth and erection clearances are maintained under all conditions. The strength and rigidity of the structures shall be such that the alignment of the apparatus, which they carry, shall not be affected by the static and dynamic loads the structures are subjected to.

Towers and gantries shall be designed for both normal and broken wire conditions as per latest IS:802 [Part-1]. The sequence of applying tension during stringing shall also be taken care of in the design of structures.

Wind pressure on towers, gantries, conductors, insulators, strings and other similar structures shall be worked out considering IS:802 [Part-1] latest edition.

Switchyard structures shall be designed to withstand the worst combination of dead loads, service loads, wind induced loads or seismic loads, thermal stresses, and any other special loads like short circuit force etc. Permissible stresses for various steel towers shall be guided by latest IS:802 [Part-1] stipulations.

When calculated deflections, under all permanent loads of any part of a structure, exceeds 6 mm or 1/220 of the span, whichever is less, a reverse camber equal to 1.5 times the calculated deflection shall be built into the unloaded structure.

Switchyard structures shall be designed for the worst combination of loads. The factor of safety for design of members shall be considered as 2 for normal and broken wire conditions and 1.5 for combined short circuit and broken wire conditions. Short circuit forces and wind forces shall not be considered simultaneously.

**5.00.00 PIPE AND CABLE RACK STRUCTURES**

The pipe and cable rack structures shall accommodate the pipes/cables with proper access and adequate working space for erection and maintenance. These shall be designed to carry safely all the loads acting on them (DL, LL, WL, EQL, forces from pipe lines etc.). The structures shall be adequately rigid to carry the forces from the pipelines at anchor points without undue deflection so that the pipelines are really anchored at the anchor points.

It is envisaged that pipe/cable rack under this Main Plant Package will have to accommodate some additional pipes and cables (such as Plant Water System etc.), which are not in the scope of the Main Plant Package successful bidder. The bidder shall in his offer keep reasonable margin for accommodating such





additional pipes/cables in the rack structure, details of which will be furnished to him during the detailed engineering stage.

## **6.00.00 OTHER SPECIFIC REQUIREMENTS**

All steel framed structures shall be either “rigid frame” or “simple space frames” or a combination of two.

Lateral forces shall be resisted by stiff jointed moment connections in rigid frame design. The column bases shall generally be fixed to concrete foundation pedestal by providing moment resistant base detail.

Simple space frame design utilizes single-span beam systems, vertical diagonal bracing at main column lines and horizontal bracing at the roof and major floor levels. The most of plant steel buildings such as Main Power House, Mill Building etc. shall be designed as simple space frame structures.

The turbine building design shall be a combination of rigid frame in transverse direction and simple frame in longitudinal direction.

Concrete floors shall be considered to provide continuous lateral support to the top (compression) flange of the support beams. However wherever large cut outs (area more than 1.0 m<sup>2</sup>) are provided in the floor slabs horizontal floor bracing shall be provided. Grating/chequered plate floor shall neither be considered to provide lateral support to the top flange of supporting beams nor to provide a shear diaphragm. Adequate lateral support in the form of shear connector and horizontal bracing shall be provided as required.

Floors for vibrating machines of all kind together with supporting framework shall be adequately braced in both horizontal and vertical planes. Floors or structure supporting mechanical equipment shall be designed to minimise vibration, avoid resonance and maintain alignment and level.

Chequered plates shall conform to IS:3502.

All indoor gratings shall be electro-forged type and outdoor gratings shall be welded type. Minimum thickness of grating shall be 40mm for indoor installation and 32mm for outdoor installation. The opening size shall not be more than 30mm x 100mm. The minimum thickness of the main bearing bar shall be 4mm. All gratings shall be hot dip galvanized @ 610 gm/sqm.

Where a steel beam or member is to be connected on RCC structure, it shall be connected using an insert plate and preferably through shear connection.

For crane girders, welding between web and flange plates shall be carried out by submerged arc welding process. Full penetration of weld between web plate and top flange shall be ensured. Intermediate stiffeners shall be connected with top flange plate by full penetration butt weld. Welding across tension flange will not be permitted. Bearing edges of crane girders shall be





machined.

The working point of the bracing connection shall be the center of column and girder to which it connects, where practical. The connections of gusset plates to column and girders shall be made to include provisions for eccentricity in connection. The double angle back-to-back with gusset plate in between shall not be used in dust-laden areas. Where double angles are not adequate, beam sections with web in the plane of bracing are used.

Permissible stresses for different members shall be allowed to exceed up to 33.33% only under normal loads along with wind and seismic conditions. However, members which are designed primarily to resist wind such as bracing members, no increase in permissible stresses will be permitted. However, permissible stresses in bolts and welds shall be allowed to exceed up to 25 % only under wind and seismic conditions.

#### Permissible Deflections

The permissible deflections of various steel members under normal loading conditions shall be as specified below. For calculation of deflections in structures and individual members dynamic effects shall not be considered, unless specified otherwise. Also, no increase in deflection limits shall be allowed when wind or seismic load are acting concurrent with normal loading conditions.

#### Vertical Deflection

- |    |   |   |  |
|----|---|---|--|
| a) | For beams supporting dynamic equipment    | : | Span / 500                                 |
| b) | For beams supporting floors / masonry     | : | Span / 325                                 |
| c) | For beams supporting pipes ( pipe racks ) | : | Span / 400                                 |
| d) | For roofing and cladding components       | : | Span / 250                                 |
| e) | For gratings and chequered plates         | : | Span / 250 subject to<br>a maximum of 6 mm |

For crane gantries or any member subjected to working loads, the maximum deflection under dead load and live load excluding impact shall not exceed the following values:

- |    |  |                     |            |             |
|----|--|---------------------|------------|-------------|
| a) | For manually operated cranes & monorails | :                   | Span / 500 |             |
| b) | For electric overhead cranes             | :                   |            |             |
|    | i)                                       | up to 50 t capacity | :          | Span / 750  |
|    | ii)                                      | over 50 t capacity  | :          | Span / 1000 |



### Horizontal deflections

The permissible horizontal deflections shall be as per following unless specified otherwise:

- |    |  |   |  |
|----|--|---|--|
| a) | Single storey building<br>(without crane load )  | : | Height / 325                                 |
| b) | Multistoried building<br>(without crane load)  | : | Height / 500                                 |
| c) | Pipe rack columns  | : | Height / 200                                 |
| d) | Open Structures  | : | Height / 200                                 |
| e) | Crane gantry girder due to surge   | : | Span / 2000 limited<br>to maximum of 15 mm   |
| f) | Building main columns at crane rail<br>level due to action of crane surge<br>load only | : | Height / 2500 limited to<br>maximum of 10 mm |
| g) | Open gantry columns at crane<br>rail level due to action<br>of crane surge load only   | : | Height / 4000 limited to<br>maximum of 10 mm |

Provisions of IS:800 and relevant IS Code shall be followed for limiting deflections of structural elements not listed above.

### Minimum Thickness of steel elements

The minimum thickness of various components of a structure and hot rolled sections shall be as follows. The minimum thickness of rolled shapes shall mean flange thickness regardless of web thickness. Structural steel members exposed to significantly corrosive environment (Exposed to open air i.e., to Rain; Contact with Soil, Coal, ash, Contact with drained liquid or contaminated water, acid/alkali etc.) shall be increased suitably in thickness or suitably protected otherwise as per good practice and sound engineering judgment in each instance.

- |    |  |   |                  |
|----|--|---|------------------|
| a) | Trusses, purlins, girts and bracing  | : | 6 mm             |
| b) | Columns and beams  | : | 8 mm             |
| c) | Gussets  | : | 8 mm             |
| d) | Stiffeners   | : | 8 mm             |
| e) | Base plates  | : | 10 mm & above    |
| f) | Chequered plates   | : | 6 mm o/p & above |
| g) | Grating flats  | : | 5 mm             |
| f) | Minimum thickness of structural members other than gratings and chequered plate directly exposed to weather and inaccessible for painting and maintenance shall be 8 mm. |   |                  |



**Minimum Sizes of steel elements**

The flange width of purlins supporting light weight concrete slab shall not be less than 65 mm and for those supporting roof sheeting and wall cladding it shall not be less than 50 mm. Width of steel rolled section connected to other member shall be at least 50 mm. The depth of beams for platform of all structures shall not be less than 125 mm.

**Slenderness and Depth Ratio**

The slenderness ratio of main members in tension, compression or bending shall be in accordance with IS:800.

The following limiting ratios of depth to span shall be considered as a general guide.

- |    |  |        |
|----|--|--------|
| a) | Truss  | 1 / 10 |
| b) | Rolled beams and girders for Ordinary floors and rafters   | 1 / 24 |
| c) | Supporting floor beams for vibrating Machinery / equipment | 1 / 15 |
| d) | Roof purlins and girts                                     | 1 / 45 |
| e) | Gable columns  | 1 / 30 |



**THE WEST BENGAL POWER DEVELOPMENT  
CORPORATION LIMITED**

**SAGARDIGHI THERMAL POWER PROJECT  
1 x 660 MW UNIT NO. 5, PHASE – III**

**EPC BID DOCUMENT**

**DOCUMENT NO. 12A05-SPC-G-001**

**VOLUME: II-G/2**

**GENERAL SPECIFICATION AND DESIGN  
CRITERIA FOR ARCHITECTURAL WORKS**



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**SEPTEMBER, 2017**



**WBPDCL**

**EPC Bid Document  
Sagardighi Thermal Power Project  
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**VOLUME: II-G/2**

**GENERAL SPECIFICATION AND DESIGN  
CRITERIA FOR ARCHITECTURAL WORKS**



**Development Consultants Pvt. Ltd.**

**Volume : II-G/2  
General Specification and Design  
Criteria for Architectural Works**



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**GENERAL SPECIFICATION  
AND  
DESIGN CRITERIA  
FOR  
ARCHITECTURAL WORKS**

**1.00.00 SCOPE OF ARCHITECTURAL WORKS INCLUDING SANITARY AND PLUMBING**

**1.01.00 Scope**

The architectural services shall cover finishing work of power house and all auxiliary buildings, Non-plant buildings included under the specification starting from brick work, partition walls, roof protection, finishing of walls, floors and Bidder ceilings, false ceiling, cladding, as required potable water system, service water, Plumbing and sanitation etc. as required for functional requirement. The bidder offer shall cover the complete requirements as per the best prevailing practices keeping in view the statutory and functional requirements of plants & facilities and providing enough space & access for operation, use & maintenance and to complete satisfaction of the owner.

**Plant buildings under this scope of work:**

- Power House Building including Electrical Bay, Switch Gear Room & Control Room
- Mill Building
- ESP Control Building
- FGD Control Building
- CW & ACW Pump House & Electrical Building
- CW Chemical Treatment Building
- CW Chlorination Building
- CPU Regeneration Building
- Vacuum Pump cum Compressor House

**Above list of Plant Buildings is not exhaustive. Buildings necessary for the smooth operation of the plant shall be within this scope of work. In case the equipment parameters considered by bidders for Phase-III differs from that of Phase-II, separate buildings may be required to accommodate such equipment and its stand-by units.**

**1.02.00 Prequalifying criteria for Architectural works**

- a) The bidder should have registered architect(s), registered under Council of Architecture (COA), as his employee. An attested copy of COA of the lead Architect should be submitted as a part of Pre-qualification document. The lead Architect should have experience of rendering architectural services one complete 500 MW or above project and this includes BTG, BOP and Non-plant buildings.







- b) The bidder may form consortium with an architectural firm. In that case MOU between the bidder and the architectural firm is to be produced. The COA registration certificate of the lead architect of the firm is to be submitted. The architectural firm should have experience of rendering architectural services for BTG, BOP & Non-plant buildings of one completed 500 MW or above TPP or STTP project.
- c) In case of foreign collaboration/consortium registration certificate of the lead architect of that country, duly approved and attested by the Consulate of that country is to be produced as per-qualifying document. Successful completion certificate of one 500 MW TPP or STTP by the architectural firm is to be submitted.
- d) The bidder shall obtain the approval from WBPDC for the agency for Architectural services.

2.00.00 **DESIGN REQUIREMENTS**

2.01.00 **Architectural Concepts**

- a) Layout of the plant area shall have definite hierarchy of road network depending upon its usage, aesthetic, visual sensibilities for creating road vistas, focal points, building back drops, building frames. General layout shall be evolved taking over the basis of landform & local climate & due consideration shall be given to orientation and wind direction. The resulting built mass shall present a definite image width in distinct vocabulary in the form of landmarks, nodes & skyline.
- b) Main plant building shall be architecturally treated in such a way that it retains a monumental scale, yet presents a pleasing composition of mass and void with suitable and functionally designed projections and recesses.

SGTPP 1X660 MW Unit No.5, Phase-III is the extension of SGTPP 2X500 MW Unit No.3&4 phase II. **The Facia of the two power house building must be same from aesthetic point of view.**

The overall impact of the building shall be one of aesthetically unified architectural composition having a comprehensible scale, blending tonal values with the surroundings and taking full consideration of the climatic conditions, the building orientation and the existing structures nearby.

**The bidder must visit the site and have a feel of the overall environment, so that a harmonious as well as integrated architectural concept of the proposed phase of development is achieved.**

- c) All other buildings and structures shall be architecturally treated in such a way so as to be in complete harmony with the main plant, surrounding structures and environment. Local architectural characters may be judiciously imbibed. The building shall be designed initiating an





architectural control common to all buildings. The architectural control shall be clearly spelt out in terms of scale, man & form.

- d) Overall colour scheme of the plant and other buildings shall be designed judiciously and in a comprehensive manner taking into account the mass and void of buildings, its facade, equipment, exposed structural elements, piping, trestles, bus ducts and other service elements.
- e) Overall emphasis shall be on developing an eco- friendly architecture, merging with the nature with its own sustainable energy management systems.

The scheme shall be conceptually finalized in totality including that of equipment so that the proper co-ordination with other agencies can be taken up at appropriate time.

## 2.02.00 Architectural Design

- a) Natural light shall be used to the maximum extent especially in the form of north light/skylight. For adequate light and ventilation, National Building Code recommendation shall be followed. **However all windows shall have minimum 1.0m sill height and bottom of lintel height shall be 2.5m from finished floor level. Minimum door height shall be 2.5m.**
- b) Entrance canopies, sunshade (projections, recesses) over openable windows and door openings on exterior facades shall be provided.
- c) All the buildings shall be architecturally designed to meet the National Building Code.
- d) Architectural design and detailing aspects of all the buildings shall be rendered through professional services of an Architect Statutory requirement and any clearances from local authority may be required to be met with, wherever essential. The Architect Consultant shall be of national/ international repute having experience in similar kind of works. The consultant shall evolve the design philosophy and shall present it in the form of presentation drawings, prospective views, 3-D Models & detail drawings. **All architectural drawings shall be prepared under responsibility of an Architect. The Architect should be registered under Council of Architecture. The registration certificate of the architect should be produced by the bidder during bid submission.**
- e) A comprehensive interior design scheme shall be conceived with the intention of projecting a definite theme and aesthetic appearance to inside working environment. It shall take into account the multidisciplinary engineering activities involving power plant technology and architectural & civil engineering for a smooth control hierarchy and man machine interface.



- f) **At the inception of the detail engineering the bidder should submit the architectural concept of the overall plant with 3D views & colour scheme of Plant & Non-plant buildings for selection of the owner. The selected concept shall be in the vernacular of the project to bring harmony all over the plant site.**

**2.03.00 Plant Buildings****2.03.01 Powerhouse Building**

Powerhouse shall be of structural steel framed with RCC floor and Brick Wall and insulated metal cladding construction. Operating floor being the heart centre of Powerhouse shall be designed as a very impressive floor having high quality finish, material and appropriate ambience.

External facade shall be with full brick thick wall up to approximately 3.0m high, plastered and painted. From 3.0m-up to roof external façade shall be clad with factory fabricated Rockwool / PU insulated metal cladding on A Row & Gable ends, on C Row and any other external exposed surfaces, single skin metal sheet cladding over brick work shall be installed where brick work is technically required. Fire Wall facing towards Transformer yard, shall be minimum 6.0M high and 1 ½ brick thick wall or 250mm thick RCC wall as per Fire Prevention regulation. Single skin metal cladding similar to the Top sheet of Insulated Metal Cladding used for other part of the facade shall be applied over the Fire wall to match the overall elevation treatment.

Sufficient natural light and ventilation has to be ensured for every part of the building unless prevented due to technical reasons. Operating floor may have large glazed area made with Structural glazing system. At Crane girder level windows on A Row, B Row and gable ends shall be provided. Sufficient natural light is to be ensured at TG Hall floor.

Rain-water pipes or sanitary pipes shall not be visible from outside. Provision of pipe ducts shall be made to ensure pipe routing.

Minimum one number Down comer shall be provided at each grid column. All cable spreader floors shall have proper slopes and provision of fire emulsifying system for drainage.

Steel columns within fire hazardous areas like electrical room, Main control room and switch gear room shall be encased with brick work or concrete. All steel columns shall have 150mm high concrete base to ensure proper floor finishing work and to protect the column base.

Minimum 2.1m high headroom clearance has to be maintained at every part of the building.

**Vertical Head room clearance shall be maintained as per industry factories Act.**

**Sufficient headroom shall be provided in cable galleries.**





Where false ceiling is to be provided, provision of human access has to be made to maintain the HVAC, Electrical and other service lines above false ceiling. If the height between false ceiling and bottom of beam is more than 2.1M then steel grid system (1.2M X 1.2M span) with catwalk to be provided to support the false ceiling system and human access respectively.

Minimum 1.5M wide passage is to be marked on the floor as safety exit route. Such passages shall lead to Fire-escape staircases or fire-safe zones. Doors of fire-hazardous rooms or areas shall open towards safety exit passage. All external doors shall open towards outside. Fire escape staircases shall be located as per fire-code and TAC.

### 2.03.02 **Mill & Bunker Building**

This shall be of steel framed structure having single skin metal cladding to clad Tripper floor only. The colour and pattern of the sheeting should match the overall ambiance of Power Island. Sufficient natural light and ventilation should be provided for tripper floor. Provision of roof access through stair should be made.

### 2.03.03 **Other Plant Buildings**

Structures of Other plant buildings shall be as per description stated elsewhere in this Civil/Structural Specification. Architectural concepts of structures shall offer its own identity and will be aesthetically blended to give pleasing appearance maintaining harmony of the plant complex. Functional needs of each building shall be maintained.

## 3.00.00 **ARCHITECTURAL REQUIREMENTS**

### 3.01.00 **Roof Insulation and Ventilation**

The roof of buildings which are recommended by HVAC department for over deck insulation shall be insulated with rigid insulating board.

Extractor fans will be provided over roof of turbine hall for ventilation. For ventilation requirements relevant section of the specification shall be referred.

### 3.02.00 **Roof Waterproofing**

Roof water proofing treatment shall be as follows:

- a) For roofs having structural slope

Spray applied an average 40 mm thick two component Hydro fluoro-carbon(CFC free), polymeric M.D.I based closed cell(96-98% as per ASTM D2856) multilayer, waterproof, insulated polyurethane foam, mixed in a ratio of 1:1 by volume with a nominal core density of 45-50 Kg/m<sup>3</sup> as per ASTM D1622 , and a thermal conductivity of 0.023 W/m.k at 25 degree mean temperature as per ASTM C518/91 possessing waterproofing properties as per ASTM C-518/91 ,ASTM C-272 and complying to Fire resistance Class B2 as per DIN 4102.





Top of insulation foam shall have a minimum 1.5mm thick sealer coat, which is a single component cold applied elastomeric waterproofing coating with  $\geq 500\%$  elongation confirming to ASTM C836 applied by a spray/brush/roller in 2 coats. Loosely laid 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating. Laying protective slope with 25mm average thick (thickness will depend upon the required slope and span of the building) M20 grade screed mixed with polypropylene fibers and admixed with integral liquid waterproofing compound conforming to IS: 2645. Green stage saw cutting on the screed will be done in panels (3mx4m) with grooves 10mmx10mm. Finally the groove will be sealed with suitable elastomeric sealant. Finally top shall be finished with 20mm thick 600x600 concrete roof tiles over 20mm thick cement: sand (1:4) bed mortar.

b) For roofs having no structural slope

Spray applied an average 40 mm thick two component Hydro fluoro-carbon (CFC free), polymeric M.D.I based closed cell(96-98% as per ASTM D2856) multilayer, waterproof, insulated polyurethane foam, mixed in a ratio of 1:1 by volume with a nominal core density of 45-50 Kg/m<sup>3</sup> as per ASTM D1622 , and a thermal conductivity of 0.023 W/m.k at 25 degree mean temperature as per ASTM C518/91 possessing waterproofing properties as per ASTM C-518/91 ,ASTM C-272 and complying to Fire resistance Class B2 as per DIN 4102. Top of insulation foam shall have a minimum 1.5mm thick sealer coat, which is a single component cold applied elastomeric waterproofing coating with  $\geq 500\%$  elongation confirming to ASTM C836 applied by a brush/roller in 2 coats. Loosely laid 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating. Laying protective slope (1:100) with 75mm average thick (thickness will depend upon the required slope and span of the building) M20 grade screed mixed with polypropylene fibers and admixed with integral liquid waterproofing compound conforming to IS: 2645. Green stage saw cutting on the screed will be done in panels (3mx4m) with grooves 10mmx10mm. Finally the groove will be sealed with suitable elastomeric sealant. Finally top shall be finished with 20mm thick 600x600 concrete roof tiles over 20mm thick cement: sand (1:4) bed mortar.

For other plant and non-Plant buildings Two component PUR foam minimum 50 mm thick as per HVAC requirement shall be laid over screed concrete mix (1:2:4) grading having minimum 25mm thickness at the lowest point of the slope over R.C.C. slab and shall be laid as per the slope specified elsewhere in the specification. Top surface of rigid insulating board shall be finished with 15mm thick cement plaster (1:4) which shall be laid over Geo-textile membrane layer. Over the finished surface APP Bitumen membrane as specified shall be laid and top of the Bitumen membrane shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thickness on 15 mm thick cement: sand (1:4) mortar under bed. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with





polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar under bed layer also.

**3.03.00 Partition Wall**

All intermediate walls shall be full brick thick wall in 1:6 cement sand mortar. Half brick thick wall in 1:4 cement: sand mortar with 2 nos. 6 mm dia rod in every fourth layer shall be provided. For long walls intermediate RCC pillars and RCC horizontal tie shall be provided or shall be provided with structural steel member at minimum 2.5 m clear height with MS inserts/lugs for anchoring in brick work shall be provided. Similarly MS lugs shall be provided on the structural member at spacing 500/600 mm on vertical face for proper anchorage for brickwork, lugs embedded in concrete and suitable vertical structural member at maximum 5m c/c. Full glazed partition in anodized aluminium frame shall be provided for operator's cubicles for clear view of the operating equipment and in Control room area.

Internal Dry Partition wall made of Gypsum board / Cement particle board / Calcium silicate board is to be used where light weight construction is required. Board thickness shall be minimum 12.0mm. Partition may be single ply or double ply construction. Boards are to be fixed on metal studs as per manufacturer's details and specifications. Provisions for glazing and glazed doors, cable conduit, etc. are to be made as necessary. Gypsum board partition shall be finished

**3.04.00 Plastering**

Exterior & rough side of interior brick wall 20mm thick minimum sand faced plaster with 1:6 cement-sand mortar in two layers. Where external finish will require rich plastering for special finish plaster shall be of 1:4/1:3.

Interior wall 12 mm thick with 1:6 cement-sand mortar

Ceiling 6 mm thick with 1:4 cement-sand mortar shall be provided to all exposed ceilings.

**3.05.00 False Ceiling**

Aluminium pre-painted/Powder coated false ceiling, similar or equal to LUXALON of Hunter Douglas/ARMSTRONG with either lineal panel system or aluminium tile/plank system for control rooms and other important areas, with suspension system as per manufacturer's details shall be used.

Areas like office space or where specified Mineral Fibre Based Acoustic Ceiling Board either Armstrong or similar to Armstrong, in aluminium snap grid suspension system as per manufacturer's specification shall be provided. As an alternative Moisture & Fire Resistant Gypsum Board false



ceiling system of Saint Gobain Gyproc India Ltd or similar manufacturer may be used.

Unimportant areas Calcium Silicate Board/Tiles false ceiling shall be of HILUX or AEROLITE or Fibre Cement Board of EVEREST Industries Ltd shall be used.

The false ceiling work shall take care of all illumination, fire detection & fighting, HVAC and all other service requirement. False ceiling shall be provided with 25 mm thick insulation of resin bonded mineral wool conforming to IS: 8183. Wherever under-deck insulation is required the insulation shall be as per specification mentioned elsewhere in the specification.

### 3.06.00 **Special Finish**

- a) The main entrance of powerhouse, control room and other important areas shall have high quality finish to floors, walls, ceilings etc.
- b) Main stairs and landing shall be equally treated.

### 3.07.00 **Doors**

- a) Generally factory made hollow metal (steel) flush doors with pressed steel frame shall be provided for plant and utility areas.
- b) Factory made Solid core wooden flush doors in teak wood frame shall be used in interior office areas. Aluminium doors shall be provided in at entrances and important areas.
- c) Rolling steel shutters shall be used where frequent use is not envisaged and large openings are required. Operation shall be manual/mechanical/ electrical depending on the size of opening.
- d) Special areas like control rooms and other special area shall be provided with minimum 15 micron pre-coated i.e. colour anodized aluminium glazed partitions with air lock facilities having two sets of doors and preferably double door systems.
- e) Minimum 2 hour Fire rated doors with panic bar shall be provided in cable spreader rooms and other areas having fire hazard and also to all fire exists as per TAC requirement.
- f) Doors shall be provided at appropriate location to prevent dust ingress from outside.
- g) Wooden panel doors shall be provided for toilet entrance and toilet internal doors shall be solid core PVC.
- h) Weather stripping shall be provided to all outside doors as well as air conditioned areas and all other doors where dust-free environment is required.





3.08.00

**Windows & Ventilators**

In Powerhouse building, full glazed windows and ventilators in minimum 15 micron anodized aluminium window frame shall be provided with 4 to 6 mm thick (depending on the size of panel) clear float glass and 6 mm thick clear wired/laminated glass where required from safety point of view. For operating floor of Power House, structural glazing may be considered as an important façade element. All windows and ventilators shall meet the requirement of industrial windows and Ventilators.

In other areas aluminium windows with 4 mm thick clear float glass shall be provided suitably in panels not exceeding 1200 mm wide. The window area shall be so decided as to allow adequate natural ventilation and light.

**Note:** Glass thickness and member sizes of Aluminium Glazed doors and windows shall be designed by the manufacturer and to be submitted for approval by the Bidder before execution.

3.09.00

**Landscaping**

Generally the natural contour shall be retained except where modifications needed for drainage or other technical reasons. Rockeries, appropriate trees, shrubs, ground cover, lawns along with landscape furniture, sculptures, fountains, decorating/ornamental fencing, electric lights & fittings, etc. shall be provided to create a visually pleasant environment. Special landscaping shall be made around main entrances of powerhouse and other important buildings. Irrigation facilities shall be provided for all green areas.

The plant area shall be covered under Landscaping. Minimum 33% or as per recommendation of MoEF (whichever is higher), of plant area shall be kept as Green Belt. Some of the plantation area shall be fenced suitably as per the choice\advise of the Owner. Trees for formation of green belt of minimum width 100 M for segregation of CHP area from the raw water reservoir will be chosen to match with prevailing landscape in the adjacent areas. Names of some of avenue trees are given for selection, which are "Arjun, Ashoke, Elengi, Amaltus, Gulmohur, Mohua, Sirish, Margose, and White Ceden" and of other species suitable to the local environment. Special landscaping shall be made around main entrance of Power House, Service Building, Main Gate Complex. The area shall be covered by shrubs and seasonal flowers. Plantation for green belt shall commence immediately after the mobilisation of the Bidder at site, so that trees are sufficiently grown at the time of commissioning. The plants shall be maintained for a minimum period of one year after planting, and dead plants, if any shall be replaced. The Bidder shall also lay and commission the irrigation scheme for the landscaped areas which shall include supplying and installing pumps to draw water from the sewage and effluent treatment plant and pump into the system at required head, supplying and laying buried GI pipes of adequate capacity with associated fittings and control valves and sprinklers of approved design for distribution and sprinkling of water to various disposal points. A nursery has to be set up in the area to cater to the need of plantation. Some beatification work like decorative landscaping, rockeries, fountain, and lily pond shall be provided at locations to be suggested.





The Bidder shall furnish detail drawing schedule for landscaping prepared by experts in the respective discipline. The work shall be taken up duly after approval of the Owner.

Arboriculture and avenue plantation all along roads suitable to environment shall be provided.

### **3.10.00 Facilities in Buildings**

Adequate toilet and drinking water facilities shall be provided for personnel working in each building. Each building shall have toilet facilities both for Gents and Ladies. Number of toilet fixtures shall be adequate for the occupancy as per National Building Code.

However minimum 1 Water Closet with cistern, 1 washbasin with mirror, towel rail, soap case, 1 urinal shall be provided in each toilet.

Each floor shall have drinking water facility connected through potable water with water cooler.

Provisions should be kept for barrier free environment for physically challenged persons like ramps in 1 in 12 slope, lifts, toilets, etc.

### **3.11.00 Potable Water System and Service water Plumbing**

This system for various buildings shall be connected to the drinking water and service water systems, the scheme for which is indicated elsewhere in this specification.

Water outlets shall be provided for an instantaneous flow rate of approximately 7 Cu.M/Hr. (25 GPM).

System will satisfy state and local plumbing codes. Following I.S. Codes for the system shall be followed:

- a) IS-2065: Code of Practice for water supply in buildings.
- b) IS-1172: Code of basic requirements for water supply, drainage and sanitation.
- c) IS-1200: Laying of water and sewer lines including appurtenant items.  
(Pt. XVI)
- d) IS-1239 Specification for mild steel tubes and mild steel tubular and other wrought steel pipe fittings. (10 mm to 15 mm nominal diameter).
- e) IS-3589: Specification for electrically welded steel pipes for water, gas and sewage (220 mm to 2000 mm nominal diameter).





Potable water shall be supplied to basins, water coolers, showers and other plumbing fixtures. Soil and waste piping shall drain through traps to the yard sanitary sewer system.

Service water shall be supplied to water closets, urinals, sinks, and other plumbing fixtures.

### 3.12.00 **Roof Drainage Systems**

The system shall be provided for removal of water from roof surface to avoid damage to the roof structure of all buildings and shall consist of the following:

- a) Roof Drain Heads with dome strainer
- b) Rain Water Down comers
- c) Gully pits

IS-1742 code of practice for building drainage shall be followed for this purpose.

- a) Adequate numbers of rainwater drains heads shall be provided for all roof areas as per standard norms for roof area.
- b) System will be designed to handle rainfall at a rate as specified elsewhere in this specification and in accordance with stipulations of IS-1742.
- c) Any roof more than 8.0 metres above grade shall have access from within the building for cleaning of roof drains.
- d) Runoff gradient should not be less than 1 in 100.
- e) Roof drains will conduct water to storm sewers. No rain water pipes shall be exposed to outside view. Minimum 150 mm dia. Medium duty G.I pipe of TATA, Jindal or equivalent approved make shall be used.
- f) Roof drains will conduct water to storm sewers. No rain water pipes shall be exposed to outside view.

### 3.13.00 **Glazing & Glazed Partition**

- a) Glazing in Control room between A.C. and non-A.C. areas shall be insulating glass consisting of two 6 mm thick toughened float glass sheet hermetically sealed and separated by 12 mm gap for thermal insulation. Clear glass shall be provided where clear view is required. In other areas tinted glass may be provided.
- b) 4 mm thick ground glass shall be provided for toilets.
- c) Glazing between two A.C. areas shall be with 6 mm thick clear float glass.





- d) All glazing shall be in aluminium frame having 15-micron colour anodization.
- e) 6mm thick. Wired / laminated glass shall be used for windows / ventilators at higher level for safety.
- f) 24mm thick insulated double glazing having 6mm thick tinted heat-reflecting type float glass on outer side and 6mm thick clear float glass on inner side with 12mm air gap & hermetically sealed shall be mounted on 15 micron coloured anodised aluminium frame suitable for structural glazing system.
- g) For glazed aluminium door, 8.0mm thick clear float glass with or without etching is to be provided.

**3.14.00 Sealant**

Two part polysulphide sealant conforming to IS: 12118 shall be used for sealing of joints in contact with water. For other cases, bitumen sealing compound conforming to IS: 1834 shall be used. Preformed bitumen impregnated fibre board conforming to IS: 1838 or polystyrene filler board of HD100 of Supreme or equivalent shall be used as joint filler. All joints around exterior doors, windows, and expansion joints, etc. shall be sealed for proper water- lightness.

**3.15.00 Damp Proof Course**

40 mm thick 1:1.5:3 concrete with 2% waterproofing admixture or as per manufacturer's recommendation to be provided.

**3.16.00 Plinth Protection**

Minimum 1000 mm wide concrete plinth protection having thickness of 150mm with PCC M20 and over 150 mm soling, along building periphery shall be provided with surface drain of required size and slope, to suit storm water quantity, shall be connected to station main drainage system.

**3.17.00 Miscellaneous Metal Railing**

- a. For main stair & lobby of Powerhouse building up to operating floor main landing and one half landing above operating floor level, around large openings at operating floor, main stair of Service building, Administrative building shall have 40mm diameter stainless steel railing with minimum 3mm thick SS posts & decorative minimum 3mm thick seamlessly joined SS handrails. Stainless steel pipe handrail in shall be of grade SS-304 and of approved design to meet the functional requirement as well as very good aesthetic appearance. Other hand railings of Power house building shall be MS Galvanised hand railing with 40 mm NB (medium) main post and 32 mm NB (medium) as horizontal rails. With toe guard shall be provided.



- b. For any other RCC stairs of non-plant buildings 20mm square MS bar post with suitable MS Bar/flat (20 – 25 kg/Sq.m) and PVC handrails are to be provided. However design pattern shall be approved by the Owner.
- c. For plant & non-plant buildings, unless otherwise indicated in the specification the post and handrails of stairs, railings, etc. Shall be of 32 mm dia NB medium class G.I. pipes as per IS-1239-part (I).

**3.18.00 Painting**

- Exterior Masonry Surface : Buildings shall be finished with waterproof External Quality Acrylic Emulsion Paint similar to “Apex Ultima”, “Weathergurd”/ “Weathershield” over plaster. Granular textured paint may also be combined along with External Quality Acrylic Emulsion Paint to form suitable pattern on building façade. Aluminium composite panels (ACP) may be used to accentuate certain portion of the façade or certain element of the façade as the case may be.
- Exterior Steel Work : Two primer coats steel work Zinc silicate 50 microns each. Two finish coats High built epoxy finish of 90 microns each coat.
- All Woodwork : Synthetic paint over a coat of primer.
- All Internal Steel Work : Epoxy Paint over approved primer
- Steel in contact with acid /alkali : Acid/Alkali/Chemical resistant paint
- Interior Office Spaces : Acrylic emulsion paint over 3 mm  
Control Rooms, All A.C. Areas thick white cement putty punning.  
And as mentioned in the annexure
- Other Areas : Acrylic distemper over plastered surface as indicated in annexure for finish schedule in this document.
- Fire Door : Post Office red shade shall be provided.

**3.19.00 Miscellaneous Work**

- a) Counter tops in kitchen, Washbasin, pantry & similar areas shall be polished granite over RCC slab or Kota stone top.
- b) Pavements, walkways, etc. Shall be 50/ mm or of standard thickness thick anti-skid interlocking concrete pavers





- c) M.S. grill shall be generally anodized aluminium grill shall be provided. But in specific cases, M.S. grills shall be used as per approved design for security purpose made of 25 mm X 6mm M.S. Flats / 12mm – 20mm M.S. square bar of approved design shall be provided to suit security requirements.
- d) R.C.C. stair railing shall be with 20 mm square M.S. Bar balustrades with suitable M.S. flats & anodized aluminium / PVC handrails shall be provided. Stainless steel pipe railing in specific areas shall be used.
- e) For RCC main stair and landing of powerhouse building shall be of Kota stone and white marble strip combination, RCC stair of Service Building & Administrative building shall be of white marble/combination of Baroda green and pink marble with all edges and nosing moulded.
- f) Anti-termite treatment shall be given to columns pits, foundations, and trenches, below floor as per IS: 6313.
- g) Suitable arrangement of floor drain with trap shall be provided in floor where spillage of water may occur.
- h) RCC staircase shall be provided in main entrance of Turbine building, Facility building and other important buildings. Turbine hall staircase shall be provided with Structural steel work
- i) Access Floor panel of size 600x600 mm shall be all steel welded construction, with an enclosed bottom pan of 49 hemispherical and 36 reverse cones and top plain sheet which are fuse welded at 129 locations to form a panel of an overall depth of 37 mm. The panel after cleaning, degreasing, phosphating by 11 tank process is coated with 40-60 micron epoxy coat and is heated to achieve maximum adhesion to the panel surface and corrosion resistance. The inner empty core of the panel is injected with a light weight fire retardant, non-combustible cementitious compound at high pressure to fill in all the crevices of the panel and ensures support of not less than 90% of the top surface area of the panel. The panel is then laminated with 1.5/2.00 mm thick fire retardant floor grade Antistatic Laminate / ESD Laminate – PVC / Conductive PVC on a semi –automated lamination line to ensure maximum bonding to the steel surface. The edges of the laminated are protected with black Conductive PVC edge trim 5mm wide on all sides. This edge trim is mechanically locked and sealed in place to avoid detachment. **Location and area of such access flooring shall be as per electrical requirement and Electrical GA Drawings.**
- j) Doors, windows and rolling shutter in all buildings shall have sun- shade either recessed in the wall or projected out. Projection of sunshade shall be 750 mm for door and 450 mm for windows. Where doors and windows are side by side, 750 wide continuous sunshades shall be provided. For recessed type shed minimum 450 mm offset shall be provided.

### 3.20.00 Chain Link Fencing

Chain link fencing for areas as per safety requirement shall be provided. This shall be as per Civil/Structural specification.







**3.21.00 Temporary Fencing**

The construction of Temporary Fencing shall be done as mentioned below:

- a) RCC post and its foundation shall be at 3.0m interval.
- b) Fence shall be installed along lines shown on approved drawings.
- c) Post size shall be 150sqr at bottom and 100sqr at top.
- d) Total height of the posts shall be 2400mm from grade level.
- e) Strainer posts shall be provided at sharp changes in grade, at comers at change of direction and where directed, and at every 30.0m interval.
- f) All comer post will have two stay posts and every tenth post will have a transverse stay post.
- g) Barbed wires shall run post to post and to be fixed to the posts by tightening hooks.
- h) Diagonals and vertical per span with barbed wire shall be provided. In general CPWD specification is to be followed.

**3.22.00 Watch Towers**

Not applicable under this scope of work.

**3.23.00 Sanitary Drainage System**

- a) Diameter of Soil Pipe and Waster Pipe shall not be less than 100 mm.
- b) Drainage pipes shall be UPVC Type-B pipes as per IS: 13592-1992 (amended to 1995) or Cast Iron pipes as per IS: 1537 & IS: 3486 within the building.
- c) IS: 1742-Code of Practice for building drainage & IS: 5329 -Code of Practice for sanitary pipe work above ground for buildings should be followed.
- d) If not specified the minimum gradients of soil and drainage pipe line shall be as follows:
  - I. 100 mm nominal dia : 1 in 35
  - II. 150 mm nominal dia : 1 in 65
  - III. 230 mm nominal dia : 1 in 120
  - IV. 300 mm nominal dia : 1 in 200
- e) Each floor drain should have 'P' or 'S' trap connection as required.
- f) Pipe to pipe should be connected in 45<sup>0</sup> or 135<sup>0</sup> both vertically and horizontally.







- g) For cleaning purpose during maintenance, Floor Cleanout and Wall Cleanout should be provided for horizontal run and vertical run of the pipes.
- h) In no case soil pipe shall be connected to waste pipe.
- i) In vertical stack proper venting system with anti-siphonage vent pipes should be provided for all Water Closets.
- j) CI pipes shall be joined by lead caulking and UPVC pipes shall be joined by thermoplastic joint as per manufacturer's detail.
- k) Soil & Waste pipes shall be taken out of the building separately and shall be connected to separate Inspection chambers. From inspection chamber further connection shall be made to either septic tank or STP line as per plant drainage scheme.

4.00.00 **INTERIOR FINISH SCHEDULE FOR POWER HOUSE BUILDING  
(Refer ANNEXURE - I)**

5.00.00 **INTERIOR FINISH SCHEDULE FOR AUXILIARY BUILDINGS  
(Refer ANNEXURE - II)**

6.00.00 **INTERIOR FINISH SCHEDULE FOR NON PLANT BUILDINGS  
(Refer ANNEXURE - III)**

6.01.00 **Architectural Specification of Control Room & Annexure Room**

The control room of the Turbine Building is located at Operating Floor level. It is the nerve centre of the plant having state of the art facilities and requires a highly sophisticated hi-tech expression and ambience. To accentuate the Front portion of the UCB control room façade a suitable combination of Aluminium composite panel (ACP)/granular textured paint may be used. Please also note that the finish of the visitor's lounge/gallery in the control room enclosure will be same as that of control room.

The room will be fully air-conditioned and have access from T G hall side through Air locks to reduce the noise level as well as heat load. Each Air-lock space shall have two numbers of double leaf glazed sensor operated sliding aluminium doors. The wall facing the turbine hall shall be fully glazed aluminium partition wall with hermetically sealed insulating glass panels. Control room shall have an internal acoustic partition wall along the entire length of the room, facing operating desks. This partition shall be integrated with Digital Display Boards at different locations and have monolithic fabric finishes with high acoustical properties. It will have fully vitrified tiled floor, linear metal ceiling with A.C and lighting fixtures and wall with acrylic emulsion paint. The control room shall have very high quality furniture of approved make similar to Godrej/ Featherlight. The control desk of laminated and moulded finish of approved colour and texture, appropriate to accommodate/house control panels, monitors shall be equipped with all functional requirements. Operator's chairs shall be swivel type on casters and have





cushioned seat and back of approved material and colour. Necessary arrangement for sealing expansion joints on floor, wall and ceiling has to be ensured. Brief technical specifications of different items to be used for the control room are as follows.

- a) Flooring: Non-skid, full body vitrified, 10 mm thick non-porous, homogenous, abrasion resistant, floor tiles of 1st quality dual charged similar to "MARBONITE", "FERRASTONE" of "BOSS Profile Ltd", "RESTILE", "ENDURA" of H & R Jonson (India) Pvt. Ltd, KAJARIA of minimum size minimum 600 mm x 600 mm x 10mm of approved colour and shall be laid over concrete floor with laying compound strictly as per manufacturer's specification. Total thickness of the flooring shall be 50mm thick including the thickness of the tiles, under bed.
- b) Skirting: Walls of UCB control room from floor level up to false ceiling level shall be provided with vitrified tiles of 1st quality, full body vitrified, 10 mm thick nonporous, homogenous, abrasion resistant cover base of matching colour, internal and external corner strip similar to "MARBONITE", "FERRASTONE" of "BOSS Profile Ltd", "RESTILE", "ENDURA" of H & R Jonson (India) Pvt. Ltd, KAJARIA and fixed to the wall strictly as per manufacturer's specification.
- c) Wall finish: Columns, bracings or any other element within the room as the case may be shall be clad with polyester coated 3mm thick Aluminium Composite Panels (Aluminium thickness minimum 0.2mm) of approved make or composite panelling of approved pattern up to the RCC ceiling level. The colour and design composition of ACP cladding or composite panelling is to be submitted for approval of the authority before taking up the work.
- d) False ceiling: The bottom level of false ceiling shall be kept 3500mm above floor level and as applicable. Combination of Gypsum plaster board and Aluminium lineal (LUXALON or similar approved) or plank/panel false ceiling system of approved pattern having state of the art facilities and requires a highly sophisticated hi-tech expression and ambience in order to enhance the aesthetic appearance of the control room. The false ceiling work shall take care of all illumination, fire detection & fighting, HVAC and all other service requirement. Under-deck insulation with 50 mm thick resin bonded rigid mineral wool / polystyrene block with protective aluminium foil lining shall be provide on the ceiling, on the walls and beams above false ceiling level.
- e) Air lock doors: Double acting glazed aluminium door with minimum 15 micron colour anodized finish with 3mm thick shall be used having glazing thickness 6mm of clear float glass of approved brand .The doors shall be complete with weather seal, gaskets, floor spring, doorstopper, door locks, push/pull bars of similar finish and all necessary hardware. The aluminium sections shall be similar to HYDRO-Domal System.
- f) The doors shall be complete with weather seal, gaskets, floor spring, doorstopper, door locks, push/pull bars of similar finish and all necessary hardware. The aluminium sections shall be similar to HYDRO-Domal System.



- g) Glazed partition wall: The glazed partition wall shall be made of aluminium sections having same finish that of aluminium doors with double-glazed insulating glass panels. This partition height shall be from top of floor finish to the bottom of the false ceiling. Insulating glass shall consist of 2 nos. 8 mm thick toughened plain glass separated by an air gap of 12mm thick, hermetically sealed, moisture resistant and of approved manufacturer. The partitions shall be weather proof complete with gaskets, clips, hardware, etc. The aluminium sections shall be similar to HYDRO-Domal System.
- h) Internal partition wall of control room: The internal partition wall along the entire length of the room, facing operating desk shall consist of Digital Display Boards at different locations, integrated with wall panels of Anutone Acoustic Ltd or equivalent laid flush with the display board and two nos. of matching doors on either sides for access to the rear side for maintenance. This special purpose partition shall be as manufactured by Anutone Acoustic Ltd or equivalent and shall have rigid frame work consisting of G.I. Studs of adequate size @ 600 mm c/c and floor, ceiling and intermediate channels to provide a strong wall system capable of supporting wall hung C.C.T.V. at designated locations. The framing system shall be integrated with independent floor supported structural framework of digital display board so as to cover the entire exposed surface around the board with partition panels. The entire wall shall have Class I fire rating as per BS code. The partition shall not transmit any load to false ceiling. The entire partition wall shall have concealed framing system and have monolithic fabric finish of approved colour or composition of two different colours as per approved design to entire exposed surfaces including door panels on control room side.

**3D views with different colour and pattern showing flooring wall panelling and false ceiling is to be submitted for owner's selection.**

7.00.00 **DESIGN DATA FOR ARCHITECTURAL WORKS**

- |    |                                      |   |
|----|--------------------------------------|---|
| 1  | Brick works – internal and external: | 230 mm thick fly ash brick wall with 1:6 Cement- Sand mortar. All Brick work as mentioned in this document shall be with Fly Ash Bricks unless noted otherwise. |
| 2  | Half brick thick wall:               | 1:4 cement: Sand mortar with 2 nos. 6 mm dia M.S. rod in every fourth layer.  |
| 3  | One third brick wall:                | 1:3 cement: sand mortar with 2 nos. 6 mm dia M.S. rod at every alternate layer.   |
| 4. | Damp proof course:                   | 40mm thick 1:1.5:3 Concrete with a 2% admixture of water proofing compound or as per manufacturer's recommendation.   |
| 5. | Plaster:                             |   |





- Exterior & rough side: 20 mm thick with 1:4 cement- sand of interior brick wall mortar in two layers except where special finish provided.
- Interior: 12 mm thick with 1:4 cement-sand mortar
- Ceiling: 6 mm thick with 1:3 cement-sand mortar
6. White Cement Putty Punning: 3 mm thick punning to be provided to all areas receiving acrylic emulsion or Acrylic Distemper paint.
7. Cladding for Power house :

Providing and fixing of double skin insulated wall cladding system comprising of colour coated profiled external sheet manufactured out of similar or equal to 0.45 mm BMT COLORBOND® XRW or equivalent steel- High tensile with min 550 MPa yield strength, metallic hot-dipped coated with Al-Zn alloy (55% Aluminium, 43.5% Zinc, 1.5% Si ) as per AS1397 / IS15961 - ZINCALUME® AZ150 (min. 150 g/m<sup>2</sup> total on both sides) with Super Durable Polyester COLORBOND® steel XRW quality paint system of approved color, suitable for exterior application conforming to AS/NZS 2728 type-4 / IS15965 class 3.. Profile sheet of nominal.1015 mm effective cover width and nominal 28 mm deep ribs with subtle square fluting in the five pans at nominal 203 mm centre-to-centre. The end rib shall be designed for anti-capillary action, to avoid any seepage of water through the lateral overlap. The sheet shall have a total coating thickness of 35 microns, super durable polyester COLORBOND® XRW or equivalent with Thermatch™ solar reflectance technology quality paint system of 20 microns on exposed surface and 5 micron reverse polyester coat on back surface over 5 micron primer coat on both surfaces. The paint system would have stable resin & inorganic pigments for paint durability and is lead free for water harvesting. The steel sheet shall be fastened with nominal 40 µm zinc coated or nominal 25 µm Zinc-Tin alloy coated, Hex head, self-drilling screw as per AS 3566-2002 Class 3 fasteners with EPDM washer and also as per the requirement considering the profile shape and design load. The inner sheeting shall be 0.50mm/0.6mm TCT of SMP coated zincalume steel 150 gsm. (Zinc – aluminium alloy coating mass total of both sides as per AS 1397:1993) having 550 Mpa yield strength. The colour coating shall comprise of 25 microns finish coat over a 10-micron primer coat on the exposed side and a back coat of 10 microns over a primer coat of 5 micron on the reverse side. The inner sheet shall have 980mm cover width 28mm high crests at 195mm centres with special male / female side laps and anti-siphoning features to prevent leakages. The inner sheet shall be fixed to the structure by means of self drilling fasteners no. 12-24 x 25 mm conforms to AS: 3566 Class-3 long at valley. Sub- girts of size 50mm x 50mm x 50mm manufactured out of 16G GI (1.6mm GI) ‘Z’ shape would be fixed the inner sheeting on face side at runner locations and outer sheeting shall be fixed with the help of concealed compatible interlocking clips and wafer head zinc coated self drilling fasteners / screws 4.2 x 25mm long on to the sub-girts. The clips shall be concealed and no fasteners are to penetrate the external sheeting. An insulation of 50mm thick Rockwool Insulation of



density 48KG/M<sup>3</sup> conforming to IS: 8183 shall be provided and fixed to the inner sheet and between the two sheets as per specification. If the insulation is made of polyurethane foam then the core in between the outer profiled sheet and the inner sheet will be formed out of polyurethane foam in 30mm thickness having a density of 40-45 kg/cum. The foam shall be in filled in between the outer and the inner sheet using a highly dedicated foaming machine and the entire process of forming the panel will be carried out at factory Panels may be prefabricated factory made panels or in-situ type. Wherever single skin metal cladding shall be used over brickwork, the material shall be same as the outer skin of insulated metal cladding system.

**Note:** For single skin wall cladding/ roofing, specification for outer sheet as mentioned above is to be followed. Flashings shall be of same material that of sheeting.

The work is to be executed by the in-house/authorised applicator of the manufacturer, under the supervision of the authorised representative of the manufacturer.

Approved Manufacturer: LLOYD Insulations (India) Ltd. TATA Blue Scope Steel, or similar approved.

8. False Ceiling : Aluminium pre-painted false ceiling, either lineal panel system or aluminium tile/plank system.

a) PANELS

Panels to be manufactured from pre-painted, stove enamelled, alloy EN-AW-5050 or equivalent (according to EN 1396 and ECCA).

Panels are to be coupled in longitudinal direction by means of panel splices. Optionally the flange with 3 x 7 ventilation holes can be used to achieve a ventilated ceiling.

b) SUSPENSION

Rows of 0.5 Fe/0.95 Aluminium roll formed carriers shall be installed about 1200mm center on center by means of adjustable suspensions about a distance of 1200mm, center on center. Carriers will be joined by means of carrier splices. Carriers provided with prongs to hold panels in a standard module of 100mm.

c) PERIMETER PROFILES

- Clip-on U-profile, 28.6x12.5 x20 mm, made of 0.35 thick aluminium
- Wall L-profile, 29.2x19.4 mm, made of 0.5 mm thick aluminium
- Wall L-profile, 45x18.5 mm, made of 0,8 mm thick steel or aluminium
- Wall W-profile, 45x21x21x18.5 mm, made of 0.8 mm thick steel or aluminium







d) PERFORATIONS

Manufacturer shall supply panels with following perforation specifications:

- $\varnothing$  1.0 mm,  $\Delta$  2 mm with 23% open area
- $\varnothing$  2.0 mm,  $\Delta$  5 mm with 16% open area

Perforated panels to have a nominal plain border along the longitudinal panel direction to assure a maximum flatness and product stability:

- 84C panel, 1 mm perforated to have a plain border of 7 mm
- 84C panel, 2 mm perforated to have a plain border of 6 mm

e) ACOUSTICS

Manufacturer shall supply acoustic non-woven tissue, thickness 0.2 mm factory applied inside the panels. Alternatively the installer can place individual PE wrapped mineral wool pads.

f) COATING

The coating will consist of a tough and durable polyester finish in nominal thickness of 20 microns, applied in a continuous coil-coating process ensuring uniform coating and absolute adhesion.

g) INSTALLATION

All materials shall be installed by the approved applicator/erector of the manufacturer under supervision of the authorized representative of the manufacturer.

Approved make: LUXALON by Hunter Douglas, Armstrong, INTERARCH or similar approved.

Alternatively in other air-conditioned areas 12.5 mm Gypsum board/Mineral fibreboard /Calcium Silicate Board / Fibre Cement Board ceiling with aluminium grid will be used.

Approved make: Saint Gobain Gyproc India Ltd, Armstrong, AMF, Everest, HILUX , Aerolite or similar approved.

9. Floor finish:

- a. Generally finish to utility areas shall be 40 mm thick heavy-duty patent stone with metallic hardener on concrete slab.

The heavy-duty overlay shall be ready-to-use, metallic aggregates based powder after application of epoxy based bonding agent of two components, solvent less epoxy resin based equal or similar to BASF's MASTERTOP 230i. It shall be formulated to meet the requirement of ASTM C881 Type 2, Grade 2, and Class B & C. The Bonding agent shall exhibit minimum open time of 6 hours and shall exceed the tensile



strength of concrete in terms of its adhesive bond strength. The Floor topping product shall be high strength with compressive strength of 80 MPa at 28 days; flexural strength exceeding 8 MPa at 28 days. The product shall be capable of resisting metal crawler chassis and shall have abrasive wear less than 0.15 mg/cycle on H22 wheel, ASTM C501 test method. The product shall have adhesive bond strength in excess of 1.5 MPa when tested as per ASTM D4541. Curing of the layer to be done with non-degrading membrane forming curing & sealing compound shall be equal or similar to MASTERKURE 181, acrylic resin based formulation. The product shall comply with ASTM C 309 Class B. The product shall exhibit water loss not more than 0.55 kg/m<sup>2</sup> in 72 hours when tested as per ASTM C156. The product shall form non-degrading abrasion resistance film which shall also exhibit capability as primer for subsequent protective coatings or bituminous overlays.

Approved make: BASF, FOSROC, SIKA, STP or similar

- b. For T.G. Hall (operating floor) Granite / Kota stone flooring finish will be as follows :

Minimum 18~20 mm thick polished Granite/ Kota stone slab or 600x600 mm tiles to be used over minimum 30 mm thick under-bed. Stones shall be hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of  $\pm 5$  mm in dimensions and  $\pm 2$  mm in thickness will be allowed. During laying the slabs the edges of the slab shall be buttered with slurry of cement, mixed with pigment matching the colour of the stone slabs. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. Per. Sq.m. water sprinkled on to it and finished by buffing with felt or Hessian bobs.

- c. For battery room, battery charger room, chemical laboratories, chlorination room etc., the areas handling corrosive liquids, overall 40 mm thick Acid and Alkali resistant vitrified tiles flooring with 20mm thick tiles with silica based epoxy mortar shall be used. Acid and Alkali resistant vitrified tiles with silica based epoxy mortar up to 2.1M height from finished floor level shall be used as dado. Acid and Alkali resistant paint shall be applied up to the ceiling level above Acid and Alkali resistant tiles dado. Ceiling shall also be painted with Acid & Alkali resistant paint.

Approved Make: ENDURA of Jhonson, Chemstone of BOSS Profiles Ltd, RESTILE Ceramics Ltd. Or similar approved.

Paints- ICI, ASIAN Paints, Berger or similar approved.

- d. For battery room finished with Epoxy Flooring (where required)**

On the prepared substrate, one coat of a solvent free, resin based dispersion, Primer shall be applied. Density of the primer is around 1kg/lt and the mixing ratio of two components, Comp. A and B:: 1:2.5 by weight.





Over the primed surface, epoxy modified cementitious self levelling floor topping shall be laid maintaining the thickness of 2mm. The mixing ratio of three component Comp.A: Comp.B: Comp.C: 1:2.5:17 by weight, compressive strength at 30°C approx. 45N/mm<sup>2</sup> after 28days, the mortar density is around 2.2 kg/lt.

Priming should be done again with a primer of two component product, comp. A: comp. B: 4:1 (By weight). Prior to mixing of these two components, only comp. A shall be stirred mechanically. When all of part B is added to part A, the mix is to be stirred for 3 minutes until a smooth consistency is achieved. Finally, after drying of the primer, two coats of high-build, slightly thixotropic, chemical resistant epoxy protective coating shall be applied as the top coat. Minimum 2 coats are required. This is two component products, comp. A: comp. B: 3:1 (by weight). The mixed density is 1.5kg/lt at 27°C. The system shall be allowed for curing for 3 days.

Approved Make: Sika India (P) Ltd., BASF, FOSROC, STP or similar.

- e. All areas of toilet, including W.C and urinal shall have vitrified ceramic tiles floor. Dado shall be of glazed tiles of minimum 5/6 mm thickness up to 100 mm higher than lintel level starting from finish floor level.

Approved Make: Ferrastone/Hardstone of BOSS Profiles Ltd, RESTILE Ceramics Ltd. , Marbonite, Kajaria, Nitco, Endura of H R Jonson, or similar approved.

- f. Access Floor panel of size 600x600 mm shall be all steel welded construction, with an enclosed bottom pan of 49 hemispherical and 36 reverse cones and top plain sheet which are fuse welded at 129 locations to form a panel of an overall depth of 37 mm. The panel after cleaning, degreasing, phosphating by 11 tank process is coated with 40-60 micron epoxy coat and is heated to achieve maximum adhesion to the panel surface and corrosion resistance. The inner empty core of the panel is injected with a light weight fire retardant, non-combustible cementitious compound at high pressure to fill in all the crevices of the panel and ensures support of not less than 90% of the top surface area of the panel.

The panel is then laminated with 1.5/2.00 mm thick fire retardant floor grade Antistatic Laminate / ESD Laminate - PVC/ Conductive PVC on a semi-automated lamination line to ensure maximum bonding to the steel surface. The edges of the laminated are protected with black Conductive PVC edge trim 5mm wide on all sides. This edge trim is mechanically locked and sealed in place to avoid detachment

Sub structure installed to support the panel shall be suitable to achieve a minimum finished floor height of 65mm to a maximum of 600 mm from the existing floor level. Pedestal design shall confirm speedy assembly and removal for relocation and maintenance. The assembly shall provide easy adjustment of levelling and accurately align panels for a maximum  $\pm$  25 mm in the vertical direction. Pedestals shall support an axial load without



permanent deflection and an ultimate load as laid out in System Performance requirement. The Pedestal head assembly shall consist of a 90 x 90 mm x 4.00 mm embossed head mechanically riveted to a 100mm long 20mm dia rolled formed stud and 2 check nuts for level adjustment and arresting vertical movement. The pedestal head shall consist of an anti-vibrational PVC cap, for Panel and stringer location.

The Pedestal Base assembly shall consist of 25.00 mm OD pipe of thickness 2.00 mm mechanically locked on a press for perpendicularity and then welded to a base plate of 125 x 125 x 2.50 mm thick with stiffening folds.

The sub structure assembly shall be suitably anchored to the floor with suitable adhesive or fastener as recommended by the manufacturer. All steel components shall be zinc electro plated.

The stringer is hot dipped galvanized steel cold rolled construction specially designed with ribs embossed on 3 sides for strength, lateral stability, and rolling loads and to support the panels on all four sides for alignment. The stringer to have a counter sunk holes at both ends to accommodate bolting of M6 machine screws to the pedestal head assembly. The stringers shall be 21 x 32 x .8mm x570 mm length.

Approved make of Tile: Unitile® USF 1500 or similar approved.

- g. Floor/staircase and the areas prone to slippage due to oil spillage etc. Shall be provided with non-skid floor finish.
  - h. 750 mm wide, minimum, R.C. paving as plinth protection, shall be provided around all buildings with surface drain of required size.
  - i. Risers and treads of concrete staircase of powerhouse shall be of white marble slab and in all other stairs; same shall be of Kota stone finish. 20/25 mm thick Kota stone finish excepting main stair riser and treads shall be of marble. All areas shall have 150 mm high skirting unless indicated otherwise in the specification.
  - j. For MCC and Switchgear rooms flexible electric insulated PVC synthetic sheet as per IS: 15652 2006 of Suntex Insulatic Pvt Ltd or similar shall be applied.
10. Doors and Windows:
- a. Hollow metal door at all levels shall be installed from ISO 9001-2000 certified Manufacturer. All hollow metal general doors with or without vision panel. Pressed Galvanised steel Single /Double leaf to required sizes which consist of frame, shutter, infill and finish as detailed below and conforming to IS 277.

Door frame shall be Single rebate profile of size 100 x 57 mm made out of 1.20 mm thick galvanised steel sheet (18 gauge). Frames should be Mitered and field assembled with self tabs. Frames should be provided with back plate bracket and anchor fasteners for installation on a finished



plastered masonry wall opening. Once frame installed should be grouted with cement slurry if recommended on the clear masonry opening.

Door leaf should be 46 mm thick fully flush double skin door with or without vision lite. Door leaf shall be manufactured from 0.8mm (22 gauge) minimum thick galvanised steel sheet. The internal construction of the door should be rigid with steel stiffeners/ pads and reinforcement. The infill material shall be resin bonded honeycomb core. All doors should be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges, locks, and door closers. The edges should be interlocked with a bending radius of 1.4mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. Vision lite wherever applicable should be as per joinery details with a screw on glass beading on the inside. The glass should be 5 mm clear toughened glass. Louvers when recommended should be site proof and shall be flush fixed on the external surface.

All doors and frames shall be finished with etched primer coating, stove zinc phosphate primer and thermosetting polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt spray test.

Rate should include supply and installation of door and hardware.

Approved make: Shakti Met Dor, NCLSeccolor, Godrej, Gandhi Automation Pvt Ltd, or similar.

Approved Hardware: DORMA, Guardian

- b. Hollow metal fire rated doors as per IS 3614 part-1 & part-2 for stability and integrity. Pressed Galvanized steel conforming to IS 277 with the following specification shall be used. Recommended fire door shall have doors tested at CBRI for maximum rating of 2 hrs with vision panel. Test certificates should be available for vision litters /panels as part of the fire door assembly. Independent glass test certificates will not be accepted. Manufacturer test certificate shall cover doors both single and double leaf and all doors supplied should be within the tested specimen, deviation in specification and sheet thickness other than what is mentioned in the test certificates are not allowed. Proper label confirming the type of door and the hourly rating is mandatory.

Door frame shall be double rebate profile of size 143 x 57 mm made out of 1.60 mm (16 gauge) minimum thick galvanized steel sheet. Frames shall be Mitered and field assembled with self tabs. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Rubber door silencers should be provided on the striking jamb. Frames should be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. Once frame installed should be grouted with cement & sand slurry necessary for fire doors on the clear masonry opening.

Door leaf shall be 46 mm thick fully flush double skin door with or without vision lite. Door leaf shall be manufactured from 1.2 mm (18 gauge)



minimum thick galvanised steel sheet. The internal construction of the door should be rigid reinforcement pads for receiving appropriate hardware. The infill material shall be resin bonded honeycomb core. All doors shall be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges, locks, and door closers. The edges should be interlocked with a bending radius of 1.4 mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. Vision lite wherever applicable should be provided as per manufacturer's recommendation with a beeding and screws from inside. The glass should be 6 mm clear borosilicate fire rated glass of relevant rating of the door.

All doors and frames shall be finished with etched primer coating, stove zinc phosphate primer and thermosetting polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt spray test.

Rate should include supply and installation of door and hardware set as mentioned in the door and hardware schedule.

Approved Make: Shakti Met Dor, Godrej, Navair, Promat, Gandhi Entrance Automation Pvt. Ltd, or equivalent.

Hardware list: Hinge, Door closer, Panic Bar with external trim, Mortise lock & latch with lever handle for without panic bar door.

Approved Hardware: DORMA, Guardian

- c. Main Entrance of Control Room, Control Equipment Room shall be provided with air-locked lobby with provision of double doors of aluminium framework with glazing with sensor operated sliding type for main entrance for main control room, service building, administrative building and double swing type for control equipment room, etc. Doors of control room, control equipment room, computer room, etc. Shall be full glazed pre-coated minimum 3mm thick aluminium i.e. coloured anodized aluminium. Full glazed aluminium partition with airlock shall be provided along (B) row of Turbine hall operating floor where clear view is desired. Glazing between air-conditioned areas shall be single glass whereas that between air-conditioned and non-air-conditioned area shall be with hermetically sealed insulating glass.

Approved Make: Domal Systems of HYDRO, Hivalco, DORMA, or equivalent.

- d. Doors of W.C. and shower shall be wooden panel door.
- e. All windows and ventilators for prestigious buildings like power house, service building canteen, fire station, administrative building etc. Shall be glazed aluminium windows conforming to IS:1949 & IS: 1948.

Approved Make: Domal Systems of HYDRO, Hindalco, DORMA or equivalent.





- f. Pre-coated (polyester painted) steel windows and ventilators may be used for auxiliary plant buildings.

Approved make: Ncl Altek & Seccolor Ltd.

- g. Alternatively steel reinforced UPVC windows may be used for some non-plant building if agreed by the Owner.

Approved make: "Fenesta" by DSC Ltd. DURAPLAST

Approved Hardware for doors shall be of HAFELE, DORMA or similar approved.

11. Rolling Shutters:

Rolling shutters as per IS: 6248 with suitable operating arrangement (manual, mechanical and/or electric) according to size shall be provided in buildings to facilitate handling and transportation of equipment. The curtains of rolling shutter will be of interlocking scrolls made of hot rolled double dipped galvanised steel lath section of 18swg tested mild steel strips at 75mm rolling centres, locked with galvanised malleable iron clips. The bottom lath will be coupled to a locked plated fabricated from 3mm thick galvanised steel plate and security riveted with stiffening angles.

Approved Make: DITEC-Gandhi Entrance Automation Pvt .Ltd, Shakti Met Dor or similar approved.

12. Glazing:

- a. Glazing for windows in general shall be minimum 6 mm clear float glass and as mentioned elsewhere in this document.
- b. Glazing in Control room between A/C & non-A/C area shall be with double glazed insulating glass consisting of 2 nos. 6 mm clear toughened float glass with 12 mm air gap in between, hermetically sealed.
- c. Minimum 6.0 mm thick toughened float glass as specified below shall be provided in doors, partitions, windows of Power house building, Service Building, Administrative Building, etc.
- d. 24mm thick insulated double glazing having 6mm thick tinted heat-reflecting type outer float glass and 6mm thick plain inner float glass with 12mm air gap & hermetically sealed shall be mounted on 15 micron coloured anodised aluminium frame suitable for structural glazing system. Quality of glass is given below.
- e. 6mm thick Glass quality shall be toughened hard coated CVD on line process glass with Low -E coated in surface # 2 having (Light Transmission 82%, Visible light Reflectance- 10% & inside - 11%, Total Solar Energy Transmittance - 66% Reflectance-10% UV transmission - 49%, Solar Heat Gain Coefficient - 0.70





Shading Coefficient – 0.81 ,U – Factor Air 2.77 W/m<sup>2</sup>k , Sound Insulation – 31db outer lite.

- f. 6 mm thick toughened Blue low E hard coated CVD on line process glass with Low –E coated in surface # 2 having (Light Transmission 35%, Reflectance 13%outside & inside – 30 %, Total Solar Energy Transmittance – 19%, Reflection – 9%, UV – 9 %, Solar Heat Gain Coefficient – 0.29 Shading Coefficient – 0.33,U –Factor Air – 1.9 W/m<sup>2</sup>k, Sound Insulation – 33db outer lite ( # 2 surface) Glass with a combination of 6 mm thick toughen Optifloat clear 6mm glass inner lite (# 3 Surface) Now the two sheets of glass will be separated by an aluminium spacer leaving an air gap of 12.7 mm thick and sealed with the weather proof sealant.

Approved make : AIS of Asahi India Glass Ltd., Pilkington Glass India Pvt. Ltd. Saint Gobain or approved equivalent.

13. Roof waterproofing :

- a) Roof water proofing treatment shall be as follows:
- For roofs with structural slope:
  - Compressed air cleaning has to be done so as to make the surface free of dust, debris, laitance etc. Repairing cracks by cutting and making V-groove in 25x25 mm, with polymer modified mortar, filling the groove with Cement Mortar (1:3) mixed with polymer10% by weight of cement. Spray applied an average 40 mm thick two component Hydro fluoro-carbon(CFC free), polymeric M.D.I based closed cell(96-98% as per ASTM D2856) multilayer, waterproof, insulated polyurethane foam, mixed in a ratio of 1:1 by volume with a nominal core density of 45-50 Kg/m<sup>3</sup> as per ASTM D1622 , and a thermal conductivity of 0.023 W/m.k at 25 degree mean temperature as per ASTM C518/91 possessing waterproofing properties as per ASTM C-518/91 ,ASTM C-272 and complying to Fire resistance Class B2 as per DIN 4102. Top of insulation foam shall have a minimum 1.5mm thick sealer coat, which is a single component cold applied elastomeric waterproofing coating with >=500% elongation confirming to ASTM C836 applied by a spray/brush/roller in 2 coats. Water ponding/flood test is to be conducted after application. Water shall be filled up and retained for at least 24 to 48 hours. Loosely laid 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating. Laying protective slope with 25mm average thick (thickness will depend upon the required slope and span of the building) M20 grade screed mixed with polypropylene fibres (RECRON or equivalent) and admixed with integral liquid waterproofing compound conforming to IS: 2645. Green stage saw cutting on the screed will be done in panels (3mx4m) with grooves 10mmx10mm. Finally the groove will be sealed with suitable elastomeric sealant. Finally top shall be finished with 20mm thick 600x600 concrete roof tiles over 20mm thick cement: sand (1:4) bed mortar.



- All around on the roof, at the parapet wall junction, an angular fillet 50mm x 50mm shall be trowel applied in cement-sand mortar(cement, sand mortar shall be supplied by you) in 1:3 proportion. A latex based bonding agent should be added (10% by weight of cement) and also a glass cloth must be inserted around the junctions while the angle fillet is being constructed.

For roofs having no structural slope:

- Compressed air cleaning has to be done so as to make the surface free of dust, debris, laitance etc. Repairing cracks by cutting and making V-groove in 25x25 mm, with polymer modified mortar, filling the groove with Cement Mortar (1:3) mixed with polymer 10% by weight of cement. Spray applied an average 40 mm thick two component Hydro fluoro carbon(CFC free), polymeric M.D.I based closed cell(96-98% as per ASTM D2856) multilayer, waterproof, insulated polyurethane foam, mixed in a ratio of 1:1 by volume with a nominal core density of 45-50 Kg/m<sup>3</sup> as per ASTM D1622 , and a thermal conductivity of 0.023 W/m.k at 25 degree mean temperature as per ASTM C518/91 possessing waterproofing properties as per ASTM C-518/91 ,ASTM C-272 and complying to Fire resistance Class B2 as per DIN 4102. Top of insulation foam shall have a minimum 1.5mm thick sealer coat, which is a single component cold applied elastomeric waterproofing coating with  $\geq 500\%$  elongation confirming to ASTM C836 applied by a spray/brush/roller in 2 coats. Water ponding/flood test is to be conducted after application. Water shall be filled up and retained for at least 24 to 48 hours. Loosely laid 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating. Laying protective slope (1:100) with 75mm average thick (thickness will depend upon the required slope and span of the building) M20 grade screed mixed with polypropylene fibres (RECRON or equivalent) and admixed with integral liquid waterproofing compound conforming to IS: 2645. Green stage saw cutting on the screed will be done in panels (3mx4m) with grooves 10mmx10mm. Finally the groove will be sealed with suitable elastomeric sealant. Finally top shall be finished with 20mm thick 600x600 concrete roof tiles over 20mm thick cement: sand (1:4) bed mortar.
- All around on the roof, at the parapet wall junction, an angular fillet 50mm x 50mm shall be trowel applied in cement-sand mortar(cement, sand mortar shall be supplied by you) in 1:3 proportion. A latex based bonding agent should be added (10% by weight of cement) and also a glass cloth must be inserted around the junctions while the angle fillet is being constructed.
- For other plant and non Plant buildings rigid insulating board (expanded / extruded polystyrene block) as per HVAC requirement shall be laid over screed concrete mix (1:2:4) grading having minimum 25mm thickness at the lowest point of the slope over R.C.C. slab and shall be laid as per the slope specified elsewhere in the specification. Top surface of rigid insulating board shall be finished with 15mm thick cement plaster (1:4) which shall be laid over Geo-textile membrane





layer. Over the finished surface APP Bitumen membrane as specified below shall be laid and top of the Bitumen membrane shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thickness on 15 mm thick cement: sand (1:4) mortar underbed. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar underbed layer also.

- a. APP modified Bituminous Polyester reinforced waterproofing membrane of Sika® WP Shield-104 P, Dr. FIXIT TORCHSHIELD P4160 or similar approved shall be manufactured from a rich mixture of bitumen and selected polymers blended together to obtain excellent heat resistant, flexibility, UV resistance. Modified bitumen then coated onto a dimensionally stable carrier to obtain excellent tensile strength, tear and puncture resistance.
- b. APP membrane shall conform to Conforms to: UEAtc,ASTM D146, DIN52123, ASTM D36, ASTM D5, UEAtc, ASTMD 5147, ASTM D4799.
- c. Technical Data
  - Chemical Base : APP modified Bituminous Polyester
  - Thickness : 4mm
  - Unit weight : 4.40 kg/m<sup>2</sup>(According to UEAtc)
- d. Mechanical / Physical Properties
  - Tensile Strength (L/T) N/SCM - 800/600 (According to UEAtc,ASTM D146)
  - Elongation at break (L/T) - 40/50 - (According to UEAtc,ASTM D146)
  - Resistance to water pressure - No leakage - (According to DIN52123)
  - Carrier (Polyester) weight- 180 g/m<sup>2</sup>
  - Softening Point - 145 oC - (According to ASTM D36)
- e. Concrete, mortar surfaces must be clean, free from grease, oil, and loosely adhering particles. Steel and iron surfaces must be free from scale, rust, grease and oil. All surfaces must be as true as possible.
- f. Bituminous primer is to be applied to a clean, smooth and dry surface by brush, roller or spray. The material is to be Unrolled and align and re rolled correctly before torching. Overlaps should be minimum 100 mm. Gas burner is to be used to heat the substrate and thermo fusible film on the underside on lower face of membrane. When the thermo- fusible film melts after torching, the membrane is ready to stick. The membrane should be Rolled forward and press firmly against the substrate to bond. Both the overlaps shall be heated and the round tipped trowel shall be used for heating the same to smoothen and press into seam.



g. All angles and abutments should be sealed with extra care to ensure full bondage. The edges should be sealed well into the grooves.

- **For vertical surfaces (Parapet)**

Surface preparation, minor cleaning works, removal of loose concrete, laitance, dust particles, etc and filling cracks with polymer modified mortar using latex based bonding agent. Removal of algae if present is to be done. Providing and applying a water based acrylic primer over the entire surface of the parapet walls(2 part primer : 1 part water). Providing and applying 2 coats of a high performance elastomeric coating, composed of acrylic emulsion polymers having anti-carbonation properties, UV resistant and DFT of 110 microns, conforming to ASTM-D412-02, D1202-97, D 4587, D 4645, BS-EN 12390 over the exterior wall surface.

Approved make of elastomeric membrane/: Dr. Fixit, SIKA India Pvt. Ltd, LLOYD, STP Ltd., BASF, FOSROC or similar approved.

Approved make of APP Bitumen membrane: SIKA, STP, Dr. FIXIT or similar approved.

***Note: Waterproofing materials should be applied by the manufacturer in-house application wing or authorised applicators only under supervision of manufacturer's authorised person. Performance Guarantee should be given by the manufacture to the owner after completion of the roof waterproofing work.***

- b) For efficient disposal of rainwater, the run off gradient for the roof shall not be less than 1:100. The top surface of finished roof shall be such as to allow quick drainage of rainwater.
- c) The Bidder shall give guarantee in writing for all works executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof water proofing treatment work. The guarantee shall be for materials and workmanship for twenty (20) years. The mode of execution of the guarantee shall have to be acceptable to the owner.
- d) Heavy duty HDPE pipes conforming to relevant BIS Code shall be provided to drain off rainwater from the roof. The numbers and size of down comers shall be governed by IS: 1742 and IS: 2527.

14. Painting:

- a) External masonry surfaces of all buildings shall be finished with External Quality Acrylic Emulsion paint similar to "Apex Ultima", "Weathergurd" / "Weathershield" over plaster. Granular textured paint may also be combined along with External Quality Emulsion paint to form suitable pattern on building façade.





- b) Acrylic plastic emulsion paint of AkzoNobel/Asian Paints/ Berger or any other reputed make approved by APGENCO shall be provided in control room, control equipment room, computer room, UPS room, all office areas and all air-conditioned areas including entrance lobby.
- c) All other areas shall be provided with Acrylic Distemper paint.
- d) Internal surface of walls in rooms for pumps, machineries and maintenance shall be painted with washable synthetic enamel paint of dark shade up to a height of 1.5 m above floor level.
- e) Battery room and all other areas coming in contact with acid/alkali or other corrosive liquid shall be painted with acid/alkali resistant paint. Acid and Alkali resistant paint shall be applied up to the ceiling level above Acid and Alkali resistant tiles dado as specified elsewhere in this section. Ceiling shall also be painted with Acid & Alkali resistant paint.
- f) All structural steel members including doors, windows, ventilators, louvers, rolling shutters and all other exposed steel work shall have two or more coats anti-corrosive paint and shall have minimum 110 micron DFT. Anti corrosive paint shall be Specification in short: Self Priming, Single Pack, Elastomeric ( 450% elongation ), thermoplastic, fire retardant, Coating skin tensile strength 18 to 21 kg. Per sq. Cm. Antifungal, antibacterial, anticorrosive, nontoxic graft Co-polymer coating of Meta Chem Paints & Adhesive Pvt. Ltd or similar approved.
- g) All woodwork shall be painted with two coats of synthetic enamel paint over a coat of approved primer. DFT shall conform to IS specification.
- h) All fire exits shall be painted in Post Office red.
- i) Epoxy paint shall be provided in oil equipment room, oil canal, fuel oil pump house, etc.
- j) Fire-proof putty in cable penetration on walls of cable spreader rooms shall be provided.
- k) Paints shall be of reputed brand of reputed manufacturer like AkzoNobel/Berger/Asian Paints, Nerolac. For granular textured coating Vineratex, Heritage or equivalent shall be used.

## 15. Aluminium Composite Panels

### 1. Material:

Total thickness of the panel – 4mm  
Thickness of the aluminium skin – 0.5mm, Tensile strength of aluminium skin –120N/mm<sup>2</sup> minimum, Density of PE core – 920 – 980 Kg/m<sup>3</sup> (Non toxic grade Polyethylene)  
Coating – PVDF Adhesive film – DUPONT, USA Coating thickness (front foil) – 24μ - 30μ in PVDF including primer. 15μ - 18μ in polyester coating. Coating thickness (back foil) – 4μ - 7μ polyester coating.





2. Colour – as indicated in the drawing.
3. Fixing arrangement – aluminium composite sheets shall be folded inwardly on four edges (without cutting the outer skin) to form Aluminium Composite Panels (ACP) and shall be riveted to the aluminium extruded section like angle or channel. There shall be at least one rivet at the both ends of the folded edge and other rivets shall be 200mm c/c per panel edge/fold. Aluminium angles shall form a frame around the panel and shall be fixed to the steel sub-frame by self tapping screws with EPDM shim to prevent by-metallic reaction. The gap/groove between two adjacent panels shall be filled with Silicon sealant of approved make (GE or similar make) to prevent water seepage.
4. The supply fabrication and erection of ACP is inclusive of steel sub-base frame work if necessary as per site condition. The Bidder shall take site measurement and produce working drawings for approval of engineer before erection of ACP.
5. Name of system provider- Eurobond, Alu Bond, or similar.

16. **Poly Carbonate Sheet:**

- a) 2 mm thick Compact Polycarbonate sheet, transparent or smoke tinted, of Lexan Polycarbonate or MAKROLON Polycarbonate sheet or similar approved.
- b) Framing shall be specially designed aluminium sections, colour anodised, with EPDM Gasket as per system provider's details. Framing shall be fixed to the steel structure as per site measurement, drawings and – Engineer in Charge.
- c) Sealing of joints shall be done with Silicon sealant.
- d) Minimum Density required for Multiwall Polycarbonate and Compact sheets:-
  - 6 mm Multiwall Sheets: - 1.3 kg/m<sup>2</sup>
  - 8 mm Multiwall Sheets: - 1.5 kg/m<sup>2</sup>
  - 10 mm Multiwall Sheets: - 1.7 kg/m<sup>2</sup>
  - 16 mm Multiwall Sheets:- 2.8 kg/m<sup>2</sup>
  - Compact Sheets: - 1.2 kg/m<sup>2</sup>/mm
- e) The offer should be backed by warranty of 10 years against yellowing due to weathering and five years against breakage as manufacturing defect.



- f) The sheets should have the minimum co-extruded UV coating of min 45 Micron
- g) The fixing should be done Aluminium Clamping profile (top and bottom) min 60mm wide profile with EPDM gasket by using self-driving and self-tapping screws.
- h) The sheet should be produced and supplied Preferably by local manufacturer
- i) The sheet should pass the ISI 14443 specification for Multiwall system.

Approved make: BAYER India, GE or similar

17. Stairs:

- a) All stairs shall have not more than 13 risers in one flight but in case of fire escape stairs, 15 risers may be allowed instead of 13 risers. Height of risers and width of treads shall be 180 mm (maximum) and 250 mm (minimum) respectively for fire escape stairs and 166mm (maximum) & 250mm (minimum) for general staircases. Minimum width of stairs shall be 1000mm for fire escape stairs and 1200 mm for general stairs. In general rises shall be 150 mm.
- b) Aluminium angle nosing shall be provided for edge protection of RCC stairs. Moulded marble nosing shall be provided for the main stairs finished with marble slab / Kota slab finishes.
- c) 40Ø NB stainless steel pipe handrail for stair in T.G. Hall area and 32Ø NB medium class G.I pipe Handrail for stairs in other areas, minimum 1.0 metre high, shall be provided around all floor/roof openings, projections/balconies, walkways platforms, concrete and steel stairs. 1200mm high railing may be provided for external fire escape stairs. Handrail shall be two rail systems with the top rail 1000mm / 1200mm above the walkway/ platform/ floor surface and the intermediate rail 500mm below the top rail. Guardrail post spacing will be proportional to the length of the protected horizontal opening but will not exceed 1500mm c/c to posts. Stainless steel class shall be 304 grades.

18. Draining out water from floors

In all buildings, suitable floor drainage system to drain out water collected from equipment, blow downs, leakages, floor washings, fire fighting etc., shall be provided in each floor.

19. Fencing :

Minimum 3.0 metre high fencing above toe wall shall be provided around switch yard, trans-former yard, building transformer area, fuel oil area, Dry ash storage silo area & other areas where fencing is necessary





due to statutory requirements. Fencing shall comprise 2.4 metre high PVC coated galvanized chain link fencing of minimum 8 gauges (including PVC coating) of mesh size 75 mm and galvanized concertina for switch yard/transformer yard. Galvanized barbed wires of a height of 0.6 metres shall be provided above the chain link fence. The diameter of steel wire for chain link fencing excluding PVC coating shall not be less than 12 gauges. Steel entry gate matching construction shall be provided for all fenced areas. Top of the toe wall shall be minimum 200 mm above the formation level.

20. Water Supply and Sanitation:

- a) RCC roof water tank of adequate capacity depending on the number of users for 8 hours storage shall be provided for each building.
- b) Galvanized MS Pipe of medium class shall be used for internal piping work for potable water supply.
- c) Extra heavy cast iron pipes with lead joints or UPVC pipes with thermoplastic joints shall be used for sanitary work below ground.
- d) UPVC pipes with proper sealing shall be used for sanitary work above ground level.
- e) Each toilet shall contain following best quality fittings/porcelain fixtures in adequate numbers as per National Building Code. In toilets primarily meant for workers an additional squatting type WC shall be provided. Minimum one exclusive toilet facilities for handicapped shall be provided in each floor.
  - Water closet – Indian & European type.
  - Large flat back urinal with porcelain divider.
  - Shower set.
  - Wash basin – Counter-top wash basin to be provided in office areas selectively as per Owner's desire.
  - Sink – Stainless steel sink with integrated drain-board to be provided in janitor's closets, kitchen, pantry areas of "FRANKE" or similar approved make.
  - Metal storage cabinets, under- counter as well as overhead, shall be provided in janitor's room, kitchen, pantry and similar areas as per requirement of Owner.
  - Minimum 600 mm long porcelain tray.
  - Minimum 500 mm long stainless steel towel rail.
  - Stainless steel liquid soap holder.
  - Recessed porcelain soap tray in shower area.







- Stainless steel toilet paper roll holder.
- Robe hooks
- 450x750 mm high square edge 6 mm thick float glass mirror of adequate width to match toilet layout and interior décor.
- Septic tanks with up-flow filter including all accessories and extra heavy cast iron soil lines shall be provided.
- Effluent from septic tank shall pass through chlorination chamber to bring down BOD level to acceptable limit before discharging to nearest drain or to STP Main line.
- Drinking fountains in adequate numbers.

The exact number of fittings and fixtures, brand, colour etc. shall, however be finalized during detail engineering stage and same shall be of Owner's choice and Approval.

**Note** Toilets in Power House Operating Floor, Operating floor of service shall have coloured fixtures including counter-top wash basins with wide mirror, European type water closet with flush valve, sensor operated urinal, exclusive shower set etc. Other toilets in general shall have white porcelain fixtures, low down cisterns, sensor operated urinals etc. Toilets for handicapped persons shall have adequate grab bars, barrier-free access and appropriate fittings and fixtures.

Approved Make of toilet fixtures: KOHLER, Hindware, Parryware, Nycer, Cera.

Approved make of toilet fittings: KOHLER, Jaquar, ESCO, ESS ESS,

## 21. Under-Deck & Over-Deck Insulation

- ◆ Insulation material shall be Closed Cell Elastomeric Nitrile Rubber
- ◆ Density of Material shall be between 40 to 60 Kg/m<sup>3</sup>
- ◆ Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/m<sup>2</sup>K at an average temperature of 0°C
- ◆ The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990.







- ◆ Material should be FM (Factory Mutual), USA approved.
- ◆ Water vapour permeability shall not exceed 0.017 Perm inch ( $2.48 \times 10^{-14}$  Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor 'μ' value should be minimum 7000.

**Under-deck Insulation thickness shall be minimum 26mm for Kizen Project.** Under-deck insulation shall be provided for all AC areas having roof exposed to sun.

Approved manufacturer- Armaflex, Kflex

For thermal over-deck insulation on the terrace BASF's PERIPOR board or similar shall be used. The insulation board shall have interlocking tongue-groove arrangement. The insulation board shall have the following specifications;

Colour: Orange  
Thickness: 50 mm  
Compressive strength: 200-220 kN/m<sup>2</sup>  
Thermal Conductivity (K): 0.034 W/mK  
Thermal Transmittance (U): 0.5-0.6 W/m<sup>2</sup> °C  
Water Absorption (% vol): <0.1% (by total immersion)  
Actual area covered would be used for measurement.

22. Sealant:

1. Polysulphide Elastomeric joint sealant shall be, two-component, high performance polysulfide formulation equal or similar to **MASTERFLEX 700i** of BASF having weathering resistance to ultraviolet ray property. The product shall exhibit **shore 'A' hardness of 25** and have **movement accommodation factor of 25%**. The sealant must comply with the performance specifications as laid in **BS:4254 and ASTM C 920**. All the joints must be primed using compatible primer for the substrate from the equal or similar to MASTERFLEX PRIMER range of BASF. Sealant application shall be carried out, strictly in accordance with Manufacturer's recommendations.
2. Polyurethane based single component joint sealant materials based upon polyurethane resins shall be similar or equal to **Masterflex 472/474 of BASF**. They have been formulated with different modulus of elasticity 0.25-0.45 N/mm<sup>2</sup> and Shore 'A' hardness of 15-30 which makes them suitable for slightly different applications. The product shall exhibit elongation at break 600% and recovery of 80%.

23. **Expansion joints may be as per following locations:**

- a) Floor to Floor Joints at all internal locations
- b) Roof to Roof Joints





- c) Floor to Wall joints at internal locations
- d) Roof to Wall Joints
- e) Wall to Wall joints in exterior locations

During construction of RCC slab, beam, column the expansion gap shall be maintained by using polystyrene filler board of HD100 of Supreme or equivalent.

During finishing stage expansion gaps shall be finished with the either elastomeric EPDM profile or elastomeric extruded poly vinyl chloride fitted in extruded aluminium sections with aluminium joint cover to form an integral system as manufactured by Three R Construction solutions Pvt Ltd. or an approved equivalent.

Expansion gap between metal cladding shall be finished with metal saddle of same material having 'U' or 'W' shape and shall be covered with metal cladding –fixed at one end and fixed with slotted hole on other end or as per manufacturer's detail.

Externally the expansion joint sealing system shall form a continuum vertical and horizontal sealing system to make the building envelop water tight.

24. Approved make of other items:

- a) Expansion Joint Control: 3R Construction Solutions Pvt Ltd or similar
- b) Silicón Sealant: Dow Corning India Pvt. Ltd, McCoy Silicones Ltd. Or similar
- c) Insulation: TWIGA - for glass wool insulation, LLOYD, Mineral Rock Fibers Ltd. - for mineral fibre wool insulation. LLOYD - for Rockwool insulation  
Forextruded polystyrene foam insulation, "Insuboard" by The Supreme Industries Ltd, BASF, or similar approved.  
For PU Insulation by BAYER India or similar approved.
- d) Toilet Partition: Merino-Besco, Shakti Hormann or equivalent.
- e) Anchor fastener/Bolt: RIPPLE, HILTI or similar approved.

25. Statutory rules :

- a) Design shall be complied with all applicable statutory rules pertaining to Factories Act as applicable for the State, Rules of Tariff Advisory Committee (TAC), and Water Act for pollution control etc.
- b) Provision of safety, health and welfare according to Factories Act shall be complied with. These shall include provision of continuous walkway, minimum 500 mm wide, along the crane girder at crane girder level on both sides, comfortable approach to EOT crane





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1x660 MW Unit No. 5, Phase - III**

cabin, fire escape, locker room for workmen, pantry, toilets, rest rooms etc.

- c) Provision for fireproof doors, number of staircases, fire separation walls, encasing of structural members (in fire prone areas) etc. Shall be made according to the recommendation of Loss Prevention Association of India / Tariff Advisory Committee.
- d) Statutory clearance and norms of State Pollution Control Board shall be followed as per Water Act for effluent quality from plant.





## ANNEXURE - I

## DESCRIPTION OF TG BUILDING

BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
<b>Interior Finish Schedule For Power house Building</b>						
1 T.G. Hall Area,	Overall 50mm thick flooring shall be finished with 18 mm thick polished Granite stone slab/files for unloading areas and walkways shall be demarcated with 75 mm wide and 18 mm thick Granite stone (black) on both sides of Granite stone finished walkways.	Acrylic emulsion paint over white cement putty on masonry surfaces wherever necessary and all other wall surface shall be with Acrylic Distemper, Polished Granite slab minimum 20 mm thick wall cladding on (B) row wall (outer) upto false ceiling level/upto Roof slab for Control Room facade. There shall be minimum joints between granite slabs. The quality including colour texture etc. Of granite shall be approved by the owner. Above false ceiling of control room & Annexure room there shall be exposed plastered masonry surfaces. A row and gable end shall have double skin metal cladding system.	T.G. Hall – anti-corrosive paint to metal deck and all metal works. Acrylic Distemper on exposed plastered ceiling (without false ceiling). Aluminium lineal pattern false ceiling for false ceiling areas.	Hollow metal flush door in general and 2Hr Fire Check door for fire escape stairs and electrical rooms. Important areas shall have Glazed aluminium door. For main entrance to Main control room shall be sensor operated glazed sliding door.	Aluminium glazed window. Main glazed partition for Main control room shall be insulated double glazed as per specification. A Row shall have structural glazing with low E glass blue tinted toughened glass on outer face and clear toughened float low E glass on inner face as per specification.	
2 Switchgear Room, MCC Room,	Electric insulated flexible PVC sheet as per IS: 15625-2006 to be laid over heavy duty vitrified tiles flooring. Overall thickness shall be 40mm.	Acrylic Distemper	Acrylic Distemper	Hollow metal flush door / fire door	-Do-	
3 Control Rooms, Control Equipment Room, Computer Rooms, etc. Other than Main Control Room.	Non-skid, fully vitrified, 10 mm thick non-porous, homogenous, abrasion resistant, floor tiles similar to "MARBONITE", "FERRASTONE" of Pvt. Ltd, "Kajaria" of minimum size minimum 600 mm x 600 mm x 9-10 mm of approved colour and shall be laid over concrete floor with laying compound strictly as per manufacturer's specification. Total thickness of the flooring shall be 40mm thick including the thickness of the tiles and under bed.	Brick masonry walls, columns, or any other element within the room as the case may be shall be clad with polyester coated 3mm thick Aluminium Composite Panels (Aluminium thickness minimum 0.2mm) of approved make upto the false ceiling level. The colour and design composition of ACP cladding to be submitted for approval of the authority before erection.	Lineal pre-coated aluminium alloy ceiling stove enamelled on both sides similar to 'Luxalon' or "INTERARCH" in combination with Gypsum board to form patternincluding suspension system as per manufacturers details. The false ceiling work shall take care of all illumination, fire detection & fighting, HVAC and all other service requirement. False ceiling shall be provided with 25 mm thick insulation of resin bonded mineral wool conforming to IS: 8183. Wherever under-deck insulation is required the insulation shall be Closed Cell Elastomeric Nitrile Rubber.	Aluminium glazed door	-Do-	





BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
4 All office areas, Conference Room and other important areas.	10/11 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm similar to "MARBONITE", "FERRASTONE" of "BOSS Profile Ltd.", "RESTILE", ENDURA" of H & R Jonson (India) Pvt. Ltd, "Kajaria" (overall 40 mm thick) laid in pattern with different colour of tiles.	Acrylic emulsion paint over white cement putty.	Acoustic mineral fibre board ceiling on aluminium grid system. Acrylic emulsion paint over white cement putty in areas without false ceiling.	Aluminium glazed door single or double leaf with 8mm thick toughened, tinted & etched float quality glass as per owner's choice with floor spring, mortise lock & latch and all accessories.	Aluminium glazed window with minimum 4mm thick clear float glass of specific values as mentioned in the specification with all accessories. Windows shall be partially open able and partially closed type having shutter size not more than 750Wx1500H mm.	
5 Access floor where required	Minimum 600 mm high false floor with adjustable metal supporting system and fire resistant cement in-fill epoxy coated metal floor panels finished with Vitrified tiles flooring and matching skirting.	-	-			
6 Stairs & Lobby	Kota stone slab in general.	Acrylic Distemper Paint	Acrylic Distemper Paint	Hollow metal flush fire door	-Do-	
7 Main Stair & Landing	Granite slab or Aranga White marble slab/makarana pink / Jaishalmir Yellow and Baroda green combination 25 mm thick (min.) with larger possible size to be approved by the owner.	Acrylic emulsion paint over white cement putty.	Acrylic emulsion paint over white cement putty.	Aluminium glazed door/ fire door	-Do-	
8 Lift lobby	Granite slab or Aranga White marble slab/makarana pink / Jaishalmir yellow and Baroda green combination 25 mm thick (min.) with larger possible size to be approved by the owner.	Granite slab cladding	Aluminium lineal pattern false ceiling	Aluminium glazed door/ fire door	-Do-	
9 Battery Room & Battery Charger Room, UPS Room	Minimum 20 mm thick acid and alkali resistant vitrified tiles "ENDURA" or similar, set in and jointed with epoxy mortar (overall 40 mm thick) along with 2100 mm high dado of same tile.	Acid/Alkali resistant paint.	Acid/Alkali resistant paint.	Hollow metal flush fire door	-Do-	
10 Chemical Feed Station	Minimum 20 mm thick acid and alkali resistant vitrified tiles "ENDURA" or similar, or Minimum 37mm thick Acid /Alkali resistant brick, set in and jointed with epoxy mortar (overall 40 mm thick) along with 2100 mm high dado of same tile having 20mm thickness.	Chemical resistant paint.	Chemical resistant paint.	Hollow metal flush fire door with chemical resistant paint finish	-Do-	
11 AHU Rooms, Air Washer Rooms, Cable Spreader Rooms & all other service areas	50 mm thick heavy-duty cement concrete floor with metallic hardener.	Acrylic Distemper Paint	Acrylic Distemper Paint	Hollow metal flush fire door. For AHU Room and Air Washer rooms airtight doors are to be provided.	-Do-	
12 Toilet and other wet areas	Minimum 10 mm thick non-skid vitrified tile, of make "MARBONITE", "FERRASTONE" of "BOSS Profile Ltd.", "RESTILE", ENDURA" of H & R Jonson (India) Pvt. Ltd., of minimum	Acrylic emulsion paint over white cement putty.	Acrylic emulsion paint over white cement putty. Aluminium false ceiling where required.	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be PVC door frame	Aluminium glazed window/ ventilator	





	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		size 400 mm x 400 mm (overall 40 mm thick) with glazed ceramic tile of same make dado topped with 50 mm wide matching moulded ceramic trims. Dado height shall be 100 mm higher than lintel level starting from finish floor level.			&shutter.		
13	Oil Spillage area	Non-skid self-leveling epoxy over IPS (overall 40 mm thick)	Epoxy paint.	Epoxy paint.	Hollow metal flush door / fire door	-Do-	
14	Electrical Switchgear Room, MCC Room, etc	Electric insulated flexible PVC sheet as per IS: 15625-2006 to be laid over heavy duty vitrified tiles flooring. Overall thickness shall be 40mm.	Acrylic Distemper	Acrylic Distemper	Hollow metal flush door / fire door	-Do-	
15	All other general areas except operating floor	Overall 50 mm thick heavy-duty concrete floor (IPS) with metallic hardener or 40mm thick steelcrete tiles finish.	Acrylic Distemper	Acrylic Distemper	Hollow metal flush door / fire door	-Do-	





## ANNEXURE - II

## DESCRIPTION OF AUXILIARY PLANT BUILDINGS

<b>Interior Finish Schedule For Plant Buildings</b>							
BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS	
1 Mill Building	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Metal cladding	Synthetic enamel paint	Hollow metal flush door / fire door	Steel glazed window / ventilator		
2 ESP Control Building	10 mm thick non-skid fully vitrified tiles of make "MARBONITE", "FERRASTONE" of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern for Control room. Other areas 50mm thick heavy duty IPS flooring with metallic hardener. MCC & Switchgear rooms shall have flexible electric insulated PVC synthetic sheet finish over IPS.	Acrylic emulsion paint over white cement putty for control room. Other areas Acrylic Distemper paint.	Pre-coated aluminium linear ceiling 'Luxalon' or "INTERARCH" in air-conditioned areas. Acrylic Distemper paint in other areas.	Hollow metal flush fire door/ Aluminium glazed door	Steel glazed window / ventilator		
3 FGD Control Building	10 mm thick non-skid fully vitrified tiles of make "MARBONITE", "FERRASTONE" of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern for Control room. Other areas 50mm thick heavy duty IPS flooring with metallic hardener. MCC & Switchgear rooms shall have flexible electric insulated PVC synthetic sheet finish over IPS.	Acrylic emulsion paint over white cement putty for control room. Other areas Acrylic Distemper paint.	Pre-coated aluminium linear ceiling 'Luxalon' or "INTERARCH" in air-conditioned areas. Acrylic Distemper paint in other areas.	Hollow metal flush fire door/ Aluminium glazed door	Steel glazed window / ventilator		
4 CW, ACW Pump House	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Acrylic Distemper Paint	Acrylic Distemper Paint	Hollow metal flush door / fire door	Steel glazed window / ventilator		
5 CPU Regeneration Building	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Acrylic Distemper Paint	Acrylic Distemper	Hollow metal flush door / fire door	Steel glazed window / ventilator		
6 Vacuum Pump House	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Acrylic Distemper Paint	Acrylic Distemper	Hollow metal flush door / fire door	Steel glazed window / ventilator		
7 CW Chemical Treatment Building	Minimum 20 mm thick acid and alkali resistant vitrified tile "ENDURA" or Minimum 37mm thick Acid /Alkali resistant brick, set in and jointed with epoxy mortar (overall 50 mm thick) along with 2100 mm high dado of same tile having 20mm thickness. Where required, other areas with 50mm thick heavy duty flooring with metallic hardener.	Chemical resistant paint in acid & alkali prone area and rest with Acrylic Distemper paint.	Chemical resistant paint for acid & alkali resistant area and other areas with Acrylic Distemper paint.	Hollow metal flush door / fire door	Aluminum glazed window / ventilator.		
8 Transfer Points	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting.	Metal cladding	Painted exposed structure	Hollow metal flush door / fire door	Steel glazed window / ventilator		







ANNEXURE - III

DESCRIPTION OF NON-PLANT BUILDINGS

**Interior Finsih Schedule For Non Plant Buildings**

	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
1	Watch Tower						
2	Car & Scooter parking shed and Cycle parking shed						NOT APPLICABLE



**CLIENT**



**BHARAT HEAVY ELECTRICALS LIMITED**

**GEOTECHNICAL INVESTIGATION OF 1X660MW SAGARDIGHI TPS  
EXTENSION UNIT-V**

**PART-I (MAIN PLANT AREA)**

**VOL-I (METHODOLOGY, ANALYSIS & RECOMMENDATIONS)**

**OCT-2019**

***INVESTIGATED & PREPARED BY:***



**M/s. SWAYIN & ASSOCIATES**

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**Name of Project**

**“GEO-TECHNICAL INVESTIGATION &  
TOPOGRAPHICAL SURVEY OF 1 X 660 MW AT  
SAGARDIGHI TPEP PHASE-III, MURSHIDABAD,  
WEST BENGAL.**

**WO No. & Date**

**LOI Vide ref no. PSER:SCT:SDG-C  
1956:19:LOI:7580, dated 01.06.2019**

**Job No.**

**SA-1027**

**Client**

**BHARAT HEAVY ELERCTRICALS LIMITED.**

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**Reports Prepared By**

**Bibhu Ranjan Baliarsingh  
Diploma (Civil)**

**Date of Commencement  
(Field Work)**

**- 027.06.2019**

**Date of Completion  
(Field Work)**

**- 12.08.2019**

**Date of Commencement  
(Laboratory)**

**- 17.08.2019**

**Date of Completion  
(Laboratory)**

**- 30.08.2019**

**Report Submitted by  
Swayin & Associates**

**Report Submitted to  
Bharat Heavy Electricals Limited**

## **PREFACE**

We have the pleasure to again collaborate ourselves with Bharat Heavy Electricals Limited for rendering our service soil investigation work of TPEP Project Phase-III for Proposed area at Sagardighi, Murshidabad, Westbengal. Our sincere thanks to the esteemed officials of Bharat Heavy Electricals Limited including Project Engineer (PE) Executive Engineer(EE), (Asst.EE) and Site-Engineer for their endeavour and collective interest in providing adequate support for execution of above work. We will be proud enough to associate ourselves for this kind of civil engineering activities with BHEL in future days.

**SWAYIN & ASSOCIATES**

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## INTRODUCTION

Bharat Heavy Electricals Limited, Power Sector-Eastern Region, DJ-9/1, Sector-II, Salt Lake City, Kolkata - 700091, had invited tenders for execution of Geotechnical Investigation & Topographical survey work at 1 X 660 MW Sagardighi TPEP. Phase-III, Unit No-5. Murshidabad, West Bengal. In response, a tender was submitted by M/s Swayin & Associates (S&A), Bhubaneswar, Odisha. The BHEL has approved the tender of S&A and were pleased to award contract to carry out the specified Geotechnical work in accordance with the Technical Specification and guidelines. The assignment was attended by Swayin & Associates, and completed in time. Periodical reports were submitted to the client indicating the progress of Geo-technical work at Main plant area.

The Geo-Technical Investigation was completed in accordance with the proposal as per LOI vide ref no: PSER:SCT:SDG-C 1956:19:LOI:7580, dated 01-06-2019. Murshidabad , West Bengal.

Through correspondence with Bharat Heavy Electricals Limited, the investigation was intended to assist in determining the design soil parameters, for the foundation of proposed structures for 1x660MW Sagardighi TPS Extension Unit-V at Sagardighi, Murshidabad, West Bengal.

The Geotechnical Investigation Report for project area has been submitted in 03 (Three) Parts.

- Part- 1 (Main Plant Area)
  - Vol-I (Methodology, Analysis & Recommendations)
  - Vol-II (Borelogs, Field Tests & Laboratory Test Results)
- Part - 2 (CHP & AHP Area)
  - Vol-I (Methodology, Analysis & Recommendations)
  - Vol-II (Borelogs, Field Tests & Laboratory Test Results)
- Part – 3 (PLT & CPLT Test Results of Main Plant and CHP & AHP Area)

This Report particularly deals with Vol-I (Methodology, Analysis & Recommendations) for Main Plant Area.



### SCOPE OF WORK

The Geo-Technical Investigation consists of advancement of boreholes for proposed site. The boreholes were drilled to required depths based on the level of the founding in which the foundations and other sub-structures for the proposed projects leading to their economical and safe design for proposed area for Main Plant area at Sagardighi, Murshidabad.

The Scope of work for the Field Investigation was as follows:

1. Advancement of boreholes at the specified locations as per the direction of EIC.
2. Record the soil conditions encountered in the boreholes.
3. Conducting Standard Penetration test (SPT), collection of undisturbed (UDS) & disturbed (DS) soil samples from boreholes.
4. Conducting laboratory test on collected soil samples as per schedule of rates.
5. Analysis of Field and laboratory tests data and provide geotechnical characterization of the soils encountered.
7. Preparation & Submission of the Geotechnical Investigation report, with appropriate descriptions of the existing Soil encountered in the boreholes advanced for the investigation and provide recommendations with respect to the implications for construction of Buildings, Structures and Boundary Walls etc.





### EXPLORATION TECHNIQUE

- i. Soil exploration was conducted with 150mm dia boreholes. The bore were done with Rotary calyx technique as per IS 1892-1962. The top of the bore hole is taken from the actual bed level at the time of boring. Standard Penetration tests were conducted at every required interval using Standard split spoon sampler driven by a 63.5 kg hammer with free fall height of 750 mm as per IS 2131-1963. The results are recorded and represented graphically in logs of bore holes. Undisturbed & disturbed sample were collected in plastic bags for visual inspection and classification of strata from all the layers as recorded in log sheets of bore holes.
- ii. Collection representative undisturbed/disturbed soil samples from the exploratory bore holes for carrying out detailed laboratory analysis which would help finalization of design soil parameters and foundation type.
- iii. Carrying out standard penetration tests as per the provisions laid down in IS:2131-1981 in the holes and subsequently maintaining penetration chart depth-wise upto the test depth in each of the 1 nos. Exploratory bore holes at locations.

### SCOPE OF INVESTIGATION

In an attempt for optimization in the design of foundation for the proposed structures to come up at various sites, geo-technical investigations were envisaged. The entire geo-technical investigation program had been divided into three parts:-

- (i) Field Investigation
- (ii) Laboratory Test.
- (iii) Preparation of technical report

As mentioned in the framework of B.O.Q., the field works comprised of the following:

Sinking of exploratory bore holes 150 mm in diameter, 31 (Thirty one) nos., prefixed at the site as per the provisions laid down in IS: 1892-1962.



### **TRIAL PIT(IS:1892)**

Nine nos. of Trial pits were done at different locations upto the required depths for field visualization of strata and samples were taken at different depths for laboratory tests. Also water percolation was done in the trial pits.

### **PRESSURE METER TEST(IS:1892)**

Two nos. of Pressure meter tests were conducted in the field to determine the pressure meter modulus E and undrained shear strength  $C_u$  at different depths.

### **PERMEABILITY TEST(IS:5529, Pt.-I)**

Six nos. of Permeability tests were conducted in the field at different depths to determine the permeability of strata.

### **PLATE LOAD TEST(IS:1888)**

Five nos. of Plate load tests were conducted in the field at different locations to determine the safe bearing capacity and modulus of sub-grade reaction of soil.

### **CYCLIC PLATE LOAD TEST(IS:5249)**

Four nos. of Cyclic Plate load tests were conducted in the field at different locations to determine the dynamic properties of soil.

### **ELECTRICAL RESISTIVITY TEST(IS:3043, 1966)**

Fifteen nos. of Electrical resistivity tests were conducted in the field at different locations by Electrical resistivity method to determine the resistance to the flow of an electric current through the subsurface materials at intervals of ground surface.

### **DYNAMIC CONE PENETRATION TEST (IS:4968, pt.-II)**

Twelve nos. of Dynamic Cone Penetration Tests were done at different locations for continuous record of Soil Resistance. Tests were conducted by driving the Cone by hammering method. The resistance to penetration in terms of blows per 30cm of penetration of the cone was recorded.

### **BLOCK VIBRATION TEST (IS: 5249-1992)**

Two nos. of Block Vibration Tests were done at different locations. The field results are presented as amplitude versus frequency curves. The peak value on these curves represents the resonant frequency. The coefficients of elastic uniform compression,  $C_u$  have been computed using the values of resonant



frequency mass of the concrete block plus oscillator assembly, and the base contact area.

### **FIELD CBR TEST (AS PER IS 2720 PART 31)**

Four nos. of CBR tests were done at different locations as decided with the Agency.

The bearing ratio test (generally known as the California bearing ratio test) is an ad hoc penetration test used for the evaluation of the strengths of sub-grade and bases for roads and runaway pavements.

Undisturbed and disturbed soil samples for CBR Tests were collected at following Locations.

### **STATIC CONE PENETRATION TEST (IS 4968, pt-III)**

Nine nos. of Static Cone Penetration Tests were done at different locations. This test was carried out as per IS-4968 (Part-III) 1976. Among the field sounding tests, this test is the best for recording the in-situ variation of soil properties. It is most widely used to determine the frictional resistance of piles and also the required termination depth. Both cone and friction resistance were measured at an interval of 100mm. Tests were terminated at about 30mm when the sandy layer become too compact and dense and penetration was not possible.

### **PERCOLATION TEST (IS 2470, pt-II)**

Percolation test should be conduct to determine the permeability of the soil at any depth at which it is intended to dispose of the effluent.

### **CROSS HOLE TEST (IS 13372, pt-II)**

Two nos. of Cross Hole test were done at two different locations.



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### FIELD TEST DETAILS

#### DETAILS OF BOREHOLES (BH):

BH NO.	CO-ORDINATES			GROUND WATER TABLE
	EASTING	NORTHING	RL in 'm'	
BH-01	1400	1358	34.207	2.05m
BH-02	1477	1489	34.732	2.40m
BH-03	1330	1394	33.501	3.10m
BH-04	1342	1418	33.825	1.95m
BH-05	1314	1486	34.803	2.05m
BH-06	1220	1585	35.611	2.60m
BH-07	1336	1551	34.111	2.30m
BH-08	1138	1629	35.745	1.90m
BH-09	1280	1460	33.680	2.40m
BH-10	1277	1510	33.711	1.85m
BH-11	1278	1557	33.669	2.90m
BH-12	1256	1420	33.996	2.35m
BH-13	1256	1489	33.733	2.90m
BH-14	1218	1433	33.861	2.55m
BH-15	1221	1520	36.402	2.30m
BH-16	1213	1841	35.452	2.50m
BH-17	1172	1546	35.222	2.60m
BH-18	1132	1487	35.233	1.95m
BH-19	1132	1550	35.999	2.10m
BH-20	1106	1516	36.011	2.90m
BH-21	1058	1510	35.540	1.20m
BH-22	1063	1618	35.196	1.90m
BH-23	1111	1740	35.169	2.30m
BH-24	1046	1737	35.996	2.25m
BH-25	1061	1699	35.863	1.90m
BH-26	1000	1541	35.085	2.30m
BH-27	1000	1500	35.110	1.90m
BH-28	963	1584	33.293	1.30m
BH-29	963	1525	33.365	1.60m
BH-30	979	1621	34.682	0.40m
BH-31	1310	1580	34.115	2.15m



**PROJECT: GEOTECHNICAL INVESTIGATION OF 1X660MW SAGARDIGHI TPS  
EXTENSION UNIT-V.**



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**DETAILS OF TRIAL PITS (TP):**

TP	CO-ORDINATES		
	EASTING	NORTHING	RL in 'm'
TP-01	1532	1488	34.673
TP-02	1299	1397	33.947
TP-03	1232	1809	35.369
TP-04	1042	1608	34.878
TP-05	1025	1708	36.121

**DETAILS OF ELECTRICAL RESISTIVITY TESTS (ERT):**

ERT	CO-ORDINATES		
	EASTING	NORTHING	RL in 'm'
ERT-01	1305	1440	33.093
ERT-02	1325	1460	33.775
ERT-03	1150	1470	35.633
ERT-04	1060	1730	35.751
ERT-05	1432	1375	35.709
ERT-06	1500	1400	35.260
ERT-07	400	1650	33.830
ERT-08	550	1080	34.566
ERT-09	1025	1422	34.244
ERT-10	953	1390	35.128
ERT-11	1730	370	35.669

**DETAILS OF FIELD CBR TESTS:**

CBR	CO-ORDINATES		
	EASTING	NORTHING	RL in 'm'
CBR-01	1363	1471	34.653
CBR-02	1248	1522	35.009
CBR-03	1021	1600	34.788

**DETAILS OF STATIC CONE PENETRATION TESTS (SCPT):**

SCPT	CO-ORDINATES		
	EASTING	NORTHING	RL in 'm'
SCPT-01	1523	1374	34.898
SCPT-02	979	1494	35.863
SCPT-03	1026	1520	35.776
SCPT-04	1208	1789	35.376
SCPT-05	1566	1420	35.298



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**DETAILS OF DYNAMIC CONE PENETRATION TESTS (DCPT):**

DCPT	CO-ORDINATES		
	EASTING	NORTHING	RL in 'm'
DCPT-01	1321	1440	33.058
DCPT-02	1200	1432	34.101
DCPT-03	1081	1556	35.318
DCPT-04	1048	1473	35.513
DCPT-05	1045	1682	35.986

**DETAILS OF BLOCK VIBRATION TESTS (BVT):**

BVT	CO-ORDINATES		
	EASTING	NORTHING	RL in 'm'
BVT-01	1262	1510	34.409
BVT-02	1006	1520	35.324

**DETAILS OF PRESSUREMETER TEST (PMT):**

PMT	CO-ORDINATES		
	EASTING	NORTHING	RL in 'm'
PMT-01	1168	1505	35.966

**DETAILS OF CROSS HOLES SHEAR TEST (CST):**

CST	CO-ORDINATES		
	EASTING	NORTHING	RL in 'm'
CST-01	1140	1518	34.919

**DETAILS OF PUMP OUT TESTS (POT):**

POT	CO-ORDINATES		
	EASTING	NORTHING	RL in 'm'
POT-01	1289	1418	33.138
POT-02	42	1027	35.653

### LABORATORY TEST RESULTS (AS PER IS)

The soil samples collected from the boreholes were tested in the laboratory and the field tests conducted at the site. The following tests were conducted.

**a. Moisture content (IS - 2720 Pt. II)**

Natural Moisture contents were obtained by oven drying method and the results are tabulated.

**b. Bulk and dry density (IS - 2720 pt. III)**

The bulk and dry density with saturated and buoyant density of samples are tabulated.

**c. Grain Size Distribution (IS - 2720 Pt. IV)**

Both sieve size analysis and hydrometer analysis were conducted on different samples and the findings are tabulated. Grain size classification scale confirms Indian Bureau of Standards.

**d. Specific Gravity (IS-2720 Pt.III-2)**

Specific gravity was obtained by pycnometer method and the result is tabulated.

**e. Atterberg's Limits (IS - 2720 Pt. V)**

The consistency limits are the water contents at which the soil mass passes from one state to the next. The soil mass interaction has four states of consistency limits. The Atterberg's limits useful for engineering purposes are liquid limit & plastic limit which are tabulated along with other index properties.

**f. Shrinkage Limit (IS - 2720 Pt - VI)**

The maximum water content expressed as percentage of oven-dried weight at which any further reduction in water content will not cause a decrease in volume of the soil mass. The Shrinkage limit useful for engineering purposes is tabulated.

**g. Tri-axial Shear Test (IS - 2720 Pt.XII)**

This test was done by triaxial apparatus on all undisturbed & remolded soil samples of cylindrical shape, subjected to direct stress acting in three mutually perpendicular direction viz. Major principal stress in vertical direction and minor principal stress failure is determined. This test gives more accurate & precise result of C &  $\Phi$  due to uniform stress distribution of fluid from the empirical formula

$$(\sigma_1 = \sigma_3 \tan^2 \Phi + 2c \tan \Phi).$$

**h. Direct Shear Tests - IS 2720 (Part 13)**

These tests were done on identical sandy samples by shear box apparatus which was an undrained test. Shearing force was applied by increasing the successive load until the failure takes place. The plane of shear failure was determined & the graph is attached.

**i. Laboratory California Bearing Ratio – IS 2720 (pt –XVI)**

The California bearing ratio test is penetration test meant for the evaluation of sub grade strength of roads and pavements. The results obtained by these tests are used with the empirical curves to determine the thickness of pavement and its component layers. This is the most widely used method for





the design of flexible pavement. California bearing ratio is the ratio of force per unit area required to penetrate in to a soil mass with a circular plunger of 50mm diameter at the rate of 1.25mm / min.

**j. Standard Proctor Test (IS – 2720 Pt-VIII)**

Standard Proctor Compaction Test was done in the Laboratory tests, and the results are tabulated.

**k. Free Swell Index Tests - IS 2720 (Pt - L)**

To determine the free swell index of soil as per IS: 2720 (Part L) Free swell or differential free swell, also termed as free swell index, is the increase in volume of soil without any external constraint when subjected to submergence in water.

**j. Swelling Pressure - IS 2720 (Pt – L1)**

The Swelling Pressure measured in the Laboratory by the used of a conventional one – dimensional consolidation. Vertical expansion of the sample was measured under different imposed vertical pressures after being flooded with water and recorded as percentage of initial height, which was the percent of swell under certain pressure.

**k. Consolidation Test- IS 2720 (Pt - 15, 1986)**

When a compressive load is applied to soil mass, a decrease in its volume takes place, the decrease in volume of soil mass under stress is known as compression and the property of soil mass pertaining to its tendency to decrease in volume under pressure is known as compressibility. In a saturated soil mass having its void filled with incompressible water, decrease in volume or compression can take place when water is expelled out of the voids. Such a compression resulting from a long time static load and the consequent escape of pore water is termed as consolidation.

Then the load is applied on the saturated soil mass, the entire load is carried by pore water in the beginning. As the water starts escaping from the voids, the hydrostatic pressure in water gets gradually dissipated and the load is shifted to the soil solids which increases effective on them, as a result the soil mass decrease in volume. The rate of escape of water depends on the permeability of the soil.

**I. Unconfined Compression Tests - IS 2720 - X)**

This was generally performed on selected cohesive soil depends on shear characteristic of the soil which can be determined from the unconfined compression test result. Effective stress parameters (C &  $\Phi$ ) were determined from the failure envelope.



## TEST PROCEDURE

### **1. DETERMINATION OF WATER CONTENT BY OVEN-DRYING METHOD**

Clean the container and weight it with lid. Put the required quantity of the moist soil sample in the container and replace the lid. We have noted down the weight. The required quantity of soil sample is collected.

The container is placed in the oven with lid open and maintains the temperature of the oven between  $105^{\circ}\text{C}$  to  $110^{\circ}\text{C}$ , for about 16 to 24 hours. Take out the container, replace the lid and cool it in the desiccators. Found the weight of the container with lid and dried soil sample.

### **2. DETERMINATION OF SPECIFIC GRAVITY BY PYCNOMETER**

Clean the pycnometer and dry it. Found the weight of the pycnometer, brass cap and washer, accurate to 1g. Taken about 200 to 400 g of oven dried soil and placed it in the pycnometer. Weighed the pycnometer plus soil etc. Filled the pycnometer to half its height with distilled water and mixed it thoroughly with glass rod. By adding more water thorough mixture is done. Replace the screw top and fill the pycnometer flush with hole in the conical cap. Taken the weight of dry pycnometer from outside, and weighed it. Now empty the pycnometer and cleaned it thoroughly and fill it with distilled water, up to the hole of the conical cap and weighed it. By repeating the above procedure for two more times the specific gravity is determined.

### **3. DETERMINATION OF DRY DENSITY BY WATER DISPLACEMENT METHOD**

With the help of knife, we have trimmed the sample to a more or less regular shape, by avoiding re-entrant angles. Weighted the sample with the help of the brush, applied one coat of melted wax. When the coat was hardened, apply the second coat. Weighted the coated sample. Filled fresh water into the container until it overflows through the tubing. When the overflow stopped, clamp the clip of the tubing. By immersing the wax coated sample slowly into the container, until it was sunk completely. Put the beaker below the rubber tubing and open the clip. Collected all the over flown water. Found the weight of water so collected, accurate to 1g. We have taken out the wax coated sample, dried it outside and remove the paraffin wax skin. Cutted the sample into two pieces and kept a representative sample for water content determination.

### **4. DETERMINATION OF GRAIN SIZE DISTRIBUTION BY SIEVING**

By using a riffle, taken a representative sample of soil received from the field and dried it in the oven. Weighed the required quantity of dried soil, and was placed it in a tray and soaked it with water. The maximum size of material presents in substantial quantities in the soil, the weight of soil sample taken



for analysis.

Paddle the sample thoroughly in water and passed the slurry through 4.75mm sieve, which divides the gravel fraction from the sand fraction. Washed the slurry with jet of water and collect the materials that are retained on 4.75 mm sieve and the material passed through it in separate containers. Kept the material retained on 4.75 mm sieve in the oven. We washed the material passing through the 4.75 mm sieve, through the following set of sieves: 63mm, 20mm, 10mm and 4.75mm by hand sieving. While sieving through each sieve, the sieve should be agitated so that the sample rolled in irregular motion over the sieve. The material from the sieve is rubbed, with the rubber pestle in the mortar; care is taken that individual soil particles were not broken and re-sieve it to make sure that only individual particles are retained. The weight of material retained on each sieve is recorded. We sieved the dried material, retained on 75micron sieve through the following set of sieves: 2 mm, 1 mm, 600 micron, 425 micron, 300 micron, 150 micron and 75 micron size. The set of sieves should be arranged one above the other and fitted to a mechanical sieve shaker such that the 2mm sieve is at the top and the 75 micron sieve is at the bottom. A cover is placed on the top of the 2mm sieve, and receiver is placed below the 75 micron sieve. A minimum of 10 minutes sieving is done. The soil fraction retained on each sieve is carefully collected in containers and the weight of each fraction is noted and recorded. Alternatively, the material retained on 75micron sieve is dried, but is washed through a set of sieves, setted in order from the finer to the finest (75 micron) at the bottom. Washing is continued until the water passing through each sieve was substantially cleaned. The fraction retained on each sieve is emptied carefully without loss of material in separate container and oven dried. The oven dried fraction is weighed separately and their weight is recorded. The material passing through 75 micron sieve is used for the sedimentation analysis.

## 5. DETERMINATION OF GRAIN SIZE DISTRIBUTION BY HYDROMETER

### Calibration of hydrometer

To determine the volume of the hydrometer bulb ( $V_h$ ), we have poured about 800 ml of water in the 1000ml measuring cylinder and noted the reading at the water level. By immersing the hydrometer in water, noted down the water reading. The difference between the two readings was recorded as the volume of the hydrometer bulb plus the volume of that part of the stem, which was submerged.

Alternatively, we weighed the hydrometer to nearest 2g. This weight in grams was recorded as the volume of the hydrometer in ml. This includes the volume of the bulb plus the volume of the stem.

In order to find the area of cross section ( $A$ ) of the measuring cylinder in which the hydrometer is to be used, measured the distance in cm, between two graduations of the cylinder. The cross sectional area ( $A$ ) was then equal to volume included between the two graduations divided by the distance between them.



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The distance (h) is measured from the neck to the bottom of the bulb, and recorded it as the height of the bulb.

With the help of an accurate scale, the height H is measured between the neck of the hydrometer to each of the other major calibration marks ( $R_h$ ).

To calculate the effective depth (H6) corresponding to each of the major calibration marks (or hydrometer readings,  $R_h$ ) we used the expression:

$$H_6 = H + \frac{1}{2} (h - \underline{V_h})$$

A

The readings is recorded

We have drawn a calibration curve between  $H_6$  and  $R_h$  which is used for finding the effective depth ( $H_6$ ) corresponding to hydrometer readings ( $R_h$ ) which are obtained during the test.

Meniscus correction: By Inserting the hydrometer in the measuring cylinder containing 700ml of water. We have taken the reading of the hydrometer at the top and bottom of the meniscus. The difference between two readings was taken as the meniscus correction (cm), which was a constant for a hydrometer.

### DISPERSION OF SOIL

To the oven-dried soil in the evaporating dish added 100 ml of sodium hexametaphosphate solution and warmed the mixture gently for about 10 minutes. Transferred the mixture to the cup of the mechanical mixer used a jet of distilled water, and stirred it well for about 15 minutes. The sodium hexametaphosphate solution was prepared by dissolving 33g of sodium hexametaphosphate and seven grams of sodium carbonate in distilled water to made one liter of solution. This solution was unstable and should be freshly prepared approximately once in a month.

Transferred the soil suspension to the 75 micron IS sieve placed on a receiver and washed the soil on this sieve used jet of distilled water from a wash bottle. The amount of distilled water used during this operation might be about 500ml.

Transferred the soil suspension passing the 75 micron IS sieve to the 1000 ml. Measuring cylinder, and added more distilled water to made the volume to exactly 100ml in the cylinder.

Collected the material retained on 75 micron sieve and put it in the oven for drying. Determined the dried weight of soil retained on 75 micron sieve.

### SEDIMENTATION TEST WITH HYDROMETER

Insert a rubber bung or any other suitable cover on the top of the 1000ml measuring cylinder contained the soil suspension and shake it vigorously end over end. Stopped shaking and allowed it to stand.



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Immediately, started the stopwatch, and removed the top cover from the cylinder.

Immersed the hydrometer gently to a depth slightly below its floating position and then allowed it to float freely. Taken the hydrometer readings after periods of ½, 1,2 and 4 minutes. Taken out the hydrometer, rinsed it with distilled water and allowed it to stand in a jar containing distilled water at the same temperature as that of the test cylinder.

The hydrometer is reinserted in the suspension and readings are taken after periods of 8, 15 and 30 minutes; 1, 2 and 4 hours after shaking. The hydrometer should be removed, rinsed and placed in the distilled water after each reading. After the end of 4 hours, readings should be taken once or twice within 24 hours.

Composite correction. In order to determine the composite correction, put 100ml of dispersing agent solution in another 1000 ml measuring cylinder and made it to 1000 ml by added distilled water. The cylinder should be maintained at the same temperature as that of the test cylinder contained soil specimen. Insert the hydrometer in this comparison cylinder contained distilled water and the dispersed agent and taken the reading corresponding to the top of the meniscus. The negative of the hydrometer reading so obtained given the composite correction (C). The composite correction was found before the starter of the test, and also at every time intervals of 30 minutes, 1 hour, 2 hours and 4 hours after the beginning of the test, and afterwards, just after each hydrometer reading was taken in test cylinder.

The temperature of the suspension should be observed and recorded once during the first 15 minutes and then after every subsequent reading.

## 6. DETERMINATION OF LIQUID LIMIT OF SOIL

By means of the gauge on the handle of the grooving tool and the adjustment plate, adjusted the height through which the cup was lifted and dropped so that the point on the cup which comes in contact with the base falls through exactly one centimeter when the handle was rotated by one revolution. When the adjustment was complete, secure the adjustment plate by tightening its screws.

Taken about 120g of the specimen, passing through the 425 micron sieve, and mixed it thoroughly with distilled water in the evaporating dish or on the marble plate so that uniform paste was formed. Left the soil for sufficient time so that water per maturing time might be up to 25 hours. Taken a portion of the paste with the spatula and placed it in the centre of the cup so that it was almost half filled. Level off the top of the wet soil symmetrically with the spatula, so that it was parallel to the rubber base and the maximum depth of the soil was 1 cm.

With the help of grooving 'a' the paste in the cup was divided along the cup diameter (through the center line of the cam follower), by holed the tool normal to the surface of the cup and drawn it firmly across.

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Thus a V shaped gap, 2 mm wide at the bottom and 11mm at the top and 8mm deep would be formed. Turn the handle of the apparatus at the rate of 2 revolutions per second, until the two parts of the soil came in contact with the bottom of the groove along a distance of 10 mm. Recorded the number of blows required to cause the groove close for length of 10 mm.

Collected a representative slice of soil by moved the spatula widthwise from one edge to the other edge of the soil cake at right angles to the groove, included the portion of the groove in which the soil flowed together, and put it in an airtight container. Its water content was later determined by Oven drying method.

Removed the remaining soil from the cup and mixed it with the soil left earlier on the marble plate (or evaporating dish). Changed the consistency of the mix by either added more water or left the soil paste to dried. Noted the number of revolutions to close the groove and kept the soil for water content determination. These operations are repeated for 3 or 4 more additional trials. The soil paste in these operations should be of such consistency that the number of revolutions or drops to closed the groove is 25 -10. The test should always proceed from the dryer (more blows) to wetter (less blows) condition of the soil.

## 7. DETERMINATION OF PLASTIC LIMIT OF SOIL

Taken about 20g of air-dried soil from the thoroughly mixed portion of the material passed 420 micron IS sieve. Mixed it on the marble plate with sufficient distilled water to made it plastic enough to be shaped into a ball. Left the plastic soil mass for some time to mature.

Taken about 8g of the plastic soil, made a ball of it, and rolled it on the marble (or glass) plate with the hand with just sufficient pressure to roll the mass into a thread of uniform diameter throughout its length. When the diameter of the thread had decreased to 3 mm the specimen was kneaded together and rolled out again. Continued the process until the thread just crumbles at 3mm diameter. Collected the crumbled soil thread in the airtight container and kept it for water content determination. The test was repeated twice more. Thus, three readings were obtained for the determination.

## 8. DETERMINATION OF SHRINKAGE FACTORS OF SOIL

### Preparation of soil paste

Taken about 100g of soil sample from a thoroughly mixed portion of the material passing 425 micron IS sieve.

Placed about 30g of the above sample in evaporating dish and mixed it thoroughly with distilled water. Water added should be sufficient to filled the voids in the soil completely and made the soil pasty enough





to be readily worked into the shrinkage dish without entrapping air bubbles. In the case of plastic soils, the water content of the paste may exceed its liquid limit by as much as 10 percent, while for friable soils the amount of water required to obtain the desired consistency might be equal to or slightly greater than the liquid limit.

#### **Determination of weight and volume of the shrinkage dish**

Cleaned a shrinkage dish and determined its weight accurate to 0.1g. To determine its volume, placed the shrinkage dish in the evaporating dish and filled it to overflowing with mercury. Removed the excess mercury by pressing the plain glass plate firmly on its top, take care that no air was entrapped. Wipe off, carefully, any mercury which might be adhering to the outside of the shrinkage dish. Carefully transferred the mercury from the shrinkage dish to the other evaporating dish, and then determined the weight of mercury, accurate to 0.1g. The weight of mercury divided by its unit weight would give the volume of the shrinkage dish, which was also the volume of wet soil pat.

#### **Filled the shrinkage dish with wet soil pat**

Coated the inside of the shrinkage dish with a thin layer of silicon grease or Vaseline. In the centre of the dish, placed the soil paste, about one third of the volume of the dish, with the help of spatula. Tapping the dish gently on a firm surface, cushioned with layers of blotting paper or rubber sheet, and allowed the paste to flow towards the edges. Placed another equal installment of the paste in the dish and made it flow towards the edges by tapping. Tapping should be continued till the paste was compacted and all the entrapped air was brought to the surface. Repeated the process till the dish was completely filled and the excess soil overflows. Strike off the excess soil paste with a straight edge. Wipe off the soil adhering to the outside of the dish.

#### **Determined of wet and dry weight of soil pat**

Weighted immediately the shrinkage dish plus the wet soil pat, accurate to 0.1g. Kept the shrinkage dish open to air until the color of the pat turns from dark to light. Kept the shrinkage dish in the oven and thus dried the pat to constant weight at 105 to 110°C. Cooled the dish in a desiccator and weighed immediately.

#### **Determination of volume of dry soil pat**

To determine the volume of the dry soil pat, kept the glass cup in the evaporating dish. Filled the cup to overflowing with mercury. Removed the excess mercury by pressing the glass plate with the three prongs firmly over the top of the cup. Transferred the cup carefully to another evaporating dish, carefully wiping off any mercury, which might be adhering to the outside of the cup. Placed the oven-dried soil pat on the surface of mercury in the cup and carefully forced the pat into the mercury by pressing it with the same glass



plate containing three prongs. Pressed the plate firmly in the top of the cup. Collected carefully the displaced mercury and weigh to an accuracy of 0.01g. The volume of the dry soil pat was then determined by dividing this weight by the unit weight of mercury.

## 9. DETERMINATION OF SHEAR PARAMETERS BY TRIAXIAL TEST

### Sample Preparation

#### Undisturbed specimens.

The undisturbed sample had collected in a thin walled tube having the same internal diameter as that of the specimen required for testing; the sample might be extruded out with the help of sample extruder, and pushed into the split mould. The sample should be extruded from the tube pushing from the cutting edge side. The ends of the specimen were trimmed flat and normal to its axis. The split mould should be lightly oiled from inside. The specimen was then taken out, carefully, of the split mould, and its length, diameter, weight should be measured to an accuracy enabling the bulk density to be calculated to an accuracy of 10 percent. A portion of the soil trimmed was placed for water content determination. The specimen was then placed on one of the end caps and the other end cap was put on the top of the specimen. The rubber membrane was then placed around the specimen using the membrane stretcher. The membrane was sealed to the end caps by means of rubber rings. The specimen was then ready to be placed on the pedestal in the Tri-axial cell.

#### Un-drained Tri-axial compression test.

1. Covered the pedestal in the Tri-axial cell with a solid end cap or kept the drainage valve closed. Placed the specimen assembly centrally on the pedestal. Assemble the cell, with the loading ram initially cleared of the top of the specimen, and placed it in the loading machine.
2. Admitted the operating fluid in the cell, and raised its pressure to the desired value. Adjust the loading machine to bring the loading ram a short distance away from the seat on the top cap of the specimen. Read the initial reading of the load-measuring gauge. Adjust the loading machine further so that the loading ram came just in contact with the seat on the top of the specimen. Noted the initial reading of the dial measuring axial compression.
3. Applied the compressive force at constant rate of axial compression, such that failure was produced in a period of approximately 5 to 15 minutes. Taken the simultaneous readings of load and deformation dials, defined the stress strain curve. Continued the test until the maximum value of stress had passed or until an axial strain of 20 percent had passed.
4. Unload the specimen and drained off the cell fluid. Dismantle the cell and taken out the specimen. Removed the rubber membrane and noted down the mode of failure. Weight the specimen. Kept



samples for water content determination.

5. Repeated the test on three or more identical specimens under different cell pressure.

#### 10. DETERMINATION OF SHEAR PARAMETERS BY DIRECT SHEAR TEST

Collect the soil specimen which is either undisturbed or remolded. The sample should be taken using sampler and Rammer. If cohesion less soil is taking then sampler and rammer are not required.

The inner dimensions of sampler should be 60 mm x 60 mm in plan which are also the inner dimensions of shear box. The Thickness of box is about 50 mm while the thickness of sample should be 25mm.

Now attach the two halves of the shear box with locking pins and place the base plate at the bottom.

Above the bottom plate, Place the porous stone and above it place the grid plate. Plain grid plates are used for undrained conditions while perforated grid plates are used for drained conditions.

Now we have base plate, porous stone and grid plate in the shear box. Weigh the box at this stage and note down.

After that place the soil specimen above the grid plate. Undisturbed sample is directly transferred to shear box. If sandy soil is using, place it layers wise and tamper the each layer to get the required density.

Note down the weight of shear box with soil specimen.

Above the soil specimen, place the upper grid plate, porous stone and loading pad one above the other.

Now the whole box is placed in a container and mounted on the loading frame.

Proving ring is arranged in such a way that it should contact the upper half of the shear box.

Loading yoke is placed on the steel ball of loading pad of shear box.

Two dial gauges are fitted one to the container for measuring shear displacement and other one is to the loading yoke for measuring vertical displacement.

Now locking pins are removed from the shear box and spacing screws are placed in their respective positions of the box.

The upper half of the box is raised slightly with the help of spacing screws. The spacing is decided depending upon the maximum size of particle.

Now apply the normal stress which is generally 25 kN/m<sup>2</sup>. Also apply the shear load at a constant rate of strain.



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Now the box starts reacting to loads applied and for every 30 seconds note down the readings of proving ring and dial gauges.

If the proving ring reaches maximum and suddenly drops it, means the specimen is failed. Note down the maximum value which is nothing but failure stress.

For some soils, failure point is taken at 20% of shear strain.

Finally remove the box and measure the water content of the specimen.

Repeat the same procedure for different normal stresses of 50, 100, 150,200,250,300,400 kN/m<sup>2</sup>

### 11. DETERMINATION OF SWELLING PRESSURE.

The swelling pressure measured in the laboratory by the used of a conventional one-dimensional consolidometer. A soil sample of 1.5 to 2.5 cm thickness was enclosed between two porous plates and confined in a metal ring of 5 to 10 cm diameter. Vertical expansion of the sample was measured under different imposed vertical pressures after being flooded with water and recorded as percentage of initial height, which was the percent of swell under certain pressure. This means one sample was required to be tested for one vertical pressure and all the tests with the same initial conditions. 3 to 4 samples might be required with the same initial conditions for the test. The Curves obtained from the values given the relation between swelling and the vertical pressure. The point where the extrapolated curve meets the abscissa gives the swelling pressure under zero swelling, and the point where the curve meets the vertical axis gives the free swelling under zero vertical pressure.

### 12. DIFFERENTIAL FREE SWELL

#### Procedure:

Dried about 50 g of soil in an oven at 100 – 110<sup>0</sup>C, sieve the soil through 425-micron IS sieve. Taken two specimen of this soil each weighing 10 g. Filled one cycling with Kerosene oil and the other with distilled water each up to about 80-90 ml. Capacity. Pour gently one soil specimen in the first cylinder containing Kerosene and the other specimen in the second cylinder containing distilled water. Removed the entrapped air by gentle shaking or by stirring with clean glass rods. Left the soils in both the cylinders to settle for 24 hours or more. Read the final (constant) volume of soil specimen in both the cylinders. Kerosene was a non-polar liquid causing no swelling of the soil. The level of the soil specimen in the graduated cylinder containing Kerosene oil. Therefore, was read as the original volume of the soil sample. The level of the soil specimen in the second cylinder containing distilled water was taken as the free swell level.

### 13. CONSOLIDATION TEST

#### Procedure:

- Saturate two porous stones either by boiling in distilled water about 15 minute or by keeping them submerged in the distilled water for 4 to 8 hrs. Wipe away excess water. Fittings of the consolidometer which is to be enclosed shall be moistened.
- Assemble the consolidometer, with the soil specimen and porous stones at top and bottom of specimen, providing a filter paper between the soil specimen and porous stone. Position the pressure pad centrally on the top porous stone.
- Mount the mould assembly on the loading frame, and center it such that the load applied is axial.
- Position the dial gauge to measure the vertical compression of the specimen. The dial gauge holder should be set so that the dial gauge is in the beginning of its releases run, allowing sufficient margin for the swelling of the soil, if any.
- Connect the mould assembly to the water reservoir and the sample is allowed to saturate. The level of the water in the reservoir should be at about the same level as the soil specimen.
- Apply an initial load to the assembly. The magnitude of this load should be chosen by trial, such that there is no swelling. It should be not less than  $50 \text{ g/cm}^3$  for ordinary soils &  $25 \text{ g/cm}^2$  for very soft soils. The load should be allowed to stand until there is no change in dial gauge readings for two consecutive hours or for a maximum of 24 hours.
- Note the final dial reading under the initial load. Apply first load of intensity  $0.1 \text{ kg/cm}^2$  start the stop watch simultaneously. Record the dial gauge readings at various time intervals. The dial gauge readings are taken until 90% consolidation is reached. Primary consolidation is gradually reached within 24 hrs.
- At the end of the period, specified above take the dial reading and time reading. Double the load intensity and take the dial readings at various time intervals. Repeat this procedure fir successive load increments. The usual loading intensity are as follows :

0.1, 0.2, 0.5, 1, 2, 4 and  $8 \text{ kg/cm}^2$ .

- After the last loading is completed, reduce the load value of the last load and allow it to stand for 24 hrs. Reduce the load further in steps of the previous intensity till an intensity of  $0.1 \text{ kg/cm}^2$  is reached. Take the final reading of the dial gauge.



- Reduce the load to the initial load, keep it for 24 hrs. and note the final readings of the dial gauge.

Quickly dismantle the specimen assembly and remove the excess water on the soil specimen in oven, note the dry weight of it.

### 15. UN CONFINED COMPRESSIVE STRENGTH

Place the sampling soil specimen at the desired water content and density in the large mould.

Push the sampling tube into the large mould and remove the sampling tube filled with the soil. For undisturbed samples, push the sampling tube into the clay sample.

Saturate the soil sample in the sampling tube by a suitable method.

Coat the split mould lightly with a thin layer of grease. Weigh the mould.

Extrude the sample out of the sampling tube into the split mould, using the sample extractor and the knife. Trim the two ends of the specimen in the split mould. Weigh the mould with the specimen.

Remove the specimen from the split mould by splitting the mould into two parts.

Measure the length and diameter of the specimen with vernier calipers.

Place the specimen on the bottom plate of the compression machine. Adjust the upper plate to make contact with the specimen.

Adjust the dial gauge and the proving ring gauge to zero.

Apply the compression load to cause an axial strain at the rate of  $\frac{1}{2}$  to 2% per minute.

Record the dial gauge reading, and the proving ring reading every thirty seconds up to a strain of 6%. The reading may be taken after every 60 seconds for a strain between 6%, 12% and every 2 minutes or so beyond 12%.

Continue the test until failure surfaces have clearly developed or until an axial strain of 20% is reached.

Measure the angle between the failure surface and the horizontal, if possible.

Take the sample from the failure zone of the specimen for the water content determination.

### 16. CALIFORNIA BEARING RATIO

It is the ratio of force per unit area required to penetrate a soil mass with standard circular piston at the rate of 1.25 mm/min. to that required for the corresponding penetration of a standard material.



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Tests are carried out on natural or compacted soils in water soaked or un-soaked conditions and the results so obtained are compared with the curves of standard test to have an idea of the soil strength of the subgrade soil.

## PROCEDURE

Normally 3 specimens each of about 7 kg must be compacted so that their compacted densities range from 95% to 100% generally with 10, 30 and 65 blows.

- Weigh of empty mould
- Add water to the first specimen (compact it in five layer by giving 10 blows per layer)
- After compaction, remove the collar and level the surface.
- Take sample for determination of moisture content.
- Weight of mould along with compacted specimen.
- Place the mold in the soaking tank for four days (ignore this step in case of unsoaked CBR).
- Take other samples and apply different blows and repeat the whole process.
- After four days, measure the swell reading and find %age swell.
- Remove the mould from the tank and allow water to drain.
- Then place the specimen under the penetration piston and place surcharge load of 10lb.
- Apply the load and note the penetration load values.
- Draw the graphs between the penetration (in) and penetration load (in) and find the value of CBR.
- Draw the graph between the %age CBR and Dry Density, and find CBR at required degree of compaction.

## 17. PROCTOR COMPACTION TEST

- Take about 20kg of air-dried soil. Sieve it through 20mm and 4.75mm sieve.
- Calculate the percentage retained on 20mm sieve and 4.75mm sieve, and the percentage passing 4.75mm sieve.
- If the percentage retained on 4.75mm sieve is greater than 20, use the large mould of 150mm diameter. If it is less than 20%, the standard mould of 100mm diameter can be used. The following procedure is for the standard mould.
- Mix the soil retained on 4.75mm sieve and that passing 4.75mm sieve in proportions determined in step (2) to obtain about 16 to 18 kg of soil specimen.
- Clean and dry the mould and the base plate. Grease them lightly.
- Weigh the mould with the base plate to the nearest 1 gram.



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- Take about 16 – 18 kg of soil specimen. Add water to it to bring the water content to about 4% if the soil is sandy and to about 8% if the soil is clayey.
- Keep the soil in an air-tight container for about 18 to 20 hours for maturing. Mix the soil thoroughly. Divide the processed soil into 5 parts.
- Attach the collar to the mould. Place the mould on a solid base.
- Take about 2.5kg of the processed soil, and hence place it in the mould in 5 equal layers. Take about one-third the quantity first, and compact it by giving 25 blows of the rammer. The blows should be uniformly distributed over the surface of each layer.
- The top surface of the first layer be scratched with spatula before placing the second layer. The second layer should also be compacted by 25 blows of rammer. Likewise, place the third layer and compact it.
- The amount of the soil used should be just sufficient to fill the mould and leaving about 5 mm above the top of the mould to be struck off when the collar is removed.
- Remove the collar and trim off the excess soil projecting above the mould using a straight edge.
- Clean the base plate and the mould from outside. Weigh it to the nearest gram.
- Remove the soil from the mould. The soil may also be ejected out.
- Take the soil samples for the water content determination from the top, middle and bottom portions. Determine the water content.
- Add about 3% of the water to a fresh portion of the processed soil, and repeat the steps 10 to 14.

#### **CHEMICAL TEST ON WATER SAMPLES:**

##### **Measurement of pH**

50 ml of water sample is taken and it is allowed to stand for 1 hour with occasional Stirring. It is stirred again, immediately before testing.

The pH meter is calibrated with standard buffer and the pH of the water is measured.

##### **Chloride**

5 to 6 drops of potassium chromate indicator is added to 10 ml of the water sample get yellow color and then titrated against Silver nitrate solution (0.01N).

End point: yellow Brick Red colour.

Chloride Content, ppm =  $3.545 \times (V \times N) / S$

Where,

V= Volume of Silver nitrate Solution (ml)

S = Sample weight in gm.

N= Normality of Silver Nitrate Solution





**Sulphate**

10 ml of the sodium chloride- Hydrochloric acid mixture, 10 ml of glycerol-Ethanol mixture and 0.15 g of Barium Chloride is added to 50ml of water sample. This is stirred for about an hour and the absorbance is measured against distilled water blank using a colorimeter. The sulphate content of the sample is deduced from the standard curve.

**Carbonate**

The Carbonate content test was done as per IS Code 3025-51 and results are tabulated.

**Nitrate**

The Nitrate content test was done as per IS Code 3025-34 and results are tabulated.

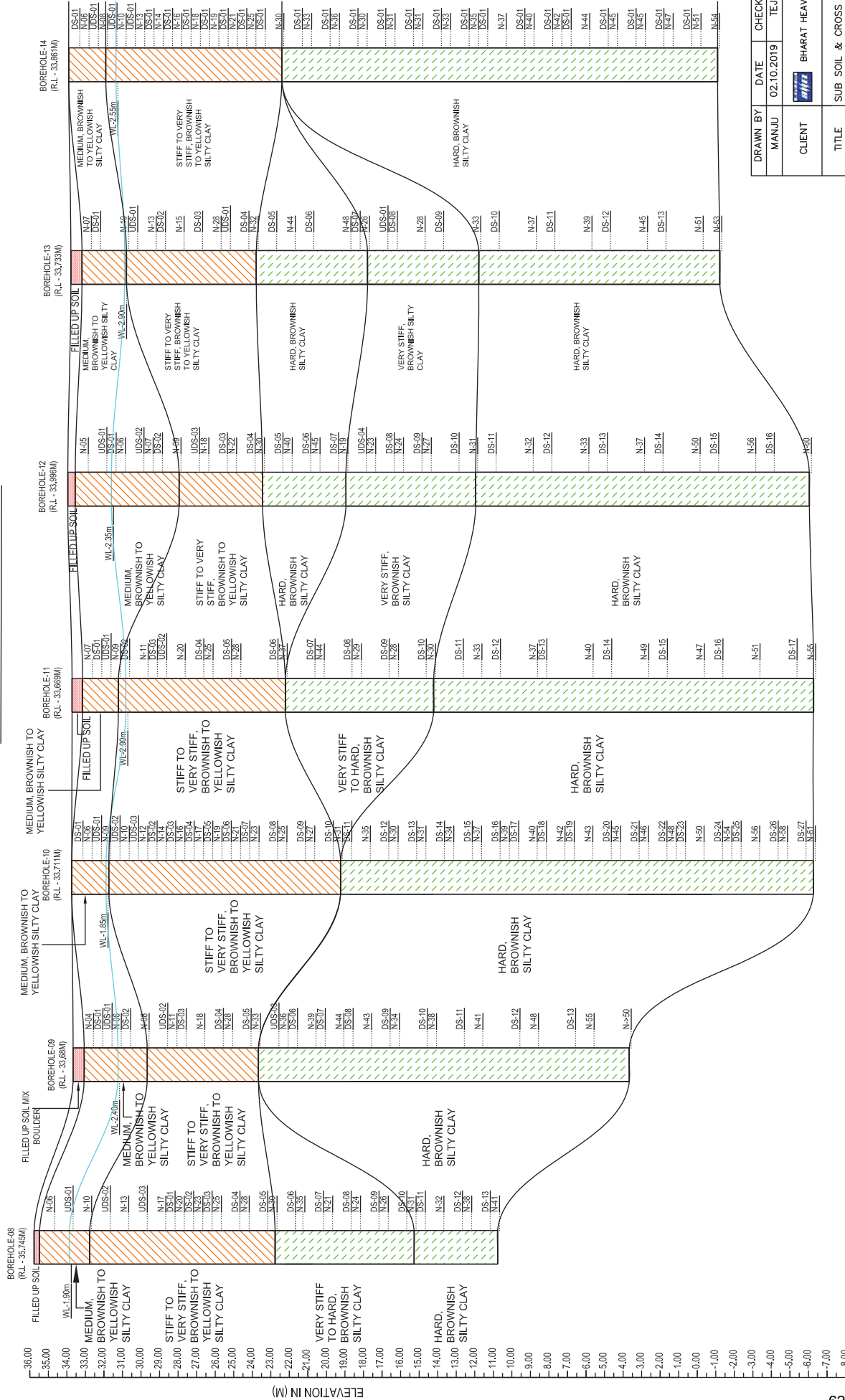
**Turbidity**

The Turbidity content test was done as per IS Code 3025-10 and results are tabulated.

**Organic Matter**

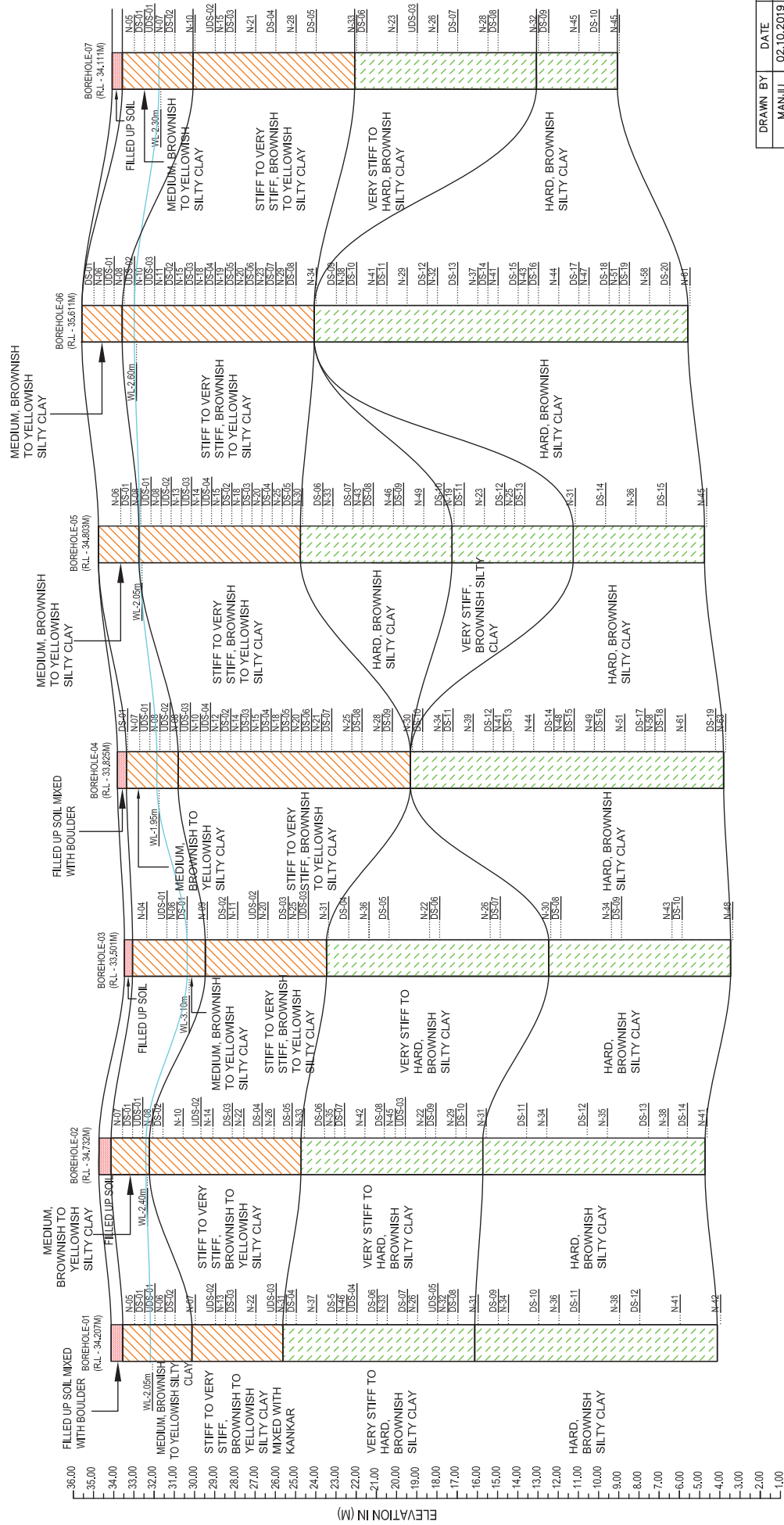
The Organic content test was done as per IS Code 3025-58 and results are tabulated.

# SUB-SOIL & CROSS PROFILE



DRAWN BY	DATE	CHECKED BY	APPROVED BY
MANJU	02.10.2019	TEJA	S.N.S
CLIENT	BHARAT HEAVY ELECTRICALS LIMITED		
TITLE	SUB SOIL & CROSS PROFILE		
PROJECT	GEOTECHNICAL INVESTIGATION OF 1X660MW SAGARDIGHI TPS EXTENSION UN		
SURVEYED BY	SWAIN & ASSOCIATES PVT. LTD 77, SATYANAGAR, BHUBANESWAR PH - (0674)2570099/2570458/2570985		
SIZE	SHEET NO		
A3	BH-02 OF 05		

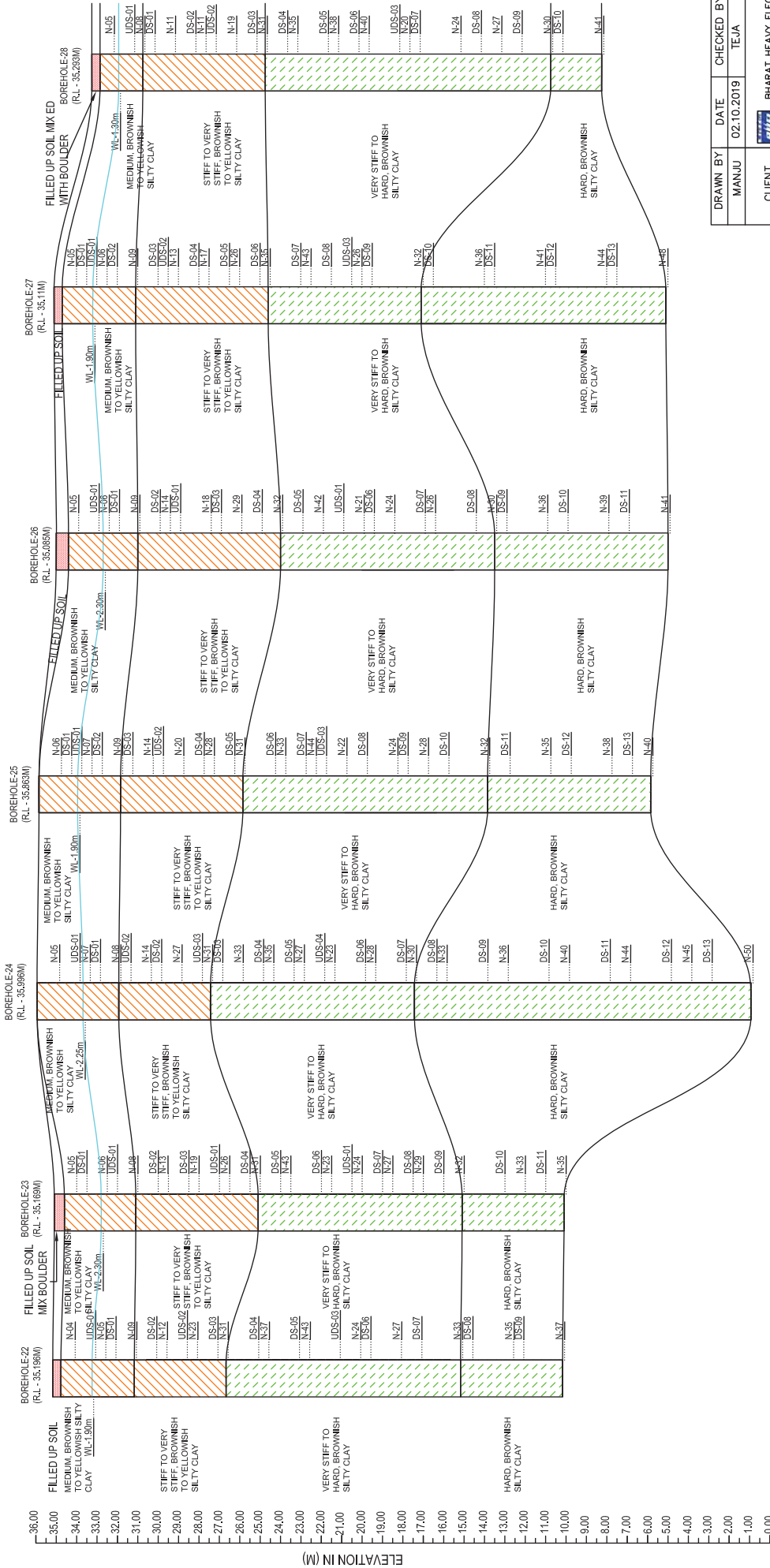
# SUB-SOIL & CROSS PROFILE



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SIZE	SHEET NO		
A3	BH-01 OF 05		

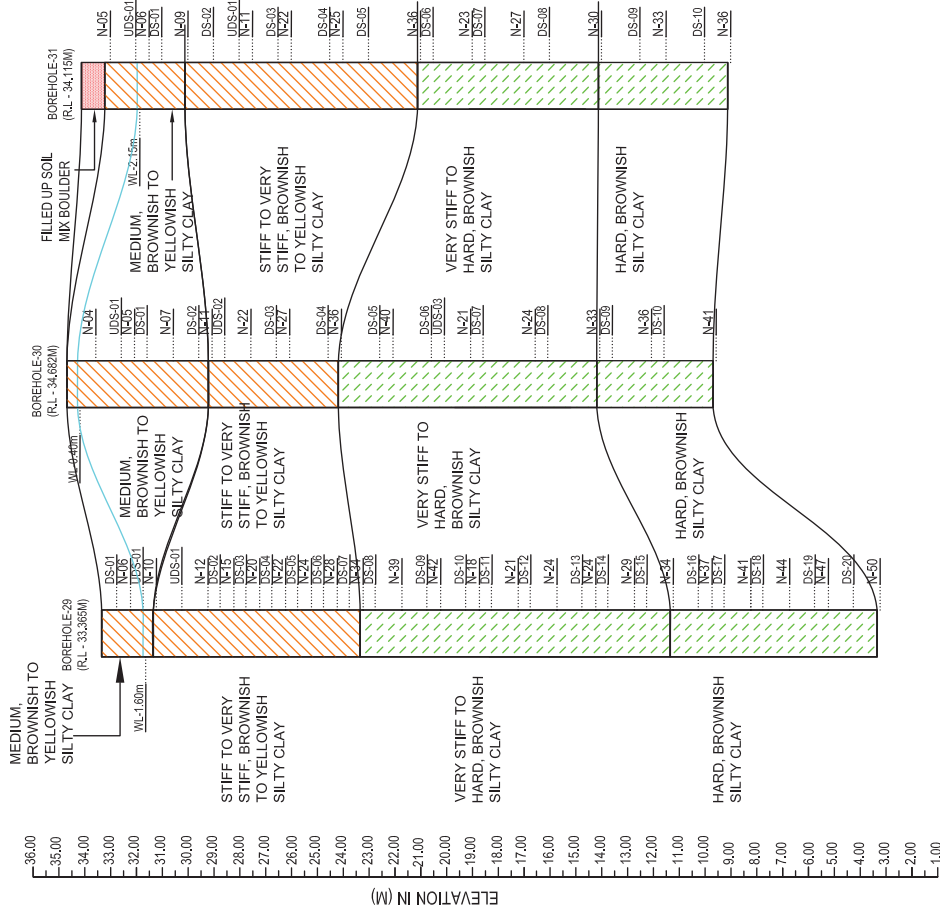


# SUB-SOIL & CROSS PROFILE



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SIZE	SHEET NO		
A3	BH-04 OF 05		

# SUB-SOIL & CROSS PROFILE



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CLIENT	BHARAT HEAVY ELECTRICALS LIMITED		
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### DESIGN PARAMETERS

- Since the project site is having uniform Sub-Soil stratification, based on bore logs, Field & Laboratory Test results, the following Design Soil Profile has been used for the analysis of Open Foundation and Pile Foundations:

#### (BH No – 01to 31)

- BH-1 & 2 – Switchyard area
- BH-3 & 4 – CST Tank & Pump house area
- BH- 5 – Transformer yard area
- BH- 7 - Air washer & DG building
- BH-6, 8 & 31 – CW Pipe corridor
- BH- 9,10,11,12 & 13 – Power House & TG area
- BH-14 – CPU Regeneration building & N-Pit
- BH-15, 17, 18 & 19 – Boiler & Mill Bunker area
- BH-16 – CTBT RO Plant area
- BH-20 & 21 – ESP area
- BH-22 – ESP Control room & FGD Control room area
- BH-23 – CW Treatment building area
- BH-24 & 25 – CW Pump house and Fore bay area
- BH-26 & 27 – ID Fan area
- BH-28 & 29 – Duct & Absorbent tank area
- BH-30 – Absorber area

\*Finished Ground Level (FGL) is considered as RL(+ )34.200m

Layer No.	Stratum Description	Depth in (m)	Thickness of Stratum (m)	Cohesion,C (t/m <sup>2</sup> )	Coefficient of Volume Compressibility m <sub>v</sub> (cm <sup>2</sup> /kg)
1	Medium, Silty Clay	FGL - 3.00	3.00	4.60	0.0168
2	Stiff, Silty Clay	3.00 - 6.00	3.00	8.00	0.0110
3	Very Stiff, Silty Clay	6.00 - 10.00	4.00	10.00	0.0100
4	Very Stiff, Silty Clay	10.00 - 12.00	2.00	18.00	0.0050
5	Very Stiff to Hard, Silty Clay	12.00 - 18.00	6.00	25.00	
6	Hard, Silty Clay	18.00 - 30.00	9.00	30.00	

#### NOTE:

\* Since at deeper depth, UDS sample could not be collected due to hard strata encountered, field test results and empirical correlations were used for arriving the above design parameters.





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**NET SBC CALCULATION FOR OPEN FOUNDATION**

**BH-01 to 31 (MAIN PLANT AREA)**

Location	Depth in 'm'	Width of Footing in 'm'	Recommended Net Safe Bearing Capacity (t/m <sup>2</sup> )			
			Shear Consideration	For Permissible Settlement of		
				25mm	40mm	75mm
MAIN PLANT AREA (BH-01 to BH-31) Covering All Structures	1.50	Upto 3	11.45	8.00	10.00	-
		> 3 to 6	11.03	10.00	10.00	-
		> 6 to 10	11.12	9.00	11.00	11.00
	2.00	Upto 3	11.76	11.00	11.00	-
		> 3 to 6	11.24	11.00	11.00	-
		> 6 to 10	11.23	9.00	11.00	11.00
	3.00	Upto 3	21.72	18.00	21.00	-
		> 3 to 6	20.27	11.00	17.00	-
		> 6 to 10	19.89	8.00	13.00	19.00
	4.00	Upto 3	22.98	20.00	22.00	-
		> 3 to 6	20.99	12.00	19.00	-
		> 6 to 10	20.45	9.00	14.00	20.00
	5.00	Upto 3	24.07	22.00	24.00	-
		> 3 to 6	21.72	13.00	21.00	-
		> 6 to 10	20.82	10.00	16.00	20.00

## NET SAFE BEARING CAPACITY

LOCATION: MAIN PLANT AREA

Shape of Footing:- .....  
 Size of footing :- 6 X 3

FGL= 34.200 M

Founding stratum:- SILTY CLAY  
 THICKNESS OF 1st LAYER = 3.00 M  
 THICKNESS OF 2nd LAYER = 3.00 M  
 THICKNESS OF 3rd LAYER = 4.00 M  
 THICKNESS OF 4th LAYER = 2.00 M  
 THICKNESS OF 5th LAYER = 8.00 M  
 FOUNDATION DEPTH = 3 M  
 WIDTH OF FOOTING = 3 M

C	$\phi$
4.60	0
8.00	0

### SHEAR CRITERIA:

Based on Lab. Test results -  
 Considering sub - stratum as cohesive

$D_f = 3$  m  
 Cohesion (c) = 8 t/sqm  
 Angle of shearing Resistance ( $\phi$ ) = 0

Nc = 5.14	Nq = 1	$N_{\gamma} = 0$
Sc = 1.1	Sq = 1.1	$S_{\gamma} = 0.8$
dc = 1.2	dq = 1	$d_{\gamma} = 1$
$i_c = 1$	$i_q = 1$	$i_{\gamma} = 1$
B = 3 m		
$\gamma_{sub} = 0.9$ t/m <sup>2</sup>		
F = 2.5		
W = 0.5		

$$q_d = cN_c S_c d_c i_c + q(N_q - 1) S_q d_q i_q + 5B\gamma N_{\gamma} S_{\gamma} d_{\gamma} i_{\gamma} W'$$

$$q_d = 54.2784$$

$$q_s = (1/F)q_d = 21.72 \text{ t/m}^2$$

where, F=Factor of safety

### SETTLEMENT CRITERIA

**Settlement of 1st layer**  $S_1 = \lambda_1 \Delta p_1 m_{v1} H_1$   
 $\lambda_1 = 0$   
 $\Delta p_1 = 0 \text{ T/m}^2$   
 $m_{v1} = 0.00168 \text{ SQ.M/T}$   
 $H_1 = 0 \text{ m}$   
**S1 = 0 mm**

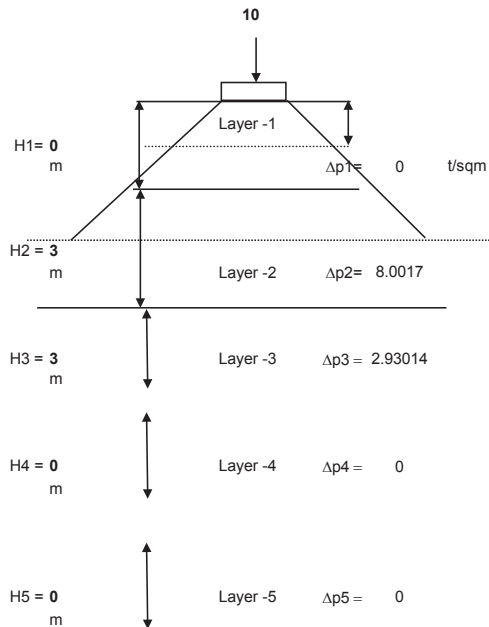
**Settlement of 2nd layer**  $S_2 = \lambda_2 \Delta p_2 m_{v2} H_2$   
 $\lambda_2 = 0.6$   
 $\Delta p_2 = 8.001699425 \text{ T/m}^2$   
 $m_{v2} = 0.00110 \text{ SQ.M/T}$   
 $H_2 = 3 \text{ m}$   
**S2 = 15.84336486 mm**

**Settlement of 3rd layer**  $S_3 = \lambda_3 \Delta p_3 m_{v3} H_3$   
 $\lambda_3 = 0.6$   
 $\Delta p_3 = 2.930139658 \text{ T/m}^2$   
 $m_{v3} = 0.00100 \text{ SQ.M/T}$   
 $H_3 = 3 \text{ m}$   
**S3 = 5.274251385 mm**

**Settlement of 4th layer**  $S_4 = \lambda_4 \Delta p_4 m_{v4} H_4$   
 $\lambda_4 = 0.6$   
 $\Delta p_4 = 0 \text{ T/m}^2$   
 $m_{v4} = 0.00050 \text{ SQ.M/T}$   
 $H_4 = 0 \text{ m}$   
**S4 = 0 mm**

### Boussinesq equation

Using = Boussinesq equation



**Settlement of 5th layer**     **$S_5 = \lambda_5 \Delta p_5 m_{v5} H_5$**   
 $\lambda_5 =$                             **0.6**  
 $\Delta p_5 =$                            **0 T/m<sup>2</sup>**  
 $m_{v5} =$                          **0.00050 SQ.M/T**  
 $H_5 =$                              **0 m**  
**S5 =**                             **0 mm**

Total Height                    6

Total settlement S =     $S_1 + S_2 + S_3 + S_4 =$     21.11761625 mm  
 Depth correction factor = **0.788578644**  
 Rigidity factor =            **0.8**  
 Final Settlement Sf =        **13.322**

so, for                    **13.322** mm settlement is for            **10.00** t/sqm  
                               **25** mm settlement ABP is =        **18.766** t/sqm  
                               **40** mm settlement ABP is =        **30.026** t/sqm  
                               **75** mm settlement ABP is =        **56.298** t/sqm

## NET SAFE BEARING CAPACITY

LOCATION: MAIN PLANT AREA

Shape of Footing:-   
 Size of footing :- 10 X 5

FGL= 34.200 M

Founding stratum:-   
 THICKNESS OF 1st LAYER = 3.00 M  
 THICKNESS OF 2nd LAYER = 3.00 M  
 THICKNESS OF 3rd LAYER = 4.00 M  
 THICKNESS OF 4th LAYER = 2.00 M  
 THICKNESS OF 5th LAYER = 8.00 M  
 FOUNDATION DEPTH = 3 M  
 WIDTH OF FOOTING = 5 M

C	φ
4.60	0
8.00	0

### SHEAR CRITERIA:

Based on Lab. Test results -  
 Considering sub - stratum as cohesive

D<sub>f</sub> = 3 m  
 Cohesion (c) = 8 t/sqm  
 Angle of shearing Resistance (φ) = 0

N<sub>c</sub> = 5.14    N<sub>q</sub> = 1    N<sub>γ</sub> = 0  
 S<sub>c</sub> = 1.1    S<sub>q</sub> = 1.1    S<sub>γ</sub> = 0.8  
 d<sub>c</sub> = 1.12    d<sub>q</sub> = 1    d<sub>γ</sub> = 1  
 i<sub>c</sub> = 1    i<sub>q</sub> = 1    i<sub>γ</sub> = 1  
 B = 5 m  
 γ<sub>sub</sub> = 0.9 t/m<sup>2</sup>  
 F = 2.5  
 W' = 0.5

$$q_d = cN_c S_c d_{c,i_c} + q(N_q - 1) S_q d_{q,i_q} + 0.5 B \gamma' N_\gamma S_\gamma d_{\gamma,i_\gamma} W'$$

$$q_d = 50.65984$$

$$q_s = (1/F) q_d = 20.27 \text{ t/m}^2$$

where, F=Factor of safety

### SETTLEMENT CRITERIA

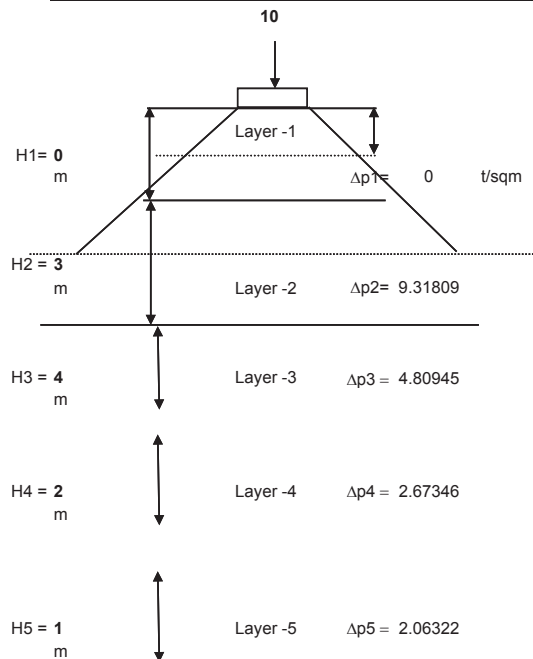
**Settlement of 1st layer**     $S_1 = \lambda_1 \Delta p_1 m_{v1} H_1$   
 λ<sub>1</sub> = 0  
 Δp<sub>1</sub> = 0 T/m<sup>2</sup>  
 m<sub>v1</sub> = 0 SQ.M/T  
 H<sub>1</sub> = 0 m  
**S<sub>1</sub> = 0 mm**

**Settlement of 2nd layer**     $S_2 = \lambda_2 \Delta p_2 m_{v2} H_2$   
 λ<sub>2</sub> = 0.6  
 Δp<sub>2</sub> = 9.3180916 T/m<sup>2</sup>  
 m<sub>v2</sub> = 0.0011 SQ.M/T  
 H<sub>2</sub> = 3 m  
**S<sub>2</sub> = 18.44982137 mm**

**Settlement of 3rd layer**     $S_3 = \lambda_3 \Delta p_3 m_{v3} H_3$   
 λ<sub>3</sub> = 0.6  
 Δp<sub>3</sub> = 4.809451514 T/m<sup>2</sup>  
 m<sub>v3</sub> = 0.00100 SQ.M/T  
 H<sub>3</sub> = 4 m  
**S<sub>3</sub> = 11.54268363 mm**

**Settlement of 4th layer**     $S_4 = \lambda_4 \Delta p_4 m_{v4} H_4$   
 λ<sub>4</sub> = 0.6  
 Δp<sub>4</sub> = 2.673461367 T/m<sup>2</sup>  
 m<sub>v4</sub> = 0.00050 SQ.M/T  
 H<sub>4</sub> = 2 m  
**S<sub>4</sub> = 1.60407682 mm**

**Boussinesq equation**  
 Using = Boussinesq equation



**Settlement of 5th layer**      **$S_5 = \lambda_{p5} m_{v5} H_5$**   
 $\lambda_{p5} =$      **0.6**  
 $\Delta p_5 =$      2.063217717 T/m<sup>2</sup>  
 $m_{v5} =$      **0.00050** SQ.M/T  
 $H_5 =$      1 m  
 **$S_5 = 0.618965315$**  mm

Total Height     10

Total settlement S =      $S_1 + S_2 + S_3 + S_4 =$      32.21554714 mm  
 Depth correction factor =     **0.872720779**  
 Rigidity factor =     **0.8**  
 Final Settlement Sf =     **22.492**

**22.492** mm settlement is for     **10.00** t/sqm  
 so, for     **25** mm settlement ABP is =     **11.115** t/sqm  
              **40** mm settlement ABP is =     **17.784** t/sqm  
              **75** mm settlement ABP is =     **33.345** t/sqm

## NET SAFE BEARING CAPACITY

LOCATION: MAIN PLANT AREA

Shape of Footing:- RECTANGULAR  
 Size of footing :- 12 x 8  
 SILTY CLAY

FGL= 34.200 M

Founding stratum:-  
 THICKNESS OF 1st LAYER = 3.00 M  
 THICKNESS OF 2nd LAYER = 3.00 M  
 THICKNESS OF 3rd LAYER = 4.00 M  
 THICKNESS OF 4th LAYER = 2.00 M  
 THICKNESS OF 5th LAYER = 8.00 M  
 FOUNDATION DEPTH = 3 M  
 WIDTH OF FOOTING = 8 M

C	φ
4.60	0
8.00	0

### SHEAR CRITERIA:

Based on Lab. Test results -  
 Considering sub - stratum as cohesive

D <sub>r</sub> =	Cohesion (c) =	Angle of shearing Resistance (φ)=	Depth (m)	Footing Size (m)		Shear	SBC(t/m <sup>2</sup> ) Based on Settlement		
				L	W		25mm	40mm	75mm
3 m	8 t/sqm	0							
N <sub>c</sub> = 5.14	N <sub>q</sub> = 1	N <sub>γ</sub> = 0	2	1	1	12.5	28.71	45.93	
S <sub>c</sub> = 1.13	S <sub>q</sub> = 1.13	S <sub>γ</sub> = 0.73	2	3	3	10.1	4.53	7.25	
d <sub>c</sub> = 1.07	d <sub>q</sub> = 1	d <sub>γ</sub> = 1	2	5	5	9.6	2.42	3.87	
i <sub>c</sub> = 1	i <sub>q</sub> = 1	i <sub>γ</sub> = 1	2	6	6	9.5	2.55	4.07	7.640371
B= 8	m		3	3	3	10.7	4.70	7.53	
γ <sub>sub</sub> = 0.9	t/m <sup>2</sup>		3	5	5	10.0	2.71	4.34	
F= 2.5			3	6	6	9.8	2.93	4.69	8.793265
W= 0.5			4	3	3	11.3	4.84	7.74	
$q_d = cN_c S_c d_{c i_c} + q(N_q - 1) S_q d_{q i_q} + 0.5 B \gamma N_\gamma S_\gamma d_\gamma i_\gamma W$			4	5	5	10.34	3.25	5.20	
q <sub>d</sub> = 49.71819			4	6	6	10.1	3.44	5.50	10.31511
q <sub>s</sub> = (1/F)q <sub>d</sub> = 19.89 t/m <sup>2</sup>									

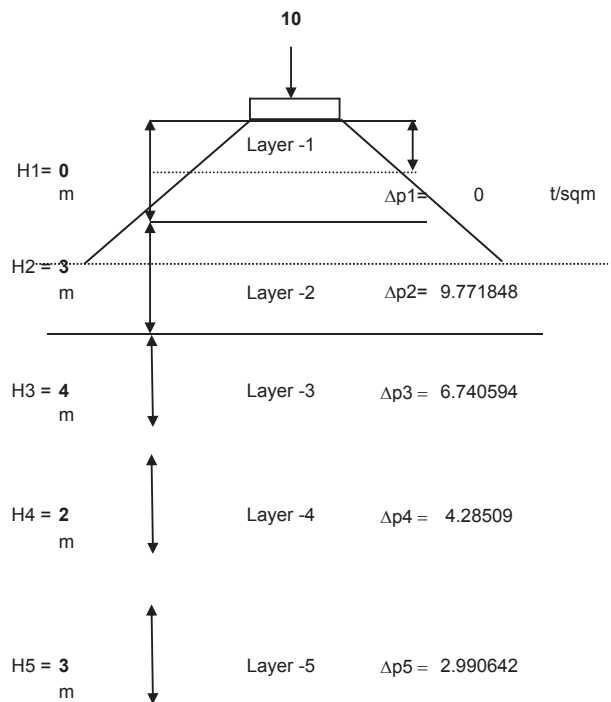
where, F=Factor of safety

### Boussinesq equation

Using = Boussinesq equation

### SETTLEMENT CRITERIA

Settlement of 1st layer		$S_1 = \lambda_1 \Delta p_1 m_{v1} H_1$
λ <sub>1</sub> =	0	
Δp <sub>1</sub> =	0 T/m <sup>2</sup>	
m <sub>v1</sub> =	0 SQ.M/T	
H <sub>1</sub> =	0 m	
S <sub>1</sub> =	0 mm	
Settlement of 2nd layer		$S_2 = \lambda_2 \Delta p_2 m_{v2} H_2$
λ <sub>2</sub> =	0.6	
Δp <sub>2</sub> =	9.771848 T/m <sup>2</sup>	
m <sub>v2</sub> =	0.0011 SQ.M/T	
H <sub>2</sub> =	3 m	
S <sub>2</sub> =	19.34826 mm	
Settlement of 3rd layer		$S_3 = \lambda_3 \Delta p_3 m_{v3} H_3$
λ <sub>3</sub> =	0.6	
Δp <sub>3</sub> =	6.740594 T/m <sup>2</sup>	
m <sub>v3</sub> =	0.00100 SQ.M/T	
H <sub>3</sub> =	4 m	
S <sub>3</sub> =	16.17742 mm	
Settlement of 4th layer		$S_4 = \lambda_4 \Delta p_4 m_{v4} H_4$
λ <sub>4</sub> =	0.6	
Δp <sub>4</sub> =	4.28509 T/m <sup>2</sup>	
m <sub>v4</sub> =	0.00050 SQ.M/T	
H <sub>4</sub> =	2 m	
S <sub>4</sub> =	2.571054 mm	



**Settlement of 5th layer**     $S_5 = \lambda_5 \Delta p_5 m_{v5} H_5$   
 $\lambda_5 =$                     **0.6**  
 $\Delta p_5 =$     2.990642 T/m<sup>2</sup>  
 $m_{v5} =$     **0.00050** SQ.M/T  
 $H_5 =$                     3 m  
**S5 = 2.691578 mm**

Total Heigt            12

Total settlement S =     $S_1 + S_2 + S_3$     40.78831 mm  
 Depth correction factor = **0.917526**  
 Rigidity factor =        **0.8**  
 Final Settlement Sf =    **29.939**

so, for            **29.939** mm settlement is for    **10.00** t/sqm  
                   **25** mm settlement ABP is    **8.35** t/sqm  
                   **40** mm settlement ABP is    **13.36** t/sqm  
                   **75** mm settlement ABP is    **25.051** t/sqm





### PILE CAPACITY CALCULATIONS

#### BORED CAST IN-SITU PILE:

BH No.: 01 to 31 (MAIN PLANT AREA)

Pile Diameter (m)	Length of Pile below Cut-Off Level (m)	Safe Load Carrying Capacity of Pile (MT)			
		Vertical Compression	Pull Out	Lateral in Fixed Head condition	Lateral in Free Head condition
0.60	24.00	150	100	10	4.63
0.76	27.00	225	150	13	5.87
0.76	30.00	245	175	13	5.87

**PILE CAPACITY CALCULATION**

(AS PER IS:2911.1.2.2010)

Pile diameter (m) = 0.60 m      Location: Main Plant Area  
 Bored Length of pile = 24.00 m  
 Cut-Off Length of Pile = 3.00 m  
 Formation Ground Level (F.G.L) = 34.200 m

Layer No.	Stratum Description	Depth in (m)	Thickness of Stratum (m)	Cohesion (t/m <sup>2</sup> )	Angle of friction (φ)	Alpha (α)	A <sub>si</sub> (m <sup>2</sup> )	Qs (t)	Remarks
1	Medium, Silty Clay	FGL - 3.00	3.00	4.60	0	1	5.65	0.00	* Cut-Off Depth
2	Stiff, Silty Clay	3.00 - 6.00	3.00	8.00	0	0.55	5.65	24.88	
3	Very Stiff, Silty Clay	6.00 - 10.00	4.00	10.00	0	0.46	7.54	34.68	
4	Very Stiff, Silty Clay	10.00 - 12.00	2.00	18.00	0	0.29	3.77	19.68	
5	Very Stiff to Hard, Silty Clay	12.00 - 18.00	6.00	25.00	0	0.28	11.31	77.75	
6	Hard, Silty Clay	18.00 - 30.00	9.00	30.00	0	0.28	16.96	142.50	

Skin Friction Resistance, Qs = Σ.α.C.A<sub>s</sub> (As per Appendix-B of IS:2911-2010)      Total skin friction = 299.50 T

End Bearing = Ap.Nc.Cp  
 (IS 2911-1-2:2010 & Terzaghis Bearing Factors)

End Bearing =  $(\pi/4 * 0.60 * 0.60) * 9 * 30$   
 End Bearing = 76.34 T

ULTIMATE CAPACITY IN VERTICAL COMPRESSION = 375.84 T

SAFE CAPACITY IN VERTICAL COMPRESSION = 150.34 T

Safe Load Carrying capacity in Pull Out = (Qs/3+Weight of Pile)  
 (unit wt. of pile as 15KN/m<sup>3</sup>) =  $(299.50/3 + \pi/4 * D^2 * 24.00 * (15 * 0.1))$   
 = 110.01 T

**Safe Load Carrying capacity in Lateral :**

Finished Ground Level (FGL) = - m  
 Cut-off level below FGL = 3.00 m  
 Length of pile below cut-off level Le = 24.00 m  
 Modulus of Sub Grade Reaction = 27.00 MN/m<sup>3</sup> (From Table-4 of IS 2911, Part1 Sec.2)  
 K = 9 (K<sub>v</sub>/1.5\*0.3/B) (From Clause C-2.2)  
 Length of pile above GL L<sub>1</sub> = 0 m  
 Grade of concrete f<sub>ck</sub> = 30 N/mm<sup>2</sup>  
 Modulus of Elasticity of Conc. E = 5000√f<sub>ck</sub>  
 = 27386 N/mm<sup>2</sup> = 27386 MN/m<sup>2</sup>  
 Moment of inertia of pile, I =  $\pi D^4 / 64$   
 = 0.00636 m<sup>4</sup>  
 Pile Stiffness R = (EI / KD)<sup>1/4</sup> (From Clause C-2.3.1 of IS-2911/II/2)  
 = 2.383 m  
 2.383295775      L<sub>1</sub> / R = 0.00 m  
 L<sub>r</sub> / R = 1.95 (From Fig 4 - IS 2911, Part1 Sec.2 of 2010)  
 Length of Fixity L<sub>r</sub> = 464.74 cm      4.6474 m

Y = Q(L<sub>1</sub>+L<sub>r</sub>)<sup>3</sup>/12EI (For Fixed Head) as per IS-2911/1/2 c-4.2

Y = 0.5 cm      0.0050 m

L<sub>1</sub> = 0 cm      0 m

LF = 464.7 cm      4.64743 m

0.0050 = Q(0+4.647)<sup>3</sup>/(12\*27386\*0.00636)\*101971.621

Q = 10619.36 kgf (1MN = 101971.621Kgf)

Safe Load in Lateral = 10.62 T (1Kgf = 0.0010T)

**HENCE RECOMMENDED SAFE LOAD CARRYING CAPACITY**

1 IN VERTICAL COMPRESSION = 150.34 T  
 2 IN TENSION (PULLOUT) = 110.01 T  
 3 IN LATERAL = 10.62 T

**PILE CAPACITY CALCULATION**

(AS PER IS:2911.1.2.2010)

Pile diameter (m) = 0.76 m      Location: Main Plant Area  
 Bored Length of pile = 27.00 m  
 Cut-Off Length of Pile = 3.00 m  
 Formation Ground Level (F.G.L) = 34.200 m

Layer No.	Stratum Description	Depth in (m)	Thickness of Stratum (m)	Cohesion (t/m <sup>2</sup> )	Angle of friction (φ)	Alpha (α)	A <sub>si</sub> (m <sup>2</sup> )	Qs (t)	Remarks
1	Medium, Silty Clay	FGL - 3.00	3.00	4.60	0	1	7.16	0.00	* Cut-Off Depth
2	Stiff, Silty Clay	3.00 - 6.00	3.00	8.00	0	0.55	7.16	31.52	
3	Very Stiff, Silty Clay	6.00 - 10.00	4.00	10.00	0	0.46	9.55	43.93	
4	Very Stiff, Silty Clay	10.00 - 12.00	2.00	18.00	0	0.29	4.78	24.93	
5	Very Stiff to Hard, Silty Clay	12.00 - 18.00	6.00	25.00	0	0.28	14.33	100.28	
6	Hard, Silty Clay	18.00 - 30.00	12.00	30.00	0	0.28	28.65	240.67	

Skin Friction Resistance, Qs = Σ.α.C.A<sub>s</sub> (As per Appendix-B of IS:2911-2010)      Total skin friction = 441.33 T

End Bearing = Ap.Nc.Cp  
 (IS 2911-1-2:2010 & Terzaghis Bearing Factors)  
 End Bearing = (π/4\*0.76\*0.76)\*9\*30  
 End Bearing = 122.48 T  
 ULTIMATE CAPACITY IN VERTICAL COMPRESSION = 563.81 T  
 SAFE CAPACITY IN VERTICAL COMPRESSION = 225.52 T

Safe Load Carrying capacity in Pull Out = (Qs/3+Weight of Pile)  
 (unit wt. of pile as 15KN/m<sup>3</sup>) = (441.33/3+π/4\*D<sup>2</sup>\*27.00\*(15\*0.1))  
 = 165.48 T

**Safe Load Carrying capacity in Lateral :**

Finished Ground Level (FGL) = - m  
 Cut-off level below FGL = 3.00 m  
 Length of pile below cut-off level L<sub>e</sub> = 27.00 m  
 Modulus of Sub Grade Reaction = 27.00 MN/m<sup>3</sup> (From Table-4 of IS 2911, Part1 Sec.2)  
 K = 7.11 (K<sub>i</sub>/1.5\*0.3/B) (From Clause C-2.2)  
 Length of pile above GL L<sub>1</sub> = 0 m  
 Grade of concrete f<sub>ck</sub> = 30 N/mm<sup>2</sup>  
 Modulus of Elasticity of Conc. E = 5000√f<sub>ck</sub>  
 = 27386 N/mm<sup>2</sup> = 27386 MN/m<sup>2</sup>  
 Moment of inertia of pile, I = π D<sup>4</sup> / 64  
 = 0.0164 m<sup>4</sup>  
 Pile Stiffness R = (EI / KD)<sup>1/4</sup> (From Clause C-2.3.1 of IS-2911/II/2)  
 = 3.018 m  
 L<sub>1</sub> / R = 0.00 m  
 L<sub>1</sub> / R = 1.95 (From Fig 4 - IS 2911, Part1 Sec.2 of 2010)  
 Length of Fixity L<sub>f</sub> = 588.58 cm = 5.8858 m

Y = Q(L<sub>1</sub>+L<sub>f</sub>)<sup>3</sup>/12EI (For Fixed Head) as per IS-2911/1/2 c-4.2  
 Y = 0.5 cm = 0.0050 m  
 L<sub>1</sub> = 0 cm = 0 m  
 LF = 588.6 cm = 5.88576 m  
 0.0050 = Q(0+5.885)<sup>3</sup>/(12\*27386\*0.0164)\*101971.621  
 Q = 13457.92 kgf (1MN = 101971.621Kg)  
 Safe Load in Lateral = 13.46 T (1Kg = 0.0010T)

**HENCE RECOMMENDED SAFE LOAD CARRYING CAPACITY**

1 IN VERTICAL COMPRESSION = 225.52 T  
 2 IN TENSION (PULLOUT) = 165.48 T  
 3 IN LATERAL = 13.46 T

**PILE CAPACITY CALCULATION**  
(AS PER IS:2911.1.2.2010)

Pile diameter (m) = 0.76 m      Location: Main Plant Area  
 Bored Length of pile = 30.00 m  
 Cut-Off Length of Pile = 3.00 m  
 Formation Ground Level (F.G.L) = 34.200 m

Layer No.	Stratum Description	Depth in (m)	Thickness of Stratum (m)	Cohesion (t/m <sup>2</sup> )	Angle of friction (φ)	Alpha (α)	A <sub>s</sub> (m <sup>2</sup> )	Qs (t)	Remarks
1	Medium, Silty Clay	FGL - 3.00	3.00	4.60	0	1	7.16	0.00	* Cut-Off Depth
2	Stiff, Silty Clay	3.00 - 6.00	3.00	8.00	0	0.55	7.16	31.52	
3	Very Stiff, Silty Clay	6.00 - 10.00	4.00	10.00	0	0.46	9.55	43.93	
4	Very Stiff, Silty Clay	10.00 - 12.00	2.00	18.00	0	0.29	4.78	24.93	
5	Very Stiff to Hard, Silty Clay	12.00 - 18.00	6.00	25.00	0	0.28	14.33	100.28	
6	Hard, Silty Clay	18.00 - 30.00	12.00	30.00	0	0.28	28.65	240.67	
7	Hard, Silty Clay	30.00 - 35.00	3.00	30.00	0	0.28	7.16	60.17	

Skin Friction Resistance, Qs = Σ.α.C.A<sub>s</sub> (As per Appendix-B of IS:2911-2010)      Total skin friction = 501.49 T

End Bearing = Ap.Nc.Cp  
 (IS 2911-1-2:2010 & Terzaghis Bearing Factors)  
 End Bearing = (π/4\*0.76\*0.76)\*9\*30  
 End Bearing = 122.48 T  
 ULTIMATE CAPACITY IN VERTICAL COMPRESSION = 623.97 T  
 SAFE CAPACITY IN VERTICAL COMPRESSION = 249.59 T

Safe Load Carrying capacity in Pull Out  
 (unit wt. of pile as 15KN/m<sup>3</sup>) = (Qs/3+Weight of Pile)  
 = (501.49/3+π/4\*D<sup>2</sup>\*30.00\*(15\*0.1))  
 = 187.58 T

**Safe Load Carrying capacity in Lateral :**

Finished Ground Level (FGL) = - m  
 Cut-off level below FGL = 3.0 m  
 Length of pile below cut-off level Le = 30.0 m  
 Modulus of Sub Grade Reaction = 27.00 MN/m<sup>3</sup> (From Table-4 of IS 2911, Part1 Sec.2)  
 K = 7.11 (K<sub>v</sub>/1.5\*0.3/B) (From Clause C-2.2)  
 Length of pile above GL L<sub>1</sub> = 0 m  
 Grade of concrete f<sub>ck</sub> = 30 N/mm<sup>2</sup>  
 Modulus of Elasticity of Conc. E = 5000√f<sub>ck</sub>  
 = 27386 N/mm<sup>2</sup> = 27386 MN/m<sup>2</sup>  
 Moment of inertia of pile, I = π D<sup>4</sup> / 64  
 = 0.0164 m<sup>4</sup>  
 Pile Stiffness R = (EI / KD)<sup>1/4</sup> (From Clause C-2.3.1 of IS-2911/1/2)  
 = 3.018 m  
 L<sub>1</sub> / R = 0.00 m  
 L<sub>2</sub> / R = 1.95 (From Fig 4 - IS 2911, Part1 Sec.2 of 2010)  
 Length of Fixity L<sub>r</sub> = 588.58 cm      5.8858 m  
 Y = Q(L<sub>1</sub>+L<sub>2</sub>)<sup>3</sup>/12EI (For Fixed Head) as per IS-2911/1/2 c-4.2  
 Y = 0.5 cm      0.0050 m  
 L1 = 0 cm      0 m  
 LF = 588.6 cm      5.88576 m  
 0.0050 = Q(0+5.8858)<sup>3</sup>/(12\*27386\*0.0164)\*101971.621  
 Q = 13457.92 kgf (1MN = 101971.621Kgf)  
 Safe Load in Lateral = 13.46 T (1Kgf = 0.0010T)

**HENCE RECOMMENDED SAFE LOAD CARRYING CAPACITY**

1 IN VERTICAL COMPRESSION = 249.59 T  
 2 IN TENSION (PULLOUT) = 187.58 T  
 3 IN LATERAL = 13.46 T

### SUMMARY AND CONCLUSIONS

Based on field and laboratory test results, the following are summarized:

1. The sub-soil is characterized by medium silty clay underlain by stiff to very stiff silty clay followed by hard silty clay layer upto the termination depth of all the boreholes.
2. The Ground Water Table in various boreholes is varying from 0.40m to 3.10m below Ground Level.
3. Recommendations for Net Safe Bearing Capacity for Open Foundations shall be as follows  
Finished Ground Level (FGL) is RL(+) 34.200M

Location	Depth from FGL in 'm'	Width of Footing in 'm'	Recommended Net Safe Bearing Capacity (t/m <sup>2</sup> )		
			For Permissible Settlement of		
			25mm	40mm	75mm
MAIN PLANT AREA (BH-01 to 31) Covering All Structures	1.50	Upto 3	8.00	10.00	-
		> 3 to 6	10.00	10.00	-
		> 6 to 10	9.00	11.00	11.00
	2.00	Upto 3	11.00	11.00	-
		> 3 to 6	11.00	11.00	-
		> 6 to 10	9.00	11.00	11.00
	3.00	Upto 3	18.00	21.00	-
		> 3 to 6	11.00	17.00	-
		> 6 to 10	8.00	13.00	19.00
	4.00	Upto 3	20.00	22.00	-
		> 3 to 6	12.00	19.00	-
		> 6 to 10	9.00	14.00	20.00
	5.00	Upto 3	22.00	24.00	-
		> 3 to 6	13.00	21.00	-
		> 6 to 10	10.00	16.00	20.00

4. The recommended Pile Capacity of bored cast-in-situ RCC Piles for different length and diameters shall be as follows:

Pile cut-off level is considered as 3m below finished ground level (FGL) which is RL(+) 34.200M

Pile Diameter (m)	Length of Pile below Cut-Off Level (m)	Safe Load Carrying Capacity of Pile (MT)			
		Vertical Compression	Pull Out	Lateral in Fixed Head condition	Lateral in Free Head condition
0.60	24.00	150	100	10	4.63
0.76	27.00	225	150	13	5.87
0.76	30.00	245	175	13	5.87

5. Swelling Pressure and Free Swell Index Test have been performed on soil samples covering the entire zone of investigation (test results are presented in Vol-II of the report; Annexure-A). The average Swelling



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JOB No: SA1027

Pressure and Free Swell Index as found from the Test are  $0.34\text{kg/cm}^2$  and 44% respectively. Hence, the sub-soil has low swelling characteristics and accordingly, the existing soil is suitable for filling/backfilling purposes.

6. Chemical Tests are carried out on sub-soil and ground water samples so as to detect the pH value, Sulphate content, Chloride content (test results are presented in Vol-II of the report). It is seen from the results that the values are within permissible limits. Hence, Ordinary Portland Cement or Portland Slag Cement or Portland Puzzolana Cement can be used for construction.
7. Compaction tests, field & laboratory CBR test results are presented in Vol-II of the report. The design CBR of 7% in soaked condition may be used for pavement design wherever roads are to be constructed in cutting. Wherever roads are to be constructed in fill, the CBR value in soaked condition shall be determined from the filled material in laboratory.
8. The sub-soil is characterized by medium silty clay underlain by stiff to very stiff silty clay followed by hard silty clay layer up to the termination depth of all the boreholes. The ground water table in various boreholes is varying from 0.40m to 3.10m below Ground Level. Hence, ordinary surface operated pumps may be used for dewatering to maintain ground water table below foundation depth. No special type of dewatering is required.
9. For excavation in virgin soil, a slope of 1(H):2(V) may be used during dry season. During rainy season, to be on the safer side, a flatter slope of 1(H):1(V) may be adopted.
10. The sub-soil strata of project site is generally silty clay. Hence, the site is not prone to liquefaction.
11. 11 no's of Electrical Resistivity Test (ERT) were performed at site and the test results are presented in Vol-II of the report.
12. 02 no's of Block Vibration Test (BVT) were performed at site and the test results are presented in Vol-II of the report.
13. 01 no of Pressure meter Test (PMT) was performed at site and the test results are presented in Vol-II of the report.
14. 01 no of Cross Hole Shear Test (CST) was performed at site and the test results are presented in Vol-II of the report.
15. 03 no's of Field California Bearing Ratio Test (FCBR) were performed at site and the test results are presented in Vol-II of the report.
16. 05 no's of Static Cone Penetration Test (SCPT) were performed at site and the test results are presented in Vol-II of the report.
17. 05 no's of Dynamic Cone Penetration Test (DCPT) were performed at site and the test results are presented in Vol-II of the report.
18. 03 no's of Percolation Test were performed at site and the test results are presented in Vol-II of the report.
19. 03 no's of Permeability Test (PUMP IN) was performed at site and the test results are presented in Vol-II of the report.
20. 02 no's of Permeability Test (PUMP OUT) was performed at site and the test results are presented in Vol-II of the report.
21. Results of Plate Load Test (PLT) and Cyclic Plate Load Test (CPLT) are presented in Vol-III of the report.

**Part-3**



## GEOLOGICAL INFORMATION

### **Stratigraphy:**

The subsurface geology of this area is completely blanketed by the alluvial deposits of recent age. Exploratory drilling for hydrocarbons, done by Standard Vacuum Oil Co. of the USA in late forties and Indo-Stanvac Petroleum Project during 1951-52 had revealed a succession of Mesozoic and Tertiary formations of this area. The Tertiary sediments become thicker towards south and the sediments that are generally brackish and estuarine in the north becomes progressively deeper in the south. This is evident from the base of the Mesozoic sediments, which at Jalangi (24°04' 13"N, 88°38' 11" E) is 3529 m below the ground surface; at Port Canning (22°19' 30"N, 88°40'00" E) the same is about 5000 m below the ground surface (Bakshi et al., 1987).





**List of Reference and IS Codes:**

- IS-2720 (Method of Tests of Soils); Foundation Design Manual by V.Nayak; Soil Mechanics and Foundation Engineering by R.Kaniraj; IS:1888-1982 (Method of Load Tests on Soil), IS:5249-1992 (R2006) (Determination of Dynamic Properties of Soil); IS:2131-1981 (R2002) (Method for standard penetration test for Soils); IS:5529 (In-situ Permeability Tests of Soils); IS:13372(Part-2):1992 (R2010) (Seismic Testing of Rock Mass); IS: 4968 Part-III(Method for Subsurface Sounding for Soils-Static cone penetration test)

## TECHNICAL DEVIATIONS

<i>Sl. No</i>	<i>Section no.</i>	<i>Clause No.</i>	<i>Page / No.</i>	<i>Specification</i>	<i>Statement of Deviations/variatioins</i>	<i>Reason for Deviation</i>	<i>cost of withdrawal</i>

## COMPLIANCE CUM CONFIRMATION SCHEDULE

The bidder shall confirm compliance with following by signing/ stamping this compliance certificate and furnishing same with the offer:

- 1) The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions/ deviations with regard to same.
- 2) QP/ test procedures shall be submitted in the event of order based on the guidelines given in the specification & QP enclosed therein. QP will be subject to BHEL/ Customer approval in the event of order & customer hold points for inspection/ testing shall be marked in the QP at the contract stage. Inspection/ testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc. The charges for 3rd party inspection (Lloyds, TUV or equivalent) for imported components shall be included in the base price of the equipment by the bidder.
- 3) All drawings/ data – sheets etc. to be submitted during contract shall be subject to BHEL/Customer review/ approval. GA drawings, as submitted with offer at tender stage are for reference purpose only and shall be subject to approval during contract stage.
- 4) There are no other deviations with respect to specification other than those furnished in the 'Schedule of Deviations'.
- 5) The offered materials shall be either equivalent or superior to those specified. Also for components where material is not specified it shall be suitable for intended duty, materials shall be subject to approval in the event of order.
- 6) The commissioning spares (if any) are supplied on 'As Required Basis' & prices for same included in the base price (If bidders reply to this is "No commissioning spares are required" and if some spares are actually required during commissioning same shall be supplied by bidder without any cost to BHEL).
- 7) All sub vendors shall be subject to BHEL/ CUSTOMER approval.
- 8) Any special tools & tackles, if required, shall be in bidder's scope.
- 9) Demonstration parameters shall stand valid till the satisfactory completion of demonstration test and its acceptance by BHEL/Customer.

**DECLARATIONS**

I .....certify that all the technical data and information pertaining to this specification are correct and are true representation of the equipment/system covered by our format proposal number Dated ..... and there is no deviation to the specification.

I hereby certify that I am duly authorized representative of the Bidder's company whose name appears above my signature.

Bidders Company Name .....

Authorized representative's Signature .....

Name .....

Bidder's Name The bidder hereby agrees to fully comply with the requirements and intent of this specification for the price indicated