

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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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.
- 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 : 4164	:	Lifting 'C' Hooks with Eye Capacity upto 25 tonnes.
2.05.00	IS : 2429 (part -I)	:	Non-calibrated Load Chain for Lifting Purposes.
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 where any equipment/component weighing above 500 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.
- 3.02.00 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 upto 5 tones shall be manual hoists.
Hoists of capacity above 5 tones shall be electric hoists.
- 4.02.00 **Effort for Mechanical Hoists**
- 4.02.01 Hoisting
Hoisting effort for hoists upto 3 tones capacity shall not be more than 20 kg.
Hoisting effort for hoists above 3 tones capacity shall not be more than 25 kg
- 4.02.02 Trolley Motion
Effort for trolley motion for hoists upto 3 tones capacity shall not be more than 15 kg.
Effort for trolley motion for hoists above 3 tones capacity shall not be more than 20 Kg.
- 4.02.03 For Electric operated hoist both hoisting and trolley motion shall be motor operated.
- 4.03.00 **Lift**
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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 Purchaser.

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 cut 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 and IS:3832. The load hook shall be swivelling 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-4164 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.
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- 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. Service class of motor shall be "M8" as per IS:3177. Conditions given in IS:3938 for hoist motor shall be followed over and above the specification of electric motor in Volume-V. 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 MCCB unit mounted at standing height at a convenient location near each hoist.
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- 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.
- 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 the mono-rail hoists shall also be tested at site as per the stipulation of relevant Indian Standards.
- 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.
- 7.02.00 For Mandatory Spares, Spares required for erection and commissioning, Recommended Spares, Special Tools And Tackles, fixtures etc., as required for regular operation and maintenance of the equipment offered and supply of first charge of lubricating oil, inhibitor oil and also adequate quantity of the consumables, please refer Technical Specification
- 7.03.00 Design calculation for selection of electric motor capacities for electric hoist.
- 7.04.00 Complete list of location, number and capacity of hoists provided.
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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 Contractor's works or at his Sub-contractor's premises or at the Owner's site or at any other place or work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points, as necessary. Such programmes shall be outlined by the Contractor and shall be finally accepted by the Owner/Authorised representative after discussions before the award of contract. A quality assurance programme of the Contractor 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-contractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.
- e) System for shop manufacturing and site erection 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-I to this section for Owners approval
- o) Internal standards, if referred in the quality plans shall generally be compatible with National / International standards and shall be mentioned in the quality plans. Alternatively bidder shall furnish extracts of the internal standards detailing out acceptance norm for the product / material.

2.00.00 **GENERAL REQUIREMENTS - QUALITY ASSURANCE**

2.01.00 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the Contractor 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 Contractor's responsibility to draw up and implement such programme duly approved 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/Authorised representative for approval. Schedule of finalisation of such quality plans will be finalised before award.

Contractor shall furnish list of Manufacturing Quality Plans of major equipments indicating proposed inspection categorisation indicating items that will be offered for Owner's inspection etc and the Field Quality Plans

2.02.00 Manufacturing Quality Plan for all the major equipment will detail out their respective important components, their in-process various tests/inspection & final inspection / tests, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's Quality Control organization. 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 are to be comprehensibly documented by Contractor.

Manufacturing Quality Plan for all major equipments/ items will be approved by owner. In these approved quality plans, Owner / Authorised representative shall identify customer hold points (CHP), test / checks which shall be carried out in presence of the Owners Engineer or his authorised representative and beyond which the work shall not proceed without consent of Owner / Authorised representative in writing. Inspection/ Test reports are to be submitted to owner as specified in final approved Manufacturing Quality Plans.

2.03.00 Field Quality Plans / Procedures for all field activities shall be submitted to

owner for review / approval. These Quality Plans / procedures will detail out, for all equipment, the quality practices and procedures etc. to be followed by the Contractor'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 Owner's approval without which manufacture shall not proceed. These approved documents shall form a part of the contract. In these approved quality plans, Owner/Authorised representative shall identify customer hold points (CHP), test/checks which shall be carried out in presence of the Owners Engineer or his authorised representative and beyond which the work will not proceed without consent of Owner/Authorised representative in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and major deviations in the form of Non Conformity Report shall be referred to Owner/Authorised representative for approval and dispositioning.
- 2.05.00 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 all previous tests/inspections by Owner's Engineer/ Authorised representative for "CHP" and "W" points marked in quality plans , and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC). For items which is not under owner's inspection the contractor shall apply for despatch clearance (MDCC) from owner by submitting their internal inspection reports and quality records
- 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 serial 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 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.
- 2.08.00 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section - IX (latest edition) or other International equivalent standard acceptable to the Owner.

All brazers, welders etc. employed on any part of the contract at Contractor's/ Sub-Contractor's works or at site shall be qualified as per ASME Section-IX (latest edition) or equivalent international standard approved by the Owner. Such qualification tests shall be conducted in presence of Owner / his authorised representative or owner approved Third Party Inspection Agency(TPIA). Previously qualified WPS & PQR shall be acceptable if witnessed by owner's approved TPIA.

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

- 2.09.00 All non-destructive examination (NDT) shall be carried out in accordance with LIST OF STANDARDS FOR REFERENCE as given below in this section.

The NDT operator shall be qualified as per SNT-TC-IA (of American Society of non-destructive examination). Results of NDT for the list major equipments / items identified for owner's inspection shall be properly recorded and submitted for review and approval. Other items not covered under owner's inspection, contractor shall review and approve the NDT results and such reports shall be submitted to owner in the final documentation of the items / equipments

- 2.10.00 All the sub-vendors proposed by the Contractor 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 Contractor and finalised with the Owner shall be subject to Owner's approval. Quality Plans of the successful vendors shall be discussed, finalised and approved by the Owner/Authorised representative and form part of the Purchase Order between the Contractor and the Vendor.

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

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

Quality audit/approval 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 Contractor in earning satisfactory performance of equipment as per specification.

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

- 2.13.00 Repair/rectification procedures to be adopted to make any job acceptable shall be subject to the approval of the Owner.

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

3.00.00 **QUALITY ASSURANCE DOCUMENTS**

- 3.01.00 The Contractor shall be required to submit two (2) copies and two (2) sets of microfilms / CDs 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 Contractor 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 Owner's Engineer, or his duly authorised representative and/or an outside inspection agency acting on behalf of the Owner shall have access inside the workshops, test labs, establishments at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Owner's Engineer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.

4.02.00 The Contractor shall give the Owner's Engineer/ Authorized Inspector twenty one (21) days written notice for "CHP" / "W" points of any material being ready for testing by owner' engineer / Authorized inspector. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The 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. If owner's Engineer / Authorised Inspector fail to attend the inspection, next mutually convenient date for test shall be agreed with Contractor. Contractor shall, in

no case proceed with the test without owner or his authorized inspectors, unless the witnessing is officially waived and advised Contractor to proceed with the test. Contractor shall forthwith forward duly certified completed test report and a product quality certificate in six (6) copies to owner upon completion of such test.

- 4.03.00 The Engineer or Inspector shall within fifteen (15) days from the date of Inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract / QAP or other approved quality documents. The Contractor 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 Engineer/Inspector giving reasons therein, that no modifications are necessary to comply with the contract / QAP or other approved quality documents.
- 4.04.00 When the factory tests have been completed at the Contractor's or sub-contractor's works, the Engineer/Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests excluding the test completion date subject to submission of all certified documents related to the test, If the tests are not witnessed by the Engineer/Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Engineer/Inspector. Failure of the owner's Engineer/Inspector to issue such a certificate shall not prevent the Contractor 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 / QAP or other approved quality documents.
- 4.05.00 In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the owner's Engineer/Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contract / QAP or other approved quality documents. Contractor and shall give facilities to the owner's Engineer/ Inspector or to his authorised representative to accomplish testing.
- 4.06.00 To facilitate advance planning of inspection in addition to giving inspection notice as per Clause 4.02.00, the Contractor shall furnish quarterly inspection programme indicating proposed 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.

LIST OF STANDARDS FOR REFERENCE

- a) International Standards Organisation (ISO).
- b) International Electro-technical Commission (IEC).
- c) American Society of Mechanical Engineers(ASME)
- d) American National Standards Institute (ANSI).
- e) American Society for Testing and Materials (ASTM).
- f) American Institute of Steel Construction (AISC).
- g) American Welding Society (AWS).
- h) Architecture Institute of Japan (AIJ).
- i) National Fire Protection Association (NFPA).
- j) National Electrical Manufacturer's Association (NEMA).
- k) Japanese Electro-technical Committee (JEC).
- l) Institute of Electrical and Electronics Engineers (IEEE).
- m) Federal Occupational Safety and Health Regulations (OSHA).
- n) Instrument Society of America (ISA).
- o) National Electric Code (NEC).
- p) Heat Exchanger Institute (HEI).
- q) Tubular Exchanger Manufacturer's Association (TEMA).
- r) Hydraulic Institute (HIS).
- s) International Electro-Technical Commission Publications.
- t) Power Test Code for Steam Turbines (PTC).
- u) Applicable German Standards (DIN).
- v) Applicable British Standards (BS).
- w) Applicable Japanese Standards (JIS).
- x) Electric Power Research Institute (EPRI).
- y) Standards of Manufacturer's Standardization Society (MSS)

- z) Bureau of Indian Standards Institution (BIS).
- aa) Indian Electricity Rules.
- bb) Indian Boiler Regulations (IBR).
- cc) Indian Explosives Act.
- dd) Indian Factories Act.
- ee) Tariff Advisory Committee (TAC) rules.
- ff) Emission regulation of Central Pollution Control Board (CPCB).
- gg) Pollution Control regulations of Dept. of Environment, Govt. of India
- hh) Central Board of Irrigation and Power (CBIP) Publications

ANNEXURE-I
FORMAT OF QUALITY ASSURANCE PROGRAMME

VENDOR'S LOGO , NAME & ADDRESS		MANUFACTURING QUALITY ASSURANCE PLAN					DOC NO:		XXXXX-CAL-QAP-M-0001								
		ITEM : -					REV NO :		0	1	2	3	4				
							DATE :										
CLIENT :							LOCATION :										
PROJECT :							REFERENCE PURCHASE ORDER NO. & DT :										
VENDOR :							REFERENCE APPROVED DATA SHEET :										
SUB VENDOR :							REFERENCE APPROVED DRAWING. NO. :										
ABBREVIATIONS :			AGENCY :					GENERAL REMARKS									
QAP - QUALITY ASSURANCE PLAN, CR - CRITICAL, MA - MAJOR, MI - MINOR SPEC - SPECIFICATION, TC - TEST CERTIFICATES P - PERFORM W - WITNESS V - VERIFY CHP - CUSTOMER HOLD POINT			MATL - MATERIAL, APP - APPROVED, DWG - DRAWING, SUPL - SUPPLIER, PROC - PROCEDURE					1 - DCPL/PROJECT AUTHORITY 2 - SUPPLIER 3 - SUB-SUPPLIER 4 - MANUFACTURER 5 - THIRD PARTY INSPECTION AGENCY					1 THE ITEMS WHICH ARE FALLING UNDER ANY STATUTORY AUTHORITY'S (LIKE I.B.R. ETC.) SCOPE SHALL BE SUBJECTED TO THAT STATUTORY AUTHORITY'S INSPECTION CLEARANCE.				
NOTES:																	
1. EXACT MATERIAL / PROCESS / INSPECTION / TESTS FOLLOWED BY THE MANUFACTURER SHALL BE SPECIFIED 2. EXACT REFERENCE DOCUMENT/ACCEPTANCE STANDARD SHALL BE SPECIFIED 3. IN CASE SPECIFIED ACCEPTANCE STANDARD / NORMS IS OTHER THAN NATIONAL / INTERNATIONAL STANDARDS . STANDARD / COPY OF THE ACCEPTANCE NORMS FOLLOWED BY THE MANUFACTURER SHALL BE SUBMITTED FOR REVIEW RECORD 4 FINAL INSPECTION DOSSIER SHALL BE PREPARED BY MANUFACTURER & SHALL BE ENDORSED BY INSPECTIONION AGENCY																	
Prepared by					Checked by					Approved By							
Revision	R0	R1	R2		R0	R1	R2		R0	R1	R2						
DATE																	

VENDOR'S LOGO, NAME & ADDRESS			ITEM :						DOC NO:				
									REV NO :		R0	R1	R2
									DATE :				
SL NO.	DESCRIPTION	CHECKS			CATEGORY	REF DOCS	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY		REMARKS		
		TYPE	METHOD	QUANTUM					P	W		V	
1	2	3	4	5	6	7	8	9	12	13	14	15	
1.00													
Notes:													
Prepared by				Checked by				Approved By					
Revision	R0	R1	R2	R0	R1	R2	R0	R1	R2				
DATE													

ANNEXURE-II

FIELD WELDING SCHEDULE

PROJECT : FWS NO :
CONTRACTOR : REV NO. :
PACKAGE : FIELD WELDING CODE :
SYSTEM : PAGE NO. :

Sl 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 Quantum	NDT Specification Number	Acceptance Norm Ref.	Remarks

The Field Welding Schedule should be submitted for :

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

7.00.00 QUALITY CONTROL & SURVEILLANCE

The System / equipment to be supplied under this specification shall have assured quality and workmanship. In the proposal, the Bidder shall submit the Quality Assurance Plan containing quality assurance programme and quality assurance documents for Purchaser's approval. The Bidder shall be bound to conduct all stage inspections on various equipment / material during manufacturing process in accordance with the approved copy of this document. Purchaser shall have the right to carry out Quality Audit and Quality Surveillance by witnessing any or all such tests to be carried out at Bidder's / Sub-Bidder's works as and when desired. The procedure applicable to Bidder's works will also apply to the works of his sub-Bidders. For items coming under the purview of any Statutory Regulation during the course of manufacture, all stage inspections and tests shall be witnessed by an inspecting authority recognized under the statutory regulation. All unpriced copies of Bids of all major bought-out items giving technical details shall be sent to Purchaser for approval prior to placement of orders on sub-vendors.

These audit/surveillance/approvals shall however, do not relieve the manufacturer / sub-vendors of their responsibility of the Quality Assurance of their product and overall guarantee and responsibility shall wholly be confined on the Bidder.

Tests/inspections shall be carried out during and after the completion of manufacture of different components and assembly as applicable in accordance with relevant codes and standards. Test Certificates for all such tests/inspections shall be made available to the Purchaser for approval.

Purchaser or his authorised representative shall have his full access to witness any or all tests/inspections to be carried out at manufacturer's shop. In case, the job is sub-contracted, it will be Bidder's responsibility to make all arrangements so that Purchaser or his authorised representative can attend such tests at Sub-Bidder's premises. Inspection (including interstage inspection) and other tests shall be done as per Approved Quality Plan.

After erection at site, SSF System shall be operated for a period of at least two (2) weeks continuously to prove satisfactory, performance and guarantee data.

8.00.00 INSPECTION, TESTING, COMMISSIONING AND PERFORMANCE GUARANTEE TESTS

The equipment, parts and materials shall be tested and inspected, but not limited to the following

8.01.00 Shop Tests

Shop tests shall include all tests to be carried out at Bidder's works, works of their sub-vendors and at works where materials to be used for fabrication of equipment are manufactured. The tests to be carried out shall include but not be limited to the following:

- a) Composition of all material, castings, forgings, etc.
- b) Hydraulic tests for pressure vessels, pipes, valves, pump casing etc.
- c) Tests to check faults in protective lining and painting.
- d) Static balancing test for agitators, stirrers, paddles etc.
- e) Static and dynamic balancing tests on all impellers.
- f) Performance tests (Head, Capacity and Power) for each of pumps and blowers.
- g) All tests with reference to instrumentations and controls complete with accessories as addressed in Technical Specifications for Instrumentation and Control
- h) All tests with reference to electrical equipment and accessories as addressed in Technical Specifications for Electrical Equipment & Accessories

8.02.00 Tests before Trial Run

Bidder shall carry out tests at site to prove to the Purchaser that individual equipment of all the System complies with the requirements stipulated and is erected in accordance with requirements specified. Before the System is put on trial run, the Bidder will be required to conduct tests to demonstrate to the Purchaser that each individual item is capable of correctly performing the functions for which it has been designed for. These tests may be conducted

concurrently with those required under commissioning sequence. Tests required shall in general be as follows:

- a) The tests to be carried out for the fabricated storage vessels shall include:
 - i. During fabrication and before lining:
 - a) Bottom testing for leakage by soap solution, after the bottom and at least the bottom course of the shell plate have been welded.
 - b) Hydraulic shell testing for leakage.
 - c) Fixed roof test for leakage by soap solution.
 - ii. After lining:

Water leakage test for storage tank shall be carried out by filling it with water up to the overflow level.
- b) All piping and valves, after installation, will be tested hydrostatically at one and half times of the maximum attainable pressure in the system to check against leak tightness.
- c) All valves/isolation gates shall be operated throughout 100% of the travel and these should function without any trouble whatsoever.
- d) Each of all pumps and blowers shall be run with the specified fluid from shut off condition to valve wide-open condition. Head developed will be checked from the discharge pressure gauge reading. Capacity may be checked from flow indicator where available. Otherwise capacity shall be checked from the volume of fluid handled (determined from level indicator reading of concerned tank) wherever applicable and duration of test.
- e) Each of pumps and blowers shall be tested at site to run smoothly without undue vibration, flow pulsation, temperature rise in bearing parts, noise etc.
- f) Each of all the agitators and other rotating/moving devices shall be run at the rated speed with water/chemicals up to the normal water level for a period of twenty four (24) hours. During this period all the components shall function smoothly without any unbalance, vibration, overheating at bearing parts etc.
- g) All the rubber lining are to be subjected to the following tests as per relevant code:
 - i. Adhesion test
 - ii. Resistance to bleeding
 - iii. Thickness measurement
 - iv. Shore hardness

- v. High voltage spark test
- h) Epoxy painting shall be checked by dry type thickness gauge.
- i) All monorail hoists shall be subjected to full working load during all motions without showing any sign of defect.
- j) Visual check on all structural components, welding, painting etc.
- i) All tests with reference to instrumentations and controls complete with accessories as addressed in Technical Specifications for Instrumentation and Control
- j) All tests with reference to electrical equipment and accessories as addressed in Technical Specifications for Electrical Equipment & Accessories

DRAWINGS & DOCUMENTS TO BE SUBMITTED

DRAWING DOCUMENTS REQUIREMENT (FOR MECHANICAL / ELECTRICAL / C&I / ETC)

After award of LOI, following drawings /documents shall be submitted by the bidder for BHEL/Customer approval. However, any additional drawing/document if found necessary for completion of the engineering, the same shall be submitted by bidder without any commercial implication.

- a) Detailed piping and instrument or engineering P&ID for process and utility, showing all equipment's, machinery, piping and instruments. All pipes should be indicated with diameter, pipe class, pipe number, fluid flowing through it as per the Employer's legend to be furnished later.
- b) Detailed configuration drawings, BOMs, Data Sheets, General arrangements and cross-sectional/assembly drags, along with the manufacturer's catalogue for all the items/equipment including control & instrumentation supplied by the bidder.
- c) Detailed installation drawings for all instruments and instrumentation schedule.
- d) Preparation and finalization of functional write-up and detailed logic diagram, for all control system, electrical wiring and schematic drgs for the development of logic diagrams, GA and layout drgs of control panels, junction boxes, bill of material for panel drgs and terminal, chart for all the panel drgs, inter connection diagram for cabling, cable schedule, earthing layout and cable tray layout drawings.
- e) Design calculation of process and mechanical design, equipment and systems. The bidder shall show, explain and prove the validity of the basis/procedures and methods used in these calculations.
- f) Details civil scope drawing for all civil works.
- g) Detailed piping layout drawings, pipe support drawings, complete bill of materials of the piping, valve schedule etc.
- h) Submission of O&M manual.
- i) P.G Test procedure shall be submitted by bidder during detail engineering and shall be subject to approval by BHEL/Customer.
- j) Against customer / BHEL comments bidder has to give replies point wise during detailed engineering after award of contract.
- k) Spec. for acid/alkali resistant lining and areas requiring such lining.
- l) Cable schedule in BHEL format (shall be handed over after award of contract)

DRAWING/DOCUEMNTS REQUIRED ALONG WITH THE BID (Please refer Electrical and C&I portion also).

- Technical Offer (including List of chemicals, Quantity of chemicals, Dosage rate, calculation, pump capacity etc.)
- Deviation/clarification, if any, in the BHEL format only (Annexure -A).
- Unpriced Schedule duly filled.
- Electrical load data format (filled).
- Documents in support of meeting the Qualification Requirement.
- Electrical Load List.
- Valve Schedule.
- Pipe Schedule.

Note-1: - 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. The bidder shall provide the same without any extra charge.

Note-2: All major drawings/documents shall be approved by BHEL/Customer during detailed engineering Stage. Successful vendor shall comply with the comment of the BHEL/Customer without price & delivery implication.

Note-3: The above Note-1 and 2 shall be applicable for Electrical and C&I also.

TECHNICAL SPECIFICATION**FOR****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.
- 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.
- 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 huge 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 repellant 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 than 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) Test

- 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.
- 6.02.02 The applied output voltage of holiday detector shall have a spark discharge of thickness equal to at least twice the thickness of the coating to assure adequate inspection voltage and compensate for any variation in coating thickness. The electrode shall be passed over the coated surface at approximately half the spark discharge distance from the coated surface only one time at the rate of approximately 10 to 20m/min. The edge effect shall be ignored. Excessive voltage shall be avoided as it tends to induce holiday in the coated surface thereby giving erroneous readings.
- 6.02.03 While selecting test voltages, consideration should be given to the tolerance on coating thickness and voltage should be selected on the basis of maximum coating thickness likely to be encountered during testing of a particular pipe.
The testing voltage shall be calculated by using following formula. (as per NACE 0274 : 2004)

Testing Voltage $V = 7900 \sqrt{T} \pm 10$ percent where T is the average coating thickness in mm.
- 6.02.04 Any audio visual sound or spark leads to indicate pinhole, break or conductive particle.
- 6.03.00 Adhesion Pull off Test :**
After holiday the coated surface is subjected to adhesion pull off test as per ASTM D 4541.
- 6.03.01 Apparatus / Instrument: Adhesion tester consists of three basic components:

A hand wheel, a black column containing a dragging indicator pin and scale in the middle and a base containing three legs and a pulling "Jaw" at the bottom and also dollies.
- 6.03.02 Prepare the test surface :

Once test area is selected, test area shall be free of grease, oil, dirt, water. The area should be flat surfaces and large enough to accommodate the specified number of replicate test.
- 6.03.03 Prepare Dolly (Test Pull Stub) :

The dolly is a round, two sided aluminium fixture. Both sides of the dolly looks same, however, one side sloped on top surface while flat on bottom surface. As the surface of the dolly is polished aluminium, roughen the same using a coarse sand paper.

6.03.04 Select an adhesive:

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

6.03.05 Attach the dolly to the surface.

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

6.03.06 Adhesion Test Procedure

- a) Attach the adhesion tester to the dolly by rotating the hand wheel counter clockwise to lower the jaw of the device.
- b) Slide the jaw completely under the head of the dolly. Position the three legs of the instruments so that they are sitting flat on the coated surface.
- c) Slide the dragging indicator pin on the black column to zero by pushing it downward.
- d) Firmly hold the base of the instrument in one hand and rotate the 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/cm² required by project specification is exceeded and the test is discontinued, (b) the maximum PSI/MPa/Kg/cm² of adhesion tester has been achieved and dolly is still attached, (c) The force applied by the adhesion tester causes the dolly to dislodge.

e) Read the scale and record the adhesion value.

6.04.00 Coating Repair

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

6.04.01 Surface Preparation:

Accessible areas of pipe requiring coating repairs shall be cleaned to remove debris and damaged coating using surface grinders or other means. The adjacent coating shall be feathered by sanding, grinding or other method. Accumulated debris shall be removed by blowing with contaminant free air or wiping with clean rags.

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

6.04.03 Coating Application :

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

6.04.04 Repair Inspection :

Repaired portion shall be electrically inspected using a holiday detector.

6.05.00 Welded Field Joints

6.05.01 Preparation :

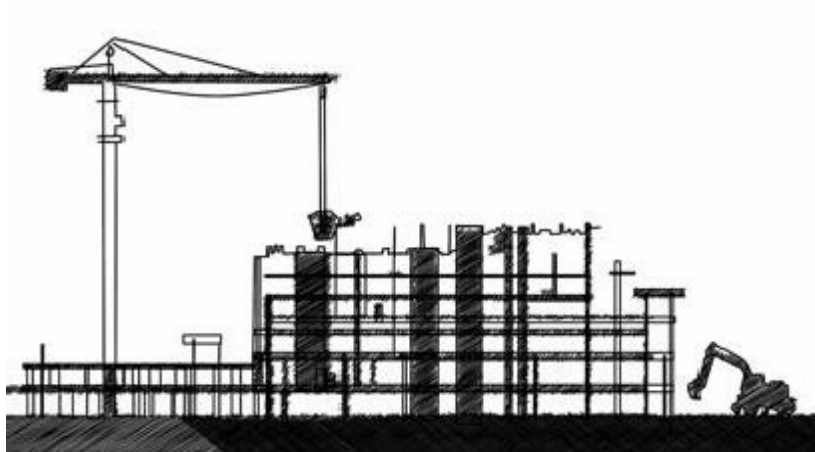
The weld joints shall be cleaned so as to be free from mud, oil, grease, welding flux, weld spatter and other foreign contaminants. The cleaned metal surfaces of the weld joint shall then be blasted or abraded using rotary abrading pads. The adjacent liquid Epoxy / PU coating shall be feathered by abrading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

6.05.02 Electrical Inspection :

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

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
OPERATIONS**

by

**SUB-
CONTRACTORS**

POWER SECTOR

HSE PLAN FOR SITE OPERATIONS BY BHEL'S SUBCONTRACTORS

AT A GLANCE

BEFORE START	SIGNING OF MOU	
	Agree to comply to HSE requirement- Statutory and BHEL's	
PLAN	HSE ORGANISATION	
	Manpower 1 (one) safety officer for every 500 workers or part thereof 1(one) safety-steward/ supervisor for every 100 workers Qualification As per Cl. 7.1	HSE Roles and responsibilities - Site In-charge- As per clause 7.2.1 - Safety officer- As per clause 7.2.2
PROVIDE	HSE Planning	
	for Man, Machinery/Equipment/Tools & Tackles	
TRAIN	HSE INFRASTRUCTURE	
	- PPEs - Drinking Water - Washing Facilities - Latrines and Urinals - Provision of shelter for rest - Medical facilities	- Canteen facilities - Labour Colony - Emergency Vehicle - Pest Control - Scrapyard - Illumination
COMMUNICATE	HSE TRAINING , AWARENESS & PROMOTION	
	Training - Induction training - Height work and other critical areas - Tool Box talk & Pep Talk	Awareness & Promotion - Signage - Poster - Banner - Competition - Awards
	HSE COMMUNICATION	
	Incident Reporting - Accident- Fatal & Major - Property damage - Near Miss	Event Reporting - Celebrations - Training - Medical camp

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

• Welding • Rigging • Cylinder- storage & Movement • Demolition work • T&Ps • Chemical Handling • Electrical works	• Fire • Scaffolding • Height work • Working Platform • Excavation • Ladder • Lifting • Hoisting appliance

HOUSE KEEPING

WASTE MANGEMENT

TRAFFIC MANAGEMENT

ENVIRONMENTAL CONTROL

EMERGENCY PREPAREDNESS AND RESPONSE PLAN

CHECKS

HSE AUDITS & INSPECTION

• Daily Checks • Inspection of PPEs • Inspection of T& Ps • Inspection of Cranes & Winches	• Inspection of Height work • Inspection of Welding and Gas cutting • Inspection of elevators etc.

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.

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REVISION HISTORY SHEET

Date	Revision No.	Details of Changes	Reason	Prepared	Reviewed	Approved
12.08.2014	00	First Issue	First Issue	S. B. Jayant, Dy Manager- FQA & Safety	A. K. Sinha, GM-FQA & Safety	Anuj Bhatnagar, ED-FQA & Safety
20.01.2020	01	Formats added: HSEP:14-F30 – Monthly HSE Planning & Review (Page 11, Clause 8.0 - updated) HSEP:14-F13E-Excavation Inspection Format (part of F30)) HSEP:14-F32B – Job Safety Analysis Format (part of F30) HSEP:14-F31A – Daily HSE Reporting (Page 18, Clause 10.3 – added) HSEP:14-F33 – HSE Performance Evaluation (Page 31, Clause 13 – revised)	IOM No. PSHQHSE/M ONREP/02 Dated 08-Jan-2020	Rohit Kumar	Santosh Nair, GM (MSX & HSE)	



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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

Health, Safety & Environment Policy of BHEL

In BHEL, Health, Safety and Environment (HSE) responsibilities are driven by our commitment to protect our employees and people we work with, community and environment. BHEL believes in zero tolerance for unsafe work/non-conformance to safety and in minimizing environmental footprint associated with all its business activities. We commit to continually improve our HSE performance by:

- Developing safety and sustainability culture through active leadership and by ensuring availability of required resources.
- Ensuring compliance with applicable legislation, regulations and BHEL systems.
- Taking up activities for conservation of resources and adopting sound waste management by following Reduce/Recycle/Reuse approach.
- Continually identifying, assessing and managing environmental impacts and Occupational Health & Safety risks of all activities, products and services adopting approach based on elimination/substitution/reduction/control.
- Incorporating appropriate Occupational Health, Safety and Environment criteria into business decisions, design of products & systems and for selection of plants, technologies and services.
- Imparting appropriate structured training to all persons at workplace and promoting awareness amongst customers, contractors and suppliers on HSE issues.
- Reviewing periodically this policy and HSE Management Systems to ensure its relevance, appropriateness and effectiveness.
- Communicating this policy within BHEL and making it available to interested parties.

sd/-

CMD, BHEL

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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-HOURS 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- Supervisor	Degree or diploma in any discipline with full time diploma in Industrial Safety with construction safety as one of the subjects	Minimum two years

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 worksite.
- 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

Monthly planning and review of HSE activities shall be carried out by subcontractor as per format No. HSEP:14-F30 jointly along with BHEL.

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:14-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:14-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)
A. Construction Area		
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. Office		
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:14-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:14-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.

10.3 DAILY HSE ACTIVITY REPORTING

Daily HSE activities shall be reported by subcontractor to BHEL as per Format No. HSEP:14-F31A



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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 refereed by subcontractor, if they so desire.

LIST OF OCPs

Safe handling of chemicals	Safety in use of cranes	Hydraulic test
Electrical safety	Storage and handling 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 Synchronization		

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 $\frac{1}{4}$ 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 outside 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 along with 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:14-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:14-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:14-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:14-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.

12.9 INSPECTION OF EXCAVATION

Excavation activities shall be inspected as per Format HSEP:14-F13A

13.0 HSE PERFORMANCE

- Contractor shall be assessed on monthly basis for HSE Compliance by BHEL Safety In-charge at site. The HSE compliance shall be based on Online HSE Evaluation System of BHEL as per Format No. HSEP:14-F33.
- BHEL shall reserve the right to use this assessment for evaluating bidder's capacity for future tenders
- Suitable HSE reward system shall be developed at site level to promote HSE compliance amongst workmen by the subcontractor.
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 site management
- 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 cause and 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:14-F01	00
02	Health Check Up	HSEP:14-F02	00
03	HSE Induction Training	HSEP:14-F03	00
04	Tool Box Talk	HSEP:14-F04	00
05	Monthly Site HSE Report	As specified by BHEL	00
06	Inspection of PPE	HSEP:14-F06	00



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07	Inspection of T&Ps	HSEP:14-F07	00
08	Status of T&Ps	HSEP:14-F08	00
09	Inspection of Cranes and Winches	HSEP:14-F09	00
10	Inspection on Height Working	HSEP:14-F10	00
11	Inspection on Welding & Gas Cutting	HSEP:14-F11	00
12	Inspection on Electrical Installation	HSEP:14-F12	00
13	Inspection on Elevator	HSEP:14-F13	00
14	HSE Penalty	HSEP:14-F14	00
15	Accident /incident / property damage /fire incident report	HSEP:14-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 recoupment 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
HOUSEKEEPING				
Waste containers provided and used				
Passageways and walkways clear				
General neatness of working area				
Other				
PERSONNEL PROTECTIVE EQUIPMENTS				
Goggles; shields				
Face protection				
Hearing protection				
Respiratory masks etc.				
Safety belts				
Other				
EXCAVATIONS / OPENINGS				
Openings properly covered or barricaded				
Excavations shored				
Excavations barricaded				
Overnight lighting provided				
Other				
WELDING, CUTTING				
Gas cylinders chained upright				
Cable and hoses not obstructing				
Fire extinguisher (s) accessible				
Others				
SCAFFOLDING				
Fully decked platforms				
Guard and intermediate rails in place				
Toe boards in place				
Adequate shoring				
Adequate access				
Others				
LADDER				
Extension side rails 1 m above				
Top of landing				
Properly secured				



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Angle + 70° from horizontal				
Other				
HOISTS, CRANES AND DERRICKS				
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				
MACHINERY, TOOLS & EQUIPMENT				
Proper instruction				
Safety devices				
Proper cords				
Inspection and maintenance				
Other				
VEHICLE AND TRAFFIC				
Rules and regulations observed				
Inspection and maintenance				
Licensed drivers				
Other				
TEMPORARY FACILITIES				
Emergency instructions posted				
Fire extinguishers provided				
Fire-aid equipment available				
General neatness				
Others				
FIRE PREVENTION				
Personnel instructed				
Fire extinguishers checked				
No smoking in prohibited areas.				
Hydrants				
Clearance				
Others				
ELECTRICAL				
Proper wiring				
ELCB's provided				
Ground fault circuit interrupters				
Protection against damage				
Prevention of tripping hazards				
Other				
HANDLING & STORAGE OF MATERIALS				
Properly stored or stacked				
Passageways clear				
Other				
FLAMMABLE GASES AND LIQUIDS				
Containers clearly identified				
Proper storage				
Fire extinguisher nearby				



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Other				
WORKING AT HEIGHT				
Safety nets				
Safety belts				
Safety helmets				
Anchoring of safety belt to the life line rope				
ENVIRONMENT				
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.				
HEALTH CHECKS				
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.				



HEALTH, SAFETY AND ENVIRONMENT PLAN FOR SITE OPERATION by SUBCONTRACTORS

POWER SECTOR

Doc no.: HSEP: 14

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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



**HEALTH, SAFETY AND ENVIRONMENT
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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 20030	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:14-F01

REV NO.: 00

PAGE NO. 01 OF 02

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection :	

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:14-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:14-F02

REV NO.: 00

PAGE NO. 1 OF 02

Name of Site :	
Name of Sub-Contractor :	
Name of Employee :	

NAME:

History Of Past Illness	H/O Epilepsy
	H/O Drug Allergy
	H/O Diabetics/ Hypertension
	H/O Unconsciousness
Personal History	
EXAMINATION	
OBSERVATION	
<u>General Physical Examination</u>	
Height	:
Weight	:
BMI	:
Built And nourishment	:
Pallor	:
Temperature	:
Chest Expansion	: Inspiration Expansion
Lymph Node Enlargement	:
<u>Ear, Nose, Throat</u>	:
Ear	:
Nose	:
Throat	:

**POWER SECTOR****HEALTH CHECK UP**

FORMAT NO: HSEP:14-F02

REV NO.: 00

PAGE NO. 2 OF 02

EXAMINATION	OBSERVATION
<u>Cardiovascular System Examination :</u>	
Inspection :	
Palpation :	Pulse BP
Auscultation (Heart Sounds) :	
<u>Respiratory System :</u>	
Inspection :	Respiratory Rate
Palpation:	
Percussion :	
Auscultation (Breath Sounds) :	
<u>Examination of Abdomen :</u>	
Inspection :	
Palpation :	
Auscultation (Bowel Sounds) :	
Any Other :	
Clinical Impression	

Signature of the examining doctor

**POWER SECTOR****HSE INDUCTION TRAINING**

FORMAT NO: HSEP:14-F03

REV NO.: 00

PAGE NO. 01 OF 01

Name of Site :	
Name of Sub-Contractor :	
Date :	
Name of Training Co-ordinator	

Sl No.	Name	Designation	Organisation	Signature

Signature of Training co-ordinator :

	POWER SECTOR	FORMAT NO: HSEP:14-F04 REV NO.: 00 PAGE NO. 01 OF 01
	TOOL-BOX TALK	

Name of Site :	
Sub-Contractors Name :	
Date :	

Topic	Name of person delivered Tool Box Talk	No. of Participants attended	Remarks

Signature of Site I/C of Subcontractor :

	POWER SECTOR	FORMAT NO: HSEP:14-F06 REV NO.: 00 PAGE NO. 01 OF 01
	PERSONAL PROTECTIVE EQUIPMENTS	

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection :	

Item	Issued this Month	Nos. Issued up to the Month	Percentage of usage at site
Safety Helmet			
Safety Shoes			
Full Body Harness			
Fall Arrestor			
Safety Nets			
Other PPEs.			

Signature of Site I/C of Subcontractor :

	POWER SECTOR	FORMAT NO: HSEP:14-F07 REV NO.: 00 PAGE NO. 01 OF 01
	INSPECTION OF T&Ps	

Name of Site :	
Name of Sub-Contractor :	
Date of Inspection :	

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	FORMAT NO: HSEP:14-F08 REV NO.: 00 PAGE NO. 01 OF 01
	STATUS OF T&Ps	

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:14-F09

REV NO.: 00

PAGE NO. 01 OF 03

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection:	

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:14-F09

REV NO.: 00

PAGE NO. 2 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:14-F09

REV NO.: 00

PAGE NO. 3 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?				
	Total Number of NO:				
	Total Number of NA:				
	% Compliance :				

Signature of Site I/C of subcontractor :

	POWER SECTOR	FORMAT NO: HSEP:14-F10 REV NO.: 00 PAGE NO. 01 OF 02
	INSPECTION OF HEIGHT WORKING	

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection:	

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.		
	ACCESS/EGRESS		
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:14-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.		
	Housekeeping		
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.		
	PPE And Safety Devices		
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	FORMAT NO: HSEP:14-F11 REV NO.: 00 PAGE NO. 1 OF 02
	INSPECTION OF WELDING AND GAS CUTTING	

Name of Site	
Name of Sub-Contractor	
Inspected by	
Date of Inspection	

Welding				
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:14-F11
REV NO.: 00
PAGE NO. 2 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			
	% Compliance			

Signature of Site I/C of subcontractor :

	POWER SECTOR	FORMAT NO: HSEP:14-F12 REV NO.: 00 PAGE NO. 01 OF 02
	INSPECTION OF ELECTRICAL INSTALLATION	

Name of Site	
Name of Sub-Contractor	
Inspected by	
Date of Inspection:	

Sr. No.	Contents	Yes/No	Remarks
A	Cable		
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	DBs/SDBs		
1.	Is earth conductor continued up to 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?		
C	ELCB		
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:14-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?		
D	Grounding		
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.		
E	Electrically operated Machines or Accessories.		
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	FORMAT NO: HSEP:14-F13 REV NO.: 00 PAGE NO. 01 OF 01
	INSPECTION OF ELEVATOR	

Name of Site	
Name of Sub-Contractor	
Inspected by	
Date of Inspection	

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)	
Signature-Subcontractor/ Subcontractor's Safety Officer		Signature-Site Safety Officer (BHEL)

	POWER SECTOR	FORMAT NO: HSEP:14-F13E REV NO.: 00 PAGE NO. 01 OF 01
	Inspection of Excavation	

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection :	

Sl.no.	Description	Yes	No	Remarks
1	Precautions taken for Underground Electrical Cable			
2	Precautions taken for Under / Above ground sewer/ Drinking Water Line			
3	Precautions taken for Underground Telecommunication Line			
4	Precautions taken for Underground Product/Utility Line			
5	Precautions taken for Underground Fire Water Line			
6	Shoring / Shuttering / Sheet piling done to prevent collapse of excavation walls. Strength of Excavation wall ensured at all times			
7	Slope Cutting / Angle Maintained			
8	Hard Barricading & Edge Protection provided			
9	Separate Safe Access for Man and Vehicle			
10	Lighting arrangement			
11	Banksman Provided			
12	Required basic PPEs provided			
13	Excavated soil / Construction Material / equipment kept away from the edge.			
14	First aid in attendance.			
15	Other:			
	Total No of YES			

Signature-Subcontractor/ Subcontractor's Safety Officer

Signature-Site Safety Officer (BHEL)

**POWER SECTOR****HSE PENALTY**

FORMAT NO: HSEP:14-F14

REV NO.: 00

PAGE NO. 1 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- HQ	FORMAT NO: HSEP:14-F15 REV NO.: 00 PAGE NO. 01 OF 01
	Incident Report (To be submitted within 24 hours of time of incident)	

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		ACTUAL COST
MARITAL STATUS		SINGLE / MARRIED				
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)					
ANALYSIS						
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		

	POWER SECTOR	FORMAT NO: HSEP:14-F30 REV NO.: 00 PAGE NO. 01 OF 3
	Format for Monthly HSE Planning & Review	

Note: This is a template and can be modified in consultation with BHEL			
Name of the Site		Name of the Subcontractor	
Scope of Work		Date	
PART- A: PLAN OF HSE ACTIVITIES FOR THE MONTH OF.....			PART-B: REVIEW ON
SN.	Description of HSE Activity & Formats	Plan & Targets for the month	Review
1	Availability of First Aid Box at Required Places and Inspection thereof as per Format: Fo1	Areas 1.	
2	Health check-up as per Format: Fo2	Health check-up for Nos 1. New inductees 2. Drivers & Operators 3. Workers in following high risk areas: a. ...	
3	Induction training of newly joined workers as per Format: Fo3	Minimum No. of workers:	
4	Toolbox talks (TBT) conducted before start of work as per Format: Fo4	Locations of TBTs & No. of workers 1. ...	
5	PPE usage and issue as per Format: Fo6		
6	Inspection of T&Ps as per Format: Fo7	List of T&Ps to be inspected 1.	
7	Identification & Inspection Status of T&Ps as per Format: Fo8		
8	Inspection of Cranes & Winches as per Format: Fo9	List of Cranes & Winches & Nos. 1. ...	
9	Inspection of Height Working as per Format: F10	Areas: 1. ...	
10	Inspection of Welding & Gas Cutting operations as per Format: F11	Areas: 1. ...	
11	Inspection of Electrical Installations as per Format: F12	Locations: 1. ...	
12	Inspection of Elevators (as applicable) as per Format: F13	Locations: 1. ...	
13	Inspection of Excavation as per Format: F13E	Locations: 1. ...	

	POWER SECTOR		FORMAT NO: HSEP:14-F30 REV NO.: 00 PAGE NO. 02 OF 3
	Format for Monthly HSE Planning & Review		
SN.	Description of HSE Activity & Formats	Plan & Targets for the month	Review
14	Job Safety Analysis as per Format F32B	Activities: 1. ...	
15	Regular Job Specific Training (Re-training) for workers involved in hazardous activities	Topics/ Hazards & No. of workers 1. ...	
16	Mass housekeeping (HK) drive in work areas	Areas 1. ...	
17	Vertigo Test of Height workers	Minimum No. of workers:	
18	Deployment of qualified HSE Officers as per contract	Location(s) & Nos. 1. ...	
19	Deployment of qualified HSE Stewards as per contract	Location(s) & Nos. 1. ...	
20	Deployment of Safety tools & Equipment (Safety Nets, Lifelines, Fall arrestors, Man-cages, flashback arrestors, scaffolding etc.)	Tool/ Equipment & Location 1. ...	
21	Safety Walks by site in charge of agency (4 -Weekly once)	Dates:	
22	Safety walks by departmental head (8-Weekly twice)	Dates:	
23	Availability/ deployment of Safety posters/ placards/ signage at strategic locations	Locations: Nos. 1. ...	
24	Provision of clean drinking water sources for workers	Locations: Nos. 1. ...	
25	Provision of toilets for workers (separate for male & female workers)	Locations: Nos. 1. ...	
26	Rest sheds for workers during lunchtime, rain, dust storm etc.	Locations: Nos. 1. ...	
27	Availability of following in Labor colony	1. Clean drinking water 2. Toilets 3. Cleanliness & Hygiene 4. Grass cutting, 5. Fogging 6. Electrical Inspection ...	

	POWER SECTOR		FORMAT NO: HSEP:14-F30 REV NO.: 00 PAGE NO. 03 OF 3
	Format for Monthly HSE Planning & Review		
SN.	Description of HSE Activity & Formats	Plan & Targets for the month	Review
28	Availability of dust/ waste bins at various locations	Locations: 1. ...	
29	Availability of Ambulance (individual/ joint) in each shift	Ambulance No.	
30	Availability of emergency vehicle in each shift	Emergency vehicle	
31	Deployment/ Availability of tested Fire Extinguishers	Locations & Nos. 1. ...	
32	Tree plantation	Locations & Nos. 1. ...	
33	Waste disposal & Scrap Bins	Locations 1. ...	
34	Illumination checks	Locations 1. ...	
35	Safety award function: 1. Display of good practices Award presentation	Minimum 1 per month	
36	Submission of Daily Reports as per Format No.F31A	Daily Reports (Night & Day Shifts)	

PLAN		REVIEW	
<u>Agency</u> Name: Sign: Date:	<u>BHEL</u> Name: Sign: Date:	<u>Agency</u> Name: Sign: Date:	<u>BHEL</u> Name: Sign: Date:



POWER SECTOR

Format for Daily HSE Reporting

FORMAT NO: HSEP:14-F31 A
REV NO.: 00
PAGE NO. 01 OF 1

Note: Following format to be submitted (preferably) in excel/ soft copy by subcontractor daily at the end of each shift. Any photographs/ records to be attached

Site												Subcontractor																		
Year									Month										Day											
Night	Day	SHIFT	Submitted By	Work Area(s)	Staff	Man-Power	Safety Officers	Safety Stewards	Tool Box (Topics and No. of Participants)	Induction Training (No. of Participants)	Vertigo Test (Numbers Tested)	On-the-Job Training (Topic & participants)	Work Permits	Job Safety Analyses conducted	Height Work Inspection	Other Hazardous Activities Inspection	T&P Inspection (Names & Nos. Inspected)	Safety Walk (Designation, Areas)	HSE Meeting	Safety Reward (Details)	Housekeeping/ Dust Suppression/ Tree Plantation Activities (Locations/ Details)	Lost time Accident	Restricted Work Case	Medical Treatment Case	First Aid Case	Near miss	Property Damage/ Fire	Non-Compliances Submitted by BHEL	Complied by Agency	Any other Remarks/ Inputs
																	NA		NA	NA	NA									



POWER SECTOR

Job Safety Analysis Format

FORMAT NO: HSEP:14-F32B

REV NO.: 00

PAGE NO. 01 OF 1

Name of the Site	
Name of the Subcontractor	
Activity, Area	

HAZARDS				PRECAUTIONS	

(Name)	Submitted By (Agency HSE)		Reviewed By (BHEL Execution)		Approved By (BHEL HSE)	
(Sign)						
(Date)						

**POWER SECTOR- HQ**

FORMAT NO: HSEP:14-F33

REV NO.: 00

PAGE NO. 01 OF 3

Checklist for Evaluation of HSE Performance

SL	Parameter for Measurement	M/ O	Wt	Supporting Documents
1a	Induction training for new workers conducted through audio-visual medium & documented ?	M	1	Induction Training Records
1b	Tool box talk conducted regularly as per plan, and documented?	M	1	Toolbox Talk Records
1c	Contractor in charge and safety in charge attended safety meetings?	M	2	Minutes of Meeting
1d	Whether observations in safety meetings are complied before next meeting?	M	2	-do-
1e	Preparation and submission of Monthly HSE report within stipulated time	M	1	Report submission date
1f	Preparation and submission of Incident/near-miss report and RCA Report (as applicable) within stipulated time	M	1	Incident/ Near Miss Records
1g	Carrying out Inspections and submission of Inspection reports within stipulated time	M	1	Inspection Records
1h	Regular Job Specific Training ensured for High Risk Workers (through audio-visual medium) as per plan	M	1	Training & Attendance Records
2a	Whether the contractor is registered under BOCW	M	2	BOCW Registration Certificate
2b	Availability of Qualified safety officer (1 for every 500 labour)	M	2	Safety Officer qualification & experience records
2c	Availability of Qualified safety supervisor (1 for every 100 labour)	M	2	Safety Officer qualification & experience records
2d	All the workers are provided and using safety helmets and safety shoes/gum boots	M	2	PPE Issue Records, Inspection/ non-conformity records
2e	Housekeeping done on regular basis and scrap removal at site	M	1	Housekeeping records, Inspection/ non-conformity records
2f	Usage of Goggles/Face shields and Hand gloves for gas cutter and grinders		1	PPE Issue Records, Inspection/ non-conformity records
2g	Wall openings & floor openings are guarded?		1	Inspection/ non-conformity records
2h	Adequate illumination provided in all working area?		1	Inspection/ non-conformity records
2i	Safety posters, sign boards and emergency contact numbers in all prominent location are displayed?		1	Inspection/ non-conformity records
2j	Availability of automatic reverse horns, Main horn, hook latches for Vehicles, mobile cranes, Hydras		1	Inspection/ non-conformity records
2k	Ban of carrying mobile phones to work place is implemented for workers		1	Inspection/ non-conformity records
2l	Availability of Tags & Inspection Certificates for Cranes of all capacities		1	Master T&P List with internal & external test details
2l.2	Availability of Tags & Inspection Certificates for Winches of all capacities		1	Master T&P List with internal & external test details
2l.3	Availability of Tags & Inspection Certificates, color coding for Chain pulley blocks		1	Master T&P List with internal & external test details
2l.4	Availability of Tags & Inspection Certificates for Vehicles - Trailers, Dozers, Dumpers, Excavators. Mixers etc.		1	Master T&P List with internal & external test details
2l.5	Availability of Tags & Inspection Certificates for Welding machines, grinders, Drilling machines, etc.		1	Master T&P List with internal & external test details
2l.6	Availability of Tags & Inspection Certificates, colour coding for Wire rope slings etc.		1	Master T&P List with internal & external test details
2l.7	Availability of Tags & Inspection Certificates for Batching plants		1	Master T&P List with internal & external test details

**POWER SECTOR- HQ**

FORMAT NO: HSEP:14-F33

REV NO.: 00

PAGE NO. 02 OF 3

Checklist for Evaluation of HSE Performance

SL	Parameter for Measurement	M/ O	Wt	Supporting Documents
2m.1	Use of Lifting Permit as per requirement		1	Permit Records
2m.2	Use of Height Permit as per requirement		1	Permit Records
2m.3	Use of Hot Work Permit as per requirement		1	Permit Records
2m.4	Use of Excavation permit as per requirement		1	Permit Records
2m.5	Use of Confined space work permit as per requirement		1	Permit Records
2m.6	Use of Grating removal and safety net removal permit as per requirement		1	Permit Records
2m.7	Use of Lockout-Tag out permit as per requirement		1	Permit Records
2m.8	Use of Radiography permit as per requirement		1	Permit Records
2m.9	Use of Night/ Holiday Work Permit as per requirement		1	Permit Records
2m.10	Use of Any other Applicable Permit as per requirement		1	Permit Records
3a	Material safety data sheet(MSDS) available for all chemicals and displayed in usage and storage area?		1	Inspection/ non-conformity records
3b	Spillages of oil/concrete and other chemical is controlled and cleaned by proper method in case of spill?		1	Inspection/ non-conformity records
3c	Availability of adequate number of urinals in workplace and in elevations and maintained	M	1	
3d	Availability of rest rooms for workers at site	M	1	
3e	Availability of Drinking water facility at work spot		1	
3f	Hygienic Labour colony is provided for workers.		1	
4a	Is heavy/complex critical lifting permit obtained for heavy, complex materials before handling/erection activity?		1	Work Permit records
4b	Whether area below lifting activities barricaded		1	Inspection/ non-conformity records
4c	Availability of experienced rigging foreman		1	Experience details of rigging foreman
4d	Is agency is following proper storage and handling procedure as per manufacturer standard for all hazardous material?		1	Procedure for storage & handling
4e	Are oxygen and acetylene cylinders are transported to work place from storage area in trolleys		1	
5a	Whether all deep excavation has been protected by barrier		1	Inspection/ non-conformity records
5b	Sloping/benching & shoring provided for excavation as per requirement?		1	-do-
5c	Proper access and egress provided for excavations?		1	-do-
5d	Blasting is done in controlled manner?		2	-do-
6a	Whether Electrical booth is equipped with Co ₂ fire extinguishers and fire buckets filled with sand?		2	Inspection/ non-conformity records
6b	Availability of Illumination lamp in electric booth?		1	-do-
6c	whether Caution Boards have been displayed?		1	-do-
6d	Usage of Metal Plug top for all hand power tools ?		1	-do-
6e	Usage of Insulated welding cables.		1	-do-
6f	Electrical Booth/Distribution Board to be covered by proper Canopy.		1	-do-
6g	Availability of functional & individual 30mA ELCB / RCCB and MCB for protection and conducting periodical check-up?		1	-do-
6h	Double earthing for panel boards and all machinery & proper earth pit with regular inspection available?		1	-do-
6i	Whether Electrician is qualified and experienced		1	Qualification & Experience records of electrician
6j	Availability and usage of Rubber hand gloves by electrician?		1	Inspection/ non-conformity records

	POWER SECTOR- HQ	FORMAT NO: HSEP:14-F33
	Checklist for Evaluation of HSE Performance	REV NO.: 00 PAGE NO. 03 OF 3

SL	Parameter for Measurement	M/ O	Wt	Supporting Documents
7a	Whether Scaffolding pipes made with steel or aluminum, are being used and checked periodically by experienced/ certified scaffolder?		2	Inspection/ non-conformity records
7b	8mm Stainless Steel wire rope with plastic cladding is provided for life line (Vertical / Horizontal) during height work?		2	-do-
7c	Availability of emergency lighting in case of power failure		1	-do-
7d	Whether all the openings are covered with Safety Nets made of fire proof Nylon?		1	-do-
7e	Whether MS pipe rails around staircases & platforms in usage are provided with top, middle rails and toe guard ?		1	-do-
7f	Whether Ladder with vertical life line /Fall arrestor is available to climb?		1	-do-
7g	Whether all workers deployed for working at height have been issued height pass after undergoing vertigo test?		1	Height Pass records
7h	Whether all workers deployed for height work / climbing ladder are provided and using Double lanyard safety belt?		1	PPE Issue records, inspection/ non-conformity reports
7i	Is all hand tools/Small material used by height workers is tied firmly to prevent fall?		1	-do-
8a	Flash back arrestors for all gas cutting sets is available on Torch side and cylinder side		1	Inspection/ non-conformity records
8b	Oxygen/Acetylene/LPG cylinders not in use have caps in place and stored separately?		1	-do-
8c	Availability of Face screen, Hand gloves, and Apron, for welders		1	-do-
8d	Protection from falling hot molten metal during metal cutting / welding at height by providing GI sheet below the cutting area especially in fire prone areas		1	-do-
9a	Pre-employment medical check-up done for all workers and submitted?		1	Medical check records
9b	Availability of first aid center, with MBBS doctor(Own or Sharing basis)	M	2	Attendance records
9c	Availability of Ambulance facility 24 hours (Own or sharing basis)	M	2	-do-
9d	Is First aid trained personnel's are available and their names are displayed at site?	M	1	-do-
9e	Availability of Emergency vehicle at site		1	
9f	Periodical medical check-up is conducted for all the workers and submitted?		1	Medical check records
9g	Availability of sufficient number of first aid box as per standard list and maintaining record		1	Inspection records
10a	Availability of Fire extinguishers, buckets at all vulnerable points		2	Fire extinguisher records
10b	Periodic fire mock drill conducted?		1	Fire, Mock drill records
10c	Are all flammable materials are stored separately?		1	
10d	Periodic grass cutting is done in material storage area?		1	
10e	Availability of 24V DC lighting in confined space work area		1	
10f	Availability of exhaust fan in confined space work area		1	

Note:

- **M: Mandatory; O: Optional.** Points other than mandatory can be excluded with appropriate justification (scope etc.) by BHEL
- Additionally: 30 Marks for each Fatal Accident and 10 mark for each major accident shall be deducted.



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.	Unwanted 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 unauthorized/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 and 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)

Original at BHEL site**Second Copy – BHEL SAFETY****Third Copy : Contractor**



ADDITIONAL GENERAL TECHNICAL REQUIREMENTS

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	CODES AND STANDARDS
2.00.00	RESPONSIBILITY FOR DESIGN
3.00.00	NAME PLATES (RATING PLATES)
4.00.00	SAFETY AND SECURITY
5.00.00	GUARDS
6.00.00	LOCATION AND LAYOUT REQUIREMENTS
7.00.00	OPERATION, MAINTENANCE AND AVAILABILITY CONSIDERATIONS
8.00.00	MATERIALS
9.00.00	LUBRICATION
10.00.00	LUBRICANTS & CONTROL FLUIDS
11.00.00	OPERATION AND MAINTENANCE
12.00.00	PLANT LIFE AND MODE OF OPERATION
13.00.00	PACKAGING & MARKING
14.00.00	PROTECTION
15.00.00	ENVIRONMENT PROTECTION AND NOISE LEVEL REQUIREMENT
16.00.00	INSPECTION AND TESTING
17.00.00	TRAINING OF OWNER'S PERSONNEL
18.00.00	DEVIATIONS

ATTACHMENTS

ANNEXURE-I	LIST OF STANDARDS FOR REFERENCE
ANNEXURE-II	CRITERIA FOR LAYOUT

GENERAL TECHNICAL REQUIREMENTS

1.00.0 CODES AND STANDARDS

1.01.0 Except where otherwise specified, the Plant shall comply with the appropriate Indian Standard or an agreed internationally accepted Standard Specification as listed in the annexure to this Section and mentioned in detailed specifications, each incorporating the latest revisions at the time of tendering. Where no internationally accepted standard is applicable, the Bidder shall give all particulars and details as necessary; to enable the Owner to identify all of the Plant in the same detail as would be possible had there been a Standard Specification.

1.02.00 Where the Bidder proposes alternative codes or standards he shall include in his tender one copy (in English) of each Standard Specification to which materials offered shall comply. In such case, the adopted alternative standard shall be equivalent or superior to the standards mentioned in the specification.

1.03.00 The plant will be designed in compliance with applicable National and International Codes and Standards such as ASME, ASTM, DIN, BS, IEC, IEEE, IS, etc. Wherever specified or required the Plant shall conform to various statutory regulations such as Indian Boiler Regulations, Indian Explosives Act, Indian Factories Act, Indian Electricity Act, Environmental Regulations, etc. Wherever required, approval for the plant supplied under the specification from statutory authorities shall be the responsibility of the Contractor.

1.04.00 In the event of any conflict between the codes and standards referred above, and the requirements of this specification, the requirements, which are more stringent, shall govern.

1.05.00 In case of any change of code, standards and regulations between the date of purchase order and the date the Contractor proceeds with manufacturing the Owner shall have the option to incorporate the changed requirements. It shall be the responsibility of the Contractor to advise Owner of the resulting effect.

1.06.00 Successful Bidder to furnish two (2) sets of latest of national/inter-national codes and standards to owner.

2.00.00 RESPONSIBILITY FOR DESIGN

2.01.00 The Contractor shall assume full responsibility for the design of the whole and every portion of the Plant, whether or not the design work was undertaken specifically in relation to the Contract and whether or not the Contractor was directly involved in the design work.

2.02.00 Notwithstanding the Owner's wish to receive the benefits of new, advanced and improved technologies, a prime requirement is that all the systems and components proposed shall have been already adequately developed and shall have demonstrated good reliability under similar, or more arduous conditions elsewhere, at least for continuous 2 years in two different power station.

2.03.00 The successful bidder shall have to carry out surge analysis, BFP transient analysis and other transient condition studies as may be necessary and as required by the Owner as per proven engineering practice.

- 2.04.00 The Bid shall include a detailed discussion on the development status of, and the reasons for any changes made in proposed systems or components for the Plant, as compared with similar items previously supplied in other installations cited by the bidder as reference plants.
- 2.05.00 The Bidder may also make alternate offers, provided such offers are superior in his opinion in which case adequate technical information, operating feed back, etc. are to be enclosed with the offer, to enable the Owner to assess the superiority and reliability of the alternatives offered. In case of each alternative offer, its implications on the performance, guaranteed efficiency, auxiliary power consumptions, etc. shall be clearly brought out to the Owner to make an overall assessment. In any case, the base offer shall necessarily be in line with the specifications i.e. Base offer shall be as per the technical specifications and the same will be considered for techno-commercial evaluation.
- 3.00.00 **NAME PLATES (RATING PLATES)**
- 3.01.00 Instruction plates, name plates or labels shall be permanently attached to each main and auxiliary item of plant in a conspicuous position. These plates shall be engraved with the identifying name, type and manufacturers serial number, together with the loading conditions under which the item of plant has been designed to operate.
- 3.02.00 Items such as valves, etc. which are subject to hand operation, shall be provided with nameplates so constructed as to remain clearly legible throughout the life of the plant giving due consideration to the difficult climatic conditions to be encountered. Nameplates shall be securely mounted where they will not be obscured in service by insulation, cladding, actuators or other equipment. Direction of flow is also to be engraved.
- 3.03.00 All trade nameplates and labels shall be in English language. All measurements shall be in M.K.S. Units.
- 3.04.00 The size and location of nameplates shall be subject to Approval of the Engineer.
- 4.00.00 **SAFETY AND SECURITY**
- 4.01.00 The design shall incorporate every reasonable precaution and provision for the safety of all personnel and for the safety and security of all persons and property. The design shall comply with all appropriate statutory regulations relating to safety. All structures and equipment shall be designed and constructed to withstand every foreseeable static and dynamic loading condition, including loading under earthquake conditions, with an adequate margin of safety.
- 4.02.00 Ready and safe access with clear head room shall be provided to all parts of the plant for operation, inspection, cleaning and maintenance.
- 4.03.00 Escape routes and clear ways shall be provided to allow speedy evacuation of the plant in the event of fire or explosion, and the plant layout shall allow for ease of access to all parts of the Works by rescue and fire fighting teams. The plant layout shall be designed to localise and minimise the effects of any fire or explosion. The recommendations of NFPA, OSHA, and TAC etc. as necessary shall be followed in all respects.
- 4.04.00 The use of corrosive, explosive, toxic or otherwise hazardous materials shall be kept to a minimum during construction and the design of the plant shall minimise the

requirement for such materials during operation and maintenance. Where such materials must be used, all necessary precautions shall be taken in the design, manufacture and layout of equipment to minimise the resulting hazard, and all equipment necessary for the protection and first-aid treatment of personnel in the event of accidents shall be provided. Particular attention is drawn to avoid the use of materials containing asbestos in any form.

5.00.00 **GUARDS**

5.01.00 Effective guards and fences must be provided to prevent injury to operators through accident or malpractice.

5.02.00 Mesh guards which allow visual inspection of equipment with the guard in place are generally preferable. The guards shall be constructed of mesh attached to a rigid framework of mild steel rod, tube, or angle and the whole galvanised to prevent loss of strength by rusting or corrosion. The guards shall be designed to facilitate removal and replacement during maintenance.

5.03.00 All drive belts, couplings, gears, sharp metallic edges and chains must be safely guarded. Any lubricating nipple requiring attention during normal running must be positioned where they can be reached without moving the guards.

5.04.00 Guards for couplings and rotating shafts shall be in accordance with BS 5304-1975 or similar approved standard. All rotating shafts and parts of shafts must be covered.

5.05.00 Suitable fencing shall be provided to enclose all openings or doorways used for the hoisting and lowering of machinery etc. This fencing must be securely fixed but quickly detachable when required. A secure hand hold must be provided on each side of the opening or doorway.

6.00.00 **LOCATION AND LAYOUT REQUIREMENTS**

The majority of plant and equipment (excluding steam generator and some other auxiliaries) shall all be of indoor installation. A broad list of buildings housing such equipment is given elsewhere in this specification. Layout should facilitate access for operation-maintenance and inspection of any one or more equipment/components at a time without disturbing the operation or installation of rest of the plant. Further, Bidder should comply with the criteria given under the various equipment and system specifications as well as those stipulated in Annexure-II attached to this section.

Enclosed General Layout and other tender layout drawings show the location of major installations and auxiliary buildings. The Bidder shall try to retain these locations as far as practicable. The layout of equipment within the power house as shown in the tender drawings is indicative. The Bidder may, subject to Owner's approval alter the same to suit the space requirement of the equipment offered.

Bidder may give as an alternative his own preferred layout clearly indicating the advantages and other implications, if any. Such alternative will not be considered for evaluating the bid, but may be considered with the successful Bidder if Owner/Engineer finds the proposal more attractive in terms of techno-economic consideration.

While developing the layout of buildings the following criteria shall be given effect :

- a) The minimum width of clear access corridors around equipment shall be 1.2 meter.
- b) Each building shall have an identified vacant space for equipment unloading and maintenance and preferably a separate bay altogether in buildings housing heavy equipment.

Provision for handling equipment by monorail hoist and/or overhead crane shall be made as specified.

- c) The minimum clear height available between two consecutive floor slabs shall not be less than five (5) meters. A clear head room of 2.5m shall be maintained between the floor and any overhead piping/ cables or other obstruction. Adequate provision for natural ventilation and illumination shall be made as per good engineering practices.
- d) There shall be at least two (2) nos. main access doors, one on either side of each building, of which one shall be minimum 3 meters wide with rolling shutters for equipment entry. For multistoried buildings, at least two (2) nos. regular staircases diagonally opposite to each other shall be provided connecting all the floors and roof. These minimum requirements shall be augmented as required depending on the floor area, statutory requirements and TAC recommendations.
- e) All buildings shall have provision for toilet and associated effluent discharge system together with facility for drinking water. The criteria for ventilation, fire protection and illumination of building spaces specified elsewhere in this specification shall be complied with.
- f) All rail/road crossings for pipe/cable racks shall be done with minimum 8 meters headroom from top of rail/road to bottom of rack. Similarly top cover over underground pipes/cables shall be minimum one (1) meter. For other detail refer to Annexure-II.
- g) Cubicle for operating personnel shall be located at safe place near the equipment.
- h) Interplant cable routing will be on overhead cable trays on pipe cum cable trestle or on cable trestle except where approved by purchaser/consultant. In exceptional case, small stretch of outdoor run of interplant cable routing may be taken through cable trench only with the Employer's prior approval.
- i) Concept of various mechanical and electrical equipment location and building dimensions (including column-row spacing) as shown in Plot Plan/Floor Plan drawing are to be adhered to. Any departure from this suggestive layout is primarily not recommended.

7.00.00 **OPERATION, MAINTENANCE & AVAILABILITY CONSIDERATIONS**

- 7.01.00 Equipment/works offered shall be designed for high availability, high reliability, low maintenance and ease of operation & maintenance. The Bidder shall specifically state the design features incorporated to achieve high degree of reliability, availability, operability and ease of maintenance. He shall also furnish details of availability records in plants stated in his experience list.
- 7.02.00 Ample space for ease of operation and maintenance including equipment removal, tube bundle/cartridge/rotor pulling etc. shall be provided. All valves, gates, dampers and other devices shall be located and oriented in such a way that they are accessible from operating floor levels. Where this cannot be adhered to, platforms and walkways with access ladders shall be provided to facilitate operation and maintenance.
- 7.03.0 Motorised lifting devices, i.e. hoists, chain pulleys, jacks, etc. shall be provided for handling and carrying out maintenance of any equipment and/or part having weight in excess of 3000 Kg. Suitable beams, hooks etc. for this purpose shall be provided in the buildings.

No lifting arrangement is necessary for part having weight less than 500 Kg. Hoist shall be well protected by environment. Suitable painting and coating covering hoist at outdoor shall be provided.

Lifting devices like lifting tackles, slings, etc. to be connected to hook of the hoist/crane shall be provided by the Bidder for lifting the equipment, accessories covered under this specification.

7.04.00 All similar parts of the equipment shall be made to gauge and shall be interchangeable with and shall be made of same material and workmanship as the corresponding parts of the equipment. Where feasible common components shall be employed in different pieces of equipment in order to optimize the spares inventory and utilization.

8.00.00 **MATERIALS**

8.01.00 In selecting materials of construction of equipment, the Contractor shall pay particular attention to the atmospheric conditions existing at the Site and the nature of material/fluid handled. Wherever deviations are taken in respect of materials specified, the reasons shall be spelt out clearly in the proposal.

All materials shall be new, and shall be of the quality most suited to the proposed application.

8.02.00 In as far as is possible; materials shall be in accordance with Indian or international standard specifications and shall be used in accordance with Indian or international codes of practice. Where such standards or codes of practice are not available sufficient information shall be provided to allow the Owner to assess the suitability of the material for the particular application.

All materials used shall have performed lengthy satisfactory service in similar or more arduous conditions to those proposed by the Contractor.

8.03.00 All parts which could deteriorate or corrode under the influence of the atmospheric, meteorological or soil conditions at the Site, or under the influence of the working conditions shall be suitably and effectively protected so that such deterioration or corrosion is a minimum over the life of the plant.

9.00.00 **LUBRICATION**

9.01.00 Provision shall be made for suitable efficient lubrication where necessary to ensure smooth operation free from undue wear.

9.02.00 Non ferrous capillary tubing shall be used throughout.

9.03.00 Gear boxes and oil baths shall be provided with filling and drain plugs, both of adequate size. An approved means of oil indication including level switches and temperature indication shall be provided.

9.04.00 All high speed gears shall be oil bath lubricated. Low speed gears shall be lubricated by means of soft grease. Removable and accessible drip pans shall be provided to collect lubricant which may drop from operating parts.

9.05.00 All lubrication points shall be conveniently situated for maintenance purposes. It must be possible to carry out lubrication from a gangway or landing and without the removal

of guarding or having to insert the hand into it. Where accessibility to a bearing for oiling purposes would be difficult a method of remote lubrication shall be fitted.

9.06.00 The Contractor shall supply grease gun equipment suitable to service each type of nipple fitted.

10.00.00 **LUBRICANTS AND CONTROL FLUIDS**

10.01.00 The Contractor shall provide a detailed and comprehensive specification for all lubricating oils, greases and control fluids required for the entire plant. A sufficient supply of these shall be provided by the Contractor for initial commissioning, first fill and till COD of the unit.

10.02.00 The Contractor shall supply a detailed schedule giving the lubricant testing, cleaning and replacement procedures. All equipment and facilities necessary for the testing, cleaning and changing of lubricants and control fluids shall be provided. The Contractor shall endeavor to reduce the varieties and grades of required lubricants and control fluids to a minimum, matching them where possible to those already in use in the generating station in order to simplify procurement and minimise storage requirements. All lubricants and control fluids shall be of internationally recognised standards and shall be easily obtainable from a large number of Indian suppliers. Bidder shall also indicate the equivalent Indian Standard for the above for easy procurement in future.

10.03.00 No lubricant or control fluid shall have toxic or other harmful effects on personnel or on the environment.

11.00.00 **OPERATION AND MAINTENANCE**

11.01.00 The plant shall be designed and constructed so that operation and maintenance manpower requirements are minimised. The design and layout shall facilitate inspection, cleaning, maintenance and repair. The importance of continuity of operation is second only to that of safety.

11.02.00 Spare parts for equipment shall be interchangeable with the original components and, so far as possible, be of common design and manufacture.

11.03.00 All similar standard components/parts of similar standard equipment provided shall be interchangeable with one another. Further identical equipments shall be provided for similar duties so that the same are interchangeable with one another in totality and component wise.

11.04.00 All heavy parts (500 Kg and above) must be provided with a convenient arrangement for slinging and handling during erection and overhaul. Any item of plant normally stripped or lifted during periods of maintenance and weighing one tonne or above, shall be clearly marked with its weight.

11.05.00 On completion of commissioning, a complete set of tools for the maintenance of the entire plant shall be provided by the Contractor. This shall include all necessary spanners, special wrenches, extraction equipment and any special tools reasonably required by the Engineer. Tools used during erection and commissioning shall not be accepted except with the specific approval of the Engineer.

11.06.00 All equipment and major valves should be provided with adequate maintenance approach and facility.

12.00.00

PLANT LIFE AND MODE OF OPERATION

The complete plant including all the equipment and systems individually and collectively shall be designed for continuous operation for an economic service life of thirty (30) years under the prevailing site conditions and for the type of duty intended. The critical components of the Steam Generator, Turbine-Generator and Auxiliary equipment, the life of which is limited by time and temperature dependent mechanisms such as thermal stress, creep and low cycle fatigue, are to be designed considering expected (hot, warm and cold) start-up, shutdown and cyclic load variations.

The allowable stresses shall be reduced so that life expectancy to minimum 2,00,000 hours of operation can be achieved. The Bidder shall discuss this aspect in his technical proposal.

The unit would be operated on base load with cyclic load variation. The load variation is expected to be as per schedule depending on power demand.

The expected start-ups should be considered as minimum
(Based on HPT metal temperature)

Cold start-up (>72 hrs. shutdown)	:	6 per year
Warm start-up (between 10 to 72 hrs. of shutdown) :		40 per year
Hot start-up (less than 10 hrs. shutdown)	:	160 per year

13.00.00

PACKAGING & MARKING

All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection. While packing all the materials, the limitations from the point of view of availability of railway wagon sizes in India should be taken account of. The details of various wagons normally available with Indian Railways for transportation of heavy equipment shall be considered by the Bidder. The Contractor shall be responsible for all loss or damage during transportation, handling and storage due to improper packing.

As per the information available, the dimensions of OD consignment for transportation of the equipment by rail (if any equipment to be handled through rail transportation) are as below :

- a) Width of the Package : 3.2 Meters
(from centre-line of rails- 1.6 metres on both sides)
- b) Height of the package from rail top : 4.47 Meters

The above indicates the dimensions which can be normally transported on the wagons without infringement of the "moving gauge". This is however not indicative of the consignment which can be carried out with infringement of "moving gauge" duly authorised and approved by the Indian Railways. There may be difference between the "moving gauge" and the "fixed structure gauge" and consignments infringing the "moving gauge" can be moved after investigation regarding possible infringement with the fixed structures. As the critical fixed structures in each route are different, consignments infringing moving dimensions have to be individually investigated to select a route and also determine the restrictions under which such movement is to be carried out. Such routes selected or other mode of transport envisaged is to be clearly brought out in the proposal wherever transport of over dimensional equipment is involved.

Bidder to consider unloading of material delivered through rail transportation, at near by railway station/ site unloading siding. The subsequent transportation up to project work place shall be considered by road only. All unloading and handling equipment both at railway station siding and at project site shall be arranged by the Bidder. Necessary arrangement to be organized with the railway authority for such purpose shall also be under the scope of services of the Bidder. Bidder may consider entire material delivered up to site through rail transportation only.

The identification marking indicating the name and address of the consignee shall be clearly marked in indelible ink on two opposite sides and top of each of the packages. In addition the Contractor shall include in the marking gross and net weight, outer dimension and cubic measurement. Each package shall be accompanied by a packing note (in weather proof paper) quoting specifically the name of the Contractor, the number and date of contract and names of the office placing the contract, nomenclature of contents and Bill of Material.

For imported equipment and material, suitable port facilities may be used in which case material may be transported from the port by tractor-trailer. Bidder may consider this aspect.

14.00.00

PROTECTION

Equipment having antifriction or sleeve bearings shall be protected by weathertight enclosures. Coated surfaces shall be protected against impact, abrasion, discoloration and other damages. Surfaces that are damaged shall be repainted.

Electrical equipment, controls and insulations shall be protected against moisture and water damages. All external gasket surfaces and flange faces, couplings, rotating equipment shafts, bearings and like items shall be thoroughly cleaned and coated with rust preventive compound as specified above and protected with suitable wood, metal or other substantial type covering to ensure their full protection. All exposed threaded parts shall be greased and protected with metallic or other substantial type protectors.

All piping, tubing and conduit connections on equipment and other equipment openings shall be closed with rough usage covers or plugs. Female threaded openings shall be closed with rough usage covers or forged steel plugs. The closures shall be taped to seal the interior of the equipment. Open ends of piping, tubing and conduit shall be sealed and taped. Returnable containers and special shipping devices shall be returned by the manufacturer's field representative at the Contractor's expense.

15.00.00

ENVIRONMENT PROTECTION AND NOISE LEVEL REQUIREMENT

15.01.00

Environment Protection

The plant shall be designed for installation and operation in harmony with the surrounding environment and all measures of pollution control shall be ensured by the Bidder to restrict pollution from the liquid effluent and stack emission within the limits as given below with due consideration of Environment (Protection) Rules 1986 as amended till date.

In case the Ministry of Environment & Forest stipulate any other conditions not specified hereunder while clearing the project shall be complied with the plant by the contractor.

15.01.01

For Liquid Effluent

- a) Provision laid down in schedule-I for Thermal Power Plants and also in Schedule-VI. General Standards for discharge of Environmental pollutants Part-A : Effects of Environmental (protection) Rules 1986, as amended till date.
- b) Any specific requirement of State Pollution Authorities over and above the above stipulation.

15.01.02 For Air Emission

- a) Suspended Particulate Matter i.e. dust burden at chimney outlet - Maximum 50 mg/Nm³(with worst coal and one field out at TMCR).
- b) NO_x - 365 ppm Max. or 750 mg/Nm³ (Equivalent NO₂).
- c) SO₂ - Concentration based standard 2000 mg/Nm³. Load based standard 0.2 metric tonne /MWe/day (for first 500 MW and 0.1 metric tonne/MWe/day for rest of the capacity above 500 MW)

In absence of Indian Standard for emission from power plants as on date, for certain gaseous effluents, the internationally accepted World Bank Standard is to be followed. Indian Standard for emission of power plants are under formulation. Should this standard is published before finalisation of the contract, the bidder has to comply the more stringent of the above norm or the new Indian Standard.

The bidder shall include in his scope all necessary equipment and measuring instruments to comply with above requirements. Location and accessibility of the instruments shall be properly coordinated.

15.02.00 **Noise Level Requirement**

The plant will be designed, constructed and provided with suitable acoustic measures to ensure the noise level criteria as per the following stipulations.

- a) Maximum noise level shall not exceed 85 dB (A) when measured at 1.0M away from the noise emission source.
- b) Maximum noise level from its source within the premises shall not exceed 70 dB (A) as per Environment (Protection) Rules 1986, Schedule-III, 'Ambient Air Quality Standards' in respect of noise.
- c) Any statutory changes in stipulations regarding noise limitation that may occur in future according to State Pollution Control Board or Central pollution Control Board or Ministry of Environment & Forest regulation during tenure of the contract, the contractor shall comply with the requirement.

An exception will be made for the plant at startup operations and other big pressure reducing devices operating during emergency periods and for the safety valves.

16.00.00 **INSPECTION AND TESTING**

16.01.00 **Inspection and Tests during Manufacture**

16.01.01 The method and techniques to be used by the Contractor for the control of quality during manufacture of all plant and equipment shall be agreed with the Owner prior to the Award of Contract.

16.01.02 The Owner's general requirements with respect to quality control and the required shop tests are set out elsewhere in this specification.

- 16.01.03 Before any item of plant or equipment leaves its place of manufacture the Owner shall be given the option of witnessing inspections and tests for compliance with the specification and related standards.
- 16.01.04 Advance notice shall be given to the Owner as agreed in the Contract, prior to the stage of manufacture being reached, and the piece of plant must be held at this stage until the Owner has inspected the piece, or has advised in writing that inspection is waived. If having consulted the Owner and given reasonable notice in writing of the date on which the piece of plant will be available for inspection, the Owner does not attend the Contractor may proceed with manufacture having forwarded to the Owner duly certified copies of his own inspection and test results.
- The Contractor shall forthwith forward to the engineer duly certified copies of the Test Certificates in six copies (one to the Purchaser and five to the Consulting Engineer) for approval. Distribution of six (6) copies of Test Certificates for approval will be two(2) copies to owner and four(4) copies to consultant. These four(4) copies will be further distributed by consultant after approval to owner, site and bidder. One copy will be retained with the consultant for record purpose.
- Further, nine (9) copies of Shop Test Certificates shall be bound with Instruction Manuals referred to elsewhere. Distribution of nine (9) copies of Shop Test Certificates for approval will be Two (2) copies to owner, Three (3) copies to site, Two (2) copies to consultant, Two (2) copies to owner's library / record.
- 16.01.05 Under no circumstances any repair or welding of castings be carried out without the consent of the Owner's Engineer. Proof of the effectiveness of each repair by radiographic and/or other non-destructive testing technique, shall be provided to the Engineer along with Defect Map.
- 16.01.06 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 Contractor shall allow for trial assembly prior to despatch from place of manufacture.
- 16.01.07 All materials used for the manufacture of equipment covered under this specification shall be of tested quality. Relevant test certificates shall be made available to the Purchaser. The certificates shall include tests for mechanical properties and chemical analysis of representative material or any other test as required by approved QAP/ Material specification.
- 16.01.08 All pressure parts connected to pumping main shall be subjected to hydraulic testing at a pressure of 150% of shut-off head for a period not less than one hour. Other parts shall be tested for one and half times the maximum operating pressure or as required by design code of that part, for a period not less than one hour.
- 16.01.09 All necessary non-destructive examinations shall be performed to meet the applicable code requirements.
- 16.01.10 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 magnuflux 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.
- 16.01.11 Statutory payments in respect of IBR approvals including inspection for design and manufacturer of equipment shall be made by the Bidder. All payment for erection

and testing at site (i.e. under IBR jurisdiction) shall also be made by the Bidder. In such case Contractor's scope shall also be extended to preparation of all necessary documents, co-ordination and follow-up with IBR authorities for above approval.

16.02.00 Performance Tests at Site

16.02.01 The full requirements for testing the system shall be agreed between the Owner and the Bidder prior to Award of Contract. The completely erected System shall be tested by the Contractor on site under normal operating conditions. The Contractor shall also ensure the correct performance of the System under abnormal conditions, i.e. the correct working of the various emergency and safety devices, interlocks, etc.

16.02.02 The Bidder shall provide complete details of his normal procedures for testing, for the quality of erection and for the performance of the erected plant. These tests shall include site pressure test on all erected pipe work to demonstrate the quality of the piping and the adequacy of joints made at site.

16.02.03 The Contractor shall furnish the quality procedures to be adopted for assuring quality from the receipt of material at site, during storage, erection, precommissioning to tests on completion and commissioning of the complete system/equipment.

16.03.00 For details of specific tests required on individual equipment refer to respective section of this specification.

17.00.00 TRAINING OF OWNER'S PERSONNEL

The Contractor shall extend all possible assistance and co-operation to the Purchaser regarding the transfer of technology and developing expertise in the area of engineering operation and maintenance of the Plant.

Number of man-days of training as mentioned below shall be included in his Tender.

17.01.00 Training at Contractor's Premises

The Contractor shall conduct training of sixty (60) engineers of the Owner on engineering, operation and maintenance of the Plant at the Contractor's or Associates or Sub-contractor's premises where adequate training facilities are available during the design and manufacturing stage of the Contractor.

The total man-months for training of engineers shall be maximum sixty (60), having following indicative break-up :

Discipline	No. of Engineers	No. of Man-month
Operation	20 heads	20
Maintenance Boiler, Turbine, Mechanical	20 heads	20
Electrical Maintenance	8 heads	4
Control & Instrumentation	8 heads	4
Maintenance Planning	4 heads	2
	-----	-----
	60 heads	60
	-----	-----

However, the details of the training programme will be discussed and finalised with the successful Bidder.

The training may also be arranged by the Contractor in any Plant where the equipment manufactured by the Contractor or his Associates is under installation, operation or testing to enable the trainees to become familiar with the equipment being furnished by the Contractor. All expenses inherently related to the training shall be borne by the Contractor and shall include but not limited to travel expenses (international and inland fares), lodging and per diem charges as well as medical insurance, instructors fee, programme and miscellaneous cost to be incurred during the training.

The training programme shall be adequate for the trainees to acquire the necessary expertise and competence in the area of engineering, operation and maintenance and as trainers for in-house technology transfer programme of the Purchaser.

The Contractor shall be responsible for the development of the Training Module and Programme Schedule which shall be submitted to the Purchaser for approval.

The components of the training modules shall include but not be limited to the training procedures/methodology, instructional materials such as audio visual materials, CDs and slides and manuals for each trainee.

Three (3) sets of the materials included in the training modules shall be handed over to the Purchaser upon completion of the training. An evaluation shall be jointly undertaken by the Contractor and the Purchaser's representative on the adequacy, appropriateness and relevance of the training and the programme effectiveness after the training. The training material shall be in English language only.

The content of the training programme shall include but not be limited to:

1. Coal fired thermal plant principles in management and practice for operators, technicians and maintenance personnel.
2. Plant operation and systems training for operators including simulator training as applicable.
3. Maintenance training programme covering electrical, mechanical and instrumentation and control.

Said training programme shall be submitted to the Purchaser for approval.

The timing of the training should be such that the participants will be conversant with sufficient know-how to participate in the pre-commissioning and commissioning tests of the Plant.

The Contractor shall provide qualified English speaking instructors and training coordinator(s) during the tenure of the training programme.

17.02.00 **Operation and Maintenance Training at Site**

The Contractor shall provide a comprehensive training programme related to design application, plant management, operation and maintenance, including trouble shooting, of the Contractor's supplied system and equipment at the Site starting from Start of Commissioning and thereafter up to the Final Acceptance of the first Unit.

The following instructors shall be at the Site continuously during the training :

- a) One (1) for Steam Generator and Auxiliaries ;
- b) One (1) for Turbine Generator and Auxiliaries ;
- c) One (1) for Electrical Works ;

- d) One (1) for Instrumentation and Control (Boiler and Auxiliaries) ;
- e) One (1) for Instrumentation and Control (Turbine and Auxiliaries).

17.03.00 **On-the-Job Training**

During the period of pre-commissioning, commissioning and trial operation, the Purchaser shall provide operation and maintenance personnel to assist the Contractor in the operation and maintenance of his supply and work under the direction of the Contractor for the purpose of on-the-job training.

The Purchaser shall have the right to send to the Site his employees later intended to operate and maintain the equipment supplied under this Contract. The Contractor shall, without additional cost, use his site staff to instruct these employees on the operation and maintenance of the equipment. All instructions shall be in the English language.

17.04.00 For detail C&I training refer to Volume-VI, Section-9.

18.00.00 **DEVIATIONS**

The Bidder is required to submit with his proposal in the relevant schedules a detail list of any and all deviations taken by him clearly without any ambiguity. In the absence of such a list it will be understood and agreed that the Bidder's proposal is based on strict conformance to this specification and no post-contract negotiations would be allowed in this regard.

Unless otherwise specifically indicated in the deviation list, it will be construed and agreed that details indicated in documents & drawings furnished by the Bidder along with the offer is in-line with the specification requirement.

ANNEXURE-I

LIST OF STANDARDS FOR REFERENCE

- a) International Standards Organisation (ISO).
- b) International Electro-technical Commission (IEC).
- c) American Society of Mechanical Engineers (ASME).
- d) American National Standards Institute (ANSI).
- e) American Society for Testing and Materials (ASTM).
- f) American Institute of Steel Construction (AISC). American Welding Society (AWS).
- g) Architecture Institute of Japan (AIJ).
- h) National Fire Protection Association (NFPA).
- i) National Electrical Manufacturer's Association (NEMA).
- j) Japanese Electro-technical Committee (JEC).
- k) Institute of Electrical and Electronics Engineers (IEEE).

- l) Federal Occupational Safety and Health Regulations (OSHA).
- m) Instrument Society of America (ISA).
- n) National Electric Code (NEC).
- o) Heat Exchanger Institute (HEI).
- p) Tubular Exchanger Manufacturer's Association (TEMA).
- q) Hydraulic Institute (HIS).
- r) International Electro-Technical Commission (IEC) Publications.
- s) Power Test Code for Steam Turbines (PTC).
- t) Applicable German Standards (DIN).
- u) Applicable British Standards (BS).
- v) Applicable Japanese Standards (JIS).
- w) Electric Power Research Institute (EPRI).
- x) Standards of Manufacturer's Standardization Society (MSS).
- y) Bureau of Indian Standards Institution (BIS).
- z) Indian Electricity Rules.
- aa) Indian Boiler Regulations (IBR).
- bb) Indian Explosives Act.
- cc) Indian Factories Act.
- dd) Tariff Advisory Committee (TAC) rules.
- ee) Emission regulation of Central Pollution Control Board (CPCB).
- ff) Pollution Control
- gg) regulations of Dept. of Environment, Govt. of India
- hh) Central Board of Irrigation and Power (CBIP) Publication
- ii) The Air Prevention and Control of Pollution Act.
- jj) The Environmental Protection Act
- kk) The Public Liability Insurance Act.
- ll) The Forest Conservation Act
- mm) The Wildlife protection Act.
- nn) The EIA Notification, 1994.
- oo) IS: 14665-Specification for Electric Traction Lift
- pp) Any other statutory Codes/Standards/Regulations

ANNEXURE-II

CRITERIA FOR LAYOUT

ITEM	SPECIFICATION REQUIREMENT
A. Site conditions to be considered	
1. Prevalent wind direction	See wind-rose in plot plan. Also refer Metrological Data.
B. Layout Requirements	
1. Maximum permissible slope in	
a) Rail track	1 in 400
b) Road	1 in 30
c) Sides of unpaved embankment	1 in 2
2. Required road width	
a) Main roads	Refer VII-A, B, C.
b) Auxiliary interconnections	Refer VII-A, B, C.
c) Road to the power house unloading bay :	
• Only for entry to the unloading bay	Yes
• To pass through the unloading bay	No
3. Required minimum horizontal distance between the nearest points of	
a) Plant boundary and the boundary of residential area	(Local municipality/factory rule)
b) Electrical transformer and any other building/facility	As per the Tariff Advisory Committee/ LPA Rules
c) Fire water supply installation and any building/facility subject to fire risk.	As per the Tariff Advisory Committee/ LPA Rules
d) Inflammable liquid (fuel oil, etc.) storage & handling installation and their fencing and other buildings/facilities.	Rules of the Indian Explosive (Indian Explosives Act) and Indian Petroleum Code
4. Required minimum vertical clearance	

a)	Under pipes/cable racks at road crossings	8.0 Metres
b)	Soil coverage over underground pipes	1.0 Metre (minimum)
5.	Railway Wagon clearance	Rules of the Indian Railways
6.	Minimum Clearance between any road edge and building/structure/ any fixed installation.	3 Metres
7.	Required level, above the local developed grade level, of	
a)	top of all roads	150 mm above FGL
b)	all outdoor paved areas	100 mm above FGL
c)	Temporary storage areas, workshops, offices, residence etc. required at the time of erection work.	Yes
d)	Green belt around power plant area	As per environmental guidelines of MOEF, Govt. of India.

BUILDING/ EQUIPMENT LAYOUT REQUIREMENTS

A.	Minimum clear space required at all working and walking areas for operating & maintenance personnel	
1.	Horizontal, in all directions	
a)	Adjacent to any electrical equipment, electrical cables, running (rotating/reciprocating) equipment, safety valve or vent/drain pipe outlet, pipe/ equipment of surface temperature exceeding 60C.	1200 mm
b)	Adjacent to any other plant facilities (including walls/structures)	1000 mm
2.	Vertical (head-room clearance)	
a)	Under any pipe/equipment surface of temperature exceeding 60C and any electrical cables or other electrical items.	2.5 Metre
b)	Under any other plant facilities (including structures, pipes etc.)	2.5 Metre
3.	For all areas where any equipment (including trucks, trolleys and other material handling equipment) will move or maneuver.	Minimum 500 mm clear in all direction from the outer edges of the equipment
4.	Minimum clear hand space required for	
a)	The application of thermal insulation	100 mm

b)	Welding work	150 mm
c)	Bolt tightening	150 mm
B.	Floors, platforms, staircase, ladders, walls, doors & windows	
1.	Statutory Requirement	As per the regulations of Tariff Advisory Committee, Indian National Building Code, Indian Factories Act, Local Municipal Rules, etc.
2.	Operation & Maintenance Requirement	
a)	Adequate floor space shall be kept to permit dismantling, temporary storing and in-situ maintenance of plant & equipment parts, satisfying the clear space requirements stated above. A separate unloading bay for such purpose is required.	Yes
b)	Floors or fixed/portable platforms with stairs/ ladders shall be provided for easy approach to any plant item, including valves, instruments, etc. to be operated, observed and/or to be frequently (more than once a month) maintained.	Yes
3.	Plinth level of all buildings, above the finished grade level	500 mm
4.	Minimum access opening required (with rolling shutter) for transportation, wherever entry of truck for material handling is envisaged	3.5M wide x 4M high or, more depending upon the equipment size to be handled.
C.	Other Maintenance Requirement	
1.	Generator stator handling In case the Generator stator cannot be handled by the turbine house crane, all provisions for its overhauling, including the arrangement to slide the stator on the turbine house floor, the foundation work for stator jacking /lowering assembly, dismantling of building end walls/structures etc. shall be kept.	Yes
2.	Maintenance of the internals/impellers of all important equipment, like boiler feed pumps,	Shall be possible without disconnecting or dismant-

- feed water heaters, Surface Condenser, fans of the boiler draft plant, Intake and circulating water pumps, cooling water pumps, coal mills, compressors, blowers, heat exchangers, fuel oil pumps, filters etc. ling any piping/ducting.
3. Overhauling and handling of the casings for the above items Shall be possible without disturbing/dismantling any piping/ducting not directly connected to them.
4. Crane Approach
Wherever required the unobstructed approach of the crane hook/other hoisting equipment hook to various plant & equipment shall be possible. Yes
- D. Central Control Room
- All electronic equipment other than those directly associated with control, operation or presentation of displays shall be mounted external to the control room in air conditioned control equipment room. Yes
- The bidder shall describe in his bid the proposed layout philosophy of the Central Control Room and Control Equipment Room and the arrangement of equipment best suited for the system offered by him and as per good ergonomically consideration.
- However, as a guide line, following features are given :
- False ceiling and false flooring shall be provided.
 - Uniform height, colouring schemes for cabinets etc. shall be available.
 - The total area of floor space covered by Control Consoles/Panels in the Control Room shall not exceed 15% of floor area.
 - No opening shall be provided from Boiler side.
 - Two double leaf doors, suitably located for entering the Control room shall be provided with opening towards the turbine floor.
 - Cable entry for the panels/consols shall be from bottom and suitable openings shall be provided.
 - The Control Room lighting shall be designed to provide a glare free uniform illumination. The level of illumination shall be minimum 400 LUX.
 - Necessary Air Conditioning shall be provided for Central Control room, Control Equipment Room and SWAS room etc.

- i) Basic amenities like toilet, Tiffin rooms, wash basins, rest rooms etc. shall be provided near the Control Room.
- E. Toilet and drinking water facility Required in all buildings and on all floors wherever operating personnel are to be deployed.

ENGINEERING SERVICES

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	GENERAL
2.00.00	DESIGN COORDINATION MEETING
3.00.00	CO-OPERATION WITH OTHER CONTRACTORS AND CONSULTING ENGINEERS
4.00.00	GUIDELINES FOR ENGINEERING SERVICES
5.00.00	OPERATING MANUALS AND MAINTENANCE INSTRUCTIONS
6.00.00	PLANT HANDBOOK
7.00.00	CONTRACT STAGE DOCUMENT SUBMISSION AND APPROVAL PROCEDURE
8.00.00	TENDER STAGE DOCUMENT SUBMISSION
	ATTACHMENTS
ANNEXURE-1	DISTRIBUTION SCHEDULE

ENGINEERING SERVICES

1.00.00 GENERAL

1.01.00 As part of the overall project management activity, the Contractor shall be responsible for proper engineering and co-ordination of activities during various phases of execution of the contract. The Contractor shall identify a person, designated as Project Manager, with whom the Owner, the Consulting Engineer or the Review Consultant shall interact on matters related to engineering as well as execution of the contract. The Project Manager shall be the single-point contact person on behalf of the Contractor and shall be responsible for all 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 Contractor or on matters involving the Contractor, his manufacturing units and sub-vendors. For the purpose of expediting the Owner or his representative may sometimes interact with the manufacturing units or sub-vendors of the contractors. However, such interaction will not, under any circumstance, dilute the responsibility of the Contractor to provide a fully engineered and co-ordinated package under this contract.

1.02.00 On finalization of the contract, a procedure for exchange of engineering information will be mutually agreed and finalized between the Owner and the Contractor.

2.00.00 DESIGN COORDINATION MEETING

The Contractor and his sub-vendors will be called upon to attend design co-ordination meetings with the Engineer, other Contractors and the Consultants of the Owner during the period of execution of contract. The Contractor 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 ENGINEERS

The Contractor shall agree to cooperate with the Owner's other Contractors and Consulting 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 Engineer shall be provided with copies of all correspondences addressed by the Contractor to other Sub- contractors and Consulting Engineers in respect of such exchange of technical information.

4.00.00 GUIDELINES FOR ENGINEERING SERVICES

4.01.00 Prior to commencement of the 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 engineering work.

4.02.00 Engineering work shall be performed on modern and proven concepts and internationally accepted good engineering practices but fully compatible with the Indian environments. Owner shall have the right to review and approve the engineering work by themselves and/or through consultant and ask for any clarifications and changes/modifications to the work performed by Contractor.

4.03.00 At any stage during the performance of assignment, the Contractor may be required to make certain changes/modification/improvements in design/ drawing/other documents which are applicable to 800 MW Unit, 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 Contractor.

- 4.04.00 During the course of review of detailed 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 engineering, it may be essential in Owner's opinion to obtain data and information on similar equipment and plants engineered by the Bidder. 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 engineering work to be carried out by Contractor, however, all engineering work required for the satisfactory completion of the plant/systems as specified shall be carried out by the Contractor. 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 Contractor 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-contractors.
 - 4.06.03 Review of sub-contractor'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 embedments etc. required for preparation of civil construction drawings and also as referred at relevant sections of Scope, Terminal Points & 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 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.

4.06.12 For all bought out item packages, the Contractor shall provide complete material / component list along with detail specification, drawings, component part no. etc. during detail engineering stage prior to final approval. Such approved drawing/document shall be made available at site in adequate number prior to commencement of work. Moreover, such document/drawing shall be provided in soft form (CD)

4.06.13 Preparation of necessary documentation, design calculations etc. required for submission to statutory authorities like IBR, Chief Electric Inspector, Factory Inspector etc.

5.00.00 OPERATING MANUALS AND MAINTENANCE INSTRUCTIONS

5.01.00 The Contractor shall provide at least six (6) months before the time of commissioning and before taking over of the plant and equipment, all necessary maintenance manuals and operating instructions. The instruction manual shall be submitted in the form of one (1) soft copy in CD and 15 hard copies as per distribution schedule (Annexure-1).

5.02.00 The information provided, which shall be contained in loose leaf stiff backed covers, shall include:

- a) A complete inventory of all main items of plant, with identification details.
- b) Service manuals for all plant and equipment giving full descriptions of the main items and auxiliary items such as power packs, hydraulic equipment, actuators, lubricating pumps, etc.
- c) A separate electrical manual covering items such as switchgear, cabling, instrumentation, controls, cabling layouts and wiring diagrams.
- d) A schedule of recommendations for routine maintenance of all electrical and mechanical equipment, recommended inspection point, information on detection, cause and rectifications of troubles & faults.
- e) A lubrication schedule with all necessary drawings diagrams to identify the lubrication points.
- f) Manufacturer's literature.

5.03.00 The instruction manual shall be subject to the approval of Owner.

6.00.00 PLANT HANDBOOK

The Contractor shall submit to the Engineer, a preliminary plant handbook preferably in A-4 size sheets which shall contain the design and performance data of various plant, equipment and systems covering the complete project including single line flow diagrams, within twenty-four (24) months from the date of his acceptance of the Letter of Intent. The final plant handbook complete in all respects shall be submitted by the Contractor six (6) months before start-up and commissioning activities. The plant handbook shall be submitted as per distribution schedule.

7.00.00 CONTRACT STAGE DOCUMENT SUBMISSION AND APPROVAL PROCEDURE

7.01.00 Within fifteen (15) days to one month of issue of Letter of Intent (LOI) by the Owner, the Contractor shall furnish a schedule of drawings and design document to be submitted by him to the Owner/Engineer indicating dates against each document.

The documents shall be divided into two categories: a) for approval and b) for information/further engineering and co-ordination by the Owner.

In preparing this schedule, the Contractor shall allow two (2) weeks from date of receipt for review and comments by the Owner/Engineer for each submission of a document. This document submission schedule shall require approval by the Owner/ Engineer.

7.02.00 All contract documents shall be marked, without fail, 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.

7.03.00 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/Engineer.

7.04.00 Unless specified otherwise, the following categories of documents/drawings would require approval of the Owner/Engineer:

- a) List of sub-vendors (from Owner only)
- b) System scheme and instrumentation diagrams
- c) Design basis justifying selection of equipment & process parameters where not specified in the Contract
- d) Equipment data sheets and general arrangement drawings
- e) Materials of construction
- f) Layout drawings.
- g) Operation logic diagrams.
- h) Typical control circuit.
- i) Drawings of Instrumentation and control.

7.05.00 Unless specified otherwise, the following categories of documents/ drawings would be treated for information/further engineering by the Owner/Engineer. The Contractor shall, however, incorporate all additional information and clarifications in these documents / drawings as and when desired by the Owner/Engineer.

- a) Equipment foundation drawings.
- b) Equipment cross-section drawings, product literature etc. which are of proprietary nature.
- c) Predicted performance curves of equipment. Various bills of quantity, schedules etc
- d) Piping fabrication drawings, isometrics etc.
- e) Panel wiring diagrams.
- f) Instruction/Operation manuals.
- g) Service manuals and troubleshooting guide for C & I system including field instruments.

- h) Cable schedule and interconnection chart.
- i) Drive/feederwise control scheme showing all external interfaces.

In essence, the Contractor is solely responsible for corrections and adequacy of design & engineering for documents under this category.

7.06.00 Upon review, the Owner/Engineer shall put his remarks and one of the following action stamps on the drawing/document:

- a) A - Drawing submitted as approved, proceed with fabrication
- b) B - Drawing approved subject to comments noted, proceed with fabrication, considering our comments. Correct as necessary and resubmit for record.
- c) C - See attached memo.
- d) D - Correct your original drawing incorporating our comments and resubmit for approval.
- e) E - Information furnished is noted.
- f) F - Prints not enclosed

For action stamps in category (c) & (d), documents must be resubmitted for review by the Owner/Engineer. For action stamp in category (b), further review by Owner/Engineer would not be necessary provided the Contractor agrees & incorporates the comments made on the document.

Except for action stamp under category (c) & (d), the Contractor 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/ Engineer.

The Owner/Engineer 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 Contractor shall be responsible for delay in such cases and no extension of time shall ordinarily be allowed on such grounds. Approval of contract documents by the Owner/ Engineer shall not relieve the Contractor of his responsibility for any errors and fulfillment of contract requirements

The Contractor's work shall be in strict accordance with the finally approved drawings and no deviation shall be permitted without written approval of the Owner/Engineer.

7.07.00 Except key plan/general yard plan, any layout drawing requiring scrutiny shall not be drawn to a scale less than 1:50.

7.08.00 For review by the Consulting Engineer, the Contractor shall furnish soft copies of drawings & documents and three (3) prints of each drawing/ document. Two (2) prints of such submission shall also be sent to the Owner. After review, comment/approval will be sent to the Contractor. Upon action under category (a) or (e), the Contractor shall directly distribute the documents to the various offices of the Owner and other agencies in number of copies as specified in the contract document. Such distribution copies shall be marked with the reference and date of the letter by which the Owner/ Engineer has accorded his final approval. Penal action shall be taken against the Contractor for any unauthorised revision in the drawings so distributed from the drawings approved by the Owner/Engineer. The contractor shall furnish three (3) CDs of all as built/final drawings for Owner/Consultant site.

7.09.00 In case of contradiction between the stipulations above and those stated elsewhere in the specification, the stipulations herein shall prevail. 7.10.00.

8.00.00 TENDER STAGE DOCUMENT SUBMISSION

8.01.00 The Bidder shall submit along with his bid all documents/drawings as requested in respective specifications. 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) L-1 network indicating target dates for intermediate milestones and final commissioning of equipment supplied; This network shall be supplemented by a detailed write-up on proposal procedure of project implementation, deployment schedule for Key personnel with their bio-data, schedule of construction machinery etc.

PROJECT MANAGEMENT AND SITE SERVICES**CONTENT**

CLAUSE NO.	DESCRIPTION
1.00.00	PROJECT MANAGEMENT SERVICES
2.00.00	SITE SERVICES
3.00.00	PROJECT INFORMATION AND MANAGEMENT SYSTEM, INCLUDING DOCUMENT MANAGEMENT SERVER (DMS)

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) Engineering Management
- c) Contracts Management
- d) Project Safety Management
- e) Quality Assurance, Inspection & Expediting
- f) Construction Management
- g) Spares Management
- h) Erection & Commissioning Management

Detailed responsibilities in the above areas are discussed below :

1.02.00 Organisation

1.02.01 Headquarters

The headquarters of the project management team shall be 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 relative to this contract.

1.02.02 Central Co-ordination Cell

The central coordination cell 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 schedule for the completion of the Project would be as follows:

Period in Months from Zero date (Taken as advance payment date of EPC Package)

a) Boiler Hydro-test By Bidder

b) Boiler light up By Bidder

c) Commercial operation

To achieve these targets, the Contractor shall furnish to the Owner, various schedules as defined below:

1.03.01 Engineering Schedules

These schedules shall cover various design submissions indicating different 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 Engineer his manufacturing and delivery schedules for all equipment within thirty (30) days from the date of issue of the Letter of Intent (LOI). 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 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 Level1 (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, SAP.

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.

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 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 packagewise status of 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 Engineering Management

Based on the master network for the project (L-1) the Contractor will prepare an exhaustive list of 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 engineering activities.

Based on (L-2) network, the Contractor shall further develop the Level-3 (L-3) network for 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 Intent and finalised within one (1) month thereafter.

All such networks shall be provided in MS PROJECT software as well as in other format / software suitable to Owner.

The engineering management team should also co-ordinate all interface engineering activity between the Contractor and the equipment sub-vendors so as to ensure the correctness and completeness of related engineering documentation before the same is submitted to the Owner.

TSGENCO is implementing SAP ERP. Hence the bidder apart from submission of the hard copies shall upload all the documents, drawings etc. in soft format in the relevant C- folder environment (web based) and comply with the additional requirements, if any.

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 manufacture 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 boughtout 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 manufacture 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 Intent. 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 twelve (12) 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 upto 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 Intent, 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 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 of the project will be held initially at least once in two (2) months at Hyderabad/site/ at the discretion of the Owner.. 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) Steering Committee
- b) Commissioning Panel.
- c) Working Parties
- d) Testing Teams.

1.07.02 Commissioning documents shall be prepared by the Contractor in the following manner and submitted for Owner's approval :

- a) Field Quality Plan

This document shall be prepared for the various equipment/ systems under commissioning and shall have the following objectives to fulfil 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 check lists 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-a-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/ Road Transportation, 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 Engineer a report detailing all the receipts during the week as well as storing, preservation of material at site.
- 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.

Apart from Boiler, proper chemical cleaning shall be carried out in following pipe lines/equipment before commissioning

- a) Deaerator
- b) Boiler feed suction, recirculation leak-off lines
- c) Boiler Feed discharge line by passing heaters
- d) At temperation lines
- e) Condensate suction & discharge piping upto deaerator by passing the feed water heaters.
- f) Fuel oil lines.

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. Safe disposal of effluent after chemical cleaning shall be done by the contractor.

2.07.00 Supply and application of the final paints and first fill lubricants on all the equipment to be erected under this specification. Supply of chemicals, lub oils and other consumables upto COD.

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.

2.08.03 Supply of all consumables, e.g. welding electrodes, cleaning agents, diesel oil, grease, lubricant etc. as well as materials required for temporary supports, scaffolding etc. as necessary for such erection work 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, Electrical Inspector 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 the regard.

2.08.09 The successful Bidder shall arrange for Tower cranes of adequate capacity for speedy erection activities.

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 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 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.

2.10.03 The Engineer shall hold weekly meetings of all the Contractors working at Site at a time and a place to be designated by the Engineer. The Contractor shall attend such meetings and take notes of discussions during the meeting and the decisions of the Engineer and shall strictly adhere to those decisions in performing his Work. In addition to the above weekly meeting, 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 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 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 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 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. 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 equipment for checking and cleaning, surface preparation, edge preparation, fabrication of tubes and pipes as per general 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 Engineer and as per the Standards.
- 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 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 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 Engineer, with all the necessary tools & tackle, manpower, etc. The alignment will be complete only when jointly certified so, by the Contractor'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 same operation of valves will be arranged by the Contractor.

2.11.00 Safety

Safety and overall cleanliness of work site shall be given top priority.

2.11.01 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 done by the Contractor and certified copies shall be supplied to the Owner. 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 All safety precautions shall be taken for welding and cutting operations as per IS-818.

2.11.12 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 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 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 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 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 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 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 Engineer prior to the commencement of each cycle and handed over to

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 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 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 surface 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 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.

3.00.00 PROJECT INFORMATION AND MANAGEMENT SYSTEM, INCLUDING DOCUMENT MANAGEMENT SERVER (DMS)

3.01.00 Contractor shall submit as part of its Work Scope detailed documentation as outlined in this section and / or required by the Technical Requirements. The content and format of the documentation to be submitted are subject to Owner's approval.

3.02.00 Contractor shall utilise a computer based system for control and management of project documentation. The system must be capable of producing customized reports and information on demand. This control system should have been successfully applied to similar projects and be familiar to the project control personnel selected.

Contractor's detailed project documentation plan shall identify all documentation requirements for the project, the party responsible for production of the document, the basic content of the document and the required timing for issue. This plan shall include, but not be limited to the details of all Drawings to be produced, plant specification / definition documentation, equipment orders and manuals. The documentation identified shall be entered into the computer based control system. The database thus created shall be capable of being sorted and ordered on a variety of selected parameters such as document type, subject description, responsible party, start date and finish date, to enable review and update to be conducted only on those documents which are relevant.

3.03.00 Regular documentation control progress reports shall be prepared by the Contractor to record the status of documentation. In the event either Party or Engineer expresses concern with the content of such progress reports, the accuracy of progress reports, status of documentation production and other such matters, the concern will be identified to the Project Manager. Within five days of notification of this concern, the Project Manager will attend a meeting with relevant Owner Representatives and provide details of specific actions to be initiated to satisfactorily overcome the difficulties identified. It will be the Project Manager's responsibility to initiate whatever action is necessary to ensure that the production of documentation is completely in accordance with Project Information Management System (PIMS).

3.04.00 Within 90 days after Effective Date of Contract, the Contractor shall establish an integrated PIMS which will support the needs of Project and management, detail design and engineering, procurement, construction and operation, and maintenance.

PIMS shall utilise software which links various software and database programs to form a composite system. The typical scope of PIMS shall include, but not be limited to, the following:

(a) Power plant systems and equipment data, from which Project specific flow diagrams, data sheets and other integrated data are derived. The Power plant systems and equipment data, from which Project specific flow diagrams, data sheets and other integrated data are derived. This data shall include, but not be limited to, the following:

(i) System descriptions and design requirements and design criteria

(ii) Equipment and material technical specifications for all engineering disciplines

- (b) Detail engineering data to create flow diagrams, plant arrangements, piping configurations, equipment layout and design, electrical and instrumentation systems, structures, and other systems. The software tool used shall be capable of manipulation and storage of plant layout and design information. The 3D model of the plant shall also contain details of the various components like pipe, structural steel work, etc., and relevant information shall be available on-line from relevant data base. Software shall be multi-user, multi-access nature allowing the designers of Contractor and major Sub-Contractors, if required, to work in interactive real time environment and software shall be capable of interference checking. The software shall allow access to different types of information held in the database. It shall estimate the type and quantity of materials required to build the plant and it shall be possible for such data to be taken off the system at any time.
- (c) Construction data to monitor and manage site activities, including material control, scheduling and progress, quality control, start-up and testing, operation, maintenance, training, and all other site functions.
- (d) Plant design and construction records to provide data for safe and efficient maintenance and operation. Records to include may be maintenance schedule, man power tracking, tools, spare parts, and test equipment inventory, equipment list, drawing, control, technical specifications, and equipment instruction manuals.

3.05.00 The PIMS shall be installed in a distributed processing array system and operated through personal computer work stations at the Contractor's site office. A complete integrated system shall be implemented. This system shall be utilised by Contractor during the Project execution.

**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.
- 2.04.00 **Mandatory Spare Parts**
- 2.04.01 The Owner considers some of the spares are essential for running the equipment irrespective of whether they are included in the list of recommended spares by the Bidder as mentioned above.

Since the components involved can not be foreseen at the bidding stage, only

broad requirements of the Owner in this respect are outlined hereinafter. The bidder shall include his proposal, on the basis of this guideline, an item-wise list of all components and the quantity, unit prices & total price thereof, offered as mandatory spares for each and every equipment. This list shall be separate from the list of recommended spares and shall be used for bid evaluation purposes. Any clarification in this respect may be obtained by the Bidder at the pre-bidding stage.

2.04.02 The mandatory spares should be supplied to the Owner at least one month before the trial run. The despatch programme is subject to approval of the Owner/Consultant after award of contract.

2.04.03.1 Criteria for selection of Quantity of Mandatory Spares :

For Mandatory Spares refer **Annexure-1**

2.04.04 Purchaser will have the option to procure any or all of the mandatory spares at his discretion.

TELANGANA STATE POWER GENERATION CORPORATION LIMITED [TSGENCO]



5 x 800MW YADADRI TPS

DESIGN CRITERIA FOR CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

**DOCUMENT NO. PE-DC-417-600-C001
(REVISION-00)**

**IN THIS DOCUMENT 1X800 MW KOTHAGUDEM SHALL BE READ AS
5X800 MW YADADRI THERMAL POWER STATION**



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**

PROJECT ENGINEERING MANAGEMENT
(CIVIL ENGINEERING DEPARTMENT)
CALCULATION SUMMARY SHEET



PROJECT TITLE 5 X 800MW YADADRI TPS

JOB NO. 417 DOCUMENT NO. PE-DC-417-600-C001

BUILDING/SYSTEM DESIGN BASIS REPORT(DBR)

SUBJECT DESIGN CRITERIA FOR CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

REV NO.	PARTI- CULARS	PREPRD. BY	CHKD. BY	APPD. BY	REMARKS
00	NAME	SV	SJ	TKM	FOR APPROVAL
	SIGN	-SD-	-SD-	-SD-	
	DATE	08-11-2017	10-11-2017	10-11-2017	
01	NAME				
	SIGN				
	DATE				
02	NAME				
	SIGN				
	DATE				

1.0 REFERENCES:

1. 1X800MW KOTHAGUEDEM TPS of TSGENCO TECHNICAL SPECIFICATION FOR CIVIL, STRUCTURAL & ARCHITECTURAL WORK INCLUDING NDCT.
2. 1X800MW KOTHAGUEDEM TPS of TSGENCO Technical Clarification/Deviation.
3. MOM DATED 05-05-2015.
4. MOM DATED 04-10-2017.
5. MOM DATED 03-10-2017.

PREFACE

This document covers design criteria for civil, structural and architectural works along with scope of civil work for 5X800MW Yadadri TPS. As this project is based on 1X800 MW Kothagudem TPS, all the Kothagudem civil deviations are incorporated in following document along with the changes sought in Civil Technical Specifications (Part A & B) for 5X800 MW Yadadri TPS. All the agreed deviations and changes sought have been marked against relevant clause in Kothagudem Civil Technical Specifications(Part A & B).

Deviations and changes sought are attached as Annexure A & B followed by minutes of meetings dated 05-05-2015 & 04-10-2017 and letter for Wind & Seismic Loads.

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1x800 MW Kothagudem TPS

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TELANGANA STATE POWER GENERATION CORPORATION LIMITED

KOTHAGUDEM, TELANGANA , INDIA

1x800 MW KOTHAGUDEM THERMAL
POWER STATION

STAGE-VII, UNIT#12

OVERALL CONTENT

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

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VOLUME : VII-B	:	GENERAL SPECIFICATION AND DESIGN CRITERIA FOR ARCHITECTURAL WORK
VOLUME : VII-C	:	TECHNICAL SPECIFICATION FOR CIVIL, STRUCTURAL AND ARCHITECTURAL WORK
~~VOLUME : VII-D~~		~~TECHNICAL SPECIFICATION FOR COOLING TOWER~~

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VOLUME : VII-B	:	GENERAL SPECIFICATION AND DESIGN CRITERIA FOR ARCHITECTURAL WORK
VOLUME : VII-C	:	TECHNICAL SPECIFICATION FOR CIVIL, STRUCTURAL AND ARCHITECTURAL WORK
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SECTION-II	:	GEO TECHNICAL INVESTIGATION
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SECTION-IV	:	EARTHWORK IN EXCAVATION AND BACKFILLING
SECTION-V	:	CEMENT CONCRETE – PLAIN AND REINFORCED
SECTION-VI	:	DRIVEN PRECAST CONCRETE PILES
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SECTION-VIII	:	BORED CAST IN SITU CONCRETE PILES
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SECTION-X	:	ERECTION OF STRUCTURAL STEEL WORK
SECTION-XI	:	ROADS AND DRAINAGE
SECTION-XII	:	CONSTRUCTION OF REINFORCED CONCRETE CHIMNEY
SECTION-XIII	:	PROPERTIES, STORAGE AND HANDLING OF COMMON BUILDING MATERIAL
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**GENERAL SPECIFICATION AND DESIGN CRITERIA
FOR
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VOLUME : VII-A

GENERAL SPECIFICATION AND DESIGN CRITERIA FOR CIVIL AND STRUCTURAL WORKS

1.00.00 GENERAL

This specification is intended to cover general as well as technical specification required for design, supply, execution & erection of complete Civil, Structural and miscellaneous work required for completion of 1x800 MW Super Critical Thermal Power Plant to the satisfaction of the Owner.

The work shall include design, construction and erection activities of both underground and above ground civil and structural work and shall include all working drawing, labor, materials, plants, equipment, transportation and all incidental items not shown or specified explicitly but reasonably implied and necessary for proper completion of the project, all in strict compliance with this specification, including the revision and amendments thereto as may be required during the execution of the work.

The work shall be carried out according to the design/drawing to be developed by the Contractor and approved by the Owner/Owner's Consultant. For all building, structure, foundations, roads, drainage, necessary details and layout shall be prepared by the Contractor keeping in view the functional requirement of the plant and the facilities and providing enough space and access for operation use and maintenance. The drawings and specifications attached herewith do not provide complete description of each and every system but state the minimum functional requirement for the plant as a whole or certain individual components.

All the quality of work and standards pertaining to field and laboratory testing, excavation, concreting, fabrication, erection, welding and other technical requirements shall strictly conform to the Technical Specification for Civil, Structural and Architectural Work - Volume VII-C of this Bid Document. The specifications are intended for the general description of the work, quality and workmanship. The specifications are not, however, intended to cover the minutest details and the work shall be executed according to the spirit of the specification and in the absence thereof according to the relevant latest Indian Standard Codes. In absence of the later, the work shall be executed according to the local public work department practice or to the recommendation of relevant American & British Standards or to the instruction of the Owner. The IS Codes to be followed are mentioned in the relevant Technical specification for different items of work. All civil and structural work shall conform to approved Architectural drawing wherever applicable and General Specification and Design Criteria for Architectural Work - Volume VII-B of this bid document.

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The bidder is expected to get clarified any doubts about the specification etc., before bidding through discussion with the Owner recorded in writing in respect of interpretation of any portion of this documents. The Owner reserves the right to alter/amend any part/criteria of this specification in the interest of the project without creating any financial implication whatsoever on the part of Owner.

Before bidding the contractor shall visit the site to get fully acquainted with site condition, approaches, transport facilities, off-site facilities, availability of materials, storage space, fabrication and bar bending yard, accommodation of workmen, site office, testing laboratory and other assorted facilities. The bidder or its consultants, if any, shall have well-equipped design office with modern drafting, validated civil/structural analysis and design soft-wares, computing and transmission facilities to comply with high rate of drawing/document production pertaining to civil & structural system to meet the stipulated time frame laid down in the specification. No extra claim shall be entertained for any unforeseen reason.

The contractor's offer shall cover the complete requirements as per the best prevailing practices and to complete satisfaction of owner.

2.00.00

SCOPE OF CIVIL AND STRUCTURAL WORK

The scope of civil and structural work comprises all necessary investigations, survey, foundations, buildings, substructures, superstructures and infrastructure required for the effective functioning of various systems of the power plant whether or not they are specifically mentioned.

The scope of work includes all the following work in conformity with approved Mechanical / Electrical layout drawings but not limited to the following.

A.

Site preparation

Demolition of existing structure is in TSGENCO scope, the ground shall be leveled upto existing ground level after dismantling by TSGENCO. However, the final leveling and grading upto FGL of the plant as per plot plan including cutting of shrubs/trees shall be in BHEL scope. Any clearance required for cutting of shrubs/trees shall be provided by TSGENCO. As per point no 01 (Civil) of agreed deviation in KTPS.

~~In general, demolition of existing quarters, leveling and grading of the site will be taken up by TSGENCO. Any additional site preparation work required in detail engineering stage will be in bidder's scope.~~

- Detail Soil investigation including measurement of soil resistivity.
- Excavation, dewatering, shoring and strutting, backfilling ,disposal of surplus soil outside of plant boundary as per requirement
- Dewatering /slope protection work if required

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B. Power Block area

Paving level from chimney to Power house shall be 250 mm above FGL. Elevation of *uls* of base plate for equipments outside building shall be kept at same level of Paving which will be encased with concrete for a height of 250 mm above paving. As per point no. 68 (Civil) of agreed deviation in KTPS.

- Power house building including Control room, Crane girder, Turbo Generator foundation and other equipment foundations. Crane capacity and crane rail level shall be fixed based on the equipment to be lifted and the method of lifting generator stator. At crane girder top flange level a crane walkway shall be provided in line with factory rules. Access shall be provided to crane walkway through staircase from operating floor in addition to cage ladders at two ends.
- Boiler area foundations including Boiler, ESP, Fan foundations, Duct supporting columns and other foundations (Equipment and structural steel work for boiler and auxiliaries will be covered under mechanical sections)
- Boiler area paving with drainage (Roads & Drains are in TSGENCO Scope.)
- Mill Building including coal bunkers and mill foundations
- Mill reject loading hoppers
- ESP Control Room
- Chimney

C. Transformer yard (Roads,Rail cum Roads & Drains are in TSGENCO Scope.)

- Transformer yard foundations and substructure including Transformer foundations, Bus duct supporting structures and foundations, foundations for pylon and deluge valves for transformer fire detection and protection system, Rail track, fire wall, common oil pits, electrical trenches, pull pits and duct banks, drainage, gates, fencing, paving etc. all complete.
- RCC roads within switchyard, fire protection walls and chain link fencing for switchyard. RCC paving shall be provided in Transformer Yard.
- All other buildings structures and foundations as per approved electrical layout

D. Switchyard (Roads & Drains are in TSGENCO Scope.)

- Switchyard structures, foundations, drains, pits, switchyard roads, RCC cable trench, gate, fencing, paving in yard using fly ash bricks in panels with pointing wherever required etc all complete.

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For prevention of vegetation, the graded ground shall be covered with fly ash bricks pavement over 300 mm ash filling to be provided in the switchyard area. Each fly ash layer shall be compacted/consolidated by using ½ ton roller with 4 to 5 passes and suitable water sprinkling. The method of application of chemicals used for soil sterilization /anti-wed treatment shall be as per manufacturer's recommendation. Also, the RCC pathway shall be provided in switchyard as per the requirement. An approved system for draining the transformer oil collection and disposal system shall be provided.

- Switchyard control room
- All other buildings structures and foundations as per approved electrical layout

E. Coal Handling system (Raw Coal Storage Yard is in TSGENCO Scope)

Separate marshalling yard of 6 lines and one additional line requirement from Gajulagudem to plant about 3 km will be provided to cater to the requirement of proposed unit as per RITE's report attached with the specification as annexure-2. EPC contractor to carry out any new or modification work in such a way that the existing structure and foundations are not disturbed and coal linkage to existing units can be continued un-interrupted.

- Wagon Tippler (2nos)
- Track Hopper
- Conveyor galleries with supporting trestles, and foundations
- In motion weigh bridge
- RCC tunnel
- Transfer points
- Pent house
- Crusher house
- Stacker/Re-claimer foundations
- Reclaim Hopper
- Crushed Coal stock pile yard for a storage of 30 days
- 1,00,000 MT Coal storage shed
- Control room / MCC room for coal handling plant

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- Tanks / Reservoirs, Sumps, Pump Houses, Compressor House for Dust suppression and other utilities and fire fighting system
- All other buildings, structures and foundations as per approved mechanical layout

F. Ash Handling system

- Ash Slurry sump and pump house
- Bottom Ash overflow sump
- Ash water sump and pump house
- Coarse ash tank and pump house
- Fly ash equipment tower
- Ash blower/compressor building
- Vacuum pump House
- Ash handling plant switchgear cum control room
- Pipe rack for conveying the ash and water pipes
- Ash pipe corridor including providing proper drainage arrangements within the plant area.
- Fly Ash Storage Silo (2 nos.) with concrete approach road
- Silo utility building
- HCSD Pump shed
- Mill reject silo
- Foundations for clarifier and other equipments as per system requirement

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- Ash pond by construction of earthen bund in extent of Ac.230.00 of land under acquisition including the construction of respective spillway, decantation well and RCC vent for relieving the water from ash pond in to the natural drain.
- Ash water recovery pump house.
- → Civil foundations for 100 MT capacity weigh bridge for weighing the ash trucks as per site requirement during detailed engineering.
- All other buildings, structures and foundations as per approved mechanical layout

Other than Silo area weigh bridge(capacity 100 tonnes), additional weigh bridge at store area of capacity 100 tonnes is required by TSGENCO. Further no weigh bridge is required at Entry gates. BHEL confirmed to provide the same. As per point 4 (General) of agreed deviation in KTPS.

G. Fuel oil System

The HFO/LDO required for the proposed Unit will be pumped from Fuel Oil system to the day tanks.

EPC contractor to carry out any modification work for enhancement of capacities of existing system such that the existing structure and foundations are not disturbed.

- HFO/LDO Day Tank foundations and dykes with RCC pavement.
- HFO/LDO pipe supporting pedestals.
- HFO/LDO Forwarding Pump House
- HFO/LDO Pressurising Pump House
- All other buildings, structures and foundations as per approved mechanical layout.

H. Raw water supply and pretreatment system including Intake

- Re-routing of existing GRP pipe line passing through the new plant area using MS pipe line of 1200 mm dia.
- Raw Water Reservoir (Complete Raw Water Reservoir(on as is where is basis) in TSGENCO scope)
- Raw Water Pump House

EPC Contractor to carry out any modification work for enhancement of capacities of existing system such that the existing structure and foundations are not disturbed and water linkage to existing units can be continued un-interrupted.

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- Clarified water storage tank
- Clarified water pump house
- Aerator
- Stilling Chamber
- Distribution Chambers
- Solid Contact Clarifier with approach stair cases to be provided diagonally at two sides of clarifiers.
- Rapid gravity filter
- Filtered water Reservoir and Pump House
- Sludge Sump & Pump House
- Filter Backwash Waste Sump & Pump House
- Chemical House cum RWPT Chlorination Building
- All other buildings, structures and foundations as per approved mechanical layout.

I. Demineralised & Potable water supply system

- DM Plant Building
- DM-Neutralizing pit and Pump House
- Potable water tank with the necessary pipe lines to all the buildings.
- All other buildings, structures , tanks and foundations as per approved mechanical layout

J. Condensate Polishing System

- CPU – Regeneration Building
- CPU- Neutralizing pit and Pump House
- All other buildings, structures , tanks and foundations as per approved mechanical layout

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- Natural Draft cooling tower
- Cooling water pipes and return pipes upto inlet flange of cooling tower including their supports and foundations, thrust blocks etc. wherever required
- CW pump house and fore bay alongwith a walkway with handrails across the forebay adjacent to CW pumphouse, channel from NDCT to CW pump house
- Provision of gates to facilitate dewatering and cleaning of sump.
- CW Treatment Plant cum Chlorination Building
- All other buildings, structures and foundations as per approved mechanical layout

L. Fire fighting system

- Fire water tanks
- Fire water pump house
- Foundations for Pylon and deluge valves
- Deluge Valve canopy with RCC slab.
- All other buildings, structures and foundations as per approved mechanical layout.

M. Waste Water Treatment System

- Boiler Blow Down Drain Pit and P/H
- Backwash Waste Water from SSF Collection Pit and P/H
- Central Monitoring basin
- CMB Effluent Transfer P/H
- Flocculation Tank, Inclined Surface Settler
- Inclined Surface Settler Sludge Pit and P/H
- Coal Particle Settling Basin

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- Coal Decanted Water Sump and P/H
- Sludge Thickener
- Centrifuge Building
- Chemical House for WWTS
- Retention Pit for Transformer Yard Oily Waste Pit and P/H
- Retention Pit for TG Building Area Oily Waste and P/H
- Retention Pit for Fuel Oil Storage Area Oily Waste and P/H
- Pre Oil Water Separator Retention Pit and P/H
- Retention Pit for Treated Effluent from OWS and P/H
- CPI Sludge Pit and P/H
- All other buildings, structures and foundations as per approved mechanical layout.

N. Centralized Sewage Treatment System

- Fixed Bar Screen Chamber
- Sewage Equalization Sump and P/H
- Extended Aeration Tank
- Settling Tank
- Clear Water Storage Tank
- Clear Water Transfer P/H
- Treated Water Storage Tank and P/H
- EPC Contractor will finalise required number and strategic locations of individual sewage lifting stations during detail engineering, subject to approval of the owner / owner's consultant.
- Finalising the location and size of centralized STP subject to approval of the owner / owner's consultant will also be in the scope of contractor.

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- All civil and structural work associated with Sanitary sewer disposal system including inspection pits, manholes etc. for all buildings and facilities, providing sewerage pumps & pump houses, the pipelines connecting the individual sewage lifting stations with the central STP as per approved lay-out , will be within the scope of this contract.

O. Other Utility services and Non-plant Building

- Pipe and Cable racks
- Mill Reject handling compressor room and silo
- DG Building
- Air Washer Building and Compressor House
- Bulldozer shed and auto repair shop (Dozer Shed in TSGENCO Scope)
- Ware house and chemical / hazardous stores
Hydrogen Generation Plant Building.
- AC Plant room
- VFD Building (if applicable)
- CPU Regeneration building
- Water Harvesting Well (in TSGENCO Scope)
- Guard pond
- Overhead storage water tank for potable water and service water
- Parking Sheds (in TSGENCO Scope)
- Service building including workshop (in TSGENCO Scope)
- Stores complex (in TSGENCO Scope)
- Chemical Lab room cum office with office furniture (in TSGENCO Scope)
- Maintenance Tool Room (in TSGENCO Scope)
- Dress change rooms and Locker rooms for workmen. (in TSGENCO Scope)
- Storage yard including storage sheds (in TSGENCO Scope)
Main Gate Building and Security building are in TSGENCO Scope
- Canteen building (in TSGENCO Scope)
Fire Station Building(In TSGENCO Scope)

Dimension shall be 20X19 m. Out of that 120 sq. m area shall be given for Office room, O & M staff room, room for spares, tools and toilet. Balance shall be Bull dozer repair area with Metal sheeting roof over trusses and purlins. All room shall be RCC frame work with masonry and RCC Roof.As per point no 02 (Civil) of agreed deviation in KTPS.

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- . Rainwater Harvesting System (In TSGENCO Scope.)
- Weigh Bridge Control Rooms
- . Simulator Building (In TSGENCO Scope.)
- Township (In TSGENCO Scope)
- . Hydrogen Storage Shed (In TSGENCO Scope.)
- Security gate and Watch towers in plant and Township (In TSGENCO Scope.)
- . Landscaping (In TSGENCO Scope.)
- Potable water system which shall be constructed in the plant at water treatment plant and pipe line shall be laid from PTP system up to 10 m beyond plant boundary as per the route shown during detailed engineering for supply of potable water to colony. Necessary pipeline network shall be provided in the plant by the bidder for supply of potable water in the plant to different locations.
- . Administration Building(In TSGENCO Scope.)

Potable water distribution within the building shall be in scope of TSGENCO for areas covered under its scope.

P. Plant roads and drainage (All Roads, Drains & Culverts are in TSGENCO Scope.)

- All internal roads, culverts & pavement within the battery limit of this specification.
- Some of the requirement for main roads is indicated on Plot Plan. However, additional roads and access to individual buildings/structures/facilities which are not specifically shown in layout but where access is necessary from inspection, operation & maintenance point of view, they shall be required with suitable designed pavement with RCC and shall be provided by the EPC Contractor.
- The scope shall also include modification and diversion of existing roads, where necessary. Approach road to ash dump area will be in EPC Contractor's scope of work.
- Complete storm water drainage system for ~~Stage 2 areas~~ with garland drains around building/structure/facilities, including providing drainage pumps (if required) along with pump house; storm water drains along both sides of the road, etc. The proposed drainage system with RCC in the plant area shall be suitably designed to discharge the effluents of the plant & storm water and to be connected to existing drains of KTPS-V & VI Stages. The scope shall also include modification and diversion of existing drains, where necessary.

Q. Miscellaneous scope of work

- Excavation for foundations and substructures, wherever necessary in all types of soil including shoring, dewatering, filling around foundations and to grade with compaction of fills and approaches.
- ~~Extension of Raw Water Pump House near Godavari river at Burgampahad with additional Raw Water Pump .~~

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- Construction of RCC room for installation of electrical panels for providing construction power supply.
- Laying of water supply lines for providing construction water from given point of source.
- Dismantling of existing structures/roads/culverts. Fouling structures are to be modified /re-laid/re-constructed/dismantled are in the scope of ~~EPC Contractor only.~~ **TSGENCO.**
Boundary Wall & Ash Dyke is in TSGENCO scope. Patrol Road is not in BHEL scope.
- ~~Boundary walls, Chain link/barbed wire fencing & gates wherever required around any buildings/area. Any modification to the existing plant boundary wall to make it suitable for the requirement of proposed plant shall be carried out by the EPC contractor.~~
- Main plant paving including plinth protections around buildings and structures
- All foundations, grouting, embedment, inserts, bolts, etc. required for Ventilation, Dust Extraction, Water supply & Dust Suppression including drainage for the same.
- Civil and Structural work associated with all HVAC equipment and accessories as specified elsewhere in this specification including making of openings in floors / walls / roofs and building insulation as required.
- Civil and structural work associated with complete station lighting including area lighting, yard lighting, road (street) lighting, security lighting, etc. in all the areas.
- Providing High mast lighting in construction areas for illumination of construction works.
- Civil and structural work associated with Plant potable water supply, Potable water over-head tank of adequate capacity, associated pipe support trestles, pedestals & trenches within & outside buildings, all other civil work associated with service water system, etc.
except potable water distribution within the buildings covered under TSGENCO scope.
- Slope protection for embankment including required filling work in plinth and plant area and RCC retaining wall along with pile wherever required.
- The scope shall also include all necessary civil work (mainly civil foundation) pertaining to erection of Generator Stator / Transformer including construction of Stator lifting portal foundations or any other equipment if required.
- Arrangement for unloading platform for TG Stator.

Refer Point no.1 (civil) of agreed deviation in KTPS.

Any addition/modification to the existing plant boundary including fencing shall be in scope of customer. BOUNDARY WALL IS IN SCOPE OF CUSTOMER. As per point no 6 & 8 (Civil) of agreed deviation in KTPS.

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- Laying of required railway track necessary for shifting of Transformers/equipment /machinery.
 - Construction of RCC pit and pedestals for Boiler Lift.
 - Providing rails for electrical panels in HT Switchgear Room.
 - ~~All roofs shall be provided with access through M S staircase.~~
- Open RCC/steel staircase shall be required even for single story building. As per point no 7 (Civil) of agreed deviation in KTPS.
- Minimum 1.2m wide access path with tiles shall be provided on roofs.
 - All roofs shall be provided with water proofing treatment.
for buildings covered under BHEL scope.
 - The scope shall also include setting up by the Contractor a complete testing laboratory in the field to carry out all relevant tests required for the civil work for the project.
 - The land will be given to the Contractor by the Owner. All site investigations, surveys, grading, leveling and dressing and other additional work shall be carried out by the Contractor as per the approved drawing.
 - During detail engineering the outfall structure for plant drainage shall be proposed by EPC contractor at a suitable location based on invert levels of existing plant drainage system as well as available contour drawings. The work shall be carried out based drawings to be developed by the Contractor and approved by the Owner.
All Drains are in TSGENCO Scope.
 - The work shall be carried out according to the design / drawings to be developed by the Contractor and approved by the Owner / Owner's authorised Consultant. For all building, structures, foundations, etc., necessary layout and details are to be developed by the Contractor keeping in view of the statutory & functional requirement of the plant & facilities and providing enough space & access for operation, use and maintenance.
 - The layout and levels of all structures shall be made by the Contractor 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 Contractor 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 Contractor

ALL CIVIL ENGINEERING AND DRAWINGS IS IN BHEL SCOPE.

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2.01.00 List of Exclusions

Levelling and grading from existing ground level upto FGL is in BHEL scope. As per point no 8 (Civil) of agreed deviation in KTPS.

- a) ~~Bidder to refer to the plot plan for existing facilities excluded from EPC Contractor's scope of work. Demolition of existing quarters, leveling and grading of the site will be taken up by TSGENCO, however any civil/structural work required to make the existing facilities compatible to the new facilities of proposed plant, shall be within the bidder's scope.~~

2.02.00 Terminal Points

Refer Minutes of meetings attached

Storm and Plant drainage	As per plot plan
Plant Service Road	Existing Plant Road
Sanitary Facilities	As required
Site Grading	As per plot plan
Site Battery limit boundary/ fencing	As per plot plan
Ash pond	As per plot plan

2.03.00 Notes

- a) This section shall be read in conjunction with Lead Specification and General conditions of contract.
- b) For Architectural requirements of the plant General Specification and Design Criteria for Architectural Work - Volume VII-B and Technical Specification for Civil, Structural and Architectural Work - Volume VII-C of this Bid Document to be referred.
- c) In the event, any contradictions, confusion arises for any statement / condition / terms pertaining to design of civil engineering systems, stated elsewhere in addition to this section, the statement furnished in this section shall prevail.
- d) In the event, the bidder notice any inadvertent error / mistake published in the specification, the same shall be immediately brought to notice of the Owner.

3.00.00 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/Technical Specifications as appropriate. The latest editions/revision of following codes and standards along with addendums/amendments, if any, shall be followed :

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3.01.00 General

- a) Internationally accepted design Codes and Standards where Indian Codes are not available and which are equivalent to 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 Work.
- e) IS-1256 : Code of Practice for Building Byelaws.
- f) APDSS where ever a) to e) does not speak off.

3.01.01 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.

3.01.02 Concrete

- a) IS-269 : Ordinary and low heat portland cement.
- b) IS-383 : Coarse and fine aggregate from natural sources for concrete.
- c) IS-432 : Mild Steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
- d) IS-455 : Portland Slag Cement.
- e) IS-456 : Code of Practice for Plain and reinforced concrete.
- f) IS-460 : Test Sieves (all parts).
- g) IS-516 : Methods of test for strength of concrete.
- h) IS-1199 : Methods of sampling and analysis of concrete.
- i) IS-1566 : Hard drawn steel wire fabric for concrete Reinforcement.

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- j) IS-1786 : High strength deformed steel bars and wires for concrete reinforcement.
- k) IS-1834 : Hot applied sealing compounds for joints in concrete.
- l) IS-2386 : Methods of test for aggregates for concrete (all parts).
- m) IS-2502 : Code of practice for bending and fixing of bars for concrete reinforcement.
- n) IS-3370 : Code of practice for concrete structures for storage of liquids (all parts).
- o) IS-3414 : Code of practice for design and installation of joints in buildings.
- p) IS-4948 : Welded steel wire fabrics for general use.
- q) IS-6452 : High Alumina Cement for Structural use.
- r) IS-7320 : Concrete slump test apparatus.
- s) IS-7861 : Code of practice for extreme weather concreting (all parts).
- t) IS-8041 : Rapid Hardening Portland Cement.
- u) IS-8112 : High strength ordinary Portland Cement.
- v) IS-10262 : Recommended guidelines for concrete mix design.
- w) IS-12269 : 53 grade ordinary Portland Cement

3.01.03 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.

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3.01.04 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).
- C) IS 4995 : Criteria for design of RC bins for storage of granular and powdery materials.

3.01.05 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.

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3.01.06 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 paneled 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.

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3.01.07 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.

3.01.08 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.

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- 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.

3.01.09 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).

3.01.10 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).

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- 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]

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- 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.

3.01.11 Paving and Road work

- a) IS-73 : Paving bitumen
- b) IS-702 : Industrial Bitumen
- c) IS-1201 : Method of testing tar and bituminous materials. thru' 1220
- d) Practice followed by Indian Road Congress (all parts).

3.01.12 Earthquake Resistant Design

- a) IS-1893 : Criteria for earthquake resistant design of structures.
- b) IS-4326 : Code of practice for earthquake resistant design and construction of buildings.

3.01.13 Chimney

- a) IS-4998 : Criteria for Design of R.C. Chimneys (all parts).

3.01.14 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 & Packing.
- c) IS-806 : Code of practice for use of steel tubes in general building construction.

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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 [Part-VIII]	:	Method of measurement of steelwork and ironwork.
p)	IS-1239	:	Mild steel tubes, tubulars 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.

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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.

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- nn) IS-8500 : Structural steel – micro-alloyed (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.

3.01.15 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 of ferrous metal
[I & II] in buildings.
- e) IS-2338 : Code of practice for finishing of wood and wood based
[I & II] 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.

- 3.01.16 a) Indian Road Congress (IRC) Bridge Codes
- b) Indian Railway Standard Bridge Rules

3.01.17 Environmental Protection

Chapter on Corporate Responsibility for Environmental Protection (CREP) published in Gazette of India dated 27.08.2003.

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4.00.00 UNITS AND LANGUAGE

4.01.00 Drawings

- All dimensions will be in SI Units - Metric (English)
- Scales
 - Planning Drawings: Site Layout & Elevations will be at 1:500, Section & Elevation of each building will be at 1:200.
 - Structural and architectural Plans, sections, and elevations will generally be at 1:100 and/or 1:50; for architectural and civil details; 1:1, 1:5, 1:10, 1:20 as required will be used.
 - Site work and yard piping plans will generally be at 1:200, 1:500
- Text will be in English language

4.02.00 Units for Calculations

All calculations will be in SI (English) units.

Length	mm, M
Area	mm ² , M ²
Volume (solids)	mm ³ , M ³
Volume (liquids)	mm ³ , M ³ , liter
Density	kN/M ³
Force	N, kN
Pressure (piping)	Bar
Moment	kNM
Stress	Mpa, N/mm ²
Distributed loads, ground pressures, etc.	kN/M ²

English language will be used in calculations

5.00.00 GENERAL SITE INFORMATION

Refer Project Information (attached)

The site is located within the premises of existing Kothagudem Thermal Power Station which already accommodates 4x60+4x120+2x250+1x500 =1720 MW units. One 800 MW supercritical unit will be installed for augmentation of total plant capacity .

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BHEL clarifies that staff colony is not in BHEL scope. As per point no. 8(Civil) of agreed deviation in KTPS.

~~For the proposed 1x800 MW extension unit, main plant, equipments, facilities and green belt will be accommodated in existing 'D' colony of the thermal power station. 230 acres land will be acquired for expansion of existing ash pond for the proposed unit. The existing ground level of the plot is approximately varies from at 85-90 M above MSL.~~

Meteorological Data	
Site Conditions :	
Annual mean daily maximum temperature	44.7 degree C
Annual mean daily minimum temperature	13.5 degree C
Design Flood Level	Not known
Seismic Criteria	Zone -III
Wind Design	Basic Wind Speed, Vb = 44m/s
Average Annual Rainfall	As per meteorological data
Maximum Hourly Rainfall Intensity	As per meteorological data

6.00.00 SITE DEVELOPMENT AND UTILITIES

6.01.00 Plant Coordinate System

- The site will be surveyed and coordinates for all points be determined.
- The surveying contractor will establish plant benchmarks and North/South and East/West control lines for control of construction on the plant site. The North/South and East/West control lines will be developed based on grid systems of the existing Plant.
- To facilitate design and construction, a plant grid system and plant north will be established. The plant coordinate system will be laid out based on this grid.
- The plant coordinate system will be indicated on the Plot Plan Drawing.

6.02.00 Grading

The plot of land for the proposed project is graded land with difference in ground level upto 7 meters. Different FGL for different blocks of the plant are shown in the plot plan. However, this is preliminary and contractor has to finalise the levels during detail engineering considering natural contours, successful operation of proposed and existing plants, proper drainage, roadways and other system and utility connectivity.

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The existing ground level of the plot is approximately varies from at 85-90 M above MSL. All plant levels referred as RL will be with respect to Mean Sea Level (MSL) and all plant elevations referred as EL will be with respect to Power House Building Ground Floor elevation as 0.0M. The site bench mark will be established by the contractor accordingly.

- ~~The road levels will generally be at 150 mm above FGL~~
Road Level shall be 250mm above FGL in general. As per point no. 10 (Civil) of agreed deviation in KTPS.
- The finished floor level of ground floor of all the buildings will generally be at 500 mm above FGL
- The top of grout (under side of equipment base/base plate) for foundations and structures outside building at grade will generally be 200 mm above finished grade. The top of grout (under side of equipment base/base plate) for all equipment foundation at ground floor within the building will generally be 150mm above finished floor unless dictated otherwise by mechanical / electrical system layout.
- Base plates for structural steel building columns will generally be sufficiently below ground floor in order to keep enlarged portion of gusseted base below ground. This portion shall be encased in concrete for corrosion protection.

6.03.00 Drainage
6.03.01 General

Drains shall be designed as a network covering the plant area within the battery-limit of this specification. Attempts shall be made to convert construction drains into main drain as far as practicable. The invert of the in-plant peripheral drains shall be kept such that water can be discharged by gravity to the main/trunk drain under all condition.

The plant shall be provided with gravity drainage systems for the followings :

- Storm water Drainage
- Plant Drainage including Oily Water/ equipment process/chemical waste water
- Sanitary waste/ Foul water Drainage

6.03.02 Storm Water Drainage System

Storm water runoff is runoff from plant areas not subjected to contamination and will be discharged to terminal point via new lifting station if required any. Examples of such areas include building roofs, roads, paved areas, stone surfaced areas, grass surfaced areas, and other natural surfaced areas.

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Storm water will be collected via a surface drainage system consisting of open drains, gully pits or catch basins, manholes and below grade pipe system to terminal points

For buildings that have a gutter and downspout system, the downspouts will empty to gullies or inspection chambers with sand trap at ground level before discharge to the main drainage system. Drainage from Basements, Cable and pipe trenches will be routed to sumps and connected to the storm water drainage system by pumping system.

The storm water drainage system shall be designed with maximum hourly intensity of rainfall and its duration.

For pitched roof with metal sheeting a minimum slope of 1 (V) to 5 (H) and for flat roof a minimum slope of ~~1(V) to 50 (H)~~ will be provided for efficient drainage of rain water. The maximum velocity for pipe drains and open drains will be limited to 2.4 M/sec and 1.8 M/sec respectively. However, minimum velocity for self cleansing of ~~0.6 M/sec~~ will be ensured. Bed slope will not be milder than ~~1 in 500~~.

Roof slope for flat slabs shall be 1 in 100. As per point no. 12 (Civil) of agreed deviation in KTPS.

Self cleansing velocity of 0.7m/sec shall be taken for design purpose as per point no. 13 (Civil) of agreed deviation in KTPS.

Bed slope shall be 1 in 1000 as per point no. 11(Civil) of agreed deviation in KTPS.

Cast iron pipes will be used below buildings and HDPE pipes will be used for below grade piping drainage system. Manhole will be provided at every 50 M interval, at connection points and at change of alignment.

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.

Design considerations

- i) Major drains will be of open type RCC construction with rectangular section and minor drains will be of brick masonry. R.C.C./brick drains shall be covered with perforated R.C.C. pre-cast slab (M-30) of minimum 50mm thickness with edge protection angles at all the side and with the provision of openable galvanized steel grating covers at every 4.0m intervals. in BTG area only. Drains other than BTG area shall not be provided with cover, as per point no 14(Civil) of agreed deviation in KTPS.
- ii) In areas where vehicular loads would be coming, pre-cast RCC covers of suitable thickness with edge angles on all the corners without perforations and designed for the vehicular loads shall be provided.
- iii) In Boiler and ESP area, drains shall be provided with galvanized steel gratings using 6 mm thick flat for both bearing and cross bars with class-1 galvanization. For areas covering vehicular movement, pre-cast covers shall be provided. The width of the pre-cast planks shall be so designed that it can be easily handled during maintenance period.

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- iv) 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.
- v) RCC pipe culverts/box culverts shall carry drainage under intercepting roads and railway tracks.
- vi) Class of RCC pipes shall be decided by Bidder as per design requirement. For pipe drains, concrete pipes of minimum grade – Class NP2 shall be used. However, for road concrete pipes of Class NP3 shall be used and for rail crossing, railway norms shall be followed.
- vii) Surface drains shall normally have a slope of 1 IN 1000 along longitudinal direction and RCC pipes to have such slopes such as to have effective discharge.
- viii) RCC or masonry structures shall be provided at drops/falls to prevent scouring. Drops/falls shall be provided on both sides of box/pipe culverts.
- ix) Minimum self-cleansing velocity should be adopted as 0.7m/sec but the velocity of flow should not be more than 1.83 m/sec for brick drain and 2.4 m/sec for concrete drain, however, it is recommended to maintain the maximum velocity within 1.2 m/sec.

6.03.03 Plant Drainage System

Oily waste water will pass through oil water interceptor and then combined with storm water drainage system for ultimately discharged to terminal point. Oily waste water will include surface run off from transformer compounds, building floors and drains from other oil contaminated areas

Oily waste water will be collected via a surface drainage system consisting of open drains, gulley pits or catch basins and below grade pipe system to terminal points. In general, any surface drainage will be designed so that vehicles and equipment can drive over the finished surface.

The contaminated surface water runoff from rain will be designed for maximum hourly rainfall intensity.

The drainage from transformer pit will be stored in a collecting tank and subsequently passed through oil water interceptor before connecting to the storm water drainage system.

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The maximum velocity for pipe drains and open drains will be limited to 2.4 M/sec and 1.8 M/sec respectively. However, minimum velocity for self cleansing of ~~0.6 M/sec~~ will be ensured. Bed slope will not be milder than ~~1 in 500~~.

Self cleansing velocity of 0.7m/sec shall be taken for design purpose as per point no. 13(Civil) of agreed deviation in KTPS.

Bed slope shall be 1 in 1000 as per point no. 11(Civil) of agreed deviation in KTPS.

Cast iron oily pipes will be used below buildings and ductile iron cement lined oily line will be used outdoors. Manhole will be provided at every 50 M interval, at connection points and at change of alignment.

6.03.04 Sanitary Waste Sewer / Foul Water Drainage System

The sanitary waste/ foul water will be discharged to gravity fed foul manhole and then to a sewage treatment plant.

HDPE pipes shall be used for drainage. Sewers will be designed for a minimum self-cleansing velocity of 0.70 m/sec and the maximum velocity will not exceed 2.4 m/sec.

Manhole will be provided at every 50 meter along the length, at connection points and at every change of alignment, gradient or diameter of sewer pipeline.

The slope of sanitary pipe within the buildings will equal 20 mm per meter (1:50). Piping outside the buildings will be designed to maintain a minimum self-cleansing velocity with slopes not milder than 1 in 500.

Manual on Sewerage and Sewage treatment (published by Central Public Health Environment Engineering Organization, Government of India) shall be followed for design purpose.

6.04.00 Roads

All new roads, hardstands will be provided to have accessibility to the plant where required and to be connected with the existing road network at suitable points..

- Minimum carriageway and shoulder width shall be as listed below. Shoulders width shall be added to the carriageway widths to obtain minimum roadway widths.

Main approach road shall be 10m wide. The same shall be indicated in the plot plan. Security path road around boundary wall shall be 4m wide BT road. As per point no. 16 (civil) of agreed deviation in KTPS.

Road Type	Classification	Carriageway Width (m)	Shoulder (m)	Roadway Width (m)
1.	Primary Road (Peripheral)	~~12.0~~ 10	2.0	~~16.0~~ 14
2.	Primary Road (internal Road)	7.0	1.5	10.0
3.	Accessways	4.0	-	4.0

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- All internal roads in Power House area from Switch Yard to Chimney area including roads around Power House shall be Cement Concrete (CC) roads and all other roads within the battery limit of this package shall be water bound macadam with RCC topping on prepared sub grade with 300 mm minimum soling for heavy vehicles. (Refer point no. 01 of changes sought sheet)

Total thickness of bituminous topping shall be 115mm as detailed below: a) 70mm thick Dense bituminous macadam (Bitumen Binder Content and aggregate confirming to Grade-I of MORTH & H specification. b) 40mm thick Bituminous Concrete. Bituminous binder content & aggregate grading shall be as per Table 500-18 of MORTH & H specification. c) 5mm thick mixed seal coat with bitumen @ 0.06cu.m/10 sq. m mixed with medium coarse sand. As per point no 15(Civil) of agreed deviation in KTPS.

- All internal roads in Power House area from Switch Yard to Chimney area including roads around Power House shall be Cement Concrete (CC) roads with Vacuum Dewatered Flooring (VDF) concrete and other plant roads with bitumen macadam, water bound macadam base and sub-base shall be as per IRC standards with 300 mm minimum soling. ~~Minimum total thickness of black topping (premix carpeting) shall be 50 mm in 2 layers of 25 mm each.~~ Bituminous topping of all plant roads shall be done after completion of plant construction.

For premix carpet, recommendation of IRC-14 shall generally be followed. Spreading of black topping work shall be carried out using mechanical paver / finisher.

- RCC pavement with Vacuum Dewatered Flooring (VDF) concrete shall be provided at areas requiring parking facilities.
- A detailed CBR test shall be carried out as per the procedure outlined in IS:2720 (Part XVI).
- For road crossing of pipelines supported on ground, the pipe top level generally shall not be more than 100mm above the top of the road. Suitable hump with slope not steeper than 1:30 shall be provided for the roads. Necessary modification shall be done by the Bidder for the roadside drains.
- Roads shall be designed as per IRC-37:1984 "Guidelines for the design of flexible pavements". California Bearing Ratio (CBR) method shall be adopted for the design of roads.

The geometric design of roads shall be done in accordance with IRC-73. Road widths, curves and parking areas shall have adequate space for maneuvering of vehicles. The ruling gradient for roads in longitudinal direction shall be 1 in 30. Normally the roads shall have much flatter gradient. Transverse camber of 1 in 60 shall be provided for the black topping of roads and a slope of 1 in 40 shall be provided on shoulders. Finished top (crest) of roads shall be 250 mm above the surrounding ground level.

Shoulders shall be formed with gravel on par with the road level.

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6.04.01 Pavement/Footpaths in Other areas

Paving as required will be provided using interlocking pre-cast concrete block.

Surface Treatment

a) Main plant Area

The entire area from Power House to Chimney shall be paved with reinforced cement concrete with Vacuum Dewatered Flooring (VDF) concrete and sloped to drains.

b) Transformer Area & Switchyard

Oil cooled equipment, such as transformers, shall be located within concrete basins filled with HBG metal. The individual basins shall be connected by pipeline to a separate chamber/oil pit for collection and further reclamation of oil through oil water separators, if necessary.

Drains shall be adequate to remove full discharge from deluge system used for fire control. Transformer Yard shall be paved with reinforced cement concrete with Vacuum Dewatered Flooring (VDF) concrete.

Switchyard area excluding the internal access roads shall be paved with ash bricks on edge over a layer of 100 mm thick lean concrete (M10) as specified elsewhere of this specification. Anti-weed chemical treatment as per specification to be done as required.

c) Cooling Tower Area

Paving in this area shall be as specified in Volume VII-D Technical Specification for Natural Draft Cooling Tower

d) Necessary pavement, surface treatment shall be done for Coal handling, DM plant and PT plant.

6.05.00 Fencing

6.05.01 Fencing with gates shall be provided around transformer yard, Switchyard, fuel oil area and other areas wherever necessary due to security, safety, and statutory requirements as per following specifications.

The fencing, with gate (unless specified otherwise) shall comprise of PVC coated G.I. welded wire mesh fencing of minimum 4 mm diameter (including PVC coating) of mesh size 75mmX75mm of height 2.4m above the toe wall with a 600mm high galvanised concertina at the top, such that total fence height of 3.0m above the toe wall is achieved. The diameter of the steel wire for chain link fence (excluding PVC coating) shall not be less than 2.5 mm.

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The PVC coated chain link shall be stretched by the clips at 0.5m intervals to three strands of galvanised high tensile spring steel wire (HTSSW) of 2.5 mm diameter interwoven with chain link wire mesh and kept under tension which in turn are attached to the fence post with security nuts and bolts. On every fourth post a clamping strip shall be threaded through the links of chain link and bolted to the fence post with the help of security nuts and bolts.

Above the chain link a 600mm high tensile serrated galvanised wire (HTSW) concertina made with wire diameter of 2.5mm shall be stretched to 6m and attached to two strands of galvanised HTSSW of 2.5 mm diameter by means of clips at 1m intervals. These two HTSSW strands shall be attached to the fence posts with 12 mm security fasteners.

All nuts, bolts, fasteners, clamping strips, clamps, clips, etc., shall be galvanised.

All fence posts shall be of 75 x 75 x 6 MS angles spaced at 2.5m c/c distance. All corner posts shall have two stay posts and every tenth post shall have transverse stay post. Suitable R.C.C. foundations for the post and stays shall be provided based on the prevailing soil conditions. All posts of fencing shall be painted with chlorinated rubber paint over a suitable primer.

Toe walls either of brick masonry with bricks of minimum 75 kg./sq.cm. Crushing strength or of hollow concrete block masonry shall be provided between the fence posts all along the run of the fence with suitable foundation. Toe wall shall be minimum 200mm above the formation level with 50mm thick P.C.C. coping (1:2:4) and shall extend minimum 300mm below the formation level.

Toe wall shall be plastered with cement sand mortar (1:6) on both sides and shall be painted with two coats of textured cement point (Sandtax Matt or equivalent) of approved colour and shade. Toe wall shall be provided with weep holes at appropriate spacing.

All gates shall be of structural steel of minimum 3.75 metres clear width for single lane access road and 7.75 m clear width for double lane access roads. The height of gate shall be same as that of the fence. Each gate shall have provision for wicket gate of size 1.0 m x 2.1 m.

The gate frame and post shall be fabricated from medium class MS pipe of nominal diameter not less than 75 mm. The panel plate shall be of minimum thickness 2.5 mm conforming to IS: 513.

The gate shall be complete with fabricated hinges, MS aldraps with locking arrangement, tempered steel pivot, guide track of MS tee, bronze aluminium ball bearing arrangement, castor wheel, etc.

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All electrical conduits (duct bank) laid under ground will be encased in concrete. Reinforcements will be provided in the encased concrete at main traffic crossings and other areas requiring access during construction based on the final design and the Construction Sequence.

6.07.00 Pipe and Electrical Concrete Trenches

Generally pipe or electrical cables will be taken through concrete trenches with precast concrete covers. Suitable drainage and working arrangement inside trench shall be provided. The trench cover shall be provided with edge protection angles and lifting devices. Suitable inserts and opening shall also be provided as per service requirement. Precast covers for trenches shall be light weight and shall not weigh more than 65 Kg. each.

CW pipe line will be constructed by providing suitable supporting pedestals at 10 mts interval and burring the pipe in a trench after being rapid coated with bitumen bound approved coating. Pipe bed will be made of 500 mm thick, well compacted sand and sand fill will be packed at both sides upto 50% diameter of the pipe, followed by filling up rest of the portion by good selected earth so as to have min. 1.5m of earth cushion over the pipe. While crossing the road & railway suitable road/rail structure will be considered as per relevant IRC codes & loading specified elsewhere in this specification.

Generally all cableways outside building will be either through concrete underground duct banks housing PVC pipes or overhead on pipe rack except for HV cables which will be through trench. However, any trenches located outside buildings will project 150 mm above the finished formation level to avoid ingress of storm water. The bottom of trench will be sloped suitably for draining out the collected water into sump pit.

6.08.00 Electrical Manholes

Cast-in-place, reinforced concrete manholes will be provided as required to meet the electrical system construction requirements.

Drainage sumps will be included in all manholes to improve ability to remove water from manholes. The use of portable pumps to remove water from manholes will be considered.

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7.00.00 GEO-TECHNICAL CRITERIA

7.01.00 General Description of Soils

Owner has carried out preliminary geotechnical investigation in the proposed power plant area. Representative borelog details along with the recommendations given in soil report shall be considered by the Contractor for reference only. Contractor shall make his own assessment for the type of foundations envisaged based on his site visit and data collected from site during the site visit. In any case, the contractor has to carry out detailed geotechnical investigation after the award of contract, through approved/reputed agency and to submit geotechnical investigation report with recommendations for the Owner's review and approval. The recommendation given in approved final report becomes binding on the Contractor. The Contractor is not eligible to increase his cost or demand any extension of time if the final report is in variance from preliminary report furnished by the Owner. The preliminary geotechnical investigation report is available with the owner and will be furnished for reference on request.

7.02.00 Ground Water and Dewatering Requirements

GWT is located at about 2.5M to 3.5M below the existing ground level shown in contour map attached as Annexure 1 . HHFL is about 88M. However, the bidder has to determine the exact GWT during detailed engineering based on soil investigation at his scope.

7.03.00 Excavation Criteria including De-watering

Unless otherwise specifically mentioned in geo-technical report this shall be followed.

Excavation shall be carried out in all types of soil including soft soil, soft moorum, hard moorum, soft rock, hard rock etc.

After excavating to the founding level, the exposed sub-grade will be inspected and proof rolled, if required, prior to placing lean concrete for subsequent placing of rebar, setting forms and placing concrete. Soft or yielding areas will be excavated and replaced with compacted backfill. Bearing grades will be cleaned and kept dry prior to placing concrete.

Excavations will be maintained and protected against earth collapse from natural causes or subsequent construction work and will have stable slopes, as appropriate, to meet local soil conditions and safety codes.

Dewatering wherever is necessary has to be done at bidder's cost only.

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7.04.00 Backfill Criteria

Site-excavated material free from unsuitable material or non-expansive bottom ash or pond ash may be used as backfill against pit and sump walls and as structural fill beneath foundations if suitable.

Off-site material if required to be used for backfill, it will be fully tested and installed as per the project specifications.

7.05.00 Compaction Criteria

Fill and backfill material will be as recommended in the Geo-technical Report and as required by project specification requirements.

Material used as structural fill (load bearing) beneath structures and roads will be compacted to a minimum of 95% of the maximum dry density (modified Proctor). Moisture content of material will not deviate more than 2 percent of optimum.

Material used as backfill (non load bearing) around structures will be compacted to a minimum of 90% proctor density. Natural moisture content of material will not deviate more than 3 percent of optimum.

8.00.00 LOAD AND STABILITY CONSIDERATIONS

8.01.00 Loads and their Combinations

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 and foundations shall be designed for most critical combinations of dead load, live load, equipment load, pipe and cable tray loads, crane loads, wind loads, seismic loads, temperature loads and special loads as applicable as per requirement of relevant codes and standard.

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.

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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, screed concrete, Plaster	: 24.0 kN /cum
Steel grating floor	: 0.5 kN/sq.m
Checkered plate cover	: 0.5 kN/sq.m
False floor	: 1.0 kN/sq.m
False ceiling in control and Electric rooms	: 0.4 kN/sq.m
Metal decking	: 0.15 kN/sq.m
Insulated metal siding	: 0.25 kN/sq.m
Non insulated metal siding	: 0.15 kN/sq.m
Masonry unit with plaster on Both sides :	
230 mm nominal thickness	: 4.95 kN/sq.m
115 mm nominal thickness	: 2.47 kN/sq.m
Coal	: 12.0 kN /cum
Fly Ash	: 16.0 kN /cum
Bottom Ash	: 16.0 kN /cum

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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		Refer point no 02 of change sought sheet.
a)	Roofs :		0.75
	Inaccessible roof	:	~~0.075~~ 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).
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 (for supporting beams) 7.0 kN/Sq.m (for grating/ chequered plate)
e)	Office, Laboratory, Conference rooms and other non-plant areas etc.	:	5.0 kN/Sq.m

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- ii) **Power House Building**
- a) Ground Floor
- Unloading Bay : 35 kN/Sq.m
- Other areas : 20 kN/Sq.m
- b) Mezzanine Floor : 15 kN/Sq.m plus hung loads.
- c) Operating Floor
- T.G. Lay-down Area : 30 As per point no. 17 (Civil) of agreed deviation in KTPS. ~~25~~ kN/Sq.m plus hung loads or actual load furnished by equipment supplier whichever is higher
- Other Areas in Turbine Hall : 15 As per point no. 17(Civil) of agreed deviation in KTPS. ~~25~~ kN/Sq.m plus hung loads
- Rotor removal area beams shall also be checked for half the rotor load at the center of the beam
- Other Areas in Operating Floor : 15 kN/Sq.m plus hung loads
- d) Cable Spreader Floor : 7.5 kN/Sq.m plus hung loads
- e) All other floors : 15 kN/Sq.m plus hung loads
- f) Due to anchoring of conductors on "A" row column : 2 x 20 = 40 kN (Twin ACSR Moose Conductor) and 10 kN (Shielding Wires)
OR
actual load furnished by equipment supplier
- iii) **Mill Building, Bunker and coal handling system**
- 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 : 10 kN/Sq.m + hung loads + 0.5 kN/Sq.m (dust load).

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- d) Coal Weight : 8.0 kN/Cu.M for storage volume calculation
: 12.0 kN/Cu.M for load calculation

iv) **Auxiliary Buildings**

- a) Ground Floor : 10 kN/Sq.m
b) Cable Spreader Floor : 7.5 kN/Sq.m
c) Pump House Operating Floor : 10 kN/Sq.m
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) **Underground Structures/Trenches/pits**

Minimum surcharge shall be 10 kN/Sq.m. For structures in vicinity of roads and heavy vehicular movement, 20 kN/Sq.m surcharge shall be considered. Trenches/pits inside building shall be designed for a surcharge equal to Live Load intensity of Ground Floor or 10 kN/Sq.m whichever is greater. In Boiler area and other outdoor areas within Power Block, the minimum surcharge shall be 20 kN/Sqm.

vii) **Covers for Trenches**

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 be considered.

Trench cover at entry to buildings and at road crossings, shall be designed for class AA & Class A loadings as per IRC whichever is critical at centre. The trench cover at other location shall be designed with a surcharge of 1.0 T/Sq.M or a concentrated load of 1.0T at centre.

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Design of roads shall be in accordance with Indian Road Congress standard .

ix) Road Culverts

Road culverts shall be designed for Class 'AA' loading (wheeled and tracked both) & to be checked for Class 'A' loading as per IRC standards.

x) Reduction in Live Load

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, shall 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 shall be estimated from similar jobs or catalog data.
- ii) All equipment, tank and piping design loadings shall include Hydraulic Testing loads.
- iii) Air & gas duct loadings shall include weight of insulation, duct attachments, dust accumulation loads, seismic, wind and other loads as applicable.

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- iv) Crane girders and supporting columns shall 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 shall 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 shall 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 shall be in accordance with Indian Standard Code IS:875 (Part 3):1987 for a basic wind speed of 44 m/s upto a height of 10 metres above mean ground level.

Terrain Category-~~4~~, Class-C shall be considered for all structures.

E. Seismic Loading

2

Refer point no. 03 of changes sought sheet..

The site falls in Zone-III as identified in the map in IS:1893-2002. Analysis and design of structures to resist the seismic forces will be established in accordance with the recommendations of IS: 1893 (Part IV): 2005. Importance factor to be considered is 1.5 for all structures. Ductile detailing of RCC structures will be as per IS: 13920.

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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 shall 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 = 13.5° C

Mean Daily maximum ambient temperature during hottest month of the year = 44.7° 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 sub-structure of pump house, cold water basin of cooling water and underground liquid storage tanks earth pressure at rest shall be considered.

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.

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I. Crane, Monorail & Elevator Loads

Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as per crane vendor'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

Elevator support systems shall be designed to accommodate the capacity load of the elevator plus the weight of the cab and accessories

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.

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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.

Dispersion of load in any direction through soil shall be as per IS:8009 (Relevant part). Dispersion of load through concrete shall be considered at an angle of 45 degree with horizontal from the edge of contact area.

L. Thrust Load

Thrust blocks shall 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

- 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.

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8.01.01 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) 0.9*DL $\pm$ EL (for DL only) $\pm$ TL
- vi) 0.9*DL $\pm$ WL1 $\pm$ TL
- vii) 0.9*DL $\pm$ 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

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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) - 1987 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) - 1987. 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 shall be permitted.

Applicable load factors to be used for design of RCC structures by Limit State Method as per IS:456.

8.01.02 **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.

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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.

8.01.03 Other loading considerations

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 deck and 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 shall 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.

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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.

8.02.00 **Stability of Structures**

Design shall be checked against buoyancy due to the ground water during construction and maintenance stages for structures like under ground 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.

The design calculations and respective drawings in AUTOCAD format shall be submitted accordingly.

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9.00.00 BUILDING DESIGN CONCEPT

9.01.00 Framing System and Method of Analysis

Analytical model of the building structure will be either two dimensional or a three dimensional space frame. Analysis of models shall be done using STAAD Pro Software.

For Steel frame structure, it will be either (1) Simple frames with vertical diagonal bracings at column lines in both directions and horizontal bracing at the roof and major floor levels or (2) Moment resisting frame in transverse direction with braced frames in longitudinal direction. For Concrete frame structure, it will be Moment resisting frame in both directions.

For composite framed building moment resisting frame will be provided in transverse and longitudinal direction with reinforced concrete columns and steel roof truss/girder framing members in transverse direction and reinforced concrete framing members in longitudinal direction.

9.02.00 Method of Design

The Strength design of Steel members will be done by working / allowable stress method using IS:800 (Latest Edition) where as the Strength design of Concrete members will be done by limit state method using IS:456 (Latest Edition).

Un-braced lengths for steel beams will be as per code or as determined from following criteria

- Beams supporting concrete slab with shear connectors / compression flange embedded in RCC slab will be considered continuously supported.
- Beams supporting metal roof deck attached with welding washers plug welded will be considered continuously supported.
- Beams supporting metal deck or concrete slabs formed with metal decking will have an un-braced length based on framing member locations.
- Beams supporting grating floor will not be considered continuously supported.
- Beams which are part of a truss will use the distance between panel points as their un-braced length or, if the panel has connecting major members, the un-braced length will be based on the distance between panel points or connecting members, whichever is the shorter distance.

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- In grating floor, for two parallel, interconnected beams, the beam with greater load will be considered as un-braced and the other beam as braced at the points of interconnection
- In grating floor, for three or more parallel, interconnected beams with loads of same order or magnitude, all beams will be considered as braced at points of intersections. When the beams are loaded disproportionately, the un-braced lengths will be determined as stated above.
- **Acceptance Criteria for required depth**
 - For steel members, minimum depth equals to 1/24 of span unless clearance requirements will dictate lower depth in certain areas.
 - For Concrete members, minimum depth equals to 1/16 of span unless clearance requirements will dictate lower depth in certain areas.
 - Members will be framed into members of equal or greater depth

10.00.00 DESIGN OF REINFORCED CONCRETE STRUCTURES

- a) The design of R.C. Structures shall be carried out by limit state or working stress method as per the provisions of IS-456.

Concrete tanks/water retaining structures shall be designed in accordance with the recommendation of IS-3370.
- b) For reinforcement detailing IS:5525 and SP:34 shall be followed. Ductile detailing of RCC structures will be as per IS: 13920.
- c) The walls shall be provided with reinforcement on both faces for sections 150 mm or more, even if not required from design consideration.
- d) **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.

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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.

Pressure relieving valves, if required shall be provided for liquid retaining structure to counter uplift force, however vendor presence is required at the time of fixing. As per point no. 20(Civil) of agreed deviation in KTPS.

All water retaining / storage structures shall be designed assuming liquid up to the height of wall irrespective of provision of any over flow arrangement. ~~No pressure relieving devices shall be permitted in underground structures.~~

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. The sequence of construction shall also be specified on drawings showing construction joints.

e) Water reservoirs

The in plant raw water reservoir will be compartmentalized to ensure de-sludging/maintenance of any section without affecting plant operation. With a view to conserve water LDPE of approved make of 500 microns lining as per IS 3370 will be provided on bed and sides.

Refer point 4 of changes sought sheet.

BHEL is considering an earthen reservoir with 500 micron LDPE lining. 50 thick precast concrete tile to be laid over LDPE lining for protection over sides and Bottom. No covering with RC slab is envisaged. As per point no. 19(Civil) of agreed deviation in KTPS.

~~Raw water reservoir will be provided with concrete slab.~~ It is also to be attended with necessary methods of base preparation works for controlling the abnormal/uncontrollable seepage, if any.

Raw water storage Net capacity ~~1,50,000~~ ¹⁰⁸⁰⁰⁰⁰ M³ with 1.2M free board is to be adopted.

Level gauge with approach steps shall be provided.

Outlet pipe with sludge valve shall be provided and stop gates at inlet may be provided.

The surface shall be provided with anti-weed treatment.

Hand railing shall be provided.

Floating matter trap gates at inlet shall be provided.

With a view to conserve water, the fire water reservoir will be provided with concrete slabs on top as protective cover, LDPE film lining will be provided on bed and sides to prevent seepage loss.

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10.01.00 Foundation design

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.

a) Foundations resting on virgin soil

All Major foundation shall rest either on pile or on virgin soil. Preliminary Geo-Technical investigation for the proposed site has been carried out by the owner and the report is available with the owner. The same will be furnished to bidder on request and for reference only.

Bidder however, shall carry out necessary geo-technical investigation at all relevant locations before deciding the type of foundations. Bidder shall decide the type of foundation based on the load from structure and the outcome of bidder's soil investigation.

b) Foundations resting on fill material

All grade slab, trenches, pits, electrical trenches & duct banks, manholes and other lightly loaded equipments & structures with bearing pressure not exceeding 50kN/Sq.M will be founded on this founding medium. A minimum of 0.5M below foundation will be of compacted sub-grade to a min. of 95% of the max. dry density (modified Proctor).

- **Minimum Founding Depth**

The bottom of foundations on virgin soil will not be less than 1.0 meter from finish grade level unless specified otherwise in geo-technical investigation and recommendation. Foundations for Misc. Skids and other minor supports will be kept minimum 300 mm below finished grade unless greater depth is required by site specific requirements.

For steel columns of Power House building, Boiler, Mill and Bunker building, ESP, etc., Top of RCC foundation 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 shall have to be suitably lowered to accommodate underground services, pits, trenches, etc.

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RCC design shall be done by working stress method for all machine foundations.

All block foundations supporting rotating equipment resting on hard strata shall be designed using the elastic half space theory.

Bidder's design scope of work shall consist of the following :

- a) Finalization of the general arrangement layout and levels of foundation for Turbine Generator, Pulverizer, Turbine & Motor driven pump and large fans based on the equipment layout considering limitations of available space and any other layout constraints.
- b) Submission of design criteria for approval
- c) Submission of the following information as provided by equipment supplier and as applicable depending up on approved design criteria:
 - 1. Loading diagram showing static and dynamic loads and points of application of loads.
 - 2. Operating speed of m/c; Critical speed of m/c.
 - 3. Weight of rotating parts; maximum eccentricity of rotating mass from the geometric axis of rotation.
 - 4. Location of C.G. of machines in all three axes.
 - 5. Mass Moment of Inertia.
 - 6. Allowable amplitude/velocity of vibration at machine bearing points.
 - 7. Temperatures in various areas during operation.
- d) Analysis of the top deck, design and detailing of reinforcement.
- e) Submission of all design calculation, all loading diagrams, General arrangement drawings, embedment drawings and reinforcement drawings for the foundations under the scope for the approval of the owner.
- f) Carrying out revisions / alterations based on the comments of the owner. In addition to hard copies, the final soft copy of all drawings (in autocad and pdf format) and documents shall also to be submitted.

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- g) Submission of construction methodology / casting sequence and any special requirement. Concreting of STG columns shall be cast in single pour and methodology including temperature control shall be got approved by the Engineer.
- A. Design considerations for major equipment foundations that supported on conventional machine foundations:
- Design of foundations 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 shall consist of free vibration analysis and forced vibration analysis. While designing following aspects shall also be taken care of.
 - Foundations shall be isolated from adjacent structures for vibration control.
 - Natural frequencies of structures and components shall be away from the running speed of equipment as per frequency separation criteria and amplitude criteria 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 pile shall be designed using the pile-soil interaction.
 - 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%.
 - Tension in piles shall not be allowed for any combination of loads. For Foundations of rotating major equipments, the natural frequency and allowable vibrating amplitude/velocity shall be as per criteria furnished by the Vendor. In absence of such criteria, the foundation shall satisfy the criteria set forth in IS 2974, DIN 4024 and VDI 2056.

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- B. Specific considerations for foundations where equipments are supported on vibration isolation system :

- **General Requirement**

Vibration Isolation System shall NOT be provided in any of the rotation equipment foundation except Boiler Feed Pump.

The vibration isolation system shall consist of steel helical spring units and viscous dampers supporting the RCC deck which would support the equipment. Complete Vibration Isolation System shall be provided for the foundations of Boiler Feed Pumps, Coal Mills, ID, Fan, FD Fan, PA Fan and all other rotating equipment except Turbo-generator.

Steel helical springs and viscous dampers shall be provided by GERB or equivalent manufacturer with requisite experience and proven track record of similar installation in power plants of Unit capacity not less than 500 MW.

- **Material (Design & Supply)**

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.

- 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.

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- 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.
- 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.
- 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.
- The steel helical springs and viscous dampers shall be designed for ensuring “fit and forget” guarantee.
- 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.
- 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.
- Tension in piles shall not be allowed for any combination of loads.
- **Manufacturing & Testing**

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 contractor/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.

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- 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.
- 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.
 - **Erection, Commissioning and Supervision**
 - i) 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.

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- ii) 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.
- iii) The contractor 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".

- **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 contractor as and when asked for at no extra cost of the Owner.

- **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

- **Codes and Standards**

Latest revision of following codes shall be used for the design of the spring supported foundations :

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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 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 .

C. Steam Turbine Generator Foundation Design Criteria

- The Steam Turbine Generator shall be rigid RCC frame structure supported on pile foundations wherever necessary. The concrete outline and embedments/inserts/pockets detail shall be supplied by machine manufacturer. The turbine generator pedestals shall be designed to meet the manufacturer's deflection criteria and other recommendations.

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.

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Detailed static and dynamic analysis shall be performed both for normal operating condition & abnormal condition such as short-circuit, accidental loss of blades & earthquake. At any event of time any two transient loading (short circuit, seismic) need not be assumed to act in the same direction simultaneously. Seismic analysis shall be done by response spectrum method.

The dynamic analysis shall consist of free-vibration and forced vibration analysis. Frequency separation criteria and amplitude criteria as laid down in IS-2974 and or VDI 2056 and/or as required by machine manufacturer whichever is more stringent shall be satisfied.

Elaborate mathematical model shall be considered. Due regard shall be given to pile stiffness in lateral and vertical direction and pile-soil interaction.

Stress for thermal load, shrinkage and creep shall be properly accounted for. Minimum reinforcement shall be governed by IS-2974 as well as IS-456.

For appropriate load combinations or any other information, stipulations of IS-2974 shall be satisfied.

D. Boiler Feed Pump Foundation

TDBFP & MDBFP foundations shall consist of RCC top deck supported on steel helical springs and viscous dampers inside main power house. In case the top deck is located at operating floor/mezzanine floor or any other floor level based on bidder's approved layout, the springs / viscous dampers shall be supported on a group of structural steel columns-beams grid which shall be rigidly integrated with the Main Power House structural frame.

In case the TDBFP & MDBFP foundation is envisaged to be located at ground floor of Power House, these foundations shall consist of top deck supported on steel helical springs & viscous dampers which shall in turn be supported on RCC sub-structure. This is generally a RCC block foundation resting on either on piles or raft as per the design based on soil strata. Concrete outline and details of pipe sleeves/pockets/embedments shall conform to the data provided by machine manufacturer.

E. PA, FD, ID Fan and Mill Foundations

These foundations shall consist of top deck supported on steel helical springs & viscous dampers which shall in turn be supported on RCC sub-structure. RCC substructure shall be supported below ground level on pile or soil as per the design based on soil strata. (RCC foundation with provisions for pockets and cut-outs for bolts and electrical cables shall be as per vendor's outline drawing. The fan foundations shall be provided with detachable roof for protection of fans.

F. Minor equipment Foundations

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 as specified elsewhere in this specification.

10.01.02 Open Foundations

- a) In case open foundations are adopted, the following shall be adhered to :

Minimum width of foundation shall be 1.0 m.

Minimum depth of foundation shall be 1.0 m below NGL.

- b) 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.

- c) 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.

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.

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- d) 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 :

Item	Settlement Criteria
Steam Turbine Foundation	Maximum total long term vertical settlement after interconnecting systems are complete and the unit is placed in operation shall not exceed 25mm or limit specified by equipment manufacturer.
Boiler area foundations and Stack foundations	1. The allowable overall settlement of foundation shall not exceed 25mm/ vendor requirements 2. Max allowable differential settlement of foundation shall not exceed 8.0 mm./ vendor requirements
Transformer foundation (including oil fill)	1. The allowable overall settlement of foundation shall not exceed 25mm / vendor requirements. 2. Any additional long-term settlements after bus duct connections are made and transformer placed in service should not exceed 50mm
Turbine Building foundations	1. The allowable overall settlement of foundation shall not exceed 25mm. 2. Max allowable differential settlement of foundation shall not exceed 8 mm.
Other building and Structures foundations.	1. The allowable overall settlement of foundation shall not exceed 25mm. 2. Max allowable differential settlement of foundation shall not exceed 8 mm.
Miscellaneous Electrical Equipment foundations.	1. The allowable overall settlement of foundation shall not exceed 25mm.
Misc. Mechanical Equipment	The allowable overall settlement of foundation shall not exceed 25mm.
• Boiler Feed Pump	
• Lube Oil Skid	
• Other major equipments	

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Item	Settlement Criteria
Flat Bottom above Ground Storage Tanks	Uniform Settlement : - Vertical settlement after filling, hydro-test shall not exceed 25mm.at perimeter unless flexible shell nozzle connections used. Differential Settlement of Center with respect to Edge - The center of the bottom plate floor shall not exceed the settlement of the edge by more than diameter/90.

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.

10.01.03 Pile Foundations

In case piles are adopted, following shall be adhered to :

- 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.
- 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.
- Only straight shaft piles shall be used. Minimum cast length of pile above cut-off level shall be 1.0 m.
- The EPC Contractor 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.
- 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 EPC Contractor for Owner's approval.

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- f) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be as under:

Vertical	}	Minimum of 3 Nos. in each mode.
Lateral		
Uplift		

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 EPC Contractor 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). The EPC Contractor 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.

10.01.04 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.

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- 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. 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 EPC Contractor as per the instructions of the Owner up to a lead of about 5 km crow fly distance from the plant site.
- vi) CBR tests for flexible pavement design shall be carried out by the EPC Contractor 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 50mm ~~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 50mm ~~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 work. 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.

Refer point no. 5 of
changes sought
sheet.

After the tanks have been erected, hydro testing shall be done. Subsequent upon hydro testing of tank, the differential settlement.

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10.02.00 General Requirements
• Minimum Thickness of Structural Elements

The following minimum thickness shall be followed :

Pile caps 900 mm

Refer point no. 6 of
changes sought sheet.

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 /
Launder walls and base slab 125 mm

All footings (including raft foundations) 300 mm

Width of beam 150mm

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 water table 200 mm

Above ground water table 150 mm

From fire resistance point of view minimum fire rating of 2 hours shall be considered where fire hazard is expected and minimum thickness of reinforced concrete members shall be as per fig 1 and table 16a of IS 456 or specified above, whichever is higher.

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• **Concrete Cover**

Following minimum clear concrete cover to steel reinforcement will be provided.

Concrete cover of 50mm at bottom of foundation shall be provided as per IS 456. As mentioned in point no. 23(Civil) of agreed deviation in KTPS.

A.	Substructure Work	Bottom	Sides	Top	Ends
i)	Foundation	~~75~~ 50	50	50	50
ii)	Columns, Pedestals, Grade Beams/Tie Beam	50	50	50	50
iii)	Trenches, Pits, Walls, Duct Bank etc. in contact with				
	Earth	50	50	50	50
	Water	50	50	50	50
	Others	25	25	25	40
iv)	Equipment Foundations	50	50	50	50
v)	Slab on Grade	25	50	25	50
B.	Super structure Work				
i)	Columns	-	40	-	-
ii)	Beams	35	35	35	50
iii)	Slabs/Walls	20	20	20	40
iv)	Lintel, Chajja, Bands etc.	20	20	20	25
v)	Pre-cast Concrete	20	20	20	20
vi)	Silo shell side cover		30		

• **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)

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- c) Structures and equipment : as per vendor's data
supplied by vendor subject to minimum as
specified above

Foundation levels for some columns may be changed suitable to accommodate underground services, pits, trenches etc.

- **Ground floor slab-on-grade**

Refer points 7 & 8 of changes sought sheet.

Ground floor slab-on-grade shall be RCC with ~~Vacuum Dewatered~~ Flooring (~~VDF~~) concrete construction laid over minimum 100mm thick lean concrete. Minimum ~~250mm~~ thick graded stone (63 mm down size) soling with interstices filled with sand/gravel 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.

230mm

- **Stairs, Platforms, Ladders and Handrails**

Generally 150-180 mm riser shall be allowed. As per point no. 24(Civil) of agreed deviation in KTPS.

All internal stairs, platforms and walkways shall either be of RCC or GI gratings construction. All outdoor stairs, platforms and walkways shall either be of RCC or minimum 40mm thick grating. Stairway in a single run shall have the same slope. The vertical rise of the stairways shall not exceed 3.0 m for a single flight. . All stairs shall have a ~~maximum~~ riser height of ~~125 mm~~ and a minimum tread width of 250mm. Minimum width of stairs in all buildings shall be 1200 mm.

Hand railing comprising of posts 1000 mm (min.) high not exceeding 1.5m (max) c/c, shall be provided around all floors/ roof openings, projections, balconies, walkways, platforms, steel stairs etc. All hand rails and posts shall be 32NB heavy duty GI pipes as per relevant IS Codes and shall be galvanized with class-1 galvanization (as per IS-277) shall be provided for all structural steel stair cases and external RCC stairs. Hand rail will be provided with one horizontal pipe at mid-height and continuous flat iron toe guard at bottom. For all internal RCC stair cases in buildings, stainless steel hand railing shall be provided. For stainless steel handrail refer relevant architectural specification.

Steel cage ladder shall be hot dip galvanised. Stringers shall be of angles 90x90x10 with a minimum clear distance of 400 mm in-between. Rungs shall be of 20 mm diameter mild steel rods spaced at 300 mm centres. Ladder stringers shall be provided with suitable lateral stays. The ladder and its connection shall be designed for a minimum load of 200 kg at any location. Cage shall start from a height of 2.5 m above the base of ladder.

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11.00.00 DESIGN OF STEEL STRUCTURES

- a) Structural steel design shall be carried out as per the National Building Code with specific consultation to IS-800 working stress method unless noted otherwise. Design of structures in electrical substation shall be as per IS-802.
- b) Lateral forces along the length of the building shall be resisted by bracings in horizontal and vertical frames. The transverse lateral load shall be resisted by stiff jointed frame action. Additional bracing or moment connection shall be used to assure stability of the structures.
- c) Vertical bracing members which are connected to the beam shall be analyzed for all the vertical loads which the beam is subjected to along with lateral loads.
- d) Shear force in steel columns shall be transferred to the pedestals/ foundations exclusively either through foundations bolts or through shear key arrangement.

Design of base plate shall be based on the design pressure on foundation which shall not exceed the following:

- i) Pedestal in concrete grade M20 5.0 N/mm²
- ii) Pedestal in concrete grade M25 6.25 N/mm²
- iii) Pedestal in concrete grade M30 7.5 N/mm²
- e) Shop connections shall be all welded and field connections shall 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. shall be done by 16 mm dia. M.S. black bolts (minimum 4.6 grade) conforming to IS-1363 unless specified otherwise.
- f) 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 shall be fabricated using submerged arc welding procedure unless manual arc welding is specifically required. All butt welds in plate girders and columns shall be full penetration. All butt welds shall 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

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Filler wire: AWS-A-5.17-EH14
 Flux shall be agglomerated type of classification
 AWS-A-5.17-F7A2EH14

- g) All structural steel members for substation shall be hot dip galvanised in accordance with IS-4759. The fasteners shall also be galvanised in terms of IS-5358. Galvanizing of steel structure shall be done after all fabrication work is completed. Zinc coating of galvanized surface of structural members and threaded fasteners shall as recommended in IS:4759. 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.
- h) Shop primer paint shall be single coat of epoxy resin based zinc rich primer (such as blast steel EZ1 of Shalimar Paints Ltd.). The surface preparation shall be done after sand blasting 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 epoxy paint 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.
- i) 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., or ESAB India Ltd., or D & H Secheron Electrodes Pvt. Ltd or Modi electrodes or equivalent as approved by Owner.

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

- j) Minimum preheat & inter pass temperatures for welding over 40mm to 63mm (thickness of the thicker part at the point of welding) shall be 66°C and for over 63mm, it shall be 110°C. However, higher preheat & inter pass temperatures may be required due to joint restraint etc. and shall be followed as per approved welding procedure.

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- k) Minimum tests to be carried out during fabrication and erection of structural steel shall be as follows:

Steel

Ultrasonic Test: Plates above 25mm thick shall be subjected to ultrasonic test as per ASTM-A435 or equivalent to check the presence of lamination.

Fillet weld

Dye Penetration Test: 25% of the total length, Dye penetration shall be carried out to the root run.

Butt weld

Dye Penetration Test : 100% of the total length, Dye penetration shall 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. Minimum 300mm length shall be spot radiographed. When radiograph is not possible ultrasonic test shall be carried out after grinding the surface.

100% radiography test shall be carried out for the plates of 32mm thick and above.

25% radiography test shall be carried out for the plates below 32mm thick.

100% radiography test shall be carried out of the crane girders and bunker girders irrespective of thickness of the plate.

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.

- l) **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 shall be as follows:

Full shear capacity for box section.

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80% of full shear capacity or actual shear (if indicated in drawings) or 0.5 times of the web thickness which ever is more for I section. Weld shall be double fillet.

All welds shall be continuous. The minimum size of fillet weld shall 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 shall 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 shall be done considering that total load gets transferred through weld.

Erection joints shall be provided with suitable splice plates as per design after conducting the relevant weld tests for the welded joints. 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 shall 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

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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.

11.01.00 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 utilises single-span beam systems, vertical diagonal bracing at main column lines and horizontal bracing at the roof and major floor levels.

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 m²) 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.

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.

Where a steel beam or member is to be connected on RCC structure, it shall be connected using an insert plate and through shear connection.

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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 shall not be permitted. Bearing edges of crane girders shall be machined.

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 pipe lines are really anchored at the anchor points.

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 shall be permitted. However, permissible stresses in bolts and welds shall be allowed to exceed up to 25 % only under wind and seismic conditions.

11.02.00 Permissible Deflections

The permissible deflections of various steel members under normal load 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

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d)	For roofing and cladding components	:	Span / 250
e)	For gratings and chequered plates	:	Span / 250 subject to a maximum of 6 mm
f)	Coal conveyor gallery bridges:		Span/450

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 (without crane load)	:	Height / 325
b)	Multistoried building (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 to maximum of 15 mm
f)	Building main columns at crane rail level due to action of crane surge load only	:	Height / 2500 limited to maximum of 10 mm

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- g) Open gantry columns at crane rail level due to action of crane surge load only : Height/4000 limited to maximum of 10 mm
- h) Coal Handling Trestles : Height/1000

Provisions of IS: 800 and relevant IS Code shall be followed for limiting deflections of structural elements not listed above.

11.03.00 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

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.

11.04.00 Minimum Sizes of steel elements

- For Joists : I - 150
- For Channels : MC - 100
- For Angles : L 50 x 50 x 6
- Gusset plates : 8mm thick

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The flange width of purlins supporting light weight concrete slab	:	65 mm
The flange width of purlins supporting roof sheeting and wall cladding	:	50 mm.
Width of steel rolled section connected to other member	:	50 mm.
The depth of beams for platform	:	125 mm.

11.05.00 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 column	:	1 / 30

12.00.00 STRUCTURAL MATERIALS

Following materials shall be used in design and construction of the structure and foundation:

12.01.00 Structural Steel

12.01.01 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 normalized) 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 of Main producer such as "SAIL" or "TATA STEEL" or "RINL" or "JINDAL" make or vendor approved by owner.

12.01.02 Structural pipes conforming to IS 806 (YST 25)

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- 12.01.03 Structural hollow sections (square & rectangular) conforming to IS:4923
- 12.01.04 Pipes of hand rail conforming to IS:1161 (Medium class Grade YST=240)
- 12.01.05 Plates, Flats, Ordinary steel washers conforming to IS:2062 (Grade A, B & C).
- 12.01.06 Steel Gratings – Carbon steel conforming to IS:2062.
- 12.01.07 Chequered plates (6 mm thick) – Carbon steel conforming to IS:3502.
- 12.01.08 Anchor Bolts, Studs or Threaded Bars – Mild Steel of grade 4.6 conforming to IS:5624.
- 12.01.09 Connection Bolts – All High strength connection Bolts shall be of grade 8.8 conforming to IS:1367 and shall be supplied conforming to IS:3757. All mild steel connection bolts shall be of grade 4.6 conforming to IS:1367.
- 12.01.10 All nuts shall be of heavy duty hexagonal type and shall be compatible with the bolts.
- 12.01.11 All nuts & washers for high strength bolts shall conform to IS:6623 & IS:6649 respectively.
- 12.01.12 Washers for mild steel bolts shall be of mild steel conforming to IS:5369/IS:5372 or IS:5374 as the case may be.
- 12.01.13 Welding Electrodes – Low Hydrogen electrodes conforming to IS:814.
- 12.02.00 **Concrete**
- 12.02.01 **Cement**

All cement shall be Fly ash based Portland pozzolana cement conforming to IS:1489 (Part-1).

Ordinary portland cement conforming to IS:8112 (43 grade) / IS 12269 (53 grade) shall necessarily be used for the following structures :

- i) TG foundation top deck and sub-structure
- ii) Major machine foundations such as PA/FD/ID Fans, Pulverizers, TDBFP AND MDBFP
- iii) Chimney shell
- iv) Shell and racker columns of NDCT
- ~~v) Structures requiring grade of concrete of M25 and above excluding water retaining structures.~~

Refer point no 9 of changes sought sheet.

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As an alternative to Fly ash based Portland pozzolana cement, Fly ash can be added to ordinary Portland cement (Grade 43/53). Batching plant shall have facility for mixing fly ash. Fly ash shall conform to IS: 3812 (Part I & Part II). Percentage of fly ash to be mixed in concrete shall be based on trial mix and subject to maximum of 25% replacement of cement. Detailed design mix shall be carried out by the bidder and approved by the consultant / owner.

PP Cement shall be used only for miscellaneous buildings like storage sheds, concrete pavements. For all other works OP Cement (grade 43/53) shall be used.

The cement procured from mini plants will not be acceptable.

12.02.02 Grade of Concrete

The following minimum grades of concrete as per IS-456 shall generally be used :

Sl. No.	Class	Grade of conc.
1.	i) Plain cement concrete used for screeds and mud-mat	M15
	ii) Subgrade filling	M7.5
2.	Paving in main plant area, Slab on grade, Duct bank	M20
3.	i) Reinforced concrete for super structure and foundation & Chimney raft	M25
	ii) Reinforced concrete for water retaining structure	M25
4.	Pre-cast concrete	M30
5.	Reinforced concrete for foundation of TG, Mill, BFP & Fan foundations	M30
6.	TG top deck, chimney foundation	M30
7.	chimney shell	~~M40~~ 30
8.	Piles	M30

As per point no. 25(Civil) of agreed deviation in KTPS.

Detailed design mix shall be carried out by the contractor and approved by the Engineer.

All underground trenches, basement and water retaining/conveying system structures shall have plasticiser cum waterproofing cement additives such as 'SIKA', 'FOSROC' make or equivalent conforming to IS:9103. In addition, limits on permeability as given in IS:2645 shall also be met with. Addition of admixtures should not reduce the strength of the concrete below the specified strength in any case. In case of water leakage during hydro-test or otherwise, additional chemical injection grouting treatment shall be applied for repairing the leakage with no cost implication to the owner.

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Refer point no.10 of
changes sought sheet.

All concrete surface 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 up to 400mm above finished grade level. Storm water drains shall not be provided with bituminous paint.

12.02.03

Concrete Reinforcing Steel

Trenches,Duct Bank,Pipe Encasing,Minor pedestals etc.

Reinforcing bars shall be TMT bars of grade Fe415 or Fe500 conforming to IS-1786 and Mild Steel bars conforming to IS : 432 (Grade I) of either of "SAIL", "TATA STEEL" and "RINL". However, for TMT re-bars above 25mm diameter shall be of 'SAIL', 'TATA' or 'RINL' only.

Further, vendor approval is required for additional vendors other than approved vendors of APGENCO.

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13.00.00 GENERAL DESCRIPTION

Sl. No.	List of Structures/Buildings	Length (M)	Width (M)	Height (M)	No. Reqd.	No. of Storey	Remarks (Types of Building/Structure/Foundation)				
							Frame/Structure	Foundation	Roof	Floors	Cladding
1.	Power House Building						Structural Steel	For details refer to cl.10.01.00 a) of this document	RCC (metal deck form over TG Hall)	RCC	For details refer Volume VII-B
2.	Mill Bunker Building						Structural Steel	For details refer to cl.10.01.00 a) of this document	RCC (metal deck form at feeder and tripper floor levels)	RCC	For details refer Volume VII-B
3.	Turbo Generator foundation, Boiler Feed Pump Foundation and all other major equipment foundations						RCC	-do-			
4.	Boiler Foundation						RCC	-do-			
5.	ESP & Duct Supporting Foundation						RCC	-do-			
6.	ESP Control Room						RCC	-do-	RCC	RCC	For details refer Volume VII-B
7.	Chimney & Foundation						RCC	-do-			
8.	Transformer Yard Foundations including Oil Pits						RCC	-do-			

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Sl. No.	List of Structures/Buildings	Length (M)	Width (M)	Height (M)	No. Reqd.	No. of Storey	Remarks (Types of Building/Structure/Foundation)				
							Frame/Structure	Foundation	Roof	Floors	Cladding
9.	Switchyard Structures, Foundation & Trenches						RCC/ Structural Steel	-do-			
10.	Switchyard Control Room Building						RCC	-do-	RCC	RCC	For details refer Volume VII-B
11.	DM Plant, DMW Storage Tanks, Chemical House etc.						RCC	-do-	RCC	RCC	-DO-
12.	CW Pump House						RCC Sump and structural steel super-structure	-do-	RCC	RCC	-DO-
13.	Chlorination Plant						RCC	-do-	RCC	RCC	-DO-
14.	B.A. Slurry Pit & Pump House						RCC	-do-	RCC	RCC	For details refer Volume VII-B
15.	Ash / MRHS Compressor Building						RCC	-do-	RCC	RCC	-DO-
16.	Ash Handling Plant Control Building						RCC	-do-	RCC	RCC	-DO-
17.	Ash Water Pump House						RCC	-do-	RCC	RCC	-DO-
18.	Ash Pipe Rack						Structural Steel	-do-			

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Sl. No.	List of Structures/Buildings	Length (M)	Width (M)	Height (M)	No. Reqd.	No. of Storey	Remarks (Types of Building/Structure/Foundation)				
							Frame/Structure	Foundation	Roof	Floors	Cladding
19.	Service & Technical Building						RCC	-do-	RCC	RCC	For details refer Volume VII-B
20.	Clarified Water Reservoir & Pump House						RCC	-do-	RCC	RCC	-DO-
21.	HSD/HFO Day Tank Foundation						RCC	RCC Ring Wall Foundation			
22.	FO Forwarding Pump House						RCC	For details refer to cl.10.01.00 a) of this document	RCC	RCC	For details refer Volume VII-B
23.	Diesel Generator & Compressor Building						RCC	-DO-	Colour coated galvanized sheeting	RCC	-DO-
24.	Side Stream Filter						RCC	-DO-			
25.	Store						RCC	RCC Spread	RCC	RCC	For details refer Volume VII-B
26.	Fly Ash Silo						RCC	For details refer to cl.10.01.00 a) of this document	RCC cast-in-situ		
27.	Mill Reject Silo						RCC/ Structural Steel	-DO-			

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Sl. No.	List of Structures/Buildings	Length (M)	Width (M)	Height (M)	No. Reqd.	No. of Storey	Remarks (Types of Building/Structure/Foundation)				
							Frame/Structure	Foundation	Roof	Floors	Cladding
28.	HSD/HFO Pipe Corridor						RCC/Structural Steel	-DO-			
29.	Fire Water Sump						Structural Steel	RCC Ring Wall Foundation	RCC		
30.	Fire Water Pump House						RCC	For details refer to cl.10.01.00 a) of this document	RCC	RCC	For details refer Volume VII-B
31.	Wagon Tippler						Structural Steel	-DO-	Metal cladding		-DO-
32.	Transfer Point						Structural Steel	-DO-	Metal cladding		-DO-
33.	Pent House						RCC	-DO-	RCC	RCC	-DO-
34.	Crusher House						RCC	-DO-	RCC	RCC	-DO-
35.	Stacker/Reclaimer						RCC	-DO-			
36.	Equipment Laydown Space						RCC	RCC Paving			
37.	RCC Retaining Wall						RCC	-DO-			
38.	FO Pressurising Pump House						RCC	For details refer to cl.10.01.00 a) of this document	RCC	RCC	For details refer Volume VII-B
39.	Pipe Rack						Structural Steel	-DO-			

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Sl. No.	List of Structures/Buildings	Length (M)	Width (M)	Height (M)	No. Reqd.	No. of Storey	Remarks (Types of Building/Structure/Foundation)				
							Frame/Structure	Foundation	Roof	Floors	Cladding
40.	HFO & HSD Main Storage Tank						Steel	RCC Ring Wall Foundation	Steel		

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14.00.00 DESCRIPTION OF MAJOR PLANT STRUCTURES/COMPONENTS

The description of some of the major structures/components of this turn-key Package are given below:

14.01.00 Power House Building

The main power plant building comprising TG bay (A-B bay) and the adjacent electrical & deaerator bay (B-C bay) will be of steel framed construction upto the roof level. All floor slabs at intermediate level will be of RCC and will be supported on steel beams & columns. Transverse frames will be of framed type, bracings will be provided in longitudinal direction to resist horizontal forces. A-B bay will be equipped with EOT crane.

All cladding / glazing, roof material , drainage and treatment, all necessary flooring, finishing, painting, doors, windows, louvers and all other fixtures shall conform to General Specification and Design Criteria for Architectural Work - Volume II-G/2 of this bid document.

Motor driven feed pumps are kept at Mezzanine floor and turbine driven feed pumps are kept at operating floor level. as per Point no.29 (Civil) of agreed deviation in KTPS.

Within the building, the concrete pedestal for supporting the turbine generators and Boiler Feed Pumps/motors will be completely isolated from the building floors for vibration control. ~~The Boiler Feed Pumps shall be located in the ground floor of Power House Building.~~ The foundation for Turbo-generator and ~~Boiler Feed Pumps/motors~~ shall rest on conventional machine foundations. 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.

The roof over Turbine Hall 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 permanently colour coated (on exposed face) galvanized M.S. troughed metal decking of approved profile supported by steel purlins which are spanning between two adjacent roof trusses. The thickness of sheet shall be as per the design requirement considering worst load combination subject to a minimum thickness of 0.8mm. The roof shall be insulated with rigid insulating board. For Roof water proofing treatment relevant section of the Architectural specification shall be referred. Roof will be provided with suitable drainage arrangement through rainwater down comers.

All structural components will be shop welded while the field connections will be made with high-tensile bolts or welding as determined in design stage. The transverse frames will be of moment resistant design. In the longitudinal direction, these transverse frames will be braced to resist horizontal forces.

Stairs and platforms shall be provided as required for maximum utility and safety. Stairs shall have to be provided as per TAC regulations and any other statutory requirements.

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Structural steel platforms along with gratings, ladders and hand rails shall be provided to all equipment for operating the valves etc., as and where required. Bus duct support & structure shall be provided as required.

14.02.00 Mill & Bunker Building

Mill & bunker Building shall house coal pulverisers, coal bunkers, feeders, Tripper conveyor with its drives and monorails. All columns, main and secondary beams shall be made of structural steel.

The frame will be designed as a moment resisting sway frame in the transverse direction and braced frame in the longitudinal direction. The columns shall be braced in both the transverse and longitudinal direction. Bracings may be waived of in the transverse direction above the tripper floor and near the ground floor due to functional requirement. The bracings in the longitudinal direction shall be in two (2) planes through a pair of longitudinal members laced or battened together. Each bracing member shall be connected to column flange plate through gusset plate of minimum thickness of 12 mm.

Grillage type column base of minimum depth of 800 mm and consisting of bottom base plate, top plate and vertical stiffeners shall be provided for main columns. Base plates will generally be 1250 mm below ground floor in order to keep gusseted base below ground. This portion shall be encased in concrete for corrosion protection. The column and mill will be supported on pile/raft foundations.

The floors will be of reinforced concrete slab with hardened top with hatchways as required. Building roof and floor slabs at feeder and tripper floor levels will be of Cast-in-situ R.C.C. over permanently colour coated (on exposed face) galvanized M.S. troughed metal decking of approved profile, supported on steel beams/girders. Ground floor slab will have drainage trenches covered with steel grating. Rain water down take pipes of galvanized MS conforming to class medium of IS:1239 shall be provided along all the bunker supporting columns from roof level to drain at ground level.

Supporting structure for Mill maintenance arrangement will be connected to this structure. Handrails shall be provided on all sides of Feeder floor. Slit openings are to be provided in Tripper floor for entry of coal from Tripper into bunkers. Framing arrangement for structural steel platform at various levels around the bunkers shall be provided, as required, with proper access ladder for poking, striking and attending to air cannons. Mill building shall be designed considering load from connecting conveyor gallery and other Coal handling facilities. End columns to support the external gallery of the tripper conveyor shall be provided with structural steel brackets with PTFE bearings.

The building sides will be cladded with brick cladding to a height of 3.0 mts with a provision of openable windows above tripper floor and balance portion above brick wall up to roof level shall be cladded with single skin metal cladding. The remaining portion of the building below Tripper floor up to

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ground floor shall generally be uncladded. However, brick cladding shall have to be provided, if required, as per TAC and any other statutory requirements.

No staircase shall be provided in Mill & Bunker Building. There interconnections at feeder, tripper Floor & Roof for access from Boiler side. As per point no. 31(Civil) of agreed deviation in KTPS.

Stairs and platforms shall be provided as required for maximum utility and safety as per TAC regulations and any other statutory requirements. Stair should be provided from ground up to roof. ~~Minimum two (2) nos. of stairs shall be provided in each Mill Building.~~ Structural steel approach bridge from boiler structure and walkway with MS grating and handrails around the bunkers shall be provided above the feeder floor to access bunker coal level monitoring strain gauges. Structural steel platforms along with gratings, ladders and hand rails shall be provided to all equipment for their successful operation as and where required.

Bidder has the option to provide the Mill-Bunker Building independent of the boiler supporting structure or to integrate this building with the boiler structure. In case the Mill-Building is independent of the boiler structure, all walkway bridges to connect the Boiler with the RCC floors of the Mill-Bunker Building shall be provided with PTFE bearings.

The Coal bunker shall be circular in plan and cylindrical at top portion and conical at sloped hopper portion with minimum 73 deg. Slope. Minimum thickness of structural steel bunker plates shall be 12mm inclusive of 4mm corrosion allowance. Minimum wall thickness of hopper shall be 8mm. Minimum thickness of stainless steel liners on the inner surface of hopper wall shall be 4 mm conforming to grade SS304. Stainless steel liner shall be provided for complete hopper portion and extends 1.0 M in to cylindrical portion. On sides of the bunker necessary openings shall have to be provided for bunker ventilation / dust extraction. A comprehensive flowability study shall be conducted by the Bidder for the coalbunker hopper to ensure smooth flow of coal in all seasons with different moisture contents and different percentage of fines. Geometric parameters of hopper shall be decided considering the findings of flowability study.

Fastening System

The edges of stainless steel plates shall be ground smooth after cutting. The liner plates should be plug welded to the mother plate. The plug welding shall be done by drilling 20 mm. Dia. Holes @ 300 mm c/c both ways without puncturing the mother plate. The welding is to be done by using specialized stainless steel electrodes such as 308L / 309L. Shielding gas shall be Argon + Oxygen mixture or Argon + Hydrogen mixture. CO2 mixture shall be avoided.

Before commencing regular fabrication of the bunker, trial assembly of the bunker including hopper shall be made at least for one bunker.

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14.03.00 Auxiliary Plant Buildings

CW Pump House or any other superstructure of structural steel construction will be having rigid joint in transverse direction and braced in longitudinal direction. Gable and side cladding of this building shall be of brick masonry supported on steel wall beams. Roof shall be of cast-in-situ RCC slab over permanently colour coated (on exposed face) galvanized M.S. troughed metal decking of approved profile or removable formwork supported on steel purlins.

Dimensions, sizes, depth of CW pump house, control building etc. if indicated in bid specification are indicative and bare minimum only. The bidder should note that the cost implication, if any, due to change in the dimension, sizing etc. as per the equipment supplier's requirement is deemed to be included in the offer.

R.C.C. channel from Cooling Tower basin to CW Pump House shall be minimum 500 mm above F.G.L and road crossing portion shall be designed for Class 'AA' traffic.

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.

14.04.00 RCC Stack

14.04.01 General Arrangement

The reinforced concrete single brick flue stack of 275 M height shall be comprising of a wind shield of reinforced concrete shell with insulated brick lining inside the wind shield from hopper level to top. The brick flue shall be vertically supported on RCC ring corbels projected from inside face of wind shield at certain vertical spacings described elsewhere in this specification. The external RCC platforms shall be supported on RCC wind shield. Access to the platforms shall be through caged ladders outside of chimney.

i) General Parameters

1) Total height of stack above ground level.	275 M
2) Number of Stack (wind shield)	One
3) Number of flue per Stack	1 (one) brick flue
4) Number of Boilers	1

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5)	Particulate emission	50 mg/Nm ³ (approx)
6)	Foundation level	To be decided by Bidder as per recommendation based on geotechnical investigation carried out by bidder and approved by Owner
7)	Allowable Soil Bearing Capacity	To be decided by Bidder as per recommendation based on geotechnical investigation carried out by bidder and approved by Owner
8)	Exit velocity of flue gas	15 m/s with partial load 29.2 m/sec. with full load
9)	Type of stack (wind shield)	RCC wind shield with brick flue
- ii) The wind shield shall be of RCC construction. Insulated brick flue shall be housed within the windshield. Brick flue/lining shall be supported on RCC ring corbels projected from inside face of wind shield at a maximum vertical spacing of 10.0^m. External RCC platforms shall be provided at regular intervals satisfying all functional as well as statutory requirements. The flue ducts shall be entering the wind shield at a particular level.
- All external RCC platforms shall be supported on R.C. shell of the wind shield. External cage ladder for access to all platforms shall be provided. Access door at grade level and clean out door at hopper level shall be provided for access into the windshield and to the hopper. All doors like inspection/maintenance doors shall be as per IS code / environment regulation.
- Natural Ventilation within the windshield shall be provided as required.
- iii) **Elevator and Caged Ladder**
- Elevator and caged ladder outside windshield shall be provided.
- The travel of the elevator shall be up to the last platform level. Caged ladder shall be provided from ground up to top level of chimney with access to all external platforms. The maximum spacing between intermediate landings shall be restricted to 9.0 m at which locations the direction of ladder shall be changed.

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Steel cage ladder shall be hot dip galvanised. Stringers shall be of angles 90x90x10 with a minimum clear distance of 600 mm in-between. Rungs shall be of 20 mm diameter galvanized iron rods spaced at 300 mm centres. Ladder stringers shall be provided with suitable lateral stays connected to the chimney wind shield. The ladder and its connection shall be designed for a minimum load of 200 kg at any location.

iv) Paintings

Entire external surface of the windshield shall be painted at least two coats over prime coat in alternate band of signal red and white colour starting with signal red colour at the top and in line with aviation requirements. External painting shall have acid, UV and heat resisting properties conforming to IS-158. Total dry film thickness (DFT) shall be at least 150 microns. The top of shell and top of acid resistant bricks at the roof level shall be painted with two coats of 'EXPILUX 5 COAL TAR EPOXY PAINT' over a thin coat of the same paint as manufactured by M/s. Berger Paints (India). The overall DFT shall be at least 230 microns.

The inner surface of wind shield from ground floor up to full height shall be painted with acid and heat resisting black bitumen paint (two coats) of approved make to give a paint DFT not less than 150 microns .

Surface preparation and paint application shall be in accordance with manufacturer's recommendation and as per specification.

v) Flue Gas Sampling Ports on chimney

- a) Gas sampling ports fabricated from stainless steel with flanged ends shall be provided for liner at platform levels, including proper insulation, blank plates, nuts, bolts etc. The location, orientation and levels of ports shall be as per the regulations of Central Pollution Control Board & Andhra Pradesh State Pollution Control Board.
- b) Flue gas sampling ports for on line Emission monitoring instruments & Test Ports for local sampling & testing, fabricated from MS pipes of standard schedule shall be provided on the liner at access platform level.
- c) The contractor shall provide one (1) nozzle made of 200 NB MS pipe and projected approximately 200 mm outside the flue wall with an upward inclination of 5 Degree with the horizontal plane of flue can for mounting of SOx, NOx & CO analyzer.

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- d) The contractor shall provide two (2) nozzles in diametrically opposite position made of 200NB MS pipe and projected approximately 200 mm outside the flue wall for mounting of Opacity monitor.
- e) Location of the Sampling & Test ports, on the stack, shall be at least at a distance of 8D (D= Stack diameter) downstream along the direction of flue gas flow from ID fan duct connection to stack. Further the selected position shall be at least 2D before stack exit. The height of the test ports shall not be less than 82.5 metre from FGL, fulfilling all above the criteria.
- f) Temperature Test pockets with a stub of size M33X2 for installing thermo-well shall be provided by Bidder for flue gas temperature measurement & correction for opacity measurement.
- g) In addition to the above sampling ports for instrumentation purpose there shall be four (4) gas sampling ports on the flue can at 90 degree apart with flanged ends for local sampling & testing. Contractor shall provide required counter flange, nuts, bolts and gaskets. The size of each nozzle shall be 100 NB and provided with blind flanges.
- h) Access platforms shall be provided for maintenance of the above analyzers and for local sampling.
- i) Power connection with 240V, 15A AC plug socket arrangement shall be installed at this platform level for operating the Test Instruments.
- j) Dimensions indicated above are tentative, which shall be finalized during detail engineering upon receipt of vendor data. The exact details of pipe & flange and their elevations will be furnished during detail engineering on receipt of data from analyzer supplier.

Bidder shall furnish the arrangement drawings for the sampling and test points for Owner's approval during detail Engineering.

vi) **Ash Hopper**

- i) Hopper shall be of reinforced concrete and lined with 75 mm thick acid resistant brickwork laid over 75 mm vermiculite concrete. Only shaped acid resistant bricks shall be used in the hopper portion. The bricks, mortar and details of laying and joining shall conform to the requirements laid down for acid resistant brick lining as per latest IS codes.

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Hopper shall be supported on continuous RCC corbel projected from wind shield. A ring beam shall be provided at end of hopper at top which will rest on RCC corbel over 12 mm thick asbestos board.

Hopper shall be properly sloped to enable accumulation of dust towards the central opening at bottom.

At the bottom of the hopper, Cast Iron (CI) flanged pipe with puddle flange of required diameter and length shall be provided. Inside of this pipe sleeve shall be coated with sodium silicate.

Adequately designed RCC baffle wall shall be provided at flue-duct level above hopper. Baffle wall shall be placed at the centre of the wind shield perpendicular to the incoming flue-duct and the same shall be supported from RCC wind shield. Acid resistant brick lining shall be provided on all surfaces of the baffle wall.

ii) Maintenance Provisions

The outer face of the chimney wind shield shall be provided with adequate number of stainless steel insert plates of grade 316 L at the top to enable fixing and supporting painter's trolleys and other accessories. The insert plates shall be provided with suitable number of threaded holes and nuts welded at the rear end to enable bolting of the assembly when desired.

Similar arrangement shall be made at each platform level but to fix the painting trolley arrangement directly on the platforms for the purpose of painting the chimney.

A lifting beam shall be provided to cater for lifting of materials during maintenance and painting. The size and capacity of the lifting beams shall be as per requirements.

iii) Louvres

Air outlet louvres shall be provided as per requirement. The louvre fins shall be of Z-shape in cross section and made from anodised aluminium plates of a minimum thickness of 4 mm. The frame work supporting the louvre fins shall be made from extruded aluminium sections of minimum thickness 6 mm. The louvres shall be mounted in the form of panels. The fins shall be closely spaced to cut off any driving rain entering the chimney wind shield. All panels must be approved by the Owner before installation.

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14.04.02 Design Criteria

Design and construction of various components and systems of the chimney shall be in accordance with relevant Indian Standard and where provisions are not covered in IS, reference shall be made to ACI, BS, CICIND and other international standards. In case of any conflict between this document and the Indian and International Standards, the stipulations of this document shall prevail.

A. Loading

a) Dead Load

- i) All permanent loads due to the weight of chimney shell, external platforms, insulated brick linings supported on corbels, ladders, other accessories etc.

b) Imposed Loads

- i) Imposed load on service platform around Chimney shell, shall be taken as 500 Kg/m². Design live load during construction / erection shall be considered as 1000 Kg/m².
- ii) Imposed loads from duct joining the Chimney shall be considered.

c) Wind Load

The wind loading shall conform to IS: 875 (Part-3). Following parameters shall be considered for assessing wind loads:

Basic wind speed = 44 m/s at 10m above mean retarding surface

k_1 = 1.08 as per Table 1 of IS: 875 corresponding to 100 years return period

k_3 = 1.0

k_2 = As per Table 2 of IS: 875 (Part – 3) corresponding to terrain (category 4)

k_2 (bar) = As per Table 33 of IS: 875 (Part – 3) corresponding to terrain (category 4)

Aerodynamic Interference Effect (proximity effect) due to presence of other tall structures and stacks in the vicinity shall be assessed based on wind tunnel test to be carried by specialized agency in this field acceptable to Owner and shall be incorporated in design.

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Profile (diameter, thickness etc.) as well as wind forces (moment/shear etc.) at different sections/levels of chimney shall be calculated as per structural analysis conforming to requirements of IS:4998 and Contract Specification. Wind Tunnel study shall be carried out based on the profile of the chimney determined. Worst of the forces calculated as per structural analysis and obtained from wind tunnel study shall be considered as design forces for final design of shell and foundation.

d) Seismic / Earthquake Load

Calculation of earthquake forces acting on the Chimney and analysis for the same shall be carried out as per IS: 1893 (Part 4) [Zone – III] using the Response Spectrum Method. Material damping factor and number of modes to be considered for the analysis shall be as per recommendation in the code referred above.

e) Thermal Effect

Thermal effect due to established thermal gradient shall be duly considered as per provisions in relevant IS code.

The temperature gradient ΔT across the shell thickness of wind shield shall be calculated as per IS : 4998 but subject to a minimum of 30°C. The temperature stresses shall be calculated according to the procedures given in ACI – 307 and IS : 4998.

f) Local Loads

The effect of following local loads shall be considered.

- i) Local moment produced by corbels (if any).
- ii) Local moment due to platforms.
- iii) Local moment due to occurrence of ovaling oscillation.
- iv) Local moment produced by thermal gradient.

B. Load Combination

Various load combination for calculation of stresses shall be as under.

- i) Dead load + Wind load.
- ii) Dead load + Earthquake effect.
- iii) Dead load + Temperature effect.

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- iv) Dead load + Wind load + Temperature effect.
- v) Dead load + Earthquake force + Temperature effect.
- vi) Circumferential stresses due to temperature effect.
- vii) Circumferential tensile stresses due to wind induced ring moment.
- viii) Circumferential compressive stress due to wind induced ring moment combined with temperature.

In load combinations (i) to (viii) above, dead load considered with or without the weight of insulated brick lining, whichever condition is more critical shall be adopted for design. Across wind loads shall be combined with co-exiting along wind loads. The combined design moment at any section shall be taken as SRSS of the moments due to across wind loads and co-exiting along wind loads.

C. Permissible Stresses For Chimney Shell

The Stress in Steel reinforcement and Concrete shall not exceed the limits as prescribed in clause 7.0 of IS: 4998 (Part-2) for various combination of loads. Except for case of dead load + wind load, the maximum permissible stress in concrete in this case shall not exceed $0.28 F_c$, where F_c = Characteristic compressive strength of concrete.

D. Analysis

- **Free Vibration Characteristics of Wind Shield**

Assessment of Natural Frequencies and mode shapes shall be carried out. For this purpose the Chimney shell shall be idealized as a vertical cantilever with Lumped masses at different nodes. The nodes shall also be provided at each platform level.

The number of modes to be considered in the analysis shall be such that at least 90% of the modal mass is excited.

- **Wind Analysis**

- a) **Along Wind Load**

Along wind load shall be assessed based on methods specified in IS: 4998 (Part-I) – 1992. For design, higher of the wind loads obtained from simplified method in A-4.1 and random response method in A-5.1 shall be used. Dynamic modulus of Elasticity of concrete as recommended in IS: 4998 (Part-1) – 1992 shall be used for evaluating the natural frequencies.

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Drag coefficient ' C_D ' or Force coefficient ' C_f ' shall be taken as 0.8 (minimum) based on Fig 5 of IS: 875 for the concrete shell in general. It will be increased as required as per IS: 4998 over the portion covered with strakes, if required. It is to be noted that provision of steel strakes may not be feasible considering the elevator and caged ladder up to top of chimney. Requirement of strakes shall be determined as per wind tunnel study.

b) Across Wind Load

The across wind response of the Chimney shall be evaluated as per the method given in Section A-4 as well as A-5 of IS: 4998 (Part-I) – 1992. Peak Oscillatory Lift Coefficient C_L shall be taken as 0.16 and Strouhal Number S_n as 0.2. Higher of the two moments shall be considered for design of the Chimney.

c) Ring Moments due to Wind

The circumferential ring moment due to wind shall be calculated in accordance with clause 5.4 of IS: 4998 (Part-I) – 1992. The wind induced stresses in concrete and steel shall be checked in accordance IS: 4998 (Part-2).

• Seismic Analysis

The Seismic Analysis shall be carried out using the Response Spectrum Method according to IS: 1893 taking the first 5 modes (minimum) of vibration in to account. 5% damping shall be considered for the analysis.

14.04.03 Component Design Criteria

A. Wind Shield

The design conditions for the concrete shell shall be as follows :

1. The concrete shell shall be designed for loads and load combinations as specified. Working stress method shall be used for design of shell. The modular ratio shall be calculated as per Annexure – B of IS – 456.
2. The concrete shell shall support all platforms as well as corbels, which in turn supports the brick flue.

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3. The permissible stress in concrete and reinforcement shall be limited to as specified in clause 8 of IS 4998 (Part 2) and as per Cl. No. 10.02.00 of this section, whichever is critical.
4. The maximum deflection at the top of the chimney for both static and dynamic cases shall not be more than $H/500$ where 'H' is the total height of the windshield above top of the foundation.
5. The static modulus of elasticity of concrete for various concrete grades shall be taken as specified in IS: 456.
6. The dynamic modulus of elasticity of concrete for various concrete grades shall be taken as lower values in the range of values specified in IS : 4998 (Part-I) – 1992.
7. Reinforcement in the shell shall be provided as per IS: 4998 (Part-2). However, the maximum spacing or reinforcement shall not be more than 250 mm both ways in the shell and 300 mm for foundation raft.

Minimum 0.12% reinforcement shall be provided on either side of stack wind shield.

While providing vertical reinforcement steel in the shell, the total number of vertical bars shall be continued till such height when alternative bars can be discontinued. However, reduction of bar diameter along the height is permissible. At any section of the shell vertical bars shall be uniformly spaced. Non-uniform spacing of vertical bars is not acceptable.

One third of the vertical bars can only be lapped at one section.

8. Openings in the shell shall be provided for ductwork, access doors, ash channel and ventilation system etc. The maximum width of opening shall be limited to an angle of not more than 30° subtended at the center of the concrete shell. Openings for ventilation shall be provided along periphery of the wind shield just below top of ash hopper.

The total plan area of the openings at a particular section shall not be more than 15% of the plan area of concrete shell at that location. The opening size for the purpose of stress calculations shall be taken as 1.1 times the actual width of the opening. The extra reinforcement around opening shall satisfy the requirements given in the following documents and the highest shall be provided.

- a) IS: 4998
- b) ACI 307
- c) Reinforced concrete chimney and tower by G.M. Pinfold.

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9. Embedment to support the caged ladder shall be provided as required.
10. Caged ladder and elevator enclosures shall be provided keeping provision for a rack and pinion type electrically operated elevator.
11. Minimum thickness of wind-shield at top of base raft level shall be 1000 mm. Minimum thickness of wind-shield at top of chimney shall be 400 mm. However, uniform thickness of shell shall be maintained from top of raft to 3.0 m above top of flue duct entry.
12. Uniform Grade of concrete shall be adopted throughout the height of chimney shell.

B.**Brick Flue**

- **General**

- a) The flue diameter shall be so sized to ensure that the flue gas exit velocity is approximately 20 meters/second at all loading conditions. It should be ensured that the flue gas exit velocity at the lowest continuous unit load is high enough (of the order of 15 meters/second) to enable adequate dispersion of the flue gases. For this purpose, 60% turbine MCR condition with design coal / worst coal firing (whichever yields lesser flue gas quantity) shall be considered as the lowest continuous load condition.
- b) The number, size and location of flue opening in the shell shall be as per the requirement of boiler supplier. The Contractor shall make arrangement for the proper support of ducting on the shell and support arrangement as required.
- c) Access doors shall be provided for the ducting where required for inspection and cleaning.

- **Brick Lining**

- a) The chimney shall be lined with 230 thick acid resistant bricks for at least first 55 metres above top of hopper and 115 thick acid resistant bricks for the rest height of the chimney except for top 10.0 m where 230 thick acid resistant brick lining shall be provided. The lining shall be supported on RCC corbels (projected from inside face of wind shield) at intervals of not more than 10.0 metres vertically.

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- b) Lining bricks shall be hard, uniformly well burnt, uniform in colour, of correct shape and size, homogenous in texture and free from cracks, voids and other flaws and shall be of material suitable to withstand the service conditions. No broken bricks shall be allowed to use except for closing the course. Each brick shall be clearly marked with the manufacturer's name and trade mark.
- c) The acid resistant bricks shall conform to Class I of IS:4860 and the mortar for this brickwork shall conform to IS:4832 (Part 1) - Silica type with potassium silicate liquid binder. Provision shall be made for differential vertical expansion at the lining support. The Contractor shall furnish test certificates confirming the acid resisting properties for acid resisting bricks from an approved laboratory for Owner's approval before bringing them to site. Properties of the acid resistant bricks of Class-I shall be as per Table-1 of IS:4860.
- d) In the case of Acid resistant Brick lining, the mortar joints shall be cured with 25% dilute HCl for a minimum period of 3 days and as per Manufacturer's specification after which exposed face shall be thoroughly cleaned with water.
- e) The value of the coefficient of thermal conductivity for acid resistant lining bricks shall not exceed $K = 1.25 \text{ Kcal/m/hr/}^{\circ}\text{C}$ and shall be considered as $K = 1.25 \text{ Kcal/m/hr/}^{\circ}\text{C}$ for the purpose of design of shell for temperature effects.
- f) Prior to despatch of bricks from Manufacturer at least six (6) samples of the lot to be despatched shall be tested for K-value at an approved laboratory and test reports submitted to Owner for approval and permission for despatch of material. While testing, the hot-face temperature of the bricks shall be 300°C .
- g) The thickness of lining shall be as per item no. (a) of this clause. The radial joints shall be broken in each course. Lining shall be strapped with circumferential and vertical double hot dip galvanised mild steel bands having a minimum dimension of 75x6 mm and 50x5 mm respectively, both spaced at one metre centres, on the exterior of the brickwork throughout the full height of the lining.
- h) The vertical and horizontal bands shall be joined together by either (a) suitable spot welding and all weld joints painted with two (2) coats of zinc rich aluminium paint over a coat of compatible primer as per the requirement of the Manufacturer, or (b) fixed by bolting arrangement, with counter sunk bolts and slotted holes.

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- i) Mortar for lining shall be used within the initial setting time and no retempering shall be permitted. Joints shall be properly filled and at a given cross section, the thickness of the joint shall not be more than 3 mm. For this purpose, the bricks shall be of necessary curvature and taper.

- **Insulation**

- a) The flue shall be insulated externally. The slag/mineral wool shall be of resin bonded type conforming to IS:8183 in the form of slabs. The material shall have a minimum density of 1.75 kN/cu.m. Maximum coefficient of thermal conductivity shall conform to requirements of IS:3677 at a mean temperature of 150°C.
- b) The insulation thickness shall be chosen based on the maximum ambient temperature, insulation surface emissivity of 0.3 and the insulation cold face maximum temperature not exceeding 60°C. However minimum 100 mm thickness of insulation shall be provided.
- c) The insulation shall be tightly secured to the exterior surface of the liner by impaling them on studs fixed to the bricks at 450 mm c/c both horizontally and vertically. The studs shall be plated and be of a minimum thickness of 10 gauge. The studs shall extend a minimum of 25 mm beyond the thickness of insulation and 63 mm. Circular or square metal plate speed washers of standard thickness shall be placed on the extended portion of the studs to hold the impaled insulation material well in place. Further, 20 gauge galvanised wire mesh with a 25 mm hexagonal pattern conforming to IS:3150 shall be wrapped around. Where the wire mesh is jointed, a minimum 150 mm overlap shall be provided. The mesh shall be bound and tied in place with a 16 gauge GI wire at 300 mm centres. Any form of lacing the mesh fibres together shall not be permitted.
- d) The diameter of the asbestos rope conforming to grade 1 of IS: 4687 shall be 25 mm.
- e) Asbestos mill board shall be 12 mm thick, unless otherwise specified. It shall be plain, dense and have a homogeneous texture, without cracks, flaws or any other manufacturing defects. It shall be laid directly over the concrete after removing all loose materials but without any mortar / plaster bedding.

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- f) The base for acid resisting brick lining in hopper portion shall be 75 mm thick vermiculite concrete.
- g) No air gap shall be provided between insulation and brick lining. Accordingly, openings/cut-out in RCC corbels (for blowing of hot air) and openings in RCC wind shield at top (for venting out of hot air) shall not be provided. The insulation shall be packed properly between wind shield and brick lining.

- **Chimney Cap Over Brick Flue**

In order to prevent gas-entrained matter from falling into the space between the liner and the shell and also to prevent the chimney top from chemical attack of flue gases, a sectional stainless steel cap of minimum 6 mm thickness over 25 mm thick asbestos mill board shall be provided. The cap shall cover the concrete shell, brick lining and insulation between them. The cap shall have slope towards the inside of the chimney at approximately 30° to the horizontal. All segments and sections of the cap shall be anchored in place with stainless bolts and stainless rag bolts respectively. The cap shall have a minimum overlapping length of 200 mm with 230 thick acid resistant brick lining with a clear gap of 6 mm between them.

C. Foundation

- Please refer provisions of Cl. No. 10.01.00 of this Section.
- The chimney foundation shall be designed for the most critical combination of forces and moments, resulting from all possible combinations of the various loadings from the chimney system during all stages of constructions.
- Ground water table shall be considered at finished grade level for foundation design. The foundation shall be checked for overturning for minimum and maximum vertical loads. Loss of contact of foundation shall also not be allowed in any combination of loads.
- Increase in allowable bearing capacity of soil under wind/seismic loading/combinations shall not be permitted.
- Base raft of chimney shall be designed as continuous considering uniform thickness without tapering. Annular raft with hollow inside is not permitted. Thickness of raft shall not be less than 0.1 times the diameter of the raft nor 0.4 times the overhang of raft from the face of the shell.
- The foundation diameter to depth ratio shall be maintained to around 10 and should preferably not exceed 12.

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- Minimum 0.12% reinforcement shall be provided on either face of foundation.
- One intermediate layer of reinforcement in raft shall be provided where the thickness exceeds 2000 mm. Two such intermediate layers of reinforcement shall be provided where the thickness of raft exceeds 4000 mm. Such reinforcement in each direction shall not be less than 0.06% of cross-sectional area of raft.
- Concrete pouring sequence shall be such that no cold joints occur. Pouring for raft concrete shall not be more than 3 segments.
- The shrinkage reinforcement shall not be less than 16mm deformed bars at 600 mm centres. In addition, vertical chair bars at 600 mm centres shall be provided to support these bars.

D. Outer Platforms

Outer platforms, shall be provided as per Directorate of Air Routes & Aerodromes (DARA) Circular for locating Aviation Warning Lights. The platforms shall be equally spaced at a spacing of 40 m (maximum). Top most platform shall be provided preferably 2.0 mts below the top of chimney. Additional platforms for sampling ports, access doors, clean out doors etc. shall have to be provided as per requirements.

The minimum clear width of the platforms shall be 1200 mm and a live load of 500 Kg/m² shall be considered for design in addition to the dead loads and other incidental loads, if any, including construction loads.

Hand railing shall be provided all around external platforms using 32 NB (medium duty) G.I. pipes. The spacing of railing posts shall not be more than 1500 mm center to center. The height of hand railing shall not be less than 1250 mm. There shall be three handrails at about 450 mm and 850 mm & 1250 mm respectively above platform level. The posts shall be embedded in RCC curb (150 x 200 high) at outside face of platforms.

150 mm dia GI pipe shall be provided to carry rainwater from all platforms to discharge point at ground level. The number of down take pipe shall be decided as per design.

E. Doors

i) Access Doors

Two access doors of size 3000 mm x 3500 mm (high) or allowable maximum size and 2000 mm x 2100 mm (high) shall be provided at ground floor level for truck and personnel access. Electrically operated roll up shutter of suitable size for truck entry access and hollow type

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pressed steel doors for personal access shall be provided. These doors shall be provided with minimum two coats of acid and alkali resistant paint conforming to IS:158 type-I to give a DFT of 100 microns on inside surface. The outside surface shall be provided with 2 coats of resin based zinc rich primer and two final coats of epoxy paint. The personal access door shall be hinged and provided with positive locking device. The hinges required for connecting the doors with door frames shall be heavy duty butt hinges conforming to IS : 1341 (latest).

ii) Clean Out Doors

One number each clean out door having clear dimension of 1000 mm x 2100 mm (high) shall be provided just above hopper level at appropriate location on either side of baffle wall with proper access for operating the door. The edges of the doors shall be properly sealed to prevent leakage of hot flue gases. The doors shall be of hollow pressed steel construction with inner plate of 10 mm and outer plate of 8 mm thickness with suitable infill of stiffeners. The hollow space shall be filled up with insulation of the type used around flue. In addition, around the door openings, removable type of insulation similar to the insulation provided around flue shall be provided. The door shall be of hinged type and provided with locking device in addition to Swivel studs with wing nuts on the remaining 3 edges. The door shall be openable from outside only. Proper sealing arrangement shall be provided in the doors to ensure leak tightness.

F. Miscellaneous

i) Ground floor slab and drainage

150 mm thick slab-on-grade over 100mm thick PCC laid over 250mm thick (compacted) boulder soling with interstices filled with sand shall be provided at ground floor. Proper slope towards internal periphery shall be provided in ground floor. RCC drain shall be provided around internal periphery of shell which shall be connected to drainage outside.

ii) Temporary Lightning Protection

During construction, temporary lightning protection should be maintained by connecting the concrete reinforcement to two (2) permanent electrical earthing conductors. After top lift of the chimney shell has been completed, temporary air terminations, which may consist of reinforcing bars, should be installed at the top to serve as temporary protection until the lining and cap are completed and permanent air terminations, conductors etc. are complete.

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iii) Temperature of concrete

Temperature of concrete for base raft shall not exceed 23° C at the time of pouring.

G. Electrical Items

For electrical equipment and accessories as required for Chimney refer to Section XV, Volume V-B under Electrical Equipment & Accessories in this bid document.

14.05.00 Coal handling plant structures

14.05.01 General arrangement

The descriptions of some major structures/components covered under this package are given below:

i) Track Hopper

The sub-structure (below ground level), its supporting enclosure structures/basement shall be provided with base raft & the cross beams for supporting rail beams along with counter-forts at an interval of 3.0 m (maximum) in longitudinal side wall. The top edges of the cross beams shall be chamfered for smooth coal flow and provided with removable abrasion resistant steel liner plates (Min. 16 mm thick) e.g. TISCRA/SAILMA. The overall depth of the above cross beams shall be restricted as per system requirement.

All faces of the beams coming in contact with coal shall be provided with removable abrasion resistant steel liner plates (Min. 16 mm thick) e.g. TISCRA/SAILMA. Paddle feeder table shall be provided with abrasion resistant steel liner plates (Min. 16 mm thick) e.g., TISCRA/SAILMA of suitable size fitted with C/S bolts through slab from bottom instead of inserts for easy replacement and repair.

The internal surface of coal hopper shall be provided with 10 mm thick SS-409M liner plates.. Gratings shall be provided as per system requirement specified elsewhere.

The walkway floor shall have non-skid finish. Water proofing for sub structures shall be done as per specification. The hopper wall in no case shall be in contact with earth/backfill.

The super structure of track hopper shall have structural framing with provision for electric traction wire for electric locomotive.

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Continuous gutter (same as roof sheet of adequate thickness) with 150 dia. GI/ MS pipe rain water down comers conforming to IS:1239 / IS:3589 shall be provided. The number and size of down comers shall be governed by IS:1742 & IS:2527. Suitable monorails and stair shall be provided at two ends of track hopper from track level to tunnel level where machine hatches are provided. In addition, one staircase at the centre of the track hopper shall also be provided. The hopper shall be provided with M.S. grating as stated elsewhere in this specification. Standard G.I. hand railings on sides to be provided, as per system requirement.

The complete track hopper complex shall be enclosed by side and roof cladding and all needed doors, window, louvers, ventilators, glazing etc. as per specifications elsewhere or as directed by the Engineer.

The vertical walls (4 sides) of track hopper over gratings shall be protected by providing 3 mm thick metal rail guards of 300 mm approx. wide, up to 1500 mm above grating level for complete hopper length and needed access from access walkway to hopper grating level at interval of 20 meter for both sides. The opening shall be minimum 1.5 meter wide. The manual Labour can enter hopper area from staircase and or removable gratings provided at track hopper floor at every 20 meters.

Electric hoist facility/equipment hatch/removable grating covers, hand railing etc shall be provided in each maintenance bay. Access Stair/maintenance platform with sufficient space around the equipment for O&M shall be provided. Clear width of stair shall be 1500 mm (minimum), landing to landing height shall not exceed 3.2 M.

All structures of Track Hopper under influence of railway loads shall be designed for static/moving loads of locomotive and wagons. The number of locomotives and wagons with capacity, design axle load, braking force, impact factors etc. shall be considered for design as per latest Indian Railway Code of Practice. Indian Railway Code of Practices shall be strictly adhered to for design. It shall be the responsibility of the contractor to get the designs and drawings of structures under railway loads approved by Railway authorities. For portion of structures without Railway loads the structure shall be designed for Earth & Water Pressure., Surcharge Pressure, uplift, material load, seismic and wind force.

Top level & Pockets for inserts on the beam supporting Track hopper rail shall be strictly as per Rail drawings with minimum tolerance of ($\pm$) 5mm.

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All edges of concrete shall be provided with edge protection steel members and thickness of such members shall not be less than 8.0mm. Floor shall be provided cross slope towards side drains. Cross slope shall not be flatter than 1:50. Side drain shall be sloped towards sump where sump pump shall be provided. The slope of the side drain shall not be flatter than 1:400. Concrete surface in contact with soil shall have water proofing treatment as per specification.

Water-tightness shall be ensured and guaranteed. To achieve the same, methodology in design and construction in the way of providing water bars at construction/expansion joints and/or injection grouting, usage of admixture in concrete should be adopted subjected to approval from owner/owner's consultant.

The inside of the Maintenance house shall be free from any columns.

ii) **Wagon Tippler**

The sub-structure (below ground level), its supporting enclosure structures/basement shall be of reinforced cement concrete (RCC). Cross beams supporting the railway track may be provided at suitable spacing considering easy flow of coal. Suitable supporting RCC Foundation system for Side Arm Charger shall be provided as per design requirements

The top edges of the cross beams shall be chamfered for smooth coal flow. The overall depth of the above cross beams shall be restricted as per system requirement. All faces of the beams coming in contact with coal shall be provided with removable abrasion resistant steel liner plates (Min. 16 mm thick) e.g. TISCRA/SAILMA. The internal hopper surface shall be finished with 10 mm thick SS lining. The walkway floor shall have non-skid finish. Water proofing for sub structures shall be done as per specification. The hopper wall in no case shall be in bare contact with earth/backfill irrespective of whatever shown in tender drawings. Gratings shall be provided as per system requirement specified elsewhere.

The super structure of wagon tippler shall have structural framing with provision of electric traction wire for electric locomotive.

Continuous gutter (same as roof sheet of adequate thickness) with 150 dia. GI/ MS pipe rain water down comers conforming to IS:1239 / IS:3589 shall be provided. The number and size of down comers shall be governed by IS:1742 & IS:2527. The hopper shall be provided with M.S. grating as stated elsewhere in this specification. Provide continuous standard G.I. hand railings on one side covering the entire length of the hopper fulfilling requirement of railway clearance to prevent any person falling inside. Stairs shall be provided at each end of wagon tippler hopper as well as at transfer points.

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All structures of Wagon Tippler complex under influence of railway loads shall be designed for static/moving loads of locomotive and wagons. The number of locomotives and wagons with capacity, design axle load, braking force, impact factors etc. shall be considered for design as per latest system requirements. Indian Railway Code of Practices shall be strictly adhered to for design. It shall be the responsibility of the contractor to get the designs and drawings of structures under railway loads approved by Railway authorities. For portion of structures without Railway loads the structure shall be designed for Earth & Water Pressure, Surcharge Pressure, uplift, material load, seismic and wind force. All edges of concrete shall be provided with edge protection steel members and thickness of such members shall not be less than 8.0mm. Floor shall be provided cross slope towards side drains. Cross slope shall not be flatter than 1:50. Side drain shall be sloped towards sump where sump pump shall be provided. The slope of the side drain shall not be flatter than 1:400. Concrete surface in contact with soil shall have water proofing treatment as per specification.

iii) **Underground Transfer Points**

All underground transfer points shall be of RCC construction with waterproofing as per specification. The intermediate floor and basement floor shall be provided with floor finish as per specification. Other requirement for design loading and internal drainage etc. shall be alike underground tunnels described below. In all underground structures the drain shall be minimum 250mm depth. All internal drains shall be provided with min 40mm deep M.S. galvanized grating above.

All underground TPs shall be provided with minimum 1.2m wide RCC stair with hand railings as per specification.

iv) **Over Ground Transfer Points, Pent Houses & Pump Houses including Boiler, ESP, Bunker columns, STG etc:**

All over ground TPs shall have R.C. foundations resting on firm strata. The super structure for TPs shall be structural steel framed with adequate bracing arrangement. All intermediate floors and roof shall be of RCC. The ground floors for buildings shall be of RCC over PCC sub base over min. 230 thick compacted boulder/stone soling. Height of plinth shall be 500mm from ground level and RCC pedestals for column shall be 300mm above floor level. In all the floors steel column shall be encased with R.C.C. of min. grade M-20 with reinforcement up to minimum height of 500mm from respective FFL. Adequate windows and doors shall be provided as per specification.

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TPs shall be provided with independent steel stair block with steps of M.S. grating from ground to roof with access to roof. The width of the stair shall be minimum 1.2 m. The tread shall be minimum 250mm and riser shall be uniform throughout the height and not exceeding 180mm. Continuous hand rails shall be provided in stair. For Pent House continuous GI handrail shall be provided on roof over R.C.C. kerb. For other structures RCC parapet of 900 mm height shall be provided. Adequate provision shall be made for roof drainage.

The transfer point structures shall be so designed that the transverse deflection at places where conveyor galleries meet, should be equal to the respective transverse deflection of the conveyor supporting trestle. The permissible vertical deflection for beams supporting drive machinery shall be restricted to span/500 and for other beams it shall be within span/325.

For pent houses and pump houses similar specifications shall be adopted except that the structural arrangement shall be of RC framed instead of structural steel frame.

v) Crusher House & Crusher Foundations

The Specification for Crusher house is similar to over ground TPs mentioned above.

The crusher house shall have an independent stair with access to roof for general use like other TPs. In addition, it shall have a separate stair block for fire escape suitably located complying with fire fighting norms of TAC. 250mm thick brick wall to be placed in suitable structural frames for stability and safety between two crushers in full height with a provision of a door.

The crusher shall be supported on RCC deck which in turn will rest on suitable vibration isolation system consisting of springs and dampers. This RCC deck slab shall be isolated from the building frame work / floor by a clear design gap. However, the vibration isolation system consisting of springs and dampers may rest on main building frame work. The design shall be as per recommendations of approved manufacturer of vibration isolation system e.g. GERB or equivalent.

VIS shall be designed with 90% isolation efficiency or manufacturer's recommendation whichever is more stringent. Stiffness of supporting structure shall be 10 times more than that of spring element. Deflection of beams supporting the crusher shall be limited to the permissible value as specified by the spring manufacturer.

The transverse deflection of the frames and deflection of the beams (other than vibration isolation supporting structures) shall be same as transfer point structures.

The Dynamic analysis will consist of free vibration analysis and forced vibration analysis. Frequency separation criteria and amplitude criteria as laid down in IS: 2974 and/or DIN 4024/ VDI 2056 and/or ISO 10816-2:2001(E) or as required by the machine manufacturer, whichever is more stringent shall be satisfied. R.C.C design will be done by Working stress method for all machine foundations. A fatigue factor of 2.0 will be considered for Dynamic forces. Minimum reinforcement shall be governed by IS: 2974 as well as IS : 456.

The spring units shall conform to DIN 2089 and DIN 2096 and the normal spring capacity will be 35 % higher for crusher foundation. The horizontal spring stiffness shall not be less than 50 % of vertical stiffness.

vi) **Under Ground Tunnels for Conveyors**

All under ground tunnels shall be of RCC considering box sections. The roof of the tunnel shall be straight. The profile of the tunnels shall match with profile of conveyor. The tunnels shall have side and/or central walkways of required width as per Mechanical system requirement. The tunnel shall have water proofing as per specification. Floor shall be non skid type and shall be provided with proper slope to drain out water by means of drains, running along the length of tunnel and connected to sumps. Arrangement shall be made for disposal of this water upto the inlet of coal slurry settling basin. The drain shall be provided with M.S. pressure locked type (preferably electro forged) galvanized grating manufactured in accordance with applicable Indian Standard. RCC (M-20) steps shall be provided where the inclination is more than 8 degree inside portion of tunnel. The risers for walkway steps shall not exceed 150mm. Continuous Hand rails of 32 NB GI pipes shall be provided along both side walls. Sufficient insert plate shall be provided at the side walls & roof soffit of the tunnel for Mechanical/Electrical requirements.

The tunnel shall be designed for Earth & Water pressure, surcharge load or load due to Coal pile/Bulldozer/Railway loads (as applicable) whichever is higher, over burden etc. Tunnels below roads shall be designed for Bulldozer or Class A/Class-AA loading (as per IRC) whichever is critical. Necessary approval for designs of tunnels under influence of Railway loads shall be obtained by the Contractor from Railway authorities. Tunnels for Conveyor in coal stock pile area shall be designed for additional loads due to coal pile of 5.0m high, bulldozer loads or a combination of above whichever is critical.

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vii) Over Ground & On Ground Galleries & Trestles

Over ground and on ground galleries shall be of enclosed type. The gallery shall have walkways and the width and height shall be as per system requirement. A continuous slit opening of 500 mm height shall be provided on both sides of gallery just below roof sheeting. The gallery shall be made of structural steel.

The floor for on-ground galleries shall be raised at least 500 mm above finished ground level and paved with min. 150 thick RCC (M-25) over 100 mm thick lean concrete (M10) over 230 thick boulder/stone pitching interstices filled with sand. The raised floor shall be retained by continuous brick walls at both sides of enclosures running along length of the conveyor and the surface of the wall shall be plastered and finished with cement based paints externally as per specification. Conveyor Gallery structures shall be designed considering both conveyors operating simultaneously. All gallery supporting trestle shall be so proportioned that the transverse deflection of gallery due to wind/seismic load should not be exceeded height/1000 as stipulated in IS:11592. Overhead conveyor will be located in a suitable enclosed gallery of structural steel and will consist of two latticed girders having rigid jointed portal frames at both ends. The latticed girder will be braced together in plan at top and bottom. Roof truss will be provided at upper node points of latticed girder to form an enclosure. The maximum span of gallery will not exceed 25 m unless higher span is required due to site condition subject to the approval of Owner. Sliding PTFE bearing supports shall be provided at one end of the gallery for relieving forces due to temperature variation. Accordingly for the purpose of analysis one end of the gallery shall be taken as hinged and other on roller. End of conveyor gallery which will be supported over transfer point, shall be so detailed that no horizontal force in longitudinal direction is transferred from conveyor gallery and vice versa. This side of the gallery shall therefore be supported on sliding PTFE support. The top of pedestal for the foundations shall project minimum 300 mm above the grade level.

For ground conveyor, all portals will be placed at a maximum spacing of 6.0 m.

For Conveyor Galleries washing water down comer shall be provided at every Trestle location.

The conveyor trestle legs in CHP area shall be encased with R.C.C. (M-20) upto 1.5 m from finished ground level.

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All trestles having height more than 20.0 m will be 4 legged. Adequate 4 legged trestles shall be provided to take care longitudinal forces in conveyor. Four legged trestles will be placed at a maximum interval of 90.0 metres and an emergency caged ladder up to ground level at every 4-legged trestle except at stair locations shall be provided.

Walkway portion of over ground conveyor galleries shall be of chequered plate construction with anti-skid steel bars (10 mm) @ 500 mm along the length of gallery below 8 degree inclination of conveyor gallery. However, for inclination more than 8 degree chequered plate steps shall be provided with toe guard. For both sides & Central walkway continuous hand rail shall be provided as specified elsewhere. The floor of conveyor gallery all along the gallery length, shall be provided with minimum 3 mm thick seal plates and the same is to be provided under the conveyor galleries in such a way that complete gallery bottom shall form a leak proof floor. The seal plates shall conform to IS : 1079 (semi-killed quality).

Roof, side sheeting and slit opening on walls for over ground conveyor galleries shall be similar to ground conveyor explained above. The area for natural light shall not be less than 15% of floor area. Crossover shall be provided at intervals not exceeding 100m c/c & stair upto the ground floor level shall be provided at every location of crossover. Crossovers shall preferably be located over four-legged rigid trestle location. Platforms for cross over shall be provided with chequered plate flooring and hand railing as per specification. The foundations & structures for gravity take up with platform and hand railing shall be provided by the bidder's drawing and specification. Fencing with lockable gate shall be provided around Gravity take ups. Trestles shall be of structural steel braced adequately and provided at suitable locations. Location of trestles adjacent to boiler house and railway lines shall have to be decided carefully so that there is no interference (both underground and over ground) with other buildings, equipment/equipment structures foundations nearby as well as railway lines, ducting, trenches, drains etc. Adequate clearance required by Railway authorities shall be maintained. Execution and erection sequence of foundation for trestles and galleries or any other coal handling plant equipment and structures has to match erection sequence of boiler, ESP or other adjoining structures.

In Tripper floor, necessary pockets, inserts, bolts etc. for conveyor and equipment supporting structures will be kept at floor level based on the requirements of conveyors.

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viii) Stacker-Cum-Reclaimer

Stacker-Reclaimer foundation shall be in RCC and shall be designed as a continuous wall or RCC framed structure (in longitudinal direction) with lateral tie-beams between two rails supporting elements at a regular interval of approx.3.0 m center. The foundation shall rest on firm strata through open foundation or through piles only. Foundation shall be designed in such a way that the differential settlement in rail do not exceed recommended value as per machine manufacturer or as per IS whichever is critical. (The contractor shall assess such requirement and decide foundation system to be adopted, prior to submission of his bid). The walkway and portion below conveyor shall be paved with min. 150 thick RCC (M-25) over 100 mm thick lean concrete over 230 thick boulder/stone pitching interstices filled with sand.

Dozer access over drain to be provided for stock pile area. Remaining portion of Conv. (other zones excluding RCC foundation portion for stacker & reclaimer) shall be raised and retained by continuous brick wall on both side and walkway floor shall be as described earlier.

ix) Reclaim Hoppers

Underground Reclaim Hopper shall be of RCC construction with waterproofing as per specification. Reclaim hoppers shall be designed for 4.0m high coal pile and Bulldozer loads also. The intermediate floor and basement floor shall be provided with floor finish as per specification.

The super structure of Reclaim hopper shall have structural framing. The roof and side sheeting shall be single skin metal cladding system of specification as specified for Track Hopper.

All faces of the beams coming in contact with coal shall be provided with removable abrasion resistant steel liner plates (Min. 16 mm thick) e.g. TISCRA/SAILMA. The internal hopper surface shall be finished with 10 mm thick SS lining. Gratings shall be provided as per system requirement specified elsewhere.

Other requirement for design loading and internal drainage etc. shall be alike underground tunnels described above.

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x) Coal Stock Yard

Entire area shall be excavated to average 250 mm depth and given slope of 1 in 100 in suitable directions as approved. Entire excavated area shall be watered and rammed and compacted with 10 tonne roller. 100 mm thick river sand cushion layer shall be placed over compacted sub grade and consolidated by flooding 150 mm thick boulder soling shall be laid over sand cushion, joints filled with river sand. Over boulder soling, 75 mm thick lean concrete (1:4:8) shall be spread. Final layer shall be minimum 150 mm thick RCC slab. M20 with double layer reinforcement. Slope is to be maintained through all layers.

The coal stack area shall be graded with suitable slope for draining the surface.

Retaining wall of minimum 1m depth to be provided around the crushed coal pile to prevent coal spillage into the drain. Necessary control joints in the grade slab shall be considered to avoid temperature and shrinkage cracks in the slab. The design of coal stack area should take care of loads arising due to dozer movement and shall be designed to sustain coal water pressure.

xi) Coal Stock shed

Coal storage area to accommodate one lakh metric tonne (1.00.000MT) of crushed coal shall be covered with a shed constructed of structural steel. A large intermediate column-free area to accommodate coal stock piles and an operating Stacker- cum- Reclaimer with highest boom position shall be considered in the design of this structure. Rails for stacker –cum- Reclaimer shall run on concrete foundation throughout the length of this area. Drainage at ground level below coal bed shall be considered by providing a network of perforated pipes which would discharge the water to the trenches running parallel to two sides of rails . The roof shall be covered with pre-coated coloured and transparent sheeting as per requirement. The specification for structural steel work shall satisfy the Technical Specifications for fabrication and erection of Structural steel work. All necessary provisions for ventilation, illumination, dust suppression and safety shall be incorporated. Bidder shall provide an arrangement drawing along with his bid.

xiv) Area Drainage

The entire Coal Handling Plant area shall be suitably graded for easy drainage of water. Suitable storm water drainage arrangement on either side of rail with graded filter at about 1.5 m intervals on the

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sides to trap coal dust shall be provided. The drain shall be of RCC with precast perforated RC cover. Weepholes shall be provided in the trench walls at the locations of filter pockets for collecting surface water in the longitudinal drains for discharging into the main surface drains by the side of the road. The stock yard & CHP drains carrying coal dust shall be connected to coal slurry Settling Pond.

14.05.02 Design requirement

- a) For design, Bulk density and angle of repose for coal shall be considered as 1.20 MT/Cu.M, 34 deg for (crushed coal) and 35 deg for (uncrushed coal) respectively. However for storage volume consideration, density 0.8 MT/CuM shall be considered.
- b) Loads as defined under clause 8.00.00 shall be applicable. All hoppers shall be designed under the following load conditions.
 - i) The hopper is full upto it's full capacity with top surface horizontal at grating level.
 - ii) The hopper is partially empty with the highest level of coal at grating level and making an angle as specified in clause a above.

The above conditions are to be analysed for the case where the whole content of coal within the hopper is supported by the hopper only without taking support from any other structures below.

The hopper shall also be designed for lateral coal pressure, frictional forces during filling and emptying and forces due to impact and failing of arches of coal within the hopper, etc.

- c) Wagon Tippler structure shall be analyzed and designed for the worst load combinations. However, it shall be analyzed for the following load combination also.

Combination – 1

- i) Hopper full.
- ii) Maximum load from railway track.
- iii) Earth pressure without surcharge and sub-soil water pressure.
- iv) Maximum load from steel column for shed.
- v) Maximum load from paddle feeder support.
- vi) Maximum load from coal tray.

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Combination – 2

- i) Hopper full.
- ii) Maximum load from railway track.
- iii) Earth pressure with surcharge and sub-soil water pressure.
- iv) Maximum load from steel column for shed.
- v) Maximum load from paddle feeder support.
- vi) Maximum load from coal tray.

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Combination – 3

- i) Hopper full.
- ii) No load from railway track.
- iii) Earth pressure with surcharge and sub-soil water pressure.
- iv) No load from steel column for shed.
- v) DL only from paddle feeder supporting structure.
- vi) DL only from coal tray.

Wagon Tippler Hopper / Reclaim Hopper shall have removable type steel grating cover. The opening size for grating shall be as per mechanical requirement. Bar grid shall be fabricated and made of rolled sections and flats of minimum thickness of 20 mm.

d) Load considered for grating design

- i) Wagon Tippler : 1.0 M hight of coal and wheel loader operating with bucket carrying boulders / oversize ROM coal
- ii) Reclaim Hopper : Two bulldozer operating side by side.

Or

Two bulldozer operating side by side over coal heap of 4.0 M whichever is critical

Fire and Noise proofing shall be taken care as per applicable TAC and environmental regulations.

14.05.00 Ash dyke

14.05.01 Design Criteria

The ash dyke around the storage has been planned to be constructed in stages. The starter dyke construction shall be under the scope of the bidder. Maximum height of starter dyke shall be considered as 10M above existing grade level.

For defining the profile of the phreatic line across the dyke section, a comprehensive seepage analysis shall be done for the ultimate height of the dyke, with full water inside and tail water (if any due to H.F.L.), on outside of the dyke, before doing the stability analysis. The slope stability analysis of the dyke for ultimate stage shall be done for steady seepage condition both for static and dynamic (earthquake) cases as per IS: 7894 –Code of Practice for stability.

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14.05.02 Basic Guidelines

- **Lagooning System**

The ash disposal area shall consist of two storage lagoons in equal (approx.) compartments each having water recovery facilities. The storage lagoons shall be planned in such a way that when one lagoon is in the process of filling, the other lagoon can be evacuated/emptied before the other lagoon is filled up.

The dykes of lagoons shall be constructed using earth as the main construction material to be arranged by contractor. Free board of 1.5 m shall be kept for dyke.

The water from the storage lagoons shall escape through RCC water escape well type structures located in the storage lagoons and RCC hume pipes of suitable diameter. These hume pipes shall be lined with rectangular RCC section, with minimum lining thickness of 250 mm at bottom & 150 mm on all other sides and shall have suitable isolation gates. Collection well shall have approach for maintenance. Arrangement shall be such that recovery of clean ash water would be possible at progressively higher levels at stages with water level rising along with gradual increase in ash level stored, closing the collection points at lower levels.

- **Design of Embankment**

The design of embankment shall be done by a process of successive trials and refinements. The following steps may be followed. Select a trial embankment section incorporating the available materials, with the following parameters.

Top width - 6 metre minimum having a WBM road of 4.0 m wide and suitable vehicular turn shall be provided at every 500 M with 100 mm and 150 mm of base & sub-base respectively. Higher top width shall be provided if pipelines are to be run over the dyke top.

Free board - 1.5 metre minimum. Higher free board shall be provided if required from the anticipated wave height and from run up point of view.

Side slopes - Minimum 2.5 Horizontal to 1 Vertical. 3m wide berms shall be provided for all slopes at about 6 metre height intervals.

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Impervious lining – In order to arrest ground water contamination from ash water, provision of lining to make the ash dyke bed impervious by achieving permeability less than 1×10^{-6} cm/sec shall be done by either providing impervious clay lining or by blending the soil with bentonite as per MOEF norms. In case of clay blanket a minimum thickness of 600 mm shall be maintained. In case of naturally existing soil blended of bentonite percentage of bentonite and layer thickness shall be decided by laboratory tests. Method of mixing of soil with bentonite shall be decided by Contractor.

Internal drainage arrangement should be provided as follows :

Sand chimney of minimum 1.0 metre thickness, up to 0.5 m below dyke top.

Sand blanket of minimum 1.0 m depth.

Rock toe at the downstream toe of embankment. Height of rock toe should be minimum 3.0 metre. With the above drainage arrangements, the phreatic line is expected to follow the drainage path.

The exit gradient of seepage flow near the downstream toe shall be checked by drawing flownets. The exit gradient shall not exceed about 0.14. If the gradient is more than this value, the dyke slope shall have to be flattened to reduce the gradient.

Contractor shall arrange necessary borrowed earth required for the ash dyke.

- **Slope Protection Work**

On the downstream slopes no stone pitching is envisaged.

Wherever, there are chances of water accumulation on the downstream side, the slope shall be protected by stone pitching of suitable thickness, depending upon the wave height likely to act on the slope, in the region from 1.5 metre above the maximum water level to 1.5 metre below the minimum water level.

On the upstream slope, no stone pitching is envisaged.

On the top of dyke, Water Bound Macadam surfacing shall be made for movement of vehicles, which shall also give protection to the earth surface against rain and wind erosion.

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- **Cut-off Trench**

As the foundation material is very impermeable, a nominal cut-off trench shall be provided in the portion upstream of sand chimney, to increase the drainage path of any seepage occurring at the junction between the embankment and its foundation. A minimum bottom width of 4m shall be provided for the cut-off trench to facilitate compaction with rollers. A depth of 1 to 1.5m may be adopted with 1:1 side slope in earth. If rock is available at a depth less than 1 metre, the cut-off trench may be stopped at the rock level itself. The effect of cut-off trench is not taken in the design and it is only provided as an additional precaution against piping failure in foundation.

- **Filters**

Filters are to be provided below stone pitching and between rock toe and the embankment material.

- **Instrumentation**

In order to monitor the performance of ash dyke during construction and operation the following instruments should be installed at approximate distance of 500 metre along the alignment of dyke and at critical locations.

Piezometers

Surface settlement markers

14.05.03 Other Requirements

The contractor is expected to visit actual site conditions in order to assess its actual area, distance etc, and other conditions, which shall have bearing on the design and construction of the ash dyke as per specified requirements and the cost thereof.

The required borrow areas for dyke construction and clay blanket shall be identified and arranged by contractor. All costs associated to borrow material / borrow areas including any royalties, tax, cess, etc. to be paid, shall be borne by the contractor.

Depth of cuts in all parts of borrow areas shall be determined by the Engineer and shall be as uniform as possible. No earth shall be borrowed from inside the lagoons.

When the borrow area is located contiguous to the dyke alignment then it must be ensured that the borrow area shall not be opened within a distance of 5 times the height of embankment contiguous to the heel or the toe of the embankment or 25 metres whichever is more.

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The required approach roads and haul roads shall be constructed and maintained by the contractor. The contractor shall divert the existing roads, if any, which are in the ash, dyke area at his own cost before the start of work. The foundations of the different stretches of the dykes may fall on different soil conditions depending on actual site conditions. It may be on virgin ground or may be on filled up area. However, for peripheral starter dyke, if filling is encountered in the alignment, the same shall be stripped to virgin ground before construction.

A cut-off trench with 4.0m base width, 1.0m deep and 1:1 side slopes shall be excavated at base of the dyke and shall be filled with impervious soil as per specifications.

The foundation shall be stripped for the full width of the dyke including the width of the toe drain plus 1.0 m more on both sides.

The slopes of divide bund between two storage lagoons shall be lined on both sides for top 3.0m vertical heights for protection against wave, with brick lining in brick masonry panel walls. This divide bund shall have sand chimney and sand blanket also to take care of any seepage water from the first lagoon when under use.

To ensure proper compaction of the shoulders, the WBM road on top of the dyke shall be constructed by making the dyke embankment up to the design top level of the dyke first and then cutting the box for accommodating the road construction. The width of road shall be 3.75m. The sub base shall be placed in two layers of 100 mm-compacted thicknesses each with 90-45 mm graded stone aggregates. The base shall be placed in two layers of 75 mm-compacted thicknesses each with 63-45 mm and 53-22.4 mm graded stone aggregates.

14.06.00 Switchyard Structures

14.06.01 Basic design requirements

- a) All structures shall be latticed type with bolted connections.
- b) 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. All structural steel plates and sections shall be either of "SAIL" or "TATA STEEL" or "RINL" make or equivalent.
- c) All connections shall be bolted unless specified otherwise. M.S. galvanized bolts (minimum 4.6 grade) of minimum 16mm diameter conforming to IS-1363 shall be used unless specified otherwise.

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- d) All structures shall be galvanized as described elsewhere in this specification.
- e) All butt welds shall be full penetration butt welds.
- f) Connection of base plate & gusset members with the columns shall be done considering that total load gets transferred through weld.
- g) For design of steel structures loads such as dead loads, live loads, wind loads etc. shall be based on IS: 802 Part-1/ Sec 1
- h) For materials and permissible stresses IS: 802, Part-I, Section-2 shall be followed in general. However, additional requirements given in following paragraphs shall be also considered.
- i) Minimum thickness of galvanized tower member shall be as follows:

Member	Minimum thickness (mm)
Leg members, Ground wire	
Peak members/Main members	6
Other members	6
Redundant members	6
Gussets	8
Stiffeners	8
Base plates	10 & above

- j) Maximum slenderness ratios for leg members, other stressed members and redundant members for compression force shall be as per IS-802.
- k) Minimum distance from hole center to edge and between center to center of holes shall be as per provisions in IS: 800.
- l) In order to facilitate inspection and maintenance, the structures shall be provided with climbing- devices. Each tower shall be provided with step bolts not less than 16 mm diameter & 175mm long spaced at 300 mm apart, staggered on faces on one leg extending from about 0.5 meters above ground level to the top of the tower. The step bolt shall conform to IS: 10238.

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14.06.02 Design Criteria

- a) All towers & girder structures shall be designed for the worst combination of dead loads, live loads, wind loads as per IS-802, seismic forces as per code IS: 1893 (latest), importance factor of 1.5, loads due to deviation of conductor, load due to unbalanced tension in conductor, torsional load due to unbalanced vertical and horizontal forces, erection loads, short circuit forces including "snatch" in the case of bundled conductors etc.

Short circuit forces shall be calculated considering a fault level of 40.0 KA for 400kV switchyard. IEC-865 may be followed for evaluation of short circuit forces.

- b) Switchyard girders structure shall be designed for the two conditions i.e. normal condition and short circuit condition. In both conditions the design of all structures shall be based on the assumption that stringing is done only on one side i.e. all the three (phase) conductors broken on the other side.

Factor of safety of 2.0 under normal conditions and 1.5 under Short circuit condition shall be considered on all external loads for the design of switchyard structures, which are of lattice type.

- c) Vertical load of half the span of conductors/string and the earth wires on either side of the beam shall be taken into account for the purpose of design. Weight of man with tools shall be considered as 150 kgs for the design of structures.

- d) Terminal/line take off girders shall be designed for a minimum conductor tension of 1000Kg per sub conductor per phase for 400 kV. The distance between terminal girders and dead end tower shall be taken as 100 meters. The design of these terminal girders shall also be checked considering +/- 30 deg deviation of conductor in both vertical and horizontal planes. For other girders, conductor tension shall be worked as per requirement and shall be considered in design.

- e) The girders shall be connected with lattice columns by bolted joints.

- f) All support structures used for supporting equipment shall be designed for the worst combination of dead loads, erection load, wind load/seismic forces, short circuit forces.

Short circuit forces shall be calculated considering a fault level of 40.0 kA for 400kV switchyard. IEC-865 may be followed for evaluation of short circuit forces.

- g) Foundation bolts shall be designed for the loads for which the structures are designed.

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- h) Lighting towers shall be designed for diagonal wind condition. Lighting towers shall be provided with a structural steel ladder within its base upto mounting height of fixtures.

Two platforms shall be provided one each around 10mtr and another at upper level for mounting of lighting fixtures. The platforms shall have protection railing.

14.06.03 Fabrication

The fabrication and erection work shall be carried out generally in accordance with IS 802. A reference however may be made to IS 800 in case of non-stipulation of some particular provision in IS 802. All materials shall be completely shop fabricated and finished with proper connection material and erection marks for ready assembly in the field.

▪ **Shop assembly**

The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specific camber, if any, is maintained. In order to minimise distortion in member the component parts shall be positioned by using the clamps, clips, lugs, jigs and other suitable means and fasteners (bolts and welds) shall be placed in a balanced pattern. If the individual components are to be bolted, paralleled and tapered drifts shall be used to align the part so that the bolts can be accurately positioned.

Sample towers, beams and lightning masts and equipment support structures shall be trial assembled in the fabrication shop and shall be inspected and cleared by Contractor based on the design approval accorded by purchaser before mass fabrication.

Pursuant to above the B.O.Ms along with corrected fabrication drawing shall be prepared and submitted by the main vendor to Purchaser as document for information. Such BOM, which shall be duly certified by the main vendor for its conformity to the approved design, shall be the basis for Purchaser to carry out inspection.

▪ **Bolting**

Every bolt shall be provided with a washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together.

All steel items, bolts, nuts and washers shall be hot dip galvanised.

2.0% extra nuts and bolts shall be supplied for erection.

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The work shall be done as per approved fabrication drawings, which clearly indicate various details of joints to be welded, type of weld, length and size of weld. Symbols for welding on erection and shop drawings shall be according to IS: 813. Site welding shall not be permitted in general.

14.06.04 Foundation bolt

Foundation bolts for the towers and equipment supporting structures and elsewhere shall be embedded in first stage concrete while the foundation is cast. The Contractor shall ensure the proper alignment of these bolts to match the holes in the base plate and shall utilize steel templates as required.

The Contractor shall be responsible for the correct alignment and leveling of all steel work on site to ensure that the towers/structures are plumb.

All foundation bolts for lattice structure are to be supplied by the Contractor.

All foundation bolts shall be fully galvanised as per requirement of coastal environment and shall be as specified elsewhere in this specification.

All foundation bolts shall conform to IS 5624 but the steel material shall be MS conforming to IS: 2062.

14.06.05 Galvanizing

All structural steel work and supports shall be galvanized after fabrication. The galvanizing bath shall be long enough so as to reduce the number of splices in the long members. The galvanization bath should have controlled heating arrangements and the hot deep bath should remain clear and free from any foreign matter floating on the top.

Zinc required for galvanizing shall have to be arranged by the manufacturer. Purity of zinc to be used shall be 99.95% as per IS: 209.

The Contractor shall be required to make arrangement for frequent inspection by the Purchaser as well as continuous inspection by a resident representative of the Purchaser, if so desired for fabrication work.

14.06.06 Touch-up painting

The touch up primers and paints shall consist of Red Oxide / Zinc chromate conforming to the requirements of IS: 2074 with a pigment to be specified by the Purchaser.

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14.07.00 Natural Draft Cooling Tower

All civil and structural work for Natural Draft Cooling Tower shall be as specified in Volume VII-D Technical Specification for Natural Draft Cooling Tower.

15.00.00 MISCELLANEOUS REQUIREMENTS

Further to all requirements described in the preceding clauses, the following criteria shall be strictly complied with pertaining to analysis, design, layout & construction of aforesaid power plant.

15.01.00 Dense concrete with controlled water cement ratio preferably 0.45 shall be used for all underground concrete structure such as basement, pump houses, water-retaining structure, cable & pipe trenches etc., for achieving water tightness.

15.02.00 All joints, including construction and expansion joints for the water retaining structure shall be made watertight by using 230 mm (minimum) PVC ribbed water stops with central bulb. However, kicker type (Externally placed) PVC water stops shall be used for the base slab and in other areas where it is required to facilitate concreting.

15.03.00 Anti termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc., as per IS-6313 and other relevant standards.

15.04.00 Minimum 100 mm thick lean concrete shall be provided below all underground structure, trenches etc., to provide a base for construction.

15.05.00 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.

750mm wide Plinth Protection.

15.06.00 Each building shall be provided with ~~minimum 1.0m wide reinforced concrete paving~~ all round unless specified otherwise. All buildings shall have a slab offset of 300 mm from the wall. Paving shall be sloped to provide a rapid run off of rainwater away from building.

Refer point no 11
of changes sought
sheet.

15.07.00 The steel column base plate along with stiffening gusset plates shall not be protruded above floor level.

The steel columns below ground floors shall be encased in concrete up to minimum 250 mm above finished floor.

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15.08.00 Stability of structure

The Supplier shall be responsible for the stability of the structure at all stages of its erection at site and shall take all necessary measures by the additions of temporary bracings and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operations.

15.09.00 Grouting

The method of grouting the column bases shall be subject to approval of Purchaser and shall be such as to ensure complete uniformity of contact over the whole area of the steel base. The Contractor shall be fully responsible for the grouting operations.

Grouting shall be done with 'SIKA' or Conbextra GPX-2 of 'Fosroc' 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.

15.10.00 Steel chequered plates and gratings shall be hot double dip galvanised.

15.11.00 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 supporting covers, edges of manholes supporting covers, and any other places where breakage of corners of concrete is expected. Precast cover slabs shall have edge protection angles at top and bottom on all the four sides along with lugs.

15.12.00 All drains inside the building shall have minimum 40 mm thick grating covers and in areas where heavy equipment loads would be coming, pre-cast RCC covers shall be used in place of steel grating.

15.13.00 All steel platforms above grade shall be constructed with kick plates at edge of platform to prevent tools or materials from falling off from platform.

15.14.00 For all buildings suitable arrangements for draining out of water collected from equipment blow-downs, leakage, floor washing, fire-fighting etc., shall be provided for each floor and connect the drain pipes to drains at ground level..

15.15.00 Duct banks consisting of PVC/GI conduits for cables shall be provided with concrete filling conforming to IS-456. The minimum depth of top of duct bank from grade level shall be 500mm. Duct banks for cables shall be sealed using approved fire retardant sealing compound.

Refer point no.12 of changes sought sheet.

15.16.00 All sand filling shall be compacted to minimum ~~95%~~ ^{75%} of the relative density.

15.17.00 All buildings shall have framed super structure. All walls shall be non-load bearing infilled panel walls.

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- 15.18.00 Increased cover to reinforcement for all RCC structures as per IS-456 - 2000 shall be provided to withstand corrosive environment if there be any.
- 15.19.00 All gates and stop-logs shall be of structural steel, which shall be hot double dip galvanised.
- 15.20.00 All mild steel parts used in the water retaining structures shall be hot double dip galvanised. Galvanising shall be checked and tested in accordance with IS-2629.
- 15.21.00 A screed of concrete layer not less than 100 mm thick shall be provided below all water retaining structures. A sliding layer of bitumen paper or craft paper shall be provided over the screed layer to destroy the bond between the screed and the base slab concrete of the water retaining structure.
- 15.22.00 For steel pipes encased in concrete, concrete encasement to steel pipe shall be with M20 grade of concrete and shall be of minimum 150 mm thickness all around pipe.
- 15.23.00 Ramps for building entrance shall be cast- in-situ RCC slab designed as a slab spanning over supports or rigid pavement resting on subgrade provided that the thickness of slab and the property of subgrade shall be such to ensure of its being treated as rigid pavement. The slope of ramps shall not be more than 20°. Minimum thickness of slab shall be 150mm.
- 15.24.00 Only sewage and drainage pipe may run below road. Any other pipe like system water pipe may run beyond 1.0m from the edge of road along its longitudinal direction.
- 15.25.00 Provisions of safety, health & welfare according to factories Act shall be complied with. These shall include provision of continuous walkway of minimum 750 mm wide along the crane girder at crane girder level with side handrails on both sides of the building, access staircase at one end and cage ladders at two ends to EOT crane walkway from operating floor, railing, fire escape, locker room for workmen, pantry, toilets, rest room etc.
- 15.26.00 Trenches located outside building shall project at least 150mm 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.
- 15.27.00 All cables & pipes in outlying area shall run above ground over steel trestle or other supporting structures for easy inspection and maintenance except in transformer yard area and some other local area where the same can run in RCC trenches or through duct-banks. However laying of cables shall be as per approved Electrical layout.

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A minimum clearance (clear head room) of 8.0m shall be kept for all over ground pipe/cable trestles for all road/rail crossings. In case of rail crossings the above mentioned clearance shall be maintained from the top of rail level and not from the top of formation level. In other areas the clear height shall be 3.0m (minimum) from ground/grade level.

All trestles shall be provided with continuous walkway of minimum 750 mm width with handrail and toe-guards all along the length of the trestle along with approach ladder near roads, passageways etc.

A barrier of suitable height shall be constructed near rail/road crossing, so as to prevent the approach of cranes (having height more than 8.0m) etc. upto the pipe/cable rack trestles.

Four-legged trestles & foundations are to be provided for supporting the pipe/cables at suitable intervals or at corners as per layout. Crossover, operating platform & necessary thrust resisting arrangement at pipe bend shall be provided as required.

- 15.28.00 For all trench structures, the bottom slope perpendicular to the run of the trench shall be minimum 1 in 200 and shall be minimum 1 in 500 for slope along the length of the trench.
- 15.29.00 Top of CW pipes shall be minimum 1.50 m below grade level/ formation level.
- 15.30.00 For open horizontal drains, reservoirs concrete lining of minimum M15 grade on sides & bottom shall be provided. The thickness of lining shall be minimum 100mm or as per design consideration whichever is higher.
- 15.31.00 Provision for fire proof doors, nos. of staircases, fire separation walls etc., shall be made according to the recommendations of TAC /LPA regulation.
- 15.32.00 All roofs shall be provided with access through a staircase. All roofs shall be provided with water proofing treatment.
- 15.33.00 Fly ash bricks shall be used for masonry work. Bidder shall ascertain himself at site regarding the availability of fly ash bricks of minimum 75 Kg/sq.cm compressive strength before submitting his offer. Bidder shall take approval of APGENCO for usage of bricks other than fly ash bricks. respectively.
- 15.34.00 Ground floor slab for the buildings and paving shall be of minimum 150 mm thick VDF concrete laid over 100 mm PCC and 230 mm (minimum) soling unless specifically mentioned otherwise. The reinforcement shall consist of minimum 8 mm diameter bars at 200 mm c/c of grade Fe 415 at top and bottom in both direction.
- 15.35.00 Windows of ground floor of all buildings shall be provided with heavy duty MS grill for MS windows and Aluminium grill of 7.5mm thick weighing 3.58Kgs/1Sqm for aluminium windows.

DEVELOPMENT CONSULTANTS
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16.00.00 STATUTORY REQUIREMENTS

The Civil Engineering and building work shall comply with all appropriate statutory requirements including all current Building Control regulations, and with all planning or other conditions as required by the relevant local, state, and National authorities.

16.01.00 The contractor shall provide full general arrangement drawing (Civil, Structural & Architectural) of all buildings, structures and facilities to the Owner for comment. The Contractor shall not proceed with these drawings further without such comment. Any work carried out by the Contractor using drawings unacceptable by the Owner shall be at the Contractor risk.

16.02.00 The Contractor shall seek and obtain all necessary approvals and detailed planning consents outstanding at the time of placing the contract and shall be responsible for all necessary liaison with such authorities to obtain the same and for the payment of due fees for such approvals.

16.03.00 The Contractor shall obtain approval from the appropriate authority regarding the safe means of escape in the event of fire or other hazard before relevant construction work proceeds. As a minimum, the Contractor is required to ensure that the work shall comply with all statutory requirements including:

- i) Central Government/State Government - for all building control regulation
- ii) State factories act - For Safety, health & welfare, use of hazardous substance
- iii) Central and State Pollution Board - For limits on pollution levels.
- iv) Central Water Authority/State Irrigation Department - For Water obstruction/supply for withdrawal of water from local source, location of Intake pump house / Jack well.
- v) State Water & Disposal Department - for waste & Foul Water disposal.
- vi) Ministry of Environment - for all matters relating to environment.
- vii) Ministry of Railway - for all matters for railway line construction.
- viii) Tariff Advisory Committee - for regulation concerning fire safety/means of escape.
- ix) Aviation Authorities - for clearance of tall structure like stack etc.
- x) State Public Work Department - for regulations on Civil work/road work.
- xi) Ministry of Forestry - for deforestation, if any, for site development.

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- 16.04.00 The Contractor shall make due allowance for all necessary negotiation/ administration required and the time needed to obtain these permission and approvals in his programme. Failure to obtain such approvals in a timely manner shall not be a reason for extension of the programme.
- 17.00.00 **DOCUMENTS TO BE SUBMITTED**
- 17.01.00 **Design Documents**
- A. The Contractor shall be required to prepare a 'Basis of Design' for each Elements/Structures of Civil Work expanding on the information given in the specification. The 'Basis of Design' shall include the following:
- i) A concise description of the form of Structure considered.
 - ii) A statement of salient assumptions made.
 - iii) Codes of practice and references used
 - iv) A description of the design approach
 - v) Detail Calculations including Computer inputs & results with conclusion.
 - vi) Design/working drawings showing necessary details
- The design and drawings shall be addressed to Owner / consultant appointed by the Owner for scrutiny of the same at least 12 weeks prior to the commencement of the relevant construction activity. The comments of the consultants shall be considered for effecting further revision.
- B. The submission shall be in accordance with dates set down in Contractors civil work design and construction programme.
- C. The Contractor shall be required to carry out at his own cost, any rectification, alteration or replacement of work progressed within 12 weeks of submission of the design basis and drawings and resulting from engineers comments on the design submission.
- D. Acceptance of the Contractor 'Basis of Design' calculations or drawings by the Owner shall not relieve the Contractor of any of his obligations to meet all the requirements of the Contract or relieve the Contractor's responsibility for the correctness of design and safety of the structure for the design life of the plant. The Contractor shall make any changes in the design/drawing in the form of DCN without any financial implication, which are necessary to make the work comply with the contract.

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- E. The Contractor shall prepare detailed calculations for all structure / elements in accordance with cl. no.17.01.00 A. The Contractor shall also make available any additional calculations, other than routine structural calculation, as requested by the Owner during the period of Contract.
- F. In addition to Geotechnical investigation report, the Contractor shall arrange and make available any other reports and investigations the Owner deems necessary for safety & stability of plant. The investigations shall be carried out in any standard laboratory of repute and as recommended by the Owner. All laboratory tests shall be carried out in the presence of Owner's engineer.
- G. In the event, the Contractor adopts any patented method of design and Construction, not popular or practiced in this country; the Contractor shall sought prior approval of Owner in writing. The Contractor shall forward appropriate literatures, documents, certificates, case histories etc., to establish the viability of the method.
- H. The bidder shall submit the tender with a schedule of proposed sub contractors for different construction packages (if necessary), structural consultants, (if any), any hired personnel for expertise, along with their name address, etc. and shall obtain approval of the Owner before fixing up of sub-contractor with required credentials for a particular work.
- I. Each calculation document shall include the following
- i) Contractor's name
 - ii) Package identification (if any)
 - iii) Designer's name/initials
 - iv) Checker's name/initials
 - v) Reference No.
 - vi) Index
 - vii) Date & Revision No.
 - viii) Revision identification mark
 - ix) Detail calculations including computer input data and output.
- J. Calculation packages shall preferably be bound at A4 size sheets. All numerical analysis shall be done through computer. The bidder shall have either their own system or have access in other system outside their premises.

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The Contractor shall be a bonafide license holder of any software package used in this project. Any in-house developed software may also be used subject to the approval of the Owner through validation with standard computer programme. Any pirated & unlawful use of software shall not be permitted. The Contractor shall furnish:

- i) Name of Software
- ii) Developing Agency
- iii) A write-up/overview of the programme. As supplied by the copyrighter.
- iv) Relevant documents verifying users right for using this software in this country.

K All construction drawings furnished by the contractor shall consist of total quantity of concrete (grade-wise), reinforcement steel (diameter-wise) and structural steel (section-wise).

17.02.00 Construction Documents

Based on approved design drawing, detailed drawings for construction will be prepared by the Contractor. For reinforced concrete structures and foundations detailed bar bending schedules in approved format shall accompany each detailed drawing. For structural steel work the Contractor 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 /bill of materials need be furnished to Owner/Consultants along with bar bending schedule.

17.03.00 All working & construction drawings shall be drawn by CAD system, and shall be issued in A0/A1 size. The drawing shall include:

- i) Name of Project, Owner, Consultant & Contractor.
- ii) Title of the Drawing
- iii) Drawing No. Issue Date, Revision No.
- iv) Statement for Revision
- v) Revision Identification Mark
- vi) Release Status
- vii) Designer/Checker's/Draughtsman's name/initial

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17.04.00 The Contractor, who shall maintain an upto date drawing & document register, shall monitor drawing & document issue. This register shall list all drawings & documents used in the design and construction for civil and structural work. The drawing register shall be a controlled document and shall be kept updated/revised and shall be issued on A4 size sheets.

17.05.00 All drawings, design documents, reports, correspondence pertaining to civil structural work shall be in 'English Language'. Documents in any other language shall be translated in English before submitting to Owner.

18.00.00 **LAYOUT**

Before starting the work, the Contractor shall carry out the setting out of foundation and structures and provide levels, with reference to general existing grid and bench mark. If the Contractor uses the grid, bench mark and reference pillar made by other Contractors, he shall co-ordinate 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 bench mark which has been followed by other agency at the instruction of the Engineer. In case any discrepancy be 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 Contractor 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 bench marks 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 Contractor 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 work correctly. The Tenderers shall take into account the cost of these in quoting their price.

19.00.00 **WORKMANSHIP**

Workmanship shall be of the best 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 lanning 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 Contractor shall arrange to have the work done by such registered or licensed personnel. In case of manufactured materials, the Contractor 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.

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20.00.00 TEMPORARY WORK

All scaffoldings, staging, temporary bracing and other necessary temporary work required for proper execution of the Contract shall be provided by the Contractor 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 Contractor 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 Contractor at the direction of the Engineer without any delay and any extra cost on this account shall be borne by the Contractor.

21.00.00 INTERFACE WITH STRUCTURES UNDER OTHER'S SCOPE OR EXISTING STRUCTURES

Modification in layout of foundation/structure during detail engineering stage may be necessary to avoid fouling with those under other's scope or existing structures. Necessary changes on this account will be made without any extra cost to Owner.

22.00.00 SEQUENCE OF WORK AND PROGRESS REPORT

The sequence in which the work 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 Contractor. Contractor shall furnish quality assurance and quality control plan. 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 Contractor shall regularly submit to the Engineer progress reports for periods of working as specified by the Engineer showing upto date progress on all important items of work.

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ANNEXURE-1
GROUND CONTOUR PLAN

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ANNEXURE-2

FINAL FEASIBILITY STUDY REPORT
BY RITES LIMITED

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VOLUME : VII-B

**GENERAL SPECIFICATION AND DESIGN CRITERIA
FOR
ARCHITECTURAL WORKS**

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GENERAL SPECIFICATION AND DESIGN CRITERIA FOR ARCHITECTURAL WORKS

1.00.00 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 ceilings, false ceiling, cladding, as required potable water system, service water, Plumbing and sanitation etc. as required for functional requirement. The contractor 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
- Switch Yard Control Building
- ESP Control Building
- CW & ACW Pump House & Electrical Building
- Ash Slurry Pump House
- Ash Handling Electrical / Control Room
- AHP Compressor Building
- DG & Compressor House
- HFO & LDO Forwarding Pump House
- DM Plant
- Clarified Water Pump House
- Chemical House (in TSGENCO Scope).
- CW Chemical Treatment Building
- CW Chlorination Building
- Crusher House & Transfer House
- CHP Control & MCC Building
- Ash Water Pump House
- Raw Water Pump House & Electrical Building
- HCSD & Silo Utility Pump House
- CPU Regeneration Building
- Vacuum Pump House
- Centrifuge Building
- Condensate Transfer Pump House

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Non Plant buildings under this scope of work :

- Service Building & Workshop (in TSGENCO Scope).
- Canteen (in TSGENCO Scope).
- Fire Station (in TSGENCO Scope).
- Permanent Store & Yard (in TSGENCO Scope).
- Time and security office with Gates, watchman cabins. (in TSGENCO Scope).
- Weigh Bridge Control Room
- Bulldozer Shed (in TSGENCO Scope).
- Car Parking stand (in TSGENCO Scope).
- Cycle/ Scooter stand (in TSGENCO Scope).
- Watch Tower (in TSGENCO 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.

1.01.00

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 TSGENCO for the agency for architectural services.

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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 with 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. 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.
- 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, equipments, 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 equipments so that the proper co-ordination with other agencies can be taken up at appropriate time.

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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 the vernacular of the project to bring harmony all over the plant site.

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2.02.00 Plant Buildings

2.02.01 Powerhouse Building

Powerhouse shall be of structural steel framed with RCC floor and part Brick Wall and balance part double skin insulated colour coated galvalume sheets 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-upto 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 minimum 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 facia 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. ~~North Light system shall be provided on roof of power house building at suitable locations so that sufficient natural light can be obtained at TG Hall floor.~~

North light shall be avoided in view of seepage in later stage. Natural light shall be provided by side and gable end glazings. As per point no. 40 (Civil) of agreed deviation in KTPS.

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.

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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.

2.02.02 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 ambience of Power Island. Sufficient natural light and ventilation should be provided for tripper floor. Provision of roof access through stair should be made.

2.02.03 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**3.01.01 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.

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3.01.02 Roof Waterproofing

Roof water proofing treatment shall be as follows :

a) Roof water proofing treatment shall be as follows :

i) For roofs with structural slope :

The cleaning and preparation of the substrate to which the elastomeric membrane is applied must be carried out thoroughly to leave a sound base for the application. Any laitance present on the surface must be removed mechanically. Release oil and other contaminants which may impair adhesion must be removed.

Over the finished well prepared sloped surface of RCC slab, application of elastomeric membrane shall be a single component the liquid, cold applied, elastomeric polyurethane based, that cures by reaction with atmospheric moisture to form a tough but flexible waterproofing membrane. It is elastomeric, seamless waterproof membrane applied in 2 coats to a DFT of 1.2 mm thick having a elongation capacity of over 600% and average tensile strength of 1 MPa, tear resistance as per GBT 19250-2003 >20N/m. The material shall comply with – ASTM C 836 National Std. of Canada 37.58 – M86 by CGSB. over the entire surface of waterproofing membrane laying a separation layer of non-woven polypropylene geo-textile of 120 gsm followed by application of rigid insulation board expanded polystyrene BASF PERIPOR or BASF or similar approved for thermal insulation as per HVAC requirement shall be laid over the finished separation layer of geotextile. 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/m²
- Thermal Conductivity (K): 0.034 W/mK
- Thermal Transmittance (U): 0.5-0.6 W/m² oC
- Water Absorption (% vol): <0.1% (by total immersion)

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The top surface of the rigid polystyrene block of Peripore of BASF or similar approved shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thick on 15 mm thick cement plaster (1:4) which laid over 120 gsm non-woven polypropylene geo-textile separation layer. 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.

- ii) For roofs having no structural slope: The cleaning and preparation of the substrate to which the elastomeric membrane is applied must be carried out thoroughly to leave a sound base for the application. Any laitance present on the surface must be removed mechanically. Release oil and other contaminants which may impair adhesion must be removed.

Over the finished well prepared flat surface of RCC slab, application of elastomeric membrane shall be a single component the liquid, cold applied, elastomeric polyurethane based, that cures by reaction with atmospheric moisture to form a tough but flexible waterproofing membrane. It is elastomeric, seamless waterproof membrane applied in 2 coats to a DFT of 1.2 mm thick having a elongation capacity of over 600% and average tensile strength of 1 MPa, tear resistance as per GBT 19250-2003 >20N/m. The material shall comply with – ASTM C 836 National Std. of Canada 37.58 – M86 by CGSB. over the entire surface of SONOSHIELD HLM 5000R waterproofing membrane laying a separation layer of non-woven polypropylene geo-textile of 120 gsm followed by application of rigid insulation board expanded polystyrene BASF PERIPOR for thermal insulation as per HVAC requirement shall be laid over the finished separation layer of geotextile. 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/m²
- Thermal Conductivity (K): 0.034 W/mK
- Thermal Transmittance (U): 0.5-0.6 W/m² oC
- Water Absorption (% vol): <0.1% (by total immersion)

The top surface of the rigid polystyrene block of Peripore shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thick on screed concrete mix (1:2:4) grading having minimum 25 mm thickness at the lowest point of the slope over R.C.C. slab and shall be laid as per the slope laid over 120 gsm non-woven polypropylene geo-textile separation layer. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in

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both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar under bed layer also.

- iii) 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.

Chequered concrete tiles shall be given on pathways only and on other areas 0.6mx0.6m precast concrete tiles shall be provided. As per point no. 41(Civil) of agreed deviation in KTPS.

- a) APP modified Bituminous Polyester reinforced waterproofing membrane of Sika® WP Shield-104 P 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, ASTM D 5147, ASTM D4799.
- c) Technical Data
- | | |
|-----------------|---|
| • Chemical Base | APP modified Bituminous Polyester |
| • Thickness | 4mm |
| • Unit weight | 4.40 kg/m ² (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 (Polyster) weight- 180 g/m²

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- Softening Point - 145 oC - (According to ASTM D36)
 - Penetration - 15-25 at 25oC d mm-(According to ASTM D5)
 - Tear resistance (L/T) N-170/180- -(According to UEATc)
 - Water Absorption% (BSP)- <0.15-(According to ASTMD 5147)
 - Heat Resistance- No Flow at 100oC-
 - Resistance to Aging after 2000 hrs (Weather –O-Meter)- No Delamination- (According to ASTM D4799)
- 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.
- iv) For Liquid, cold-applied PU elastomeric waterproofing membrane system shall be a single component the liquid, cold applied, of elastomeric polyurethane base that cures by reaction with atmospheric moisture to form a tough but flexible waterproofing membrane of BASF's SONOSHIELD HLM 5000R or similar approved. It is elastomeric, seamless waterproof membrane applied in 2 coats to a DFT of 1.2 mm thick having a elongation capacity of over 600% and average tensile strength of 1 MPa, tear resistance as per GBT 19250-2003 >20N/m. The material shall comply with – ASTM C 836 National Std. of Canada 37.58 – M86 by CGSB.

Note : Waterproofing materials should be applied by the manufacturer authorised applicators only.

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3.01.03 Partition Wall

All intermediate walls shall be full brick thick wall in 1:4 cement sand mortar. Half brick thick wall in 1:4 cement: sand mortar with RCC band 100 mm thick & with 2 nos. 8 mm dia rod in every eighth 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.

3.01.04 Plastering

Exterior & rough side of interior brick wall 20mm thick minimum sand faced plaster in two layers with 1:4 cement sand mortar of 12mm thick first layer and 1:3 cement sand mortar with 8mm . Where external finish will require rich plastering for special finish plaster shall be of 1:4/1:3.

Interior wall 12 mm thick with 1:4 cement-sand mortar.

Ceiling 3 mm white cement punning subjected to even surface at ceiling shall be maintained.As per point no. 42 (Civil) of agreed deviation in KTPS. ~~6 mm thick with 1:3 cement sand mortar shall be provided to all exposed ceilings.~~

3.01.04 False Ceiling

Aluminium pre-painted/Powder coated false ceiling, 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.

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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.

3.01.05 Special Finish

- a) The main entrance of powerhouse, Service Building, 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.

3.01.06 Doors

- a) Generally factory made hollow metal (steel) double plate flush doors shutters comprising of two outer steel sheets 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.

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3.01.07 Windows & Ventilators

In Powerhouse building, full glazed windows and ventilators in minimum 15 micron anodized aluminium window frame shall be provided with 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 Contractor before execution.

3.01.08 Landscaping (In TSGENCO Scope) as per point no. 44(Civil) of agreed deviation in KTPS.

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 Contractor 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 Contractor 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

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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 Contractor 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.

3.01.09 Facilities in Buildings

Adequate toilet and drinking water facilities shall be provided for personnel working in each floor of building. Each floor of 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.

3.01.10 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.
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- 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.

3.01.11 **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/ dome strainer
- b) Rain Water Down comers
- c) Gully pits

IS-1742 code of practice for building drainage shall be followed for this purpose.

Adequate numbers of rainwater drains heads shall be provided for all roof areas as per standard norms for roof area.

System will be designed to handle rainfall at a rate as specified elsewhere in this specification and in accordance with stipulations of IS-1742.

Slope of roof for drainage should be not less than 1 in 100.

Any roof more than 8.0 metres above grade shall have access from within the building for cleaning of roof drains.

Roof drains will conduct water to storm sewers. No rain water pipes shall be exposed to outside view. 150mm dia. Medium duty G.I pipe of TATA, Jindal or equivalent approved make shall be used.

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3.01.12 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 thk. 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.

3.01.13 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.

3.01.14 Damp Proof Course

40 mm thick 1:1.5:3 concrete with 2% waterproofing admixture or as per manufacturer's recommendation to be provided.

3.01.15 Plinth Protection

750mm

Refer point no. 14 of
changes sought sheet.

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..

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3.01.16 Miscellaneous Metal Railing

- a) For main stair & lobby of Powerhouse building upto operating floor, 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 Service Building & Administrative building, ESP control room, switch yard control room, chemical house & other all control rooms stainless steel railing with SS posts & decorative SS handrails or CP teak wood rails shall be provided.
- c) For any other RCC For any other RCC stairs of non-plant buildings 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.
- d) 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).

3.01.17 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 finish coats of high built epoxy finish of 90 microns each over two primer coats of Zinc silicate 50 microns each shall be applied on exterior steel work.
All Woodwork	:	Synthetic paint over a coat of primer.

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All Internal Steel Work	: Epoxy Paint over approved primer
Steel in contact with acid /alkali	: Acid/Alkali/Chemical resistant paint
Interior Office Spaces Control Rooms, All A.C. Areas	: Acrylic emulsion paint over 3 mm thick white cement putty punning.
Other Plant Buildings	: Interior masonry surfaces of all plant buildings shall be painted with synthetic enamel paint up to 1.50 m height from floor level and balance portion with Acrylic Distemper paint of two coats over one coat of primer over white cement putty.
Fire Door	: Post Office red shade shall be provided.

3.01.18 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) Anodized aluminium grill of heavy duty of thickness not less than 7.5mm and weight not less than 3.58Kgs/Sqm shall be provided for aluminium glazed windows. 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 / CP Teakwood 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, RCCstair 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.

Aluminium/MS grills shall be provided at ground floors of all buildings. As per point no. 46(Civil) of agreed deviation in KTPS.

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- 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) Covered car parking stand for 20nos cars module with minimum 50mm thick coloured interlocking cement concrete tile flooring over reinforced concrete hard standing and module for 50 nos. Two-wheelers & cycle parking stand shall be provided as per requirement at the desired location of the owner. Structure shall be of RCC. The structure shall be aesthetically harmonious.
- j) 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.
- k) Doors, windows and rolling shutter in all buildings shall have sunshade 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.
- l) North Light provisions on the powerhouse shall be made of Polycarbonate sheet of M/s BAYER fixed to structural framework as per approved design. Arrangement shall have to be provided to prevent ingress of rainwater if any. The system shall be of M/s McCoy Architectural Systems Pvt. Ltd or similar approved.

3.01.19 Chain Link Fencing

Chain link fencing for areas as per safety requirement shall be provided. This shall be as per Civil/Structural specification.

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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.

3.01.21 Boundary Wall for Admin Building

The construction of boundary wall shall be done as mentioned below:

- a) RCC column and its foundation at 3 m interval.
- b) RCC plinth beam with top 100 mm below ground level between RCC columns.
- c) Fly Ash Brick masonry wall with cement sand mortar 1: 6.
- d) 12 mm thick inside plastering with cement-sand mortar (1: 4).
- e) 20 mm thick outside plastering in two layers – 12 mm internal & 6 mm external with cement – sand mortar (1: 4).
- f) Minimum 100 mm thick RCC coping at top of wall with 75 mm projection on both side of wall.
- g) The height of the boundary wall (at top of coping) shall be 0.75 m above the ground level. The top of RCC column shall be 150 mm above the top of boundary wall.

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- h) Over the boundary wall there shall be 1.25m high ornamental fencing made of wrought iron or MS Bars & Flats, with support posts & pillars having same ornamentation. The posts are to be fixed to the boundary wall with proper grout inside grouting hole of size 75x75x150mm and pillars are to be welded or bolted to cap plate fixed to the RCC columns.
- i) The boundary wall shall be painted with one coat of approved primer and two coats of cement-base painting of approved manufacturer. Metallic portion shall be painted with Epoxy or PU Paint over coats of approved primer.
- j) 10m on both side of the Main Gate of Admin Building complex, boundary wall shall be specially treated, aesthetically inviting with proper landscaping.

3.01.22 Plant Main Gate and Material Gate (In TSGENCO Scope)

- a) Gate complex shall have separate vehicular entry & exit gates and also separate pedestrian entry & exit gates.
- b) Vehicular entry & exit gates shall be both electrically and mechanically operated retractable gate of reputed manufacturer like DiTEC-Gandhi Entrance Automation Pvt Ltd or similar approved.
- c) Gate complex building shall house observation post for security personnel, frisking area with toilet facility, baggage scan area and locker facility, gate pass issuing counter, security officer room, staff office, pantry, toilets, etc.
- d) Gate complex shall have inviting and landmark quality expressed through modern material and innovative idea.
- e) Provision of card punching area may be kept as per discretion of the owner.
- f) Construction of Material Gate shall be as follows:
- g) The Gate frame shall be made of medium duty MS sections conforming to relevant IS with welded joints.
- h) The gates shall be fabricated with welded joints to achieve rigid connections. The gate frames shall be painted with one coat of approved steel primer and two coats of synthetic enamel paint.
- i) Gates shall be fitted with approved quality iron hinges, latch and latch catch. Latch and latch catch shall be suitable for attachment and operation of pad lock from either side of gates. Hinges shall permit gates to swing through 180 degree back against fence.

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- j) Gates shall be fitted with galvanized chain hook or gate hold back to hold gates open. Double gates shall be fitted with centre rest and drop bolt to secure gates in closed position.
- k) Gates shall be installed in locations shown on drawings. Next to the main gate, a human access gate (1.25 m wide, single leaf) shall also be provided.
- l) Bottom of gates shall be set approximately 40mm above ground surface and necessary guiding mechanism shall be fitted.

3.01.23

Watch Towers (In TSGENCO Scope)

- a) Watch Towers shall be steel structure having watch platform at (+)7.0m level, 2m x 2m clear space for security staff and 1m wide watch balcony around the room or as per National security standards and as per site requirement and land terrain.
- b) Steel stair shall be provided to access the platform.
- c) Security room shall be brick clad/ sheeting/ Aero com panelling with full length vision window on every side.
- d) Minimum roof height shall be 2.2m at edges of the balcony.
- e) Roof may be of RCC or insulated metal sheet roofing.
- f) Distance between watch towers shall be about 300m and at every corner or turn of the boundary wall one watch tower is to be provided.
- g) Hollow metal pressed steel doors shall be used.
- h) Windows shall be Aluminium/steel windows with 4mm thick clear float glass.
- i) External wall surface shall be painted with Cement Paint over 20mm thick external plaster. Internal wall surface shall be painted with Oil bound Distemper over 12mm thick internal plaster. Internal ceiling surface (if RCC roof) shall be painted with Oil bound Distemper over 6mm thick ceiling plaster.
- j) All steel work shall be painted with Epoxy paint over approved primer.
- k) Balcony railing height shall be 1200mm.

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3.01.24 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° or 135° 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.

Common inspection chamber shall be provided for soil & waste water pipe. As per point no 47 in deviation of Civil. As per point no.47(Civil) of agreed deviation in KTPS.

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**4.00.00 INTERIOR FINISH SCHEDULE FOR POWER HOUSE BUILDING
(Refer Attachment)**

4.01.00 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.

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 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 upto 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 and fixed to the wall strictly as per manufacturer's specification.

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1st Quality approved make and design tiles cladding for walls up to 1.5M from floor level and it shall be painted with plastic emulsion paints over primer over two coats of cement putty. Columns brackngs 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 min. 0.2mm) of approved make. The colour and design of ACP Cladding or composite paneling is to be submitted for approval of the concerned authority before taking of the work. As per point no 48(Civil) of agreed deviation in KTPS.

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 upto the false 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. Gypsum plaster board false ceiling 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

6mm thk toughened glass shall be used for hermetically sealed partition with 12mm air gap. Shall be confirmed during detail engg stage. As per point no 49(Civil) of agreed deviation in KTPS.

Equivalent quality with approval of TSGENCO during detail engineering. As per point no. 50(Civil) of agreed deviation in KTPS.

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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 front side of the frame shall have Excelsior Acoustical Panels – Elega finish – 2400/1200 x 600 x 19 mm thick FABRICO SoundSoak – Plane Texture of approved colour. The rear side of partition shall have Excelsior Acoustical Panels – Elega finish – especially Sound Smart – Burl of size 2400/1200 x 600 x 19 mm thick smooth finished with gypsum plaster and finished with acrylic emulsion paint. 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.

5.00.00 INTERIOR FINISH SCHEDULE FOR AUXILIARY BUILDINGS
Refer attachment for Finish schedule)

6.00.00 BRIEF DESCRIPTIONS OF NON PLANT BUILDINGS

6.01.00 Brief Description of Service Building (In TSGENCO Scope)

Separate service building: 6000 sq.m as per MoM

Only 01 no. of elevator is sufficient. As per point no. 52(Civil) of agreed deviation in KTPS.

The Service Building is a multi storied building. However the Number of stories shall depend upon the TG operating floor level. Building is located adjacent to the Power House Building as shown in the Plot Plan. Minimum space between the service building and power house building shall be kept for Approach road for Workshop floor at Zero metre in service building. An all weather covered access corridor to be provided with powerhouse building at operating floor level. Overall area per floor of the building shall be approximately 2000 Sqm. However the building size shall be suitably decided during detail engineering stage. It will house the facilities as listed below. Building shall have 2(two) nos. Passenger elevator (13 passenger) and 1 (one) main staircases and 1 (one) fire escape staircase. Overhead water PVC / RCC tank of 10,000-litre capacity should be provided at roof of the building.

It is an important part of operation and maintenance of the plant having state of the art facilities and requires a highly sophisticated hi-tech expression and ambience.

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Facilities at Different floors shall be decided during detail engineering stage.

The Building will be centrally air-conditioned. All finishing items, Layout, and other requirements should be of owner's choice. However modern design approach of an office building like- open & flexible (workstation based) layout, usage of natural light, solar control, energy efficient, etc shall be considered. Since this is one of the most prestigious buildings, aesthetically this should achieve landmark quality.

Specially designed long and spacious RCC porch shall be given in front of the main entrance for receiving cars of VIP's.

Special attention to be given in front of service building in landscaping the area and developing garden with flowering plants and fountains etc

Shaded car parking facility with RCC roof shall be provided as per requirement of the owner.

Brief technical specifications of different items to be used for the area as follows :

a) Flooring

Generally floor finish shall be Non-skid double charged, fully vitrified, of Class-I quality 10/11 mm thick or as per manufacturer non-porous, homogenous, and abrasion resistant, floor tiles, of minimum size minimum 600 mm x 600 mm of approved colour & design, 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, under bed. However Workshop floor shall be provided with 50 mm thick heavy duty floor or 20 mm thick steelcrete tile floor.

For Entry cum reception lounge, VIP lounge, Main meeting/ conference room:-

Suitable and approved combination shed of marble slab and strips shall be used. Floor pattern shall be approved by the owner before erection.

For staircase and Corridors :

Steps – risers & tread, stair skirting, corridor floor should be combination of Aranga white marble and Abu green marble or Baroda green and Jaishalmir yellow marble combination. Wall cladding of Elevator Lobby shall be of polished granite slab of light grey/any other approved shade by owner.

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For Toilet :

Minimum 10 mm thick non-skid vitrified tile, of minimum size 400 mm x 400 mm (overall 40 mm thick) with glazed ceramic tile of same make, Dado shall be 100 mm higher than bottom of lintel level. Only for toilet at operating floor and Third floor, dado shall be topped with 50 mm wide matching moulded ceramic trims.

For other areas like AHU room, Generator room, Electrical room, Etc: shall have 40 mm thick heavy duty cement concrete (IPS) floor with metallic hardener and matching skirting or 20 mm thick steelcrete tile floor.

b) Wall finish

Two coats of Acrylic Emulsion paint of approved colour shall be applied over a coat of approved primer on the masonry surface prepared with White Cement Putty (Birla White or JK White or similar approved) for all area except areas like AHU room, Generator room, Electrical room, Etc which shall be of plastered surface with Acrylic Distemper paint. Front wall for elevator shaft shall have polished granite slab wall cladding (min 12 mm thick).

Painting to exterior surfaces of wall shall be of Acrylic Emulsion Paint similar to "Apex Ultima", "Weathergurd"/ "Weathershield" over plaster. To accentuate the building façade a suitable combination of Aluminium composite panel (ACP)/granular textured paint may be used.

c) False ceiling

It will be applicable for all areas excluding non A/C areas like AHU room, Generator room, Electrical room, Etc, pantry and toilet. It shall be of aluminium panelled (size 600x600mm) acoustic false ceiling with rock wool insulation on top similar to LUXALON of Hunter Douglas or INTERARCH having approved colour with stove enamel finish, and or Mineral fibre board of Armstrong and or Gypsum MR board as per functional requirement and interior design scheme, integrated with light fixtures, HVAC grills and other ceiling mounted accessories, complete in all respect with metal suspension system, trims, profiles etc.

For pantry and toilet false ceiling shall be ~~perforated aluminium stove enamel finished panels of size 600x600mm.~~

As per clause 3.01.04 calcium silicate board/tiles false ceiling is to be provided for unimportant areas. As per point no 53(Civil) of agreed deviation in KTPS.

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d) Doors

Factory made Solid core wooden flush doors with high quality PVC lamination on both sides giving hi-tech expression in teak wood frame shall be used in interior office areas. 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 of similar to HYDRO- Domal system. Glazed partition may be etched with suitable and approved designed. Wooden doors shall be of factory made solid core wooden flush door with C. P. Teak veneered surfaces in wooden frame with wooden architrave.

~~Toilet & pantry doors shall be wooden panel door~~

Doors for areas like AHU room, Generator room, Electrical room, Etc shall be hollow metal flush door.

e) Glazed Panels

The glazed panels 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 and maximum available width. Insulating glass shall consist of 2 nos. 6 mm thick clear float 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 of HYDRO-Domal system.

Glazed partition may be etched with suitable and approved designed.

f) Windows, Glazed Curtain wall

All windows of A/C areas shall be separated with heat reflecting glass/double insulated glass from non AC areas. Other windows shall be 15micron thick colour anodized aluminium glazed window with minimum 4mm thick clear float glass. Window system shall be of HYDRO-Domal system.

Glazed curtain wall shall be Unitised structural glazing system comprising of 30 micron colour anodised aluminium extrusions with double insulated heat reflecting glass. The system shall be able to withstand wind pressure as per relevant data given elsewhere in this specification at all heights. Structural glazing system shall be of HYDRO-Domal system or equivalent.

Toilet & pantry doors shall be wooden panel door with aluminium frame.As per point no. 54(Civil) of agreed deviation in KTPS.

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g) **Utilities**

All utility lines like water supply line, Electrical wiring, telephone line etc. Shall be concealed type. Fittings and fixtures for toilets should be of best quality and to be got approved by Owner prior to installation. Roof treatment, sanitary & sewerage system, roof drainage etc. Shall be as per detail technical specification.

- h) Any other items of work not specifically mentioned here shall be as per the guidelines indicated in relevant Architectural Technical Specification.

6.02.00

Brief Description of the Canteen Building (In TSGENCO Scope)

- a) This shall be single storey RCC framed structure with brick cladding. Spacing of columns shall such that large column free areas are available in the dining area.
- b) The dining area shall have the arrangement to seat minimum 75 people at one time. In addition there shall be a separate executive dining area fully air-conditioned and with gypsum board false ceiling to accommodate about minimum 25 executives and separate dining area for women. 25 no. women employees shall be taken into consideration, as per point no. 55(Civil) of agreed deviation in KTPS.
- c) Adequate space shall be provided for stores, preparation, cooking, serving and washing facility.
- d) Toilet and hand wash shall be kept sufficiently away from cooking area to satisfy statutory requirements.
- e) Walls of the dining hall, cooking and serving area shall be given dado of glazed ceramic tiles to a height of 2100 mm.
- f) Adequate exhaust fans and ventilation facility shall be given in the cooking area and in dining area.
- g) Special arrangement shall be made to lead off the wastewater from canteen to the effluent treatment plant.
- h) Main entrance door shall be of aluminium glazed swing type with two leaves opening outside. Doors of other areas shall be wooden panel door, hollow metal flush door as applicable.
- i) All windows shall be glazed aluminium window with diamond grill.

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- a) Fire station shall be a single/double storied RCC framed building with brick walls in office area.
- b) The fire station shall have provision for parking for fire tenders including one bay for maintenance with pit, office for the station-in-charge, duty room, stores, recreation cum class room, record cum general room, toilet blocks etc.
- c) Parking area for tenders shall ensure fast movement of the fire tender in an emergency.
- d) In addition adequate space shall be provided for hose drying and drill ground.
- e) The arrangement shall in general satisfy requirement of the local fire brigade.

6.04.00 Brief Description of the Permanent Store. (In TSGENCO Scope)

- a) This building shall be brick clad of RCC framed structure with RCC roof or sheet metal roofing on metal deck or steel truss as per structural design consideration.
- b) In the heavy material storage area, electric hoist of adequate capacity shall be provided.
- c) Store building shall have facility to store heavy materials, light materials, electronic equipment & parts, etc.
- d) Store building shall also provide for office space for superintendent and his supervisory staff, locker room and change room for workers, toilet etc.
- e) Entry and exit of trucks shall be through adequately sized rolling shutters. In addition a minimum 2 single leaf steel flush door shall be provided for entry of the staff.
- f) Adequate windows shall be provided for ventilation and lighting. Offices inside shall be of glazed partition above 900 mm high single brick wall. Total height of partition including brickwork shall be 2400 mm. Doors to the cabins shall be of glazed aluminium.
- g) Gypsum board false ceiling shall be provided for AC areas.

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6.05.00 Brief Description of the Gate Complex (In TSGENCO Scope)

- a) Gate complex shall have separate vehicular entry & exit gates and also separate pedestrian entry & exit gates.
- b) Vehicular entry & exit gates shall be both electrically and mechanically operated retractable gate of reputed manufacturer like DiTEC-Gandhi Entrance Automation Pvt Ltd or similar approved.
- c) Gate complex building shall house observation post for security personnel, frisking area with toilet facility, baggage scan area and locker facility, gate pass issuing counter, security officer room, staff office, pantry, toilets, etc.
- d) Gate complex shall have inviting and landmark quality expressed through modern material and innovative idea.
- e) Provision of card punching area may be kept as per discretion of the owner.

6.06.00 Coal handling plant structures

6.06.01 General arrangement

The architectural descriptions of some major structures/components covered under this package are given below :

i) Track Hopper

The super structure of track hopper shall have structural framing with provision for electric traction wire for electric locomotive. The roof and side sheeting shall be single skin metal cladding system comprising of profiled sheet manufactured out of 0.55 mm TCT (Total Coated Thickness) permanently colour coated zincalume steel (150 gsm zinc – aluminium alloy coating total of both sides as per AS 1397 : 1993) having 300 Mpa yield strength. The colour coating shall comprise of SMP/super polyester XRW (as per AS/NZS-2728:1997 category 3). The colour coating shall comprise of 20 microns finish coat over a 5-micron primer coat on the exposed side and a back coat of 5 microns over a primer coat of 5 micron on the reverse side. The metal cladding shall have 500 mm cover width, 47 mm high crests at 250 mm centres with special male / female side laps and anti siphoning feature to prevent leakage. 2.0 mm thick fire resistant and UV resistant polycarbonate sheet of approved make for adequate natural light and louvers for ventilation purpose shall be provided for side cladding. The polycarbonate sheet shall have troughed profile to match with the metal cladding profile & to be provided 15 % of floor area.

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Continuous gutter (same as roof sheet of adequate thickness) with 150 dia. GI/ MS pipe rain water down comers conforming to IS:1239 / IS:3589 shall be provided. The number and size of down comers shall be governed by IS:1742 & IS:2527. Suitable monorails and stair shall be provided at two ends of track hopper where machine hatches are provided. The hopper shall be provided with M.S. grating as stated elsewhere in this specification. Standard G.I. hand railings on sides, as per system requirement are to be provided.

ii) Wagon Tippler

The super structure of wagon tippler shall have structural framing with provision of electric traction wire for electric locomotive. The roof and side sheeting shall be single skin metal cladding system comprising of profiled sheet manufactured out of 0.55 mm TCT (Total Coated Thickness) permanently colour coated zincalume steel (150 gsm zinc – aluminium alloy coating total of both sides as per AS 1397 : 1993) having 300 Mpa yield strength. The colour coating shall comprise of SMP/super polyester XRW (as per AS/NZS-2728:1997 category 3). The colour coating shall comprise of 20 microns finish coat over a 5-micron primer coat on the exposed side and a back coat of 5 microns over a primer coat of 5 micron on the reverse side. The metal cladding shall have 500 mm cover width, 47 mm high crests at 250 mm centres with special male / female side laps and anti siphoning feature to prevent leakage with provision of minimum 2.0 mm thick fire resistant and UV resistant polycarbonate sheet of approved make for adequate natural light and louvers for ventilation purpose. The polycarbonate sheet shall have troughed profile to match with the metal cladding profile & also to be provided 15 % of floor area in a staggered fashion on the roof.

Continuous gutter (same as roof sheet of adequate thickness) with 150 dia. GI/ MS pipe rain water down comers conforming to IS:1239 / IS:3589 shall be provided. The number and size of down comers shall be governed by IS:1742 & IS:2527. The hopper shall be provided with M.S. grating as stated elsewhere in this specification. Provide continuous standard G.I. hand railings on one side covering the entire length of the hopper fulfilling requirement of railway clearance to prevent any person falling inside.

iii) Underground Transfer Points

All underground transfer points shall be of RCC construction with waterproofing as per specification. The intermediate floor and basement floor shall be provided with floor finish as per specification.

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All underground TPs shall be provided with minimum 1.2 m wide RCC stair with hand railings as per specification. Risers for steps shall not exceed 180 mm and tread width shall not be less than 250 mm. Hand rails shall comprise of posts 40 NB M.S. galvanized pipe 1.1 m high not exceeding 1.5 m (max) c/c with 2 nos. 32 NB M.S. galvanized pipe horizontal placed at top and mid height respectively and continuous flat iron toe guard at bottom.

iv) Over Ground Transfer Points, Pent Houses & Pump Houses

All over ground TPs shall have R.C. foundations resting on firm strata. The super structure for TPs shall be structural steel framed with adequate bracing arrangement. All intermediate floors and roof shall be of RCC. The ground floors for buildings shall be of RCC over PCC sub base over min. 230 thick compacted boulder/stone soling. The RC floors shall be provided with floor finish as per specification and roof shall be provided with heavy water proofing treatment as per specification. The cladding shall be of brick work plastered on both faces up to 3.0 M from lowest working floor and remaining height with 0.55 mm TCT (Total Coated Thickness) permanently colour coated zincalume steel sheet as specified above. The colour coating shall comprise of 20 microns finish coat over a 5-micron primer coat on the exposed side and a back coat of 5 microns over a primer coat of 5 micron on the reverse side. Sheetting shall be fixed with the help of concealed compatible interlocking clips and wafer head zinc coated self drilling fasteners. The clips shall be concealed and no fasteners are to penetrate the sheetting. Height of plinth shall be 500mm from ground level and RCC pedestals for column shall be 300mm above floor level. In all the floors steel column shall be encased with R.C.C. of min. grade M-20 with min reinforcement upto 300mm from respective floor. Adequate windows and doors shall be provided as per specification.

The polycarbonate sheet shall have troughed profile to match with the metal cladding profile & to be provided in a continuous band around periphery at suitable locations in between floors with at least 20% of cladding area.

TPs shall be provided with independent steel stair block with steps of M.S. grating from ground to roof with access to roof. The width of the stair shall be minimum 1.2 m. The tread shall be minimum 250mm and riser shall be uniform throughout the height and not exceeding 180mm. Continuous hand rails shall be provided in stair. For Pent House continuous GI handrail shall be provided on roof over R.C.C. kerb. For other structures RCC parapet of 900 mm height shall be provided. The pent houses and pump houses shall be of brick cladding and treated with cement based paint as per specification. Adequate provision shall be made for roof drainage. Roof shall be

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provided with 150 dia. GI rain water down comer pipes, steel door and steel windows (with Chajjas/fins) access and stair ways etc.

v) Crusher House

The Specification for Crusher house is similar to over ground TPs mentioned above except cladding area of Polycarbonate sheeting.

The polycarbonate sheet shall have troughed profile to match with the metal cladding profile & to be provided in a continuous band around periphery at suitable locations in between floors covering at least 25% of cladding area.

The crusher house shall have an independent stair with access to roof for general use like other TPs. In addition, it shall have a separate stair block for fire escape suitably located complying with fire fighting norms of TAC. 250mm thick brick wall to be placed in suitable structural frames for stability and safety between two crushers in full height with a provision of a door.

vi) Over Ground & On Ground Galleries & Trestles

Over ground and on ground galleries shall be of enclosed type. The gallery shall have walkways and the width and height shall be as per system requirement. A continuous slit opening of 500 mm height shall be provided on both sides of gallery just below roof sheeting. The gallery shall be made of structural steel with galvalume sheet and minimum 2.0 mm thick fire resistant and UV resistant polycarbonate sheet of approved make for adequate natural light on roof and walls to be provided as mentioned elsewhere in this specification.

The floor for on-ground galleries shall be raised at least 500 mm above finished ground level and paved with min. 150 thick RCC (M-25) over 100 mm thick lean concrete (M10) over 230 thick boulder/stone pitching interstices filled with sand. The raised floor shall be retained by continuous brick walls at both sides of enclosures running along length of the conveyor and the surface of the wall shall be plastered and finished with cement based paints externally as per specification.

For Conveyor Galleries washing water down comer shall be provided at every Trestle location.

Roof, side sheeting and slit opening on walls for over ground conveyor galleries shall be similar to ground conveyor explained above. The area for natural light shall not be less than 15% of floor area. Crossover shall be provided at intervals not exceeding 100m c/c & stair upto the ground floor level shall be provided at every location of crossover. Crossovers shall preferably be located over four-legged rigid trestle location. Platforms for cross over shall be provided with

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chequered plate flooring and hand railing as per specification. The foundations & structures for gravity take up with platform and hand railing shall be provided by the bidder's drawing and specification. Fencing with lockable gate shall be provided around Gravity take ups. Trestles shall be of structural steel braced adequately and provided at suitable locations. Location of trestles adjacent to boiler house and railway lines shall have to be decided carefully so that there is no interference (both underground and over ground) with other buildings, equipment/equipment structures foundations nearby as well as railway lines, ducting, trenches, drains etc. Adequate clearance required by Railway authorities shall be maintained shall have. The Contractor has to execute work very carefully so that any existing foundations are not damaged. Execution and erection sequence of foundation for trestles and galleries or any other coal handling plant equipment and structures has to match erection sequence of boiler, ESP or other adjoining structures.

vii) Substations & Control Rooms

These shall be RCC framed structures with columns, beams, slabs and foundation etc. Cladding shall be of brick work with plaster on both side. Adequate aluminium doors and windows shall be provided for natural ventilation & views. Roof shall be provided with roof water proofing treatment as per specification. The control rooms shall have superior ambience and finish employing high quality glass, Aluminium false ceiling, dust free superior flooring etc. All air-conditioned areas (specified in Electrical Specification) shall be provided with the suspended permanently anodised aluminium natural colour matt finish false ceiling system with corrosion resistance aluminium alloy panels of minimum thickness 0.5 mm. 50mm thick mineral wool insulation (as per IS:8183) bound in polythene bags shall be laid on top of panels. Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures, AC ducts etc. Suitable M.S. channel (min. MC 75) grid shall be provided above the false ceiling level for movement of personals to facilitate maintenance of lighting fixtures. Under deck insulation shall be provided on the ceiling (underside of roof slab) and underside of floor slab of air-conditioned areas depending upon the functional requirements.

Control panel room for control room near track hopper shall be provided with thick wired glass (min. 5.5 mm thick) on all sides so as to permit operators to have full view on operation of Track Hopper. Adequate number of 150 mm dia. RWDC pipe has to be provided. Control room floor shall be Heavy duty vitrified Ceramic Tiles tiled finish. Well polished Kota stone shall be provided for staircase, passages, lobbies and general circulation areas. 40 mm thick IPS (28 mm under bed & 12 mm thick topping with metallic hardener) shall be provided for MCC rooms, cable vault/cable spreader rooms etc. For battery room & areas of corrosive liquids, 20 mm thick acid & alkali resistant tiles set in with acid & alkali proof epoxy mortar underbed

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shall be used. Silica based epoxy mortar which is chemical resistant shall be used in dado at least up to 1.5 m from finished floor level. The ceiling, door and windows and all other fixtures shall be provided with acid resisting paint as per specification.

Separate Fire escape stair shall be provided in Control Building.

All control room shall be provided with toilet facilities with toilet fixtures as specified elsewhere for 20 (twenty) users and drinking water supply facilities. All doors of toilet shall be of standard PVC door of approved make & colour. If the effluent for sewer should have independent septic tank then the septic tank shall be located at a distance of 15m (min.) from building.

viii) Crusher House Control & MCC Room

These shall be RCC framed structures with columns, beams, slabs and foundation etc. Cladding shall be of brick work with plaster on both sides. Adequate aluminium doors and windows shall be provided for natural ventilation & views. Roof shall be provided with roof water proofing treatment. All air-conditioned areas shall be provided with the suspended permanently anodised aluminium natural colour matt finish false ceiling system with corrosion resistance aluminium alloy panels of minimum thickness 0.5mm. 50mm thick mineral wool insulation (as per IS: 8183) bound in polythene bags shall be laid on top of panels. Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures, AC ducts etc. Suitable M.S. channel (min. MC 75) grid shall be provided above the false ceiling level for movement of personals to facilitate maintenance of lighting fixtures. Under deck or over deck insulation shall be provided on the ceiling (underside of roof slab) and underside of floor slab for air-conditioned areas depending upon the functional requirements.

Control panel room for control room shall be provided with thick wired glass (min. 6.0 mm thick) on all sides so as to permit operators to have full view on operation. Adequate number of 150mm dia. GI RWDC pipe shall be provided. Control room floor shall be Heavy duty vitrified Ceramic Tiles tiled finish. Well polished Kota stone shall be provided for staircase, passages, lobbies and general circulation areas. Overall 50mm thick IPS (27mm underbed & 13mm thick topping) shall be provided for MCC rooms, cable vault/cable spreader rooms etc. For battery room & areas of corrosive liquids, 20 mm thick acid & alkali resistant tiles set in with acid & alkali proof epoxy mortar underbed shall be used. Silica based epoxy mortar which is chemical resistant shall be used in dado at least up to 1.5 m from finished floor level. The ceiling, door and windows and all other fixtures shall be provided with acid resisting paint as per specification.

Separate Fire escape stair shall be provided in Control Building.

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All control rooms shall be provided with toilet facilities and drinking water supply facilities. All doors of toilet shall be of standard PVC door of approved make & colour.

6.07.00 Interior Finish Schedule For Non Plant Buildings (Refer attachment for finish schedule)

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 plaster shall be provided as per spec in two coats (12+8 mm). As per point no. 56(Civil) of agreed deviation in KTPS.

 : 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

3mm punning subjected to even surface at ceiling shall be maintained. As per point no. 56(Civil) of agreed deviation in KTPS.

 Ceiling : ~~6 mm thick with 1:3 cement-sand mortar~~
6. White Cement Putty Punning : 2 mm thick punning to be provided to all areas receiving acrylic emulsion or Acrylic Distemper paint.

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7. Cladding for Power house

Refer Point no.15 & 16
of changes sought
sheet.

Providing and fixing of double skin insulated wall cladding system comprising of profiled external sheet manufactured out of 0.55mm TCT (Total Coated Thickness) permanently colour coated zincalume steel (150 gsm. Zinc – aluminium alloy coating total of both sides as per AS 1397: 1993) having 300 Mpa yield strength. The colour coating shall comprise of SMP. 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~~ or 180gsm galvanised of 240 mpa. The colour coating shall comprise of 20 microns finish coat over a 5-micron primer coat on the exposed side and a back coat of 5 microns over a primer coat of 5 micron on the reverse side.

The external sheet shall have 500mm cover width, 47mm high crests at 250mm centres with special male / female side laps and anti- siphoning feature to prevent leakage. 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/M3 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.

Approved Manufacturer : LLOYD Insulations (India) Ltd.
TATA Blue Scope Steel, or
similar approved.

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8. False Ceiling : Aluminium pre-painted false ceiling, either lineal panel system or aluminium tile/plank system.
- Approved make : LUXALON by Hunter Douglas, LLOYD, Armstrong, INTERARCH or similar approved.
- 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/m² 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, Ironite or similar

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- 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 ± 5 mm in dimensions and ± 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/ltr 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/mm² after 28days, the mortar density is around 2.2 kg/ltr.

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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/lit at 27⁰ C. The system shall be allowed for curing for 3 days.

Approved Make : Sika India (P) Ltd., BASF 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

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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 ± 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, PCC paving as plinth protection, shall be provided around all buildings with surface drain of required size. Refer point 17 of changes sought sheet
- 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.

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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

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- 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 bedding 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.

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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 : Ferrastone/Hardstone of BOSS Profiles Ltd, RESTILE Ceramics Ltd. , Marbonite, Kajaria, Nitco, Endura of H R Jonson, or similar approved. al Systems of HYDRO, Hidasco, DORMA, or equivalent.

Internal doors of Toilet shall be of PVC, as per point no. 57(Civil) of agreed deviation in KTPS.

- 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.

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- 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.

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 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.

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- 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/m²k, 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/m²k, 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 :
 - i) For roofs with structural slope :

The cleaning and preparation of the substrate to which the elastomeric membrane is applied must be carried out thoroughly to leave a sound base for the application. Any laitance present on the surface must be removed mechanically. Release oil and other contaminants which may impair adhesion must be removed.

Over the finished well prepared sloped surface of RCC slab, application of elastomeric membrane shall be, a single component the liquid, cold applied, elastomeric polyurethane based, that cures by reaction with atmospheric moisture to form a tough but flexible waterproofing membrane. It is elastomeric, seamless waterproof membrane applied in 2 coats to a DFT of 1.2 mm thick having a elongation capacity of over 600% and average tensile strength of 1 MPa, tear resistance as per GBT 19250-2003 >20N/m. The material shall comply with –

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ASTM C 836 National Std. of Canada 37.58 – M86 by CGSB. over the entire surface of waterproofing membrane laying a separation layer of non-woven polypropylene geo-textile of 120 gsm followed by application of rigid insulation board expanded polystyrene BASF PERIPOR of BASF or similar approved for thermal insulation as per HVAC requirement shall be laid over the finished separation layer of geotextile. 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/m²
- Thermal Conductivity (K): 0.034 W/mK
- Thermal Transmittance (U): 0.5-0.6 W/m² oC
- Water Absorption (% vol): <0.1% (by total immersion)

The top surface of the rigid polystyrene block of Peripore of BASF or similar approved shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thick on 15 mm thick cement plaster (1:4) which laid over 120 gsm non-woven polypropylene geo-textile separation layer. 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.

- ii) For roofs having no structural slope: The cleaning and preparation of the substrate to which the elastomeric membrane is applied must be carried out thoroughly to leave a sound base for the application. Any laitance present on the surface must be removed mechanically. Release oil and other contaminants which may impair adhesion must be removed.

Over the finished well prepared flat surface of RCC slab, application of elastomeric membrane shall be a single component the liquid, cold applied, elastomeric polyurethane based, that cures by reaction with atmospheric moisture to form a tough but flexible waterproofing membrane. It is elastomeric, seamless waterproof membrane applied in 2 coats to a DFT of 1.2 mm thick having a elongation capacity of over 600% and average tensile strength of 1 MPa, tear resistance as per GBT 19250-2003 >20N/m. The material shall comply with –

ASTM C 836 National Std. of Canada 37.58 – M86 by CGSB. over the entire surface of SONOSHIELD HLM 5000R waterproofing membrane laying a separation layer of non-woven polypropylene geo-textile of 120 gsm followed by application of rigid insulation board expanded polystyrene BASF PERIPOR for thermal insulation as per HVAC

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requirement shall be laid over the finished separation layer of geotextile. 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/m²
- Thermal Conductivity (K): 0.034 W/mK
- Thermal Transmittance (U): 0.5-0.6 W/m² oC
- Water Absorption (% vol): <0.1% (by total immersion)

The top surface of the rigid polystyrene block of Peripore shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thick on screed concrete mix (1:2:4) grading having minimum 25 mm thickness at the lowest point of the slope over R.C.C. slab and shall be laid as per the slope laid over 120 gsm non-woven polypropylene geo-textile separation layer. 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.

- iii) 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.
- h) APP modified Bituminous Polyester reinforced waterproofing membrane of Sika® WP Shield-104 P 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.

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- i) APP membrane shall conform to Conforms to: UEAtc, ASTM D146, DIN52123, ASTM D36, ASTM D5, UEAtc, ASTMD 5147, ASTM D4799.
- j) Technical Data
 - Chemical Base APP modified Bituminous Polyester
 - Thickness 4mm
 - Unit weight 4.40 kg/m²(According to UEAtc)
- k) 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 (Polyster) weight- 180 g/m²
 - Softening Point - 145 oC - (According to ASTM D36)
 - Penetration - 15-25 at 25oC d mm-(According to ASTM D5)
 - Tear resistance (L/T) N-170/180- -(According to UEATc)
 - Water Absorption% (BSP)- <0.15-(According to ASTMD 5147)
 - Heat Resistance- No Flow at 100oC-
 - Resistance to Aging after 2000 hrs (Weather –O-Meter)- No Delamination- (According to ASTM D4799)
- l) 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.
- m) 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.

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- n) All angles and abutments should be sealed with extra care to ensure full bondage. The edges should be sealed well into the grooves.
- iv) For Liquid, cold-applied PU elastomeric waterproofing membrane system shall be a single component the liquid, cold applied, of elastomeric polyurethane base, that cures by reaction with atmospheric moisture to form a tough but flexible waterproofing membrane of BASF's SONOSHIELD HLM 5000R or similar approved. It is elastomeric, seamless waterproof membrane applied in 2 coats to a DFT of 1.2 mm thick having a elongation capacity of over 600% and average tensile strength of 1 MPa, tear resistance as per GBT 19250-2003 >20N/m. The material shall comply with – ASTM C 836 National Std. of Canada 37.58 – M86 by CGSB.

Approved make of elastomeric membrane: SIKA India Pvt. Ltd, LLOYD, STP Ltd., BASF, Dr. Fixit or similar approved.

Approved make of APP Bitumen membrane: SIKA or similar approved.

Note : Waterproofing materials should be applied by the manufacturer authorised applicators only.

- 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 contractor 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.

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- b) Acrylic plastic emulsion paint of AkzoNobel/Asian Paints/ Berger or any other reputed make approved by TSGENCO 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, non toxic 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.

Clause says fire-crete material for fire sealing at cable entry points in wall/floor. As per point no. 58(Civil) of agreed deviation in KTPS.

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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/mm² minimum, Density of PE core – 920 – 980 Kg/m³ (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 contractor 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:

1. 4mm thick Compact Polycarbonate sheet, transparent or smoke tinted, of Lexan Polycarbonate or similar approved.

2. 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.

3. Sealing of joints shall be done with Silicon sealant.

Approved make : BAYER India, GE or similar

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- a) Shape of the roofing shall be as per drawing and approved by the owner.
- b) Name of system provider – McCoy Architectural Systems Pvt. Ltd. / Citadel Architectural Solutions Pvt. Ltd. / or equivalent.
- c) System provider shall prepare and submit the detailed working drawing for approval of engineer before erection.

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.

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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 sealings 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.

Marble stone partition shall be provided. As per point no.59(Civil) of agreed deviation in KTPS.

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- 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,.

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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/m³
- ◆ Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/m²K 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 (2.48×10^{-14} Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor 'μ' value should be minimum 7000.

Under-deck insulation of 50mm thk for area having roof exposed to sun & for remaining areas 25mm thk insulation will be provided. As per point no 60(Civil) of agreed deviation in KTPS.

~~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/m²

Thermal Conductivity (K): 0.034 W/Mk

Thermal Transmittance (U): 0.5-0.6 W/m² oC

Water Absorption (% vol): <0.1% (by total immersion)

Actual area covered would be used for measurement.

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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/mm² 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%.
3. Bitumen sealing compound shall be conformed to IS:1834. Preformed bitumen impregnated fibre board conforming to IS:1838 shall be used as joint filler.

23. Approved make of other items

a)	Expansion Joint Control	3R Construction Solutions Pvt Ltd or similar
b)	Silicon 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

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For extruded polystyrene foam insulation, "Insuboard" by The Supreme Industries Ltd BASF, TEXA or similar approved.

For PU Insulation by BAYER India or similar approved.

d) Toilet Partition: Merino-Besco or equivalent.

24. 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 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
Interior Finish Schedule For Power house Building							
1.	T.G. Hall Area,	Overall 50mm thick flooring shall be finished with 18 mm thick polished Granite for unloading areas and walkways shall be demarcated with 75 mm wide and 18 mm thick Granite stone (black) on both sides of Granite finished walkways.	Granite tiles/10mm thick high polished decorated coloured background 1st quality digital series dual charged glazed tiles of size not less than 18"x12" shall be provided for inner faces of all four sides walls of operating floor TG hall and columns (by encasing structural steel columns along A-row and both gable ends with brick masonry for 3.0mts height above operating floor) up to bottom of window lintel level or 1.80mts height from operating floor level whichever is high and balance portion of brick wall shall be painted with two coats of plastic emulsion paint over primer and white cement putty. A row and gable end shall have double skin metal cladding system above brick masonry wall. Synthetic enamel paint up to 1.50mts height and acrylic emulsion paint for balance height for all other floors of STG building.	T.G. Hall – anti-corrosive paint to metal deck and all metal works. Acrylic Distemper on exposed plastered ceiling (without false ceiling). Aluminium panel 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.	
	Switchgear Room, MCC Room,	Electric insulated flexible PVC sheet as per IS: 15625-2006 to be laid over heavy duty IPS flooring. Overall thickness shall be 50mm.	Synthetic enamel paint upto 1.50mts height from floor level and balance portion with plastic emulsion paint over primer and white cement putty.	Acrylic Distemper	Hollow metal flush door / fire door	-Do-	

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	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
Interior Finish Schedule For Power house Building							
2.	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 "BOSS Profile Ltd", "RESTILE", ENDURA" of H & R Jonson (India) 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 50mm thick including the thickness of the tiles and under bed.	Vitrified tiles dadoing up to false ceiling level in UCB control room and annexure room shall be provided. Front portion of the UCB control room facade above glass panelling a suitable combination of Aluminium composite panel (ACP)/granular textured paint may be used. 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 upto the false ceiling level.	Gypsum board plaster false ceiling for control room and annexure rooms. The false ceiling work shall take care of all illumination, fire detection & fighting, HVAC and all other service requirement.	Aluminium glazed double door.	-Do-	
3.	All office areas, Conference Room and other important areas.	10/11 mm thick non-skid fully vitrified dual charged 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 precoated aluminium alloy panelled ceiling (600x600mm panels) stove enamelled on both sides on pre coated aluminium grid system. Acrylic emulsion paint over white cement putty in areas without false ceiling with necessary lighting arrangements for illumination shall be provided.	Factory made Solid core wooden flush doors with high quality lamination on both sides giving hitech expression in teak wood frame as per owner's choice with floor spring, mortise lock & latch and all accessories.	Aluminium glazed window with minimum 6mm 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 with diamond shape alminium grill for protection.	
4.	Access floor where required	Minimum 600 mm high false floor with adjustable metal supporting system and fire resistant floor panels finished with antistatic vinyl flooring and matching skirting.	-	-			

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	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
Interior Finish Schedule For Power house Building							
5.	Stairs & Lobby	Kota stone slab in general.	Coloured 6mm thick(min) ceramic tiles up to 1.50mts height and Acrylic emulsion Paint over white cement putty for balance height.	Acrylic Distemper Paint	Hollow metal flush fire door	-Do-	
	Main Stair & Landing	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-	
	Lift lobby	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 plank panelled pattern false ceiling.	Aluminium glazed door/ fire door	-Do-	
6.	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)	20mm thick acid resistant tiles over bitumen primer up to 1.20mts height .	Acid/Alkali resistant epoxy paint for balance height.	Hollow metal flush fire door	-Do-	
7.	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) .	20mm thick acid resistant tiles over bitumen primer up to 1.20mts height.	Acid/Alkali resistant epoxy paint for balance height.	Hollow metal flush fire door with chemical resistant paint finish	-Do-	
8.	AHU Rooms, Air Washer Rooms, Cable Spreader Rooms & all other service areas	50 mm thick heavy-duty cement concrete floor with metallic hardener.	Synthetic enamel paint up to 1.50mts height and acrylic emulsion paint for balance height over white cement	Acrylic Distemper Paint	Hollow metal flush fire door. For AHU Room and Air Washer rooms airtight doors are to be provided.	-Do-	

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	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
Interior Finish Schedule For Power house Building							
9.	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 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 full height starting from finish floor level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with 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 with PVC lamination on both sides and doors for WCs shall be PVC door frame & shutter	Aluminium glazed window/ ventilator	
10.	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-	
11.	Electrical Switchgear Room, MCC Room, etc	Electric insulated flexible PVC sheet as per IS: 15625-2006 to be laid over heavy duty IPS flooring. Overall thickness shall be 40mm.	Synthetic enamel paint up to 1.50mts height and acrylic emulsion paint for balance height over white cement putty.	Acrylic Distemper	Hollow metal flush door / fire door	-Do-	
12.	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.	Synthetic enamel paint up to 1.50mts height and acrylic emulsion paint for balance height over white cement putty.	Acrylic Distemper	Hollow metal flush door / fire door	-Do-	

ANNEXURE - II
DESCRIPTION OF AUXILIARY PLANT BUILDINGS

Interior Finish Schedule For Plant Buildings							
	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 and Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint over white cement putty for balance height for Other areas	Pre-coated aluminium panelled (600mmx600mm size) ceiling 'Luxalon' or "INTERARCH" in air-conditioned areas. Acrylic Distemper paint in other areas.	Hollow metal flush fire door/ Aluminium glazed door	Aluminium window with diamond grill window / ventilator	
3.	CHP Control & MCC Building,	10 mm thick non-skid fully vitrified tiles of make "MARBONITE", "FERRASTONE" of minimum size 600 mm x 600 mm (overall 50 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 50mm thick heavy duty IPS flooring.	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint over white cement putty for balance height for control room and Other areas	Pre-coated aluminium panelled (600mmx600mm size) ceiling 'Luxalon' or "INTERARCH" in air-conditioned areas. Acrylic Distemper paint in other areas.	Hollow metal flush fire door/ Aluminium glazed door	- DO -	
4.	AHP Compressor Building	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	- Do -	- Do -	- Do -	- Do -	

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Interior Finish Schedule For Plant Buildings							
	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
5.	Switch yard control building						
	i) Control Room, Offices	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 and offices.	Vitrified tiles dado up to 1.50 m height and Acrylic emulsion paint over white cement putty for balance height for control room and Acrylic emulsion paint over white cement putty for offices for full height	Precoated aluminium panelled (600x600mm size) ceiling 'Luxalon with insulation on top	Aluminium glazed door with collapsible door at the main entry	Aluminum glazed window / ventilator Windows of yard side shall be suitable sized to view entire yard area fixed with MS grill	
	ii) MCC & Switch gear rooms	50 mm thick heavy duty cement concrete floor with metallic hardener or flexible electric insulated PVC synthetic sheet finish and matching skirting.	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint over white cement putty	Acrylic Distemper paint	Hollow metal flush fire door	Aluminum glazed window / ventilator	
	iii) Other areas	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	-Do-	-Do-	-Do-	-Do-	
	iv) Toilet & other wet areas	10 mm thick non-skid fully vitrified tiles of make "MARBONITE", "FERRASTONE" of minimum size 400 mm x 400 mm (overall 40 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty.	Acrylic Distemper paint	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 & shutter.	-Do-	
	v) Battery Room	Minimum 20 mm thick acid and alkali resistant vitrified tile "ENDURA" or Minimum 37 mm 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 20 mm thickness.	20mm thick acid resistant tiles over bitumen primer up to 1.20mts height and Acid/Alkali resistant epoxy paint for balance height	Acid/Alkali resistant paint.	Hollow metal flush fire door	-Do-	

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Interior Finish Schedule For Plant Buildings							
	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
6.	Crusher House & TP's	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	
7.	Chemical House	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.	20mm thick acid resistant tiles over bitumen primer up to 1.20mts height and Acid/Alkali resistant epoxy paint for balance height in acid & alkali prone area and rest with Acrylic emulsion paint	Chemical resistant paint for acid & alkali resistant area and other areas with Acrylic Distemper paint.	-Do-	Aluminum glazed window / ventilator.	
8.	Raw Water Pump House & Electrical Building	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper	Hollow metal flush door / fire door	Steel glazed window / ventilator	
9.	HFO & LDO Forwarding Pump House	Self-levelling epoxy floor paint on oily areas and heavy duty IPS flooring with hardener in balance areas.	-Do-	Acrylic Distemper Paint	Hollow metal flush door / fire door	-Do-	
10.	CW, ACW Pump House	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	-Do-	Acrylic Distemper Paint	Hollow metal flush door / fire door	-Do-	
11.	DG & Compressor Building/ AHP Compressor Building	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	-Do-	-Do-	-Do-	-Do-	
12.	Misc. Pump Houses/ Fire Water Pump House/ Clarified water pump house	-Do-	-Do-	-Do-	-Do-	-Do-	
13.	HCSD & Silo Utility Pump House	-Do-	-Do-	-Do-	-Do-	-Do-	
14.	Ash Slurry & Ash Water Pump House	-Do-	-Do-	-Do-	-Do-	-Do-	

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Interior Finish Schedule For Plant Buildings							
	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
15.	DM Plant						
	a) Plant area	Minimum 20 mm thick acid and alkali resistant Vitrified tile of "ENDURA" or similar set in and jointed with epoxy mortar (overall 40mm thick).	20mm thick acid resistant tiles over bitumen primer up to 1.20mts height and Acid/Alkali resistant epoxy paint for balance height in acid & alkali prone area and rest with Acrylic emulsion paint	Chemical resistant paint for acid & alkali resistant area.	-Do-	Aluminium glazed window / ventilator	
	b) MCC Room	50 mm thick heavy duty cement concrete floor with metallic hardener or flexible electric insulated PVC synthetic sheet finish and matching skirting.	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper Paint	-Do-	-Do-	
	c) Control Room & Offices	10/11 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 and offices.	Acrylic emulsion paint over white cement putty.	Gypsum Board / Glacium Silicate Board or tiles false ceiling with insulation on top.	Aluminium glazed door At the Main entrances collapsible door shall also be provided	-Do-	
	d) Laboratories	Minimum 20 mm thick acid and alkali resistant tile set in and jointed with epoxy mortar (overall 40mm thick) along with 2100mm high dado of same tile.	Acid / Alkali resistant paint in acid & alkali prone area.	Acid / Alkali resistant paint in acid & alkali prone area.	-Do-	-Do-	
	e) Toilet	10 mm thick non-skid fully vitrified tiles of make "MARBONITE", "FERRASTONE" of minimum size 400 mm x 400 mm (overall 40 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be full height	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty.	Acrylic Distemper Paint	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 & shutter.	-Do-	

Interior Finish Schedule For Plant Buildings							
	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
16.	Ash Handling Electrical / Control Room						
	a) Electrical Room	50 mm thick heavy duty cement concrete floor with metallic hardener or flexible electric insulated PVC synthetic sheet finish and matching skirting.	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper Paint	-Do-	Steel glazed window / ventilator	
	b) Control Room	10/11 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.	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Gypsum Board / Clacium Silicate Board or tiles false ceiling with insulation on top.	Aluminium glazed door At the Main entrances collapsible door shall also be provided	-Do-	
17.	CPU Regeneration Building	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper	Hollow metal flush door / fire door	Steel glazed window / ventilator	
18.	Vacuum Pump House	-Do-	-Do-	-Do-	-Do-	-Do-	
19.	Centrifuge Building	-Do-	-Do-	-Do-	-Do-	-Do-	
20.	CW Chlorination 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 Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint over white cement putty for balance height	Chemical resistant paint for acid & alkali resistant area and other areas with Acrylic Distemper paint.	-Do-	Aluminum glazed window / ventilator.	

Interior Finish Schedule For Plant Buildings							
	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
21.	CW Chemical Treatment Building	-Do-	-Do-	-Do-	-Do-	-Do-	
22.	Condensate Transfer Pump House	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint for balance height	Acrylic Distemper	Hollow metal flush door / fire door	Steel glazed window / ventilator	
23.	Track Hopper, Wagon Tippler, Under Ground and Over Ground Transfer Points, Pent Houses & Pump Houses	-Do-	-Do-	-Do-	-Do-	-Do-	

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ANNEXURE - III
DESCRIPTION OF NON-PLANT BUILDINGS

Interior Finish Schedule For Non Plant Buildings							
	BUILDING/AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
1.	Service building						
	a) Entry cum reception lounge, VIP lounge, Main meeting/ conference room	Suitable and approved combination shed of marble slab and strips shall be used	Two coats of Acrylic Emulsion paint of approved colour shall be applied over a coat of approved primer on the masonry surface prepared with white cement putty.	Aluminium panelled (600x600mm size) acoustic false ceiling with glass wool insulation on top similar to LUXALON of Hunter Douglas or "INTERARCH" having approved colour with stove enamel finish, integrated with light fixtures, HVAC grills and other ceiling mounted accessories, complete in all respect with metal suspension system, trims, profiles etc.	Sensor operated Aluminium glazed sliding door at main entry Collapsible door shall also be provided.	Aluminium glazed window At ground floor Aluminium diamond I Grill @ 20 Kg/sq.m shall be provided	
	b) Other floors/ office area etc.	10/11 mm thick non-skid fully vitrified tiles of make "MARBONITE", "FERRASTONE", "Kajaria" of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern with matching shirting of same make	- Do -	Gypsum board or Acoustic pre-coated aluminium alloy panelled ceiling (600x600mm panels) stove enamelled on both sides on pre coated aluminium grid system false ceiling of approved make as per specification	Aluminium glazed door/Pressed steel hallow metal door/ Fire door	Aluminium glazed window	
	c) For staircase and Corridors	Steps – risers & tread, stair skirting, corridor floor should be combination of Aranga white marble and Abu green marble. Wall cladding of Elevator Lobby shall be of polished granite slab of light grey shed or colour as approved by the owner.	Two coats of Acrylic Emulsion paint of approved colour shall be applied over a coat of approved primer on the masonry surface prepared with white cement putty.	Acrylic Distemper paint colour super white.	-Do-	-Do-	

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Interior Finish Schedule For Non Plant Buildings							
	BUILDING/AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	d) Toilet & pantry	Minimum 10 mm thick non-skid vitrified tile, of minimum 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 shall be 100 mm higher than lintel level starting from finish floor level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty.	False ceiling shall be perforated aluminium stove enamel finished panels of size 600x600mm	"Main entry to toilet or wet areas shall be wooden panel door in hard teak wood frame and doors for WCs shall be UPVC door frame & shutter."	-Do-	
	e) AHU room, store Generator room, Electrical room, Etc:	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting.	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper paint	Hollow metal flush fire door	-Do-	
2.	Canteen Building						
	a) Kitchen, Dining hall etc.	10/11 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 with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic tiles. Dado shall be full height for Kitchen and 1500mm. high for other areas. All counter for Kitchen and service areas shall have Polished Granite slab over RCC slab or Kadapa stone	1st quality coloured glazed tiles of minimum 6/7 mm thickness up to 1.20mts height and balance height with Acrylic emulsion paint over primer and white cement putty	Acrylic Distemper paint over white cement putty. Airconditioned areas shall have Acoustic precoated aluminium alloy panelled ceiling (600x600mm panels) stove enamelled on both sides on pre coated aluminium grid system false ceiling of approved make as per specification	Aluminium glazed door	Aluminium glazed window	
	b) Other areas	Kota stone flooring and skirting	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper paint	Solid core flush door	Aluminium glazed window / ventilator	

Interior Finish Schedule For Non Plant Buildings							
	BUILDING/AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	c) Toilet & wash areas	10/11 mm thick non-skid fully vitrified tiles of make "MARBONITE", "FERRASTONE" of minimum size 400 mm x 400 mm over IPS floor (overall 40 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty.	Acrylic Distemper paint	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 & shutter.	Aluminium glazed window / ventilator	
3.	Permanent Store & Inflammable Store Building	50 mm thick heavy-duty cement concrete floor with metallic hardener and matching skirting. For office areas & AC stores vitrified tiles shall be used.	Acrylic emulsion paint with white cement putty for office & AC store areas and Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height for other areas	Acrylic Distemper paint over white cement putty. Offices and Airconditioned areas shall have Acoustic precoated aluminium alloy panelled ceiling (600x600mm panels) stove enamelled on both sides on pre coated aluminium grid system false ceiling of approved make as per specification	Hollow metal flush fire door/ Aluminium glazed door. Rolling shutter wherever necessary	Aluminium glazed window / ventilator	
4.	Main Gate Complex	Overall 40 mm thick Kota stone slab flooring	Acrylic emulsion paint over white cement putty	Acrylic emulsion paint over white cement putty	Hollow metal flush fire door/ Aluminium glazed door	Aluminium glazed window / ventilator	
5.	Weigh Bridge Control room	10/11 mm thick non-skid fully vitrified tiles of make "MARBONITE", "FERRASTONE" of size 600 mm x 600 mm (overall 40 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper paint	Hollow metal flush fire door/ Aluminium glazed door	Aluminium glazed window / ventilator with MS grill	

Interior Finish Schedule For Non Plant Buildings							
	BUILDING/AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
6.	Workshop Area & Bull dozer maintenance building						
	a) Workshop area, Bulldozer shed area	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height	Acrylic Distemper paint	Hollow metal flush fire door & Rolling shutter wherever necessary	Steel glazed window / ventilator	
	b) stores	-Do-	-Do-	-Do-	-Do-	-Do-	
	c) offices	10 /11mm 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 offices.	Acrylic emulsion paint over white cement putty	Moisture resistant Gyp Board or Calcium silicate Board false ceiling with insulation on top.	Aluminium glazed door	Aluminium glazed window	
	d) Laboratory	Minimum 20 mm thick acid and alkali resistant tile set in and jointed with epoxy mortar (overall 40mm thick) along with 2100mm high dado of same tile.	Acid / Alkali resistant paint in acid & alkali prone area.	Acid / Alkali resistant paint in acid & alkali prone area.	Aluminium glazed door	Aluminium glazed window	
	e) toilet	Overall 50mm thick Kota stone finish with 25mm thick Kota stone slab and 5 mm thick glazed ceramic tile dado of approved make. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	Acrylic Distemper Paint	Acrylic Distemper Paint	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 & shutter.	-Do-	

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Interior Finish Schedule For Non Plant Buildings							
	BUILDING/AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
7.	Fire Station						
	a) Office area, Toilet, Stores, Training room, Kitchen / Dining area, Dormitory,	"10/11 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 office, dormitory area with 150 high matching skirting with 5 mm thick glazed ceramic tile dado of approved make topped with 50 mm wide matching ceramic trims 2200mm. High."	Acrylic emulsion pain	Acrylic emulsion paint	Aluminium glazed door/ hollow metal flush door	Aluminium glazed window	
	b) Fire tender parking area and equipment store	50mm thick heavy duty IPS flooring with metallic hardener with matching skirting. or Paving with 65/70 mm thick pressed interlocking precast blocks	Cement paint and for equipment store Acrylic Distemper all be used	Parking area cement paint and for equipment store Acrylic Distemper shall be used.	Aluminium glazed door/ hollow metal flush door for equipment store	Aluminium glazed window for equipment store.	
8.	Watch Tower	IPS flooring with Cement Skirting	Acrylic Distemper, Epoxy paint over exposed steel structure.	Acrylic Distemper, Epoxy paint over exposed steel structure.	Hollow metal flush fire door	Steel glazed window / ventilator	
9.	Car & Scooter parking shed and Cycle parking shed	Minimum 50mm thick coloured and polished interlocking concrete tiles with pattern as approved by the owner, set on sand bed over PCC underbed. Parking near Administrative block shall have vitrified tiles suitable for parking of brand Endura of HR Jonson or similar approved.		Polycarbonate roof sheeting over RCC framed structure.			

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ANNEXURE-IV

APPROXIMATE SIZES OF NON-PLANT BUILDINGS

SI No.	Name of Building	No. Of Stories	Approximate Plan Area
1.	Fire Station Building	Ground floor + one	20.0m X 15.0m (double storey)x 4.0m height of each floor + 18.0m x 15.0m for fire tender parking.
2.	Canteen Building	Ground floor	02 Nos. 1000sq.mt
3.	Gate House including security office	Ground floor & Ground floor + one for Security office	36m X 12m roof area of gate house and 200sqm per floor shall be security office area. Clear height of gate structure shall be 8.0m
4.	Car Parking	Ground floor	2.5m x 5.0m clear area for each car for a module of 20 cars and 5.m x 12.0m clear for each bus parking area for a module of 3 buses. Height of structure shall be 2.8m clear for car parking and 6.0m clear for bus parking.
5.	Two Wheeler Parking /Cycle shed	Ground floor	20.8m x 7.8m area per shed. For a module of 100 Nos. of two wheelers. Similar module shall be made for cycle parking for 50 Nos. cycles. Clear height shall be 2.80m
6.	Permanent store	Ground floor	Storage Shed:15mx30m---18nos. One storage shed office building(15X30m) (Ground Floor) + 1st Floor(AC storage for light electronic material).

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SI No.	Name of Building	No. Of Stories	Approximate Plan Area
7.	Workshop	Ground floor	To be decided during detail engineering stage.
8.	Service Building	Ground + 3 (appx). To be decided during detail engineering stage.	6000 sq.mt
9.	Bulldozer shed	Ground floor	220Sqm x 8m height
10.	Car parking near administrative building	Ground floor	2.5m x 5.0m clear area for each car for a module of 20 cars having 2.8m clear height of the structure.
11.	Watch tower	+7.0m level from NGL	2.0m x 2.0mx3.0m (H) + 1.0m wide veranda around the room.
12.	Truck weigh bridge control room	Ground floor	6.5m x 3.25mx4.0m (H)
13.	Covered store & semi open store	Ground	50m x 15.0m x 4.5m height up to bottom of truss for covered store. For semi open store refer plot plan.
14.	Administration Building	Ground+1	4500 sq.mt

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3.7.0 Earthwork in Filling

3.7.1 The material to be used for area filling shall be selected material, approved by the Engineer, obtained directly from excavation for area grading, from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits in selected areas designated by the Engineer. The quality of the material shall conform to that mentioned in clause 2.5.2 of this specification.

Refer point no 18 of changes
sought sheet.

Where excavated material is mostly rock, the boulders shall be broken into pieces not longer than 150 mm size, mixed with properly graded fine material consisting of murum or earth to fill up the voids and the mixtures used for filling.

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If any material is rejected by the Engineer, Contractor shall remove the same forthwith from the site at no extra cost of the owner. Surplus fill material shall be deposited/disposed off as directed by the Engineer after the fill work is completed.

No earthfill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by the Engineer.

Before commencement of area filling the existing top soil shall be removed upto a minimum depth of 150 mm, or more, as directed by the Engineer in order to clear the surface of undesirable materials. After this the filling operation shall be performed with earth in layers not exceeding 250 mm, loose thickness. Each layer shall be watered and properly compacted to 95% of modified Proctor Density unless otherwise permitted/directed by the Engineer. Earth shall be compacted with approved machine and usually manual compaction shall not be allowed unless specifically permitted by the Engineer.

Since the degree of compaction depends on the moisture content of the soil, a close watch shall be kept on this aspect and corrections done to optimise the moisture content. The adequacy of the compaction and moisture control of the soil shall be determined by performing field density tests and other tests as and when directed by the Engineer and shall conform to the stipulations laid down in IS:4701.

Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed. This shall hold good for embankments as well.

The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the desired compaction has not been obtained.

Annexure-A

CIVIL						
1	Volume : VII-A	VII-A :02		In general, demolition of existing quarter, leveling and grading of the site will be taken up by TSGENCO....	TGGENCO to confirm that site shall be levelled upto finished ground level of the plant. If not, TSGENCO to furnish the level upto which site shall be leveled.	Demolition of existing structure is in TSGENCO scope, the ground shall be leveled upto existing ground level after dismantling by TSGENCO. However, the final leveling and grading upto FGL of the plant as per plot plan including cutting of shrubs/trees shall be in BHEL scope. Any clearance required for cutting of shrubs/trees shall be provided by TSGENCO.
2	Volume : VII-A	VII-A :10	2.00.00 O. 5 & 17th pt	Bulldozer shed and auto repair shop. Dress change rooms and Locker rooms for workmen.	Customer to furnish the size and detail of these facilities.	Dimension shall be 20X19 m. Out of that 120 sq. m area shall be given for Office room , O & M staff room, room for spares, tools and toilet. Balance shall be Bull dozer repair area with Metal sheeting roof over trusses and purlins. All room shall be RCC frame work with masonry and RCC Roof.
3	Volume : VII-A	VII-A :10	2.00.00 O.	Other utility services and non plant buildings	Customer to confirm the requirement of Admin building. There is no mention of scope of Admin building in this clause as well as Clause 1.00.00 of Vol VII B., however plot plan is showing location of this building in BHEL scope. Kindly furnish the salient features of this building if the same is in BHEL scope of work.	Admininstration building shall be in BHEL scope. Total area shall be 2500 sqm. The bld shall be Ground+1 story.

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4	Volume : VII-A	VII-A :11	2.00.00 O.	Other utility services and non plant buildings : Township	Construction of township shall NOT be in the scope of BHEL. PI confirm	Confirmed, Hence the centralized STP for plant is not required. Individual septic tanks for blds are to be provided by BHEL.
5	Volume : VII-A	VII-A :11	2.00.00 Q.	Extension of Raw water pump house near Godavari river at Burgampahad with additional raw water pump	Extension of Raw water pump house shall NOT be in the scope of BHEL. PI confirm.	Confirmed
6	Volume : VII-A	VII-A :12	2.00.00 Q. 6th pt	Boundary walls, Chain link/barbed wire fencing & gates wherever required around any buildings/area. Any modification to the existing plant boundary wall to make it suitable for the requirement of proposed plant shall be carried out by the EPC contractor.	Any addition/modification to the existing plant boundary including fencing shall be in scope of customer.	Confirmed
7	Volume : VII-A	VII-A :13	2.00.00 Q. 19th pt	All roof shall be provided with access through MS staircase	Access shall be provided through staircase/cage ladder. PI confirm	Open RCC/steel staircase shall be required even for single story building
8	Volume : VII-A	VII-A :14	2.01.00	List of Exclusions	Following structure/system shall be excluded from BHEL scope of work. a)Boundary wall b)Township c)Leveling and Grading d) Extension of raw water intake pump house	Leveling and grading from existing ground level to FGL is in BHEL scope
9	Volume : VII-A	VII-A :27	5.00.00	Maximum Hourly Rainfall Intensity 102 mm	The value of maximum hourly rainfall intensity as 102 mm for drainage system design seems to be high. Customer may please review the same again.	Rainfall intensity as 50 mm/hr shall be taken into consideration for design of drain system
10	Volume : VII-A	VII-A :28	6.02.00	The road levels will generally be at 150 mm above FGL	As per road Spec(CI. 6.04.00 pg-32), the road level is 250mm above FGL. Please clarify.	Road level shall be 250 mm above FGL in general.

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11	Volume : VII-A	VII-A :29	6.03.02	Bed slope will not be milder than 1 in 500.	The slope specified is very steep. Also refer point vii) slope of 1 IN 1000 is specified & normally used. Pls clarify.	Bed slope shall be 1 in 1000
12	Volume : VII-A	VII-A :29	6.03.02	For pitched roof with metal sheeting a minimum slope of 1 (V) to 5 (H) and for flat roof a minimum slope of 1(V) to 50 (H) will be provided for efficient drainage of rain water	Roof slope of 1 in 100 for flat roof is sufficient for effective draining of rain water. Pls clarify.	Roof slope for flat slabs shall be 1 in 100.
13	Volume : VII-A	VII-A :29	6.03.02	The maximum velocity for pipe drains and open drains will be limited to 2.4 M/sec and 1.8 M/sec respectively. However, minimum velocity for self cleansing of 0.6 M/sec will be ensured	Refer point ix) of clause 6.03.02 page 30, self cleansing velocity mentioned is 0.7m/sec. Please clarify which one is to followed for drainage system design.	Self cleansing velocity 0.7 m/sec shall be taken for design purpose.
14	Volume : VII-A	VII-A :29	6.03.02	Major drain will be open type....	Perforated RCC precast slab (M25) of minimum thickness with edge protection angle at all sides and with the provision of openable galvanised steel grating covers at every 4.0 m intervals shall be provided in BTG area only.	Drains other than BTG area shall not be provided with cover.

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15	Volume : VII-A	VII-A :32	6.04.00	All internal roads.....bituminous topping to all plat roads.	All internal roads shall be water bound macadam as per the cl 6.04.0 pg-32. However topping is not clear as both RCC topping & premix carpet topping has been mentioned . Pls clarify which one is applicable for internal roads.	Total thickness of bitumen topping shall be 115 mm as detailed below:- a) 70 mm thick Dense bituminous macadam.(Bitumin Binder Content and aggregate confirming to Grade-I of MORT & H Specification. b)40 mm thick Bituminous Conctete. Bitminous binder content & aggregate grading shall be as per table 500-18 of MORT & H specification. c)5 mm thick mixed seal coat with bitumen @0.06 cu. m/10 sq m mixed with medium coarse sand.
16	Volume : VII-A	VII-A :32	6.04.00	Carriageway width of primary road (peripheral) has been mentioned as 12 m.	Generally for primary roads, road width provided in other projects engineered by BHEL is upto 9.0 M. 12.0 M wide road is too high considering space constraint for Kothagudam Plant. PI confirm. Also kindly mark primary road clearly in plot plan.	Main approach road shall be 10 wide. The same shall be indicated in plot plan. Security path road around boundary wall shall be 4 m wide BT road.
17	Volume : VII-A	VII-A :40	8.01.00	Other Areas in Turbine Hall : 25 kN/Sq.m plus hung loadsRotor removal area beams shall also be checked for half the rotor load at the center of the beamOther Areas in Operating Floor : 15 kN/Sq.m plus hung loads	Please clarify the loading to be considered for other areas in operating floor.	Turbine Hall(operating floor) : 30 kN/Sq.m for equipment laydown area. Rotor removal area beams shall also be checked for half of the rotor load at the centre of the beam. Other area in operating floor 15 kN/Sq.m plus hung loads.

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18	Volume : VII-A	VII-A :50	8.02.00	The design calculations and respective drawings in AUTOCAD format shall be submitted accordingly.	Submission of engineering drawings shall be in pdf format only. Please confirm.	Follow as per spec
19	Volume : VII-A	VII-A :53	10.00.00 e)	Raw water reservoir will be provided with concrete slab.	Customer to confirm the requirement of concrete slab in case of LDPE lining. BHEL is considering an earthen reservoir with 500 micron LDPE lining. 50 thick precast concrete tiles to be laid over LDPE lining for protection over sides and bottom. No covering with RC slab is envisaged. PI confirm.	Confirmed as per BHEL proposal.
20	Volume : VII-A	VII-A :53	10.00.00 d)	Liquid Retaining Structures : ...No pressure relieving devices shall be permitted in underground structure....	Pressure relieving valves , if required shall be provided for liquid retaining structures to counter uplift forces. Please confirm.	Confirmed as per BHEL proposal. Vendor presence is required at the time of fixing of the same.
21	Volume : VII-A	VII-A :53	10.00.00 e)	Water Reservoirs : ...Fire water reservoir will be provided with concrete slabs on top as protective cover....	Fire Water Reservoir are generally open to sky. Please confirm the requirement of concrete slab on top.	Fire water tank shall be covered with RC slab.

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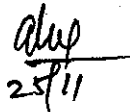
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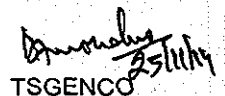
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22	Volume : VII-A	VII-A :57	10.01.01 B)	General Requirement: The vibration isolation system shall consist of steel helical spring units and viscous dampers supporting the RCC deck which would support the equipment. Complete Vibration Isolation System shall be provided for the foundations of Boiler Feed Pumps, Coal Mills, ID, Fan, FD Fan, PA Fan and all other rotating equipment except Turbo-generator.	Vibration Isolation System shall NOT be provided in any of the rotation equipment foundation except Boiler Feed Pump. PI confirm.	TSGENCO insists to provide Vibration Isolation System for foundations of Boiler Feed Pumps, Coal Mills, ID, Fan, FD Fan, PA Fan except Turbo-generator. BHEL offer currently does not envisage VIS for Mills & Fans. Same will be discussed during commercial offer. Noted
23	Volume : VII-A	VII-A :69	10.02.00	Concrete cover is mentioned 75 mm in bottom of foundation.	Concrete cover of 50mm at bottom of foundation shall be provided as per IS 456. Please confirm	IS 456 to be followed.
24	Volume : VII-A	VII-A :70	10.02.00	Stairs, Platforms, Ladders and Handrails:.....All stair shall have a maximum riser height of 125 mm.	Generally riser upto 180mm (max) is provided for industrial buildings. Please confirm.	Generally 150-180 mm riser shall be allowed.
25	Volume : VII-A	VII-A :81	12.02.02	Grade of concrete for chimney shell is mentioned as M-40	Generally M-30 grade of concrete is recommended for chimney shell construction. Kindly confirm.	Deviation accepted.
26	Volume-VII A,	VII A: 84	13.00.00	General Description 12. CW Pump House roof RCC	BHEL proposes to provide CW pump house as open structure without roof and without side cladding. PI confirm.	Tech spec shall be followed.
27	Volume : VII-A	VII-A :84	13.00.00	Point 11 : DM plant....	We propose to construct DM plant & CPU Regeneration Bldg as shed (deck sheet at roof and open sides). Pls confirm.	Tech spec shall be followed.

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28	Volume : VII-A	VII-A :85	13.00.00	Point 20 : Clarified Water Reservoir & Pump House	We propose to construct Clarified Water PH & Filtered Water PH as open structure without roof and without side cladding. Pls confirm.	Tech spec shall be followed.
29	Volume : VII-A	VII-A :88	14.01.00	...The Boiler Feed Pumps shall be located in the ground floor of Power House Building....	Motor driven feed pumps are kept at Mezanine floor and Turbine driven feed pumps are kept at operating floor level. PI confirm	Confirmed
30	Volume : VII-A	VII-A :89	14.02.00	Mill & Bunker Building : The building sides will be cladded with brick cladding to a height of 3.0 mts with a provision of openable windows above tripper floor and balance portion above brick wall up to roof level shall be cladded with single skin metal cladding....	Mill & Bunker Building is uncladded from ground floor to bottom of Tripper Floor & single sheet cladded from Tripper Floor to roof. Please confirm.	Tech spec shall be followed.
31	Volume : VII-A	VII-A :90	14.02.00	Mill & Bunker Building : ...Minimum two (2) nos. of stairs shall be provided in each Mill Building...	No staircase shall be provided in Mill & Bunker Building. There are interconnections at Feeder, Tripper Floor & Roof for access from boiler side.	Deviation accepted.
32	Volume-VII A, Section-VII	VII A: 91	14.04.01	RCC Stack – General Arrangement – The reinforced concrete single brick flue stack...	BHEL proposes single flue steel liner chimney instead of single flue brick liner in view of crucial completion target of the project. PI confirm	Tech spec shall be followed.
33	Volume : VII-A	VII-A :92	14.04.01	Point ii)....Natural Ventilation within the windshield shall be provided as required.	Please refer Clause 14.04.03 B (insulation) (g) No air gaps shall be provided between insulation & brick lining. This clause is contradictory to page 94.	50 mm air gap shall be provided for natural ventilation.

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34	Volume : VII-A A	VII-A :93	14.04.0 1	Point iv) Painting : ... The top of shell and top of acid resistant bricks at the roof level shall be painted with two coats of 'EXPILUX 5 COAL TAR EPOXY PAINT' over a thin coat of the same paint as manufactured by M/s. Berger Paints (India). ...	Please clarify the meaning of the top of shell and the top of acid resistant brick at roof level.	Exposed surface on top of shell shall be painted as per spec.
35	Volume : VII-A A	VII-A :101	14.04.0 3	Minimum thickness of wind-shield at top of base raft level shall be 1000 mm. Minimum thickness of wind-shield at top of chimney shall be 400 mm. However, uniform thickness of shell shall be maintained from top of raft to 3.0 m above top of flue duct entry.	The minimum thickness of shell at the top of raft and top of chimney shall be as per design requirements.	Tech spec shall be followed
36	Volume : VII-A A	VII-A :103 & 104	14.04.0 3 B	Insulation c): The insulation shall be tightly secured to the exterior surface of liner...	Insulation can not be fixed on exterior surface in case of brick lining. PI confirm.	Insulation shall be fixed to the interior surface of RCC shell.
37	Volume : VII-A A	VII-A :103 & 104	14.04.0 3 B	Insulation g): No air gap shall be provided between insulation and brick lining. Accordingly, opening/cut out in RCC corbel (for blowing of hot air) and opening in RCC wind shield at top (for venting out of hot air) shall not be provided...	Natural Ventilation shall be provided by provision of opening/cut out in RCC corbel and opening in RCC wind shield at top. PI confirm.	Confirmed

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38	Volume : VII-A	VII-A :104	14.04.03 c)	Chimney Foundation: Annular raft with hollow inside is not permitted. Thickness of raft shall not be less than 0.1 times the diameter of the raft nor 0.4 times the overhang of raft from the face of the shell. The foundation diameter to depth ratio shall be maintained to around 10 and should preferably not exceed 12.	Annular raft with hollow inside shall be provided if required, as reinforcement placing is very difficult at the centre for chimney raft without hollow inside. The requirement of minimum thickness of raft is contradicting in both clauses . Please confirm what is to be followed.	BHEL to follow the specification.
39	Volume : VII-A	VII-A :105	14.04.03 c)	Concrete pouring sequence shall be such that no cold joints occur. Pouring for raft concrete shall not be more than 3 segments.	Concrete pouring shall be done in 6 segments. Please confirm.	Confirmed
40	Volume : VII-B	VII-B : 5	2.02.01	Power House Building :...North Light system shall be provided on roof of power house building at suitable locations so that sufficient natural light can be obtained at TG Hall floor.....	North light shall be avoided in view of seepage in later stage. Natural light shall be provided by side and gable end glazings. Please confirm.	Confirmed
41	Volume : VII-B	VII-B : 9	3.01.02 a) iii)	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.....	Chequered concrete tiles shall be given on pathways only and on other areas 0.6mx0.6m precast concrete tiles shall be provided. Please confirm.	Confirmed

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42	Volume : VII-B	VII-B : 11	3.01.04	Ceiling : 6 mm thick with 1:3 cementsand mortar shall be provided to all exposed ceilings.	Ceiling plaster shall not be provided in view of better surface finish of form work now a days at ceiling. Instead of 6mm plaster, 2mm thk white cement punning on ceiling will done. Please confirm.	Confirmed, 3 mm punning subjected to even surface at ceiling shall be maintained.
43	Volume : VII-B	VII-B : 12	3.01.06 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.	Aluminium glazed doors shall be provided in office areas so to be matched with Aluminium Partition. Please confirm.	Tech spec shall be followed
44	Volume : VII-B	VII-B : 13	3.01.08	The contractor shall furnish detail drawing schedule for landscaping prepared by experts in the respective discipline..	Landscaping shall not be in the scope of BHEL. PI confirm.	Confirmed
45	Volume : VII-B	VII-B : 18	3.01.17	Interior Office Spaces Control Rooms, All A.C.: Acrylic emulsion paint over 3 mm Areas thick white cement putty punning.	2mm thk white cement putty punning shall be provided . Please confirm.	Tech spec shall be followed
46	Volume : VII-B	VII-B : 18	3.01.18 c)	Anodized aluminium grill of heavy duty of thickness not less than 7.5mm and weight not less than 3.58Kgs/Sqm shall be provided for aluminium glazed windows. 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.	Aluminium grills shall be provided at ground floor only & that too in specific builings which are important for security reasons. Please confirm.	Aluminium/MS grills shall be provided at ground floor only in all buildings

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47	Volume : VII-B	VII-B : 23	3.01.24 k)	Soil & Waste pipes shall be taken out of the building separately and shall be connected to separate Inspection chambers.....	Common inspection chamber shall be provided for soil & waste water pipe. Please confirm.	Shall be confirmed during detail engg stage depending on layout considerations.
48	Volume : VII-B	VII-B : 25	4.01.00 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 upto the false 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.	Wall covering shall be of same material either tiles or ACP or paint. There are discrepancies in various clauses (refer clause no. 7.00.00 point 14 b). Customer to Please confirm the wall finish in control room area clearly.	1st Quality approved make and design tiles cladding for walls up to 1.5M from floor level and it shall be painted with plastic emulsion paints over primer over two coats of cement putty. 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 min 0.2mm) of approved make. The colour and design of ACP Cladding or composite paneling is to be submitted for approval of the concerned authority before taking of the work.

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49	Volume : VII B	VII-B : 25	4.01.00 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.	6mm thk toughened glass shall be used for hermetically sealed partition with 12mm air gap. Pl confirm	Shall be confirmed during detail engg stage
50	Volume : VII B	VII-B : 25	4.01.00 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...	Anutone Acoustic wall panels to be avoided due to non-availability and maintenance purpose. Please confirm.	Equivalent quality with the approval of TSGENCO during detailed Engg.

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51	Volume : VII-B	VII-B : 26	6.01.00	Brief Description of Service Building Overall area per floor of the building shall be approximately 2000 Sqm.....	Area per floor specified is too high. We propose total area for service building as 2000 sqm. Please check & clarify.	Service building shall be ground +4 story. Total floor area shall be 4000 sqm. No workshop area at ground shall be provided.
52	Volume : VII-B	VII-B : 26	6.01.00	Brief Description of Service Building Building shall have 2 nos passenger elevator (13 passenger) and one no...	As per scope of supply clause no 2.01.00 Vol III/F Section 4, only 01 no passenger elevator of 1088 kg capacity is envisaged in Service building, which is not in line with Civil spec. PI clarify.	Only 01 no elevator is sufficient
53	Volume : VII-B	VII-B : 28	6.01.00 c)	False Ceiling : For pantry and toilet false ceiling shall be perforated aluminium stove enamel finished panels of size 600x600mm.	As per clause 3.01.04 calcium silicate board/tiles false ceiling is to be provided for unimportant areas. Please clarify.	Confirmed
54	Volume : VII-B	VII-B : 29	6.01.00 d)	Toilet & pantry doors shall be wooden panel door.	Toilet & pantry doors shall be wooden panel door with aluminium frame.	Confirmed
55	Volume : VII-B	VII-B : 30	6.02.00	Brief Description of the Canteen Building : The dining area shall have the arrangement to seat minimum 75 people at one time. In addition there shall be a separate executive dining area fully air-conditioned and with gypsum board false ceiling to accommodate about minimum 25 executives and separate dining area for women.	Please specify the no. of women employees for the dining area.	25 no women employees shall be taken into consideration.

adip
25/11

Manoj Kumar
27/11/14

CIVIL SPECIFICATIONS

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56	Volume : VII-B	VII-B : 38	7.00.00 pt 5.	Plaster Exterior & rough side : 20 mm thick with 1:4 cementsand of interior brick wall mortar in two layers except where special finish provided. Ceiling mortar : 6 mm thick with 1:3 cementsand	External Plaster shall be of 18mm & ceiling plaster shall be avoided. Please confirm.	20 mm thick plaster shall be provided as per spec in two coats (12+8 mm). for Ceiling plaster refer point no 42
57	Volume : VII-B	VII-B : 46	7.00.00 pt 10 d)	Doors of W.C. and shower shall be wooden panel door.	Internal door of Toilet shall be of PVC. Please confirm.	Confirmed
58	Volume : VII-B	VII-B : 53	7.00.00 pt 14 j)	Fire-proof putty in cable penetration on walls of cable spreader rooms shall be provided.	White cement putty is provided in all areas. Please clarify the requirement of fire-proof putty.	Clause says fire crete material for fire sealing at cable entry points in wall/floor.
59	Volume : VII-B	VII-B : 56	7.00.00 pt 20 e)	...Large flat back urinal with porcelain divider....	Type of urinals is required to be mentioned.	Marble stone partition shall be provided.
60	Volume : VII-B	VII-B : 58	7.00.00 pt 21	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.	Under deck insulation of 50mm thk for areas having roof exposed to sun & for remainaing areas 25mm thk insulation will be provided. Please confirm.	Confirmed
61	Volume-II A,	S-2 : 1	3.00.00	Land: 230 acres of land is required...	BHEL clarifies that staff colony is not in BHEL scope. TSGENCO may pl	Confirmed
62	Volume-II A,	S-2 : 2	7.01.00	Mean wind speed 5.8 kmph	The data seems to be incorrect, pl clarify	The data seems to be incorrect, pl clarify
63	Volume-II A,	S-3 : 9	1.00.00	Dismantling of all existing strcutres/buildings...	Dismantling and disposal of debris as per mentioned clause is not BHEL scope. PI confirm	Dismantling and disposal of debris is in TSGENCO scope.

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Signature
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TSGENCO

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64	Volume-II A,	S-3 : 9-10	2.00.00	Construction of residential colony including recreation club, hospital building, shopping complex, STP in residential colony, rain water harvesting structures, potable water treatment plant in colony, bank building including ATM building.	BH+F210:F273EL clarifies that construction of residential colony including its associated building as per mentioned clause is not in BHEL scope of work. TSGENCO may pl clarify.	TSGENCO scope.
65	VII-A	VII-A : 64	10.01.0 2 d)	Item		The allowable overall Settlement of foundation shall not exceed 25mm.
				Other building and Structures foundations.	It is a general practice that the total settlement of foundation for non plant bulgings/structures including misc. equipments is taken as 40mm. Can we consider accordingly instead of 25mm.Please clarify.	
				Miscellaneous Electrical Equipment foundations.		
				Misc. Mechanical Equipment • Boiler Feed Pump •Lube Oil Skid • Other major equipments The allowable overall settlement of foundation shall not exceed 25mm.		
66	VII-A	VII-A : 14	2.02.00	Site grading	Please furnish the extent of grading.	Counter map of the area was furnished on 28.10.14. Extent is to be worked out by M/s BHEL as per confirmed level of FGL as per plot plan.
67	VII-A	VII-A : 52	10.00.0 0 e)	Raw water reservoir will be provided with concrete slab.	Raw water resrvoir shall be earthen.Please conform.	Pl refer point no 19 for resolution.
68	Paving level					Paving level from chimney to Power house shall be 250 mm above FGL. Elevation of u/s of base plate for equipments outside building shall be kept at same level of Paving which will be encased with concrete for a height of 250 mm above paving.

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GENERAL						
1	VOLUME- IIIIESECTION N- IIIVOL.IIIIE/ S-III : 1	DCPL (PCT- K-03- 2013- 14-Vol IIIIE- Sec- 3.doc)	1.00.00	Hydrogen Gas shall be filled in the Generator for cooling purposes. Hydrogen Gas Cylinders shall supply make up to the system. Total minimum quantity of Hydrogen Gas Cylinders to be supplied under this section is specified in Annexure-I of this section.	Please clarify the scope of supply regarding hydrogen generation plant.	Hydrogen generation plant not required.
2	VOLUME : IICSECTION N-VIION LINE TUBE CLEANING SYSTEM	DCPL V.IIC/ S-7 : 1(PCT- K-03- 2013- 14- Vol.II	1.00.00	Two (2) nos. Debris filters in the C.W. inlet lines. Each Debris Filter shall consist of Carbon Steel flanged shell, filter screen, debrisflushing and extraction assembly, drive units for operation of debris flushing assembly, differential pressure measuring system etc.	Requirement of Debris filter arises in Sea Water Application. Since, this is a river water application. Therefore, Customer is requested to review the same.	BHEL to comply the specification requirement.
3	V IIA:10	DCPL (PCA. CD- 005.P CT-K- 03- 2013- 14-VII- A_KT PS.D OC)	1.00.01(O)	Service Building including workshop	Customer to note that workshop is mentioned in the referred clause, however detail of workshop building and mechanical workshop equipment is not available in the tender specification. Hence we understand that workshop building and workshop equipments are not in the scope of bidder. Customer to confirm acceptance.	Work shop and work shop equipment are not in BHEL scope.

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4	Plot plan (Identification number 58)	Weigh Bridge	Customer to note that in the plot plan weigh bridge near fly ash silo area is shown. Accordingly we have not considered weigh bridge near entry gate / store area. Customer to confirm acceptance.	Other than Silo area weigh bridge(capacity 100 tonnes), additional weigh bridge at store area of capacity 100 tonnes is required by TSGENCO. Further no weigh bridge is required at Entry gates. BHEL confirmed to provide the same.

PSSR:

Sl. No.	Spec Vol/Section	Sheet	Clause No	Spec. Description	Deviation/Clarification	Resolution
1	Volume IIA	Page No. V.IIA/S-3:9	1.00.00	Dismantling of all existing structures/buildings in colony (excluding the temple) needs to be done by the EPC contractor, and the disposal of the debris is to be made at a distance of about 5 KM from the plant site, location of which will be identified by the APGENCO site engineer	Clarification: During site visit on 26.09.2014, it was informed that dismantling of existing structures is in the scope of the customer.	TSGENCO Scope
2	Volume IIA	Page No. V.IIA/S-3:9	2.00.00	Construction of residential colony including recreation club, hospital building, indoor stadium, shopping complex, STP in residential colony, rain water harvesting structure, potable water treatment plant in colony, Bank building including ATM building	Deviation: Construction of residential colony including recreation club, hospital building, indoor stadium, shopping complex, STP in residential colony, rain water harvesting structure, potable water treatment plant in colony, Bank building including ATM building	TSGENCO Scope

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Annexure-B

Changes sought in Civil Technical Specifications for 5X800 MW Yadadri TPS

SI No.	Spec Volume./ Section	Page	Clause no.	Discription as per Kothagudem	"Shall be read as" for Yadadri	Remarks
1	VII:A	32	06.04.00	Soling	Soling shall be provided if CBR of sub grade is less than 30	As per IRC 37:2001 clause no 4.2.1.1" The sub-base material should have minimum CBR of 20 percent for cumulative traffic upto 2 msa and 30 percent for traffic exceeding 2mpa. " Therefore GSB shall be provided wherever CBR less than 30 . Since Yadadri has rocky strata, site may encounter with CBR of sub grade more than 30 at numerous places.
2	VII:A	39	8.01.00 B) i) a	0.075KN/m2	0.75KN/m2	As per Table 2 of IS:875 (Part 2)
3	VII:A	43	8.01.00 D)	Terrain Category-4.	Terrain Category-2.	As per letter CE/C/Thermal/KTPSD/EI/F.YTPS-M/sBHEL/D.N247/2015-16 Dtd 29.08.2105
4	VII:A	53	10.00.00 e)	LDEP of approved make of 500 micron lining	1mm HDEP Lining.50 mm thick precast concrete tiles 300 mm x 300 mm size are to be laid over HDPE liner for protection over sides and bottom.No covering with RC slab is envisaged.	
5	VII:A	67	10.01.04-vii)	75mm, 25mm	50mm, 50mm	
6	VII:A	68	10.02.00	Suspended floors/slab/walkways/canopy slab etc.	Suspended floors/slab/walkways/canopy slab etc except slab over metal deck sheet.	
7	VII:A	70	10.02.00	Vaccum Dewatered Flooring (VDF)	RCC Flooring	Wherever floor finish is envisaged, RCC flooring without vacuum dewatering system shall be provided. However, in pavings VDF flooring shall be laid since no floor finish is to be provided.
8	VII:A	70	10.02.00	250mm thick graded stone soling.	230mm thick graded stoned soling	Refer Cl. No15.34.00 of VII:A
9	VII:A	80	12.02.01-v)	v) Structures requiring grade of concrete of M25 and above excluding water-retaining structures.	Deleted	
10	VII:A	82	12.02.02	Strom water drain shall not be provided with bituminious paint.	Strom water drain,trenches,duct banks, pipe encasings,minor pedestals etc. shall not be provided with bituminious paint.	
11	VII:A	128	15.06.00	minimum 1m wide reinforced cement concrete paving	750mm wide plinth protection.	Refer Cl. No 7.00.00-9 h) of VII-B Pg 43
12	VII:A	129	15.16.00	95%	75%	As per clause 10.01.04.
13	VII:A	131	15.34.00	VDF concrete	Reinforced concrete and VDF concrete respectively.	Wherever floor finish is envisaged, RCC flooring without vacuum dewatering system shall be provided. However, in pavings VDF flooring shall be laid since no floor finish is to be provided.
14	VII:B	16	03.01.15	1000mm,Soling	750mm, soling (in case CBR of sub grade is less than 30)	As per IRC 37:2001 clause no 4.2.1.1" The sub-base material should have minimum CBR of 20 percent for cumulative traffic upto 2 msa and 30 percent for traffic exceeding 2mpa. " Therefore GSB shall be provided wherever CBR less than 30 . Since Yadadri has rocky strata, site may encounter with CBR of sub grade more than 30 at numerous places.
15	VII:B	39	7.00.00- 7	Cladding of Power House: 0.50mm/0.6mm TCT of SMP coated zincalume steel 150 gsm.	Cladding of Power House:The inner sheeting shall be 0.6mm TCT of SMP coated zincalume steel 180 gsm.	

CIVIL SPECIFICATIONS

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16	VII:B	39	7.00.00- 7	550 Mpa	240 MPa.	
17	VII:B	43	7.00.00-9 h)	R.C. paving	PCC Paving	As per clause3.01.15 of VII B- Pg16
18	VII:C/S-3	13	3.7.1	Where excavated material is mostly rock, the boulders shall be broken into pieces not longer than 150 mm size, mixed with properly graded fine material consisting of murum or earth to fill up the voids and the mixtures used for filling.	Where excavated material is mostly rock, the boulders shall be broken into pieces not longer than 150 mm size, mixed with properly graded fine material consisting of moorum, stone dust or earth to fill up the voids and the mixtures used for filling. Rock pieces having size less than 150mm and interstices filled with soil may be used for backfilling around foundations, plinths etc. and shall be compacted to minimum of 85% of original stack of material after filling of interstices.	This is as per elaborated details for compaction provided in NTPC specification for 4X660MW Barethi (Ammendment No. 114) (Copy attached)

YADRADRI THERMAL POWER STATION**Points discussed with M/s BHEL on 05-05-2015**

1. Coal analysis is to be considered same as 1x800MW Kothagudem TPS.
2. Water Analysis is to be submitted by TSGENCO by 12-05-2015. Mean while, TSGENCO will submit VTPS water analysis for preliminary engineering.
3. Common fuel oil unloading system
HDO --- 4000 m³ x 2 Nos
LDO --- 1000 m³ x 2 Nos
4. Wind Rose diagram to be submitted by TSGENCO by 12/05/2015.
5. RH, dew point, Rainfall wet bulb temperature to be submitted by 06-05-2015.
6. HFL to be considered as 70meters & FGL will not be affected by this data.
7. Seismic code & wind speed as per IS standard.
8. Contour data is not available with TSGENCO & is to be accessed by BHEL.
9. Scope will be as per Kothagudem TPS. Additional workshop building will be added to BHEL scope. Area drainage study is not required. Boundary wall and ash dyke is in TSGENCO scope. 20 nos. watch tower will be in BHEL scope and location will be provided by TSGENCO. Patrol road is not in BHEL scope.
10. Chimney will be as follows:- 2Nos twin flue chimney + 1No. Single flue chimney.
11. BHEL insisted for station transformer configuration. However, TSGENCO has asked BHEL to provide GCB in line with Kothagudem TPS.
12. There will be 2No's control room. 1 common for 2 Units & other for 3 units. Electrical & EER will be along with respective units.
13. Water table will be provided by TSGENCO by 12-05-2015.
14. 1 No. NDCT will be offered for each unit. 3 on one side & 2 on one side. Similarly for stream filtration & chlorination plant.
15. Conventional DM, CPU & PTP are common for all 5 Units.
16. DM Storage tank will be 2500T per unit.
17. Fire water and clarified water tank will be common for all 5 units including switchyard.
18. No embankment/ protection for natural canal is envisaged in BHEL scope. An approach road along with pipe line crossing over natural canal to raw water reservoir is in BHEL scope. Existing under construction bridge may be utilized.
19. Elevators 2 Nos. in Power House near control room. Balance as per Kothagudem.
20. No. of Air Compressors.
For 2 Units (common): 2W+2S each of 55 Nm³/min
For 3 Units (common): 3W+3S each of 55 Nm³/min
21. Ash silo to be shifted across road towards Ash dyke area.
22. Admin building: 4500 sq.mt.
23. Separate service building: 6000 sq.mt.
24. Canteen: 2 Nos 1000 sq.mt.
25. Storage shed: 15mx30m ---18No's.
One storage shed office building (15x30M)(Ground floor)+I st floor(AC storage for light electronic material).
26. Workshop building size: To be proposed by BHEL.

27. Fire station Building along with 7 No's Fire tenders
28. No. of locomotives: 6No's 800 HP Diesel electric BHEL make.
29. Parking shed for above along with 2 No's repair sheds.
30. 1 No. Hydrogen Generation plant is to be provided.
31. I&C labs twice of Kothagudem unit capacity.
32. Chemical lab equipment list will be optimized & submitted by TSGENCO on 11-05-2015.
33. 1 No. Operator cum training simulator will be supplied for 5x800MW project.
34. ETP --- Common for all 5 units.
35. STP--- similar to Kothagudem 800 MW. Discharge will be utilised for horticulture within plant boundary.
36. BHEL proposed to supply mandatory spares twice the quantity of kothagudem 800MW. TSGENCO to revert by 09-05-2015.
37. Raw water reservoir capacity will be 3 days.

Ash handling plant

1. AHP System shall be designed for 50% Indian +50% imported coal.
2. Ash distribution data shall be BA-25%, FA-90%, Eco-Ash-5%, Duct Hopper ash-5%.
3. Ash evacuation time shall be on par with KTPS(1x800MW)
4. Number of Silos shall be 4x2000T.
5. All other design aspects shall be proposed by BHEL on par with(1x800MW).
6. There shall be two ash handling plants i.e, (2x800MW)&(3x800MW).
7. Static rise for sizing of ash slurry disposal pumps shall be considered as 20M.
8. Ash Water Recovery water system is in scope of BHEL.

Coal handling plant

1. Tracker hopper	: 2 Nos.(Each 390M length & hopper capacity 7000 T)
2. Wagon Tippler	: 4 Nos. (Each hopper capacity 300T)
3. Crusher house	: 2 Nos.
4. Stacker	: 3 Nos.
5. Reclaimer	: 3 Nos.
6. In-Line magnetic separators	: 8 Nos.
7. Metal detectors	: 8 Nos.
8. Coal sampling unit	: 4 Nos.
9. Bull Dozers (BD-355,800 HP)	: 5 Nos.
10. Elevators	: 4 Nos.
11. Emergency Reclaimer Hopper	: 2 Nos. (Capacity to be informed by BHEL, conveying capacity will be 1000 TPH)
12. Locomotive	: 6 Nos. 800 HP Diesel Electric

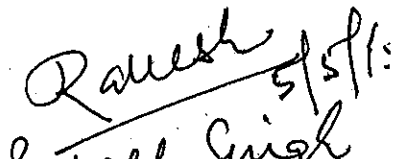
YADADRI T.P.S (5X800) - (NALGOND)

TECHNICAL SPECIFICATIONS

Annexure-16

1. Evacuation level = 400KV
 Outgoing lines = 8 Nos (Quad mode)
 (5+3 Nos)
 4 No D/C Lines
 Chouttapal, Dindi, Jangoan, Maheshwarani
 (Hyderabad)
2. Startup Power = 400KV lines.
3. System Rating = 3150 A, 50 kA / 1 sec
 Other Ratings as per Koltragnadem.
4. Line lengths approx - less than 200km.
5. Communication System = Fibre optic.
6. Startup & standby Transformers = 3 Nos.
 (2+1)
7. Provision for Bus Reactor Bay, one on both sides of Bus Section.
8. Bus Section - One for each bay.
 2 GT on one side & 3 on another


 V. K. AGRA
 987169 7537


 Rakesh Singh
 AGM/TBGM

CIVIL SPECIFICATIONS

5X800 MW YADADRI TPS					
The following Civil Works are in TSGENCO Scope. The Exclusions raised by M/s BHEL and Resolutions after the meeting are as follows:					
Sl. No.	Description	BHEL PROPOSAL		Final Resolution (as per Meeting dtd 04.10.17)	
		Terminal points	Exclusion	Scope of Work	Terminal Points
1	Roads ,Drains and Culverts	Electrical TP : Outgoing Power Terminal of LDB to Street Lighting Panels (SLPs).	Electrical Exclusion : Complete Lighting of Roads including Street Lighting Panels(SLPs),Cable, Cabling items etc.	Complete Lighting of Roads including Street Lighting Panels(SLPs),Cable, Cabling items etc in BHEL SCOPE.	
2	Make up Water Reservoir (Raw water Reservoir)	Mechanical TP : TP shall be 2 M from Raw water Reservoir outlet (2 nos. 1600 NB pipe header) towards Raw water Sump. Electrical TP : Outgoing Power Terminal of LDB to respective Lighting Panels (LPs).	Mechanical Exclusion : Raw water Reservoir in customer's scope.Customer shall terminate 2 nos of 1600 NB Pipe Header from Raw water Reservoir near Raw water Sump. Electrical Exclusion : Complete Lighting of Reservoir including LP, Cable, Cabling items etc.	Complete Raw water Reservoir (on as is where is basis) in customer's scope considering following: Mechanical : Customer shall terminate 2 nos of 1600 NB Pipe Header from Raw water Reservoir near Raw water Sump is in TSGENCO SCOPE Electrical : Complete Lighting of Reservoir including LP, Cable, Cabling items etc. is in BHEL SCOPE	Mechanical TP : TP shall be 2 M from Raw water Reservoir outlet (2 nos. 1600 NB pipe header) towards Raw water Sump. Electrical TP : Incoming Power Terminal of LDB to respective Lighting Panels (LPs).
3	Administration Building	Electrical TP : Outgoing feeder terminal of HT switchgear	Mechanical Exclusion : Electrical hoist for elevator machine room, Elevators, Air conditioning and ventilation. Electrical Exclusion : Complete Electric of Bldg. like LT Service Transformer,LT switchgear, Lighting system,Cable, Cabling items & BG & AG Earthing materials, Fire Sealing etc.	Mechanical : 1.Electrical hoist for elevator machine room, Elevators TSGENCO SCOPE 2. Centralised Air conditioning and ventilation is in BHEL SCOPE. Electrical : Complete Electric of Bldg. like Lighting system,Cable, Cabling items & Below Ground & Above Ground Earthing materials, Fire Sealing etc. is in TSGENCO SCOPE	Electrical TP : Upto and including LT switchgear in BHEL scope
4	Service Building	Electrical TP : Outgoing feeder terminal of HT switchgear	Mechanical Exclusion : Electrical hoist for elevator machine room, Elevators, Air conditioning and ventilation Electrical Exclusion : Complete Electric of Bldg. like LT Service Transformer,LT switchgear, Lighting system,Cable, Cabling items & BG & AG Earthing materials, Fire Sealing etc.	Mechanical : 1.Electrical hoist for elevator machine room, Elevators are in TSGENCO SCOPE 2. Centralised Air conditioning and ventilation is in BHEL SCOPE. Electrical : Complete Electric of Bldg. like , Lighting system,Cable, Cabling items & Below Ground & Above Ground Earthing materials, Fire Sealing etc. is in TSGENCO SCOPE	Electrical TP : Upto and including LT switchgear in BHEL scope
5	Canteen Building	Electrical TP :For Canteen Near Power House, Only 2 nos. Un-Cabled LT feeders from Nearby switchgear power terminal.	Mechanical Exclusion : Air conditioning and ventilation. Electrical Exclusion : Complete Electric of Bldg. like ,LT switchgear, Lighting system,Cable, Cabling items & Below Ground & Above Ground Earthing materials, Fire Sealing etc. (Feeding of MCC of the building shall be nearby Admin & Serv. Bld. PMCC).	Mechanical : Air conditioning and ventilation is in TSGENCO SCOPE. Electrical : Complete Electric of Bldg. like Lighting system,Cable, Cabling items & Below Ground & Above Ground Earthing materials, Fire Sealing etc. (Feeding of MCC of the building shall be nearby Admin & Serv. Bld. PMCC). is in TSGENCO SCOPE.	Electrical TP : Upto and including LT switchgear in BHEL scope

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CIVIL SPECIFICATIONS

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6	Stores building with office building	Electrical TP : Only 2 nos. Un-Cabled LT feeders from Nearby switchgear power terminal.	Mechanical Exclusion : Cranes in stores, Ventilation in stores, air conditioning and ventilation in office. Electrical Exclusion : Complete Electric of Bldg. like LT switchgear, Lighting system, Cable, Cabling items & BG & AG Earthing materials, Fire Sealing etc.	Mechanical : Cranes in stores in BHEL SCOPE Ventilation and Air Conditioning is in TSGENCO SCOPE Electrical : Complete Electric of Bldg. like Lighting system, Cable, Cabling items & below ground & AG Earthing materials, Fire Sealing etc. is in TSGENCO SCOPE.	Electrical TP : Upto and including LT switchgear in BHEL scope
7	Security Building	Electrical TP : Only 2 nos. Un-Cabled LT feeders from Nearby switchgear power terminal.	Mechanical Exclusion : Air conditioning and ventilation. Electrical Exclusion : Complete Electric of Bldg. like LT switchgear, Lighting system, Cable, Cabling items & BG & AG Earthing materials, Fire Sealing etc.	Mechanical : Air conditioning and ventilation is in TSGENCO SCOPE. Electrical : Complete Electric of Bldg. like Lighting system, Cable, Cabling items & below ground & AG Earthing materials, Fire Sealing etc. is in TSGENCO SCOPE.	Electrical TP : Upto and including LT switchgear in BHEL scope
8	Chemical lab building	Electrical TP : Only 2 nos. Un-Cabled LT feeders from Nearby switchgear power terminal.	Mechanical Exclusion : Air conditioning and ventilation Electrical Exclusion : Complete Electric of Bldg. like LT switchgear, Lighting system, Cable, Cabling items & BG & AG Earthing materials.	Mechanical : Air conditioning and ventilation is in TSGENCO SCOPE. Electrical : Complete Electric of Bldg. like Lighting system, Cable, Cabling items & below ground & AG Earthing materials. is in TSGENCO SCOPE.	Electrical TP : Upto and including LT switchgear in BHEL scope
9	Parking Sheds	Electrical TP : Outgoing Power Terminal of LDB to respective Lighting Panels (LPs)	Electrical Exclusion : complete Lighting including LPs, Cable, Cabling items & Below Ground & Above Ground Earthing materials.	Electrical : complete Lighting including Cable, Cabling items & Below Ground & Above Ground Earthing materials in TSGENCO SCOPE.	Electrical TP : Incoming Power Terminal of LDB to respective Lighting Panels (LPs), LP also in BHEL SCOPE
10	Rainwater harvesting pits			TSGENCO SCOPE	
11	Raw Coal Storage Yard			Civil : Following are in TSGENCO scope 1. Supply, fabrication and erection of structural shed for uncrushed coal stock yard 2. Foundation of uncrushed coal stock yard shed. 3. Paving of raw coal stock pile shed. 4. Drains around uncrushed coal stock pile shed. Electrical : Complete Lighting including Cable, Cabling items & Below Ground & Above Ground Earthing materials in TSGENCO SCOPE.	Electrical TP : Incoming Power Terminal of LDB to respective Lighting Panels (LPs), LP also in BHEL SCOPE

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CIVIL SPECIFICATIONS

Annexure-16

12	Dozer shed			Civil : Following are in TSGENCO Scope 1. Supply, fabrication and erection of Dozer shed 2. Foundation of Dozer shed. 3. Grade slab and flooring of dozer shed. 4. Drains around dozer shed. Electrical : Complete lighting including Cable, Cabling items & Below Ground & Above Ground Earthing materials in TSGENCO SCOPE.	Electrical TP : Incoming Power Terminal of LDB to respective Lighting Panels (LPs). LP also in BHEL SCOPE
13	Watch towers – 20 nos	Electrical TP : Outgoing Power Terminal of LDB to respective Lighting Panels (LPs).	Electrical Exclusion : Complete Lighting of watchtowers including LP, Cable, Cabling items etc	Electrical : Complete lighting including Cable, Cabling items & Below Ground & Above Ground Earthing materials are in TSGENCO SCOPE.	Electrical TP : Incoming Power Terminal of LDB to respective Lighting Panels (LPs). LP also in BHEL SCOPE
14	Simulator buildings	In view of KTPS wherein building is beyond plant boundary and power supply is extended from customer source, all Complete Mechanical and Electric of Bldg. viz. Air conditioning and ventilation, LT switchgear, Lighting system, Cable, Cabling items & Below Ground & Above Ground Earthing materials, PA system & Fire Sealing is excluded from BHEL.		In TSGENCO SCOPE	
15	Main gate building	Electrical TP : Outgoing Power Terminal of LDB to respective Lighting Panels (LPs).	Mechanical Exclusion : Air conditioning and ventilation. Electrical Exclusion : Complete Electric of Bldg. like LT switchgear, Lighting system, Cable, Cabling items & Below Ground & Above Ground Earthing materials.	Mechanical : Air conditioning & ventilation is in TSGENCO SCOPE. Electrical : Complete Electric of Bldg. like Lighting system, Cable, Cabling items & Below Ground & Above Ground Earthing materials is in TSGENCO SCOPE.	Electrical TP : Incoming Power Terminal of LDB to respective Lighting Panels (LPs). LP also in BHEL SCOPE
16	Work shop building	Electrical TP : Only 2 nos. Un-Cabled LT feeders from Nearby switchgear power terminal.	Mechanical Exclusion : Single Girder crane, Air conditioning and ventilation, Workshop equipments, etc. Electrical Exclusion : Complete Electric of Bldg. like LT switchgear, Lighting system, Cable, Cabling items & Below Ground & Above Ground Earthing materials, Fire Sealing etc.	Mechanical : Single Girder crane is in BHEL SCOPE Air conditioning & ventilation is in TSGENCO SCOPE Workshop equipments, etc. is in BHEL SCOPE Electrical : Complete Electric of Bldg. like Lighting system, Cable, Cabling items & Below Ground & Above Ground Earthing materials, Fire Sealing etc. is in TSGENCO SCOPE.	Electrical TP : Up to and including LT switchgear in BHEL scope
17	Fire station building	Electrical TP : Outgoing Power Terminal of LDB to respective Lighting Panels (LPs). 02 Nos. Uncabled feeder from nearby BHEL scope switchgear.	Mechanical Exclusion : Air conditioning and ventilation, Fire safety equipment (4 no. water tenders, 2 nos foam tender, 1 nos. DCP tender) Electrical Exclusion : Complete Electric of Bldg. like LT ACDB, Lighting system, Cable, Cabling items & BG & AG Earthing materials, Fire sealing etc.	Mechanical : Air conditioning & ventilation is in TSGENCO SCOPE Fire safety equipments (4 no. water tenders, 2 Nos. foam tenders, 1 nos. DCP tender) is in BHEL SCOPE. Electrical : Complete Electric of Fire Station Bldg. like Lighting system, Cable, Cabling items & Below Ground & Above Ground Earthing materials, Fire sealing etc. is in TSGENCO SCOPE.	Electrical TP : Up to and including LT ACDB in BHEL scope

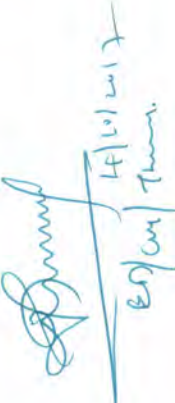
18	Hydrogen generation plant building	Electrical TP : Only 2 Nos. Un-Cabled LT feeders from Nearby switchgear power terminal.	Mechanical Exclusion : H ₂ generation electro mechanical system has been excluded. Electrical Exclusion : Complete Electric of Bldg. like LT switchgear, Lighting system, Cable, Cabling items & Below Ground & Above Ground Earthing materials, Fire Sealing etc.	Complete SCOPE of Hydrogen Generation Plant Building is in BHEL SCOPE including Civil Works	
19	Hydrogen Storage shed			Electrical : Complete Electric of Bldg. like Lighting system, Cable, Cabling items & Below Ground & Above Ground Earthing materials, Fire sealing etc. is in TSGENCO SCOPE.	Electrical TP : Upto and including LT ACDB in BHEL scope
20	Land scaping		Electrical Exclusion : Lighting if any	Electrical : Lighting if any is in TSGENCO SCOPE	

1. ALL CIVIL, MECHANICAL & ELECTRICAL ENGINEERING AND DRAWINGS IS IN BHEL SCOPE

2. The fire fighting system and equipment for the above buildings in BHEL scope

3. TSGENCO to discharge the sewage from the above mentioned individual buildings to the nearest running sewage network either by pumping or by gravity as per the requirement

4. Potable water distribution within the respective aforesaid buildings shall be in TSGENCO scope


 (SACHIN JAIN)
 M/S BHEL
 04/10/2017

04/10/17
 SPP-2
 14

04/10/17
 14

Minutes of Meeting held on 15.09.17, 16.09.17, 18.09.17, 21.09.17, 22.09.17 and 03.10.17 at Vidyut Soudha, Hyderabad for 5x800 MW Yadadri TPS

MEMBERS PRESENT: As per List enclosed.

Further to the meeting held between TSGENCO and BHEL on 26.08.17 and 01.09.17, it was agreed between CMD/TSGENCO and Director (Power) /BHEL to have a follow up meeting from 15.09.17 to settle the various technical and scope issues before the various commercial issues are finalised.

The following points were discussed and agreed:

1. **Coal Specification:**

TSGENCO agreed that Indian coal of Grade 13 (SCCL mines) shall be considered as worst coal, which would be used for design of AHP, CHP and FGD. The broad parameters of Grade-13 coal are GCV 3400 kcal/kg, Ash 46%. The ultimate and proximate coal analysis shall be furnished by TSGENCO in due course of time.

2. **Coal Handling Plant** : Agreements on various issues are as listed below:

- a) **Capacity of CHP:** CHP to be designed for worst coal (i.e G-13 grade coal, 100% BMCR = 537 TPH/unit) with 2 CHPs of 2750 TPH design capacity (i.e. 2500 TPH rated capacity) conveying system for each stage (total of 5500 TPH for five units) with necessary interchangeability between Stage 1 and stage 2.
- b) **Crusher House:** It was agreed that in each crusher house 4 nos Ring granulator crusher (2 W + 2S) each of 2000 TPH rated/2000TPH design capacity (considering 70% duty requirement) shall be provided. Similarly, 4 nos (2 W + 2S) vibrating screen each of 2000 TPH rated/2000TPH design capacity (considering 70% duty requirement) shall be provided in each crusher house.
- c) **Belt Speed:** M/s TSGENCO accepted maximum belt speed of 3.4 m/s. With this 2750TPH design capacity of each CHP the conveyor belt width shall be 1800mm.
- d) **Coal Stockpiles:** For complete CHP (all five units) there shall be 6 nos. Stockpiles, with total storage capacity of 7.54 Lakh MT of crushed coal.
- e) **Marshalling Yard and coal unloading philosophy:** It was discussed and agreed that presently for coal unloading in marshalling yard, BHEL is considering 4 nos. wagon tippler and 2 nos. track Hoppers (with single track). Tsgenco accepted the philosophy TSGENCO shall further discuss with RITES and finalise the DPR and marshalling yard layout with railways. However, if there are any changes in CHP due to the final DPR of marshalling yard then it would be discussed subsequently and would be with price implication.

BHEL agreed to provide 6 no. diesel electric locomotives of 1400 HP capacity.



- f) Stacker cum reclaimer Machines: BHEL requested that single combined stacker cum reclaimer machines may be accepted in Yadadri in line with NTPC Patratu. TSGENCO clarified that due to coal blending provision in Yadadri, 3 stacker (designed capacity 2750 TPH) and 3 reclaimer machines (peak reclaim capacity 3125 TPH) are required to be supplied. While agreeing on the above, BHEL also pointed out that the above change is over & above than Patratu.
- g) It was agreed that the total coal conveyer length for both the stream together is 23 KM in Yadadri as compared to 8.5 KM in case of 3 units for Patratu. Additional implication from this scope would be mutually settled at the time of proposed commercial settlement meeting.
- h) The commercial implications arising out of CHP of YTPS wrt Patratu shall be worked out separately for further discussion and mutual agreement.

3. Steam Parameters:

- a) BHEL made a detailed technical presentation on the suitability of adopting higher cycle steam parameters for 800 MW boilers. BHEL informed that the Patratu boiler is designed on 100% domestic coal while for Yadadri it is a fuel flexible boiler, designed for an operating range varying from 100% domestic to 100% imported coal with design point as 50:50 blended coal.

BHEL explained that range of coal adopted for Yadadri is very large (ranging from GCV of 3000 - 5750 kCal/kg) while the range of coal variation for Patratu is limited to 1000 kCal/Kg (2900 – 3900 kCal/Kg). BHEL explained in details the reasons for not recommending a boiler design with higher temperature cycle in a fuel flexible boiler. This constraint is mainly due to higher waterwall temperature resulting in higher thickness for thick walled pressure part components (separators, storage tank, SH outlet header etc) than the permissible limit for once through supercritical boilers, slagging propensity, BTL potential, use of newer material etc. Therefore, the fuel flexible design over a wide range of coal, is technically coming out to be impracticable with higher steam parameters of 600/600. Adoption of higher steam parameters would require boiler design on very limited coal range.

Due to expected variation in the coal quality during the designed life of the plant for a large plant size of 5x800 MW Yadadri project, it would be prudent to consider a wider range of coal for designing of the Boiler. Keeping in view the above, BHEL recommended to adopt standard steam temperatures of 568/596 deg C. TSGENCO was technically agreeable to BHEL recommendation.



4. Ash Handling Plant :

The design of Ash Handling system shall be stage wise based on the following philosophy:-

- a) Total Ash generated to be considered based on 46% ash, GCV 3400, Coal grade as G13
BA- 20%, ESP Ash – 85%, Eco, APH, Duct , SCR inlet / Outlet Ash – each 5%

b) System Description

System	Up to	Type	Evacuation time	System Description
Bottom + Eco Ash	Slurry sump	Jet pump System - Wet	8 Hours Ash in 2.5 Hrs	3 Streams / Unit
APH + Duct	Slurry Sump	Jet pump System	4 hrs Ash in 50 minutes	2 lines / Unit
SCR Ash	Slurry Sump	Jet Pump System	4 hrs Ash in 50 minutes	2 lines / Unit
The above ash will be evacuated sequentially				
Fly Ash -1 st stage	FAE Tower	Vacuum System	8 hours Ash in 6 Hours	6 Streams / unit
Fly Ash – 2 nd stage	Silo	Pressure System	8 Hours Ash in 6 Hours	3 Streams / unit
BA+ ECO+ APH+ DUCT+ FA+SCR from slurry sump	Ash dyke	Wet system	As and when received	14 Lines
Number of lines from Slurry sump to ash dyke(Lean slurry)			14 Lines (including standby)	Each 10 km including garlanding
Parameters to be considered for Slurry pump design			7.1 km distance and 20 m static height	

Number of Ash Silos	1 no per unit Location: shifted by 600 Mtr towards the plant from the earlier location.	12 hour capacity 1 per unit
HCSD System (additional cost)	Total 8 Pumps (5 working and 3 standby)	
HCSD pipe line (addl cost)	8 lines of each 2.5 km	For estimation purpose

c) Standby philosophy

Vacuum Pumps	50%
TA Compressors & Pressure conveying Lines	1 per max three compressors. Total transport / conveying compressors are 15W + 5S.
2 nd Stage Ash conveying lines	1 line for every 3 lines (Min 1 line)
Wet Slurry Lines (combined ash)	1 line for every 3 lines (Min 1 line)
HCSD pumps	Total 8 pumps including stand-by

5. ID Fan& Chimney:

BHEL explained that a single ID Fan is now proposed to be used for catering to the requirement of boiler, FGD and SCR. BHEL also explained that with introduction of FGD (GGH based), the inside of Chimney MS liner would be coated with corrosion resistant paint as per EIL specifications. BHEL handed over a copy of the EIL specifications and TSGENCO agreed to the recommendation of BHEL.

6. Air preheater:

It was agreed that BHEL shall size the APH to accommodate enamelled cold end elements to be incorporated at a later stage, if required, at additional cost. The cold end baskets would presently be of corten steel.

7. Water Systems:

TSGENCO informed that water system shall be stage wise i.e., Stage – I (Two units) and Stage – II (Three units) for following packages as enumerated below.

Sl. no.	Package	Stage – I	Stage - II	Remarks
1	Raw water system (pumps and pump house)	2 W + 1 S	3W + 1 S	Pumps shall be located in common pump house with pumps located stage wise. Pump capacities shall be unit-wise with interconnection of discharge header for interchangeability between stages.
2	Clarified water system (pumps, pump house, Storage water tank)	APH - 2 W + 1 S Service - 2 W + 1 S CW makeup - 2 W + 1 S DM Feed pump - 2 W + 1 S	APH - 3W + 1 S Service - 3 W + 1 S CW makeup - 3 W + 1 S DM Feed pump - 3 W + 1 S	Pumps shall be located in common pump house with pumps located stage wise. Storage water tank shall be stage wise. Pump capacities shall be unit-wise with interconnection of discharge header for interchangeability between stages.
3	Filter water tank	Potable water pumps - 2 W + 1 S	Potable water pumps - 3 W + 1 S	Pumps shall be located in common pump house with pumps located stage wise. Pump capacities shall be unit-wise with interconnection of discharge header for interchangeability between stages.
4	DM Plant	2W + 1 S stream	3W + 1 S stream	Total DM water requirement of the station (5x800 MW) shall be catered through 1 nos. working and 1 no. standby DM clarifier. Capacity of each stream shall be 65 m3/hr



Sl. no.	Package	Stage – I	Stage - II	Remarks
5	PT Plant	2 nos. clarifier	3 nos. clarifier	Total clarified water requirement of the station (5x800 MW) shall be catered through 4 nos. working clarifier. 1 no. clarifier shall be common standby for the station.

While pumps have to be provided stagewise as indicated above, the pumps of same function for both the stages may be housed together in the same building.

However, following system i.e., Hydrogen plant, ETP, STP and CPU regeneration system (two regeneration system with interconnection) shall be common for all units.

8. Condenser:

M/S TSGENCO confirmed that Water cooled condenser shall be adopted for YTPS.

9. Levelling and grading:

BHEL informed that in comparison to Patratu (equivalent to 5 units), there is significant cost implications involved in levelling and grading work at YTPS due to site conditions which will be duly accounted during commercial settlement. Further, levelling and grading for roads and drains area will also be done by BHEL. However, Civil works for roads and drains shall be in TSGENCO scope as per agreement civil exclusions for non plant building etc.

10. Civil Points:

- a) Seismic Factor: With reference to the specific query of TSGENCO about the seismic factor applicable of YTPS vis-à-vis Patratu, BHEL clarified that while the seismic factor considered in Patratu is higher than YTPS, the design of foundations and structures for all high rise buildings (Chimney, NDCT, Boiler, Transfer points, pipe rack, CHP/AHP, ESP, duct support etc) is governed by wind velocity rather than seismic factor. BHEL pointed out that Seismic is governing factor for power house building and service building bracings & foundations. TG is governed by short circuit and blade failure loads.

BHEL further clarified that the wind velocity considered for YTPS is 44 m/s as compared to wind velocity of 39 m/s for Patratu resulting in 30%

increase in wind pressure. As such there is an overall increase in the civil and structural BOQ in Yadadri over and above Patratu.

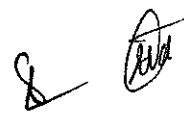
- b) BHEL stated that the coal bunker storage for 10 Hrs may be considered for Yadadri in line with NTPC Patratu as against present storage of 12 hours. This has bearing on size of bunker, mill bay structure and foundation and CHP structure and foundation. However, TSGENCO insisted to consider storage of 12 hours only.
- c) TSGENCO stated to maintain same capacity of raw water reservoir i.e. 10.8 Lakh cum only irrespective of additional requirement of water for ash slurry.
- d) STP of 1 mld, as planned earlier, shall be considered in BHEL scope. Treatment of residential township not to be included.

11. Implementation of MoEF Norms:

- a) BHEL agreed to include the scope of additional ESP field, FGD and SCR (including mandatory spares for FGD and SCR) for limiting the PM, SO_x and NO_x as per MoEF norms as specified in the Environment Clearance.
- b) FGD should be designed for worst level for inlet SO₂ concentration with G-13 grade coal having GCV of 3400 and Ash of 46% and considering sulphur content of 0.7.
- c) TSGENCO stated that the 5 days of limestone and 5 days of gypsum storage is required to be planned. BHEL confirmed meeting the requirement subject to availability of the space
- d) COC: BHEL informed that as the new water analysis report is being provided, the requirement of meeting new COC of 6.5 (from COC of 5.0 in the initial offer) and Zero Liquid Discharged would be included. As the new COC requirement is additional to Patratu, it would be mutually settled at additional cost.

12. Other points discussed during the meeting:

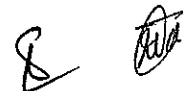
- a) BHEL agreed to include 2 No. Bus Reactors in their scope in line with NTPC Patratu.
- b) BHEL agreed to include rooftop solar PV plant upto a maximum capacity of 2.5 MW subject to availability of the roof top space.
- c) TSGENCO clarified that they require separate transformers to cater to the requirement of FGDs.
- d) It was agreed to provide Electrical, C&I & Chemical Lab stage wise. The list of equipment in each of these labs shall be as per Kothagudem.
- e) Four AAQMS are required for the entire power plant.



- f) In line with NTPC Patratu, TSGENCO requested BHEL to provide 3-d modelling.
- g) As required by TSGENCO, BHEL agreed to provide 100 T fly ash weigh bridge at each silo
- h) Price implication on account of GIS vis-à-vis AIS (if any) shall be duly considered during commercial settlement.
- i) VIS for BFP and Crushers shall be included in BHEL scope

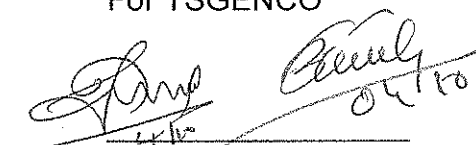
13. Additional Points with Cost Implications:

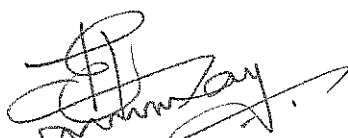
- a) Uncrushed Raw Coal Storage: TSGENCO requested BHEL to include total two nos. raw coal storage pile(1 no. each separately for CHP-1 & CHP-2) with cost implications, as per the following requirement:
 - I. Dimension of each shed: 225m x 50 m x 23 m (LxBxH),
 - II. Taking feed from conveyor streams prior to crusher houses, with telescopic chute arrangement for temporary stacking
 - III. Coal from this temporary pile shall be bull dozed inside the respective shed
 - IV. From shed reclaiming through emergency reclaim hoppers
 - V. Hopper capacity below each ERH shall be 50MT..
 - VI. Downstream conveyors shall be (1 W +1S)of capacity 800TPH.
 - VII. No pavement is required for these piles
 - VIII. No retaining wall is required. However, drain is envisaged around these piles
 - IX. Structure encasing shall be provided upto 8.5 m from ground level
- b) BHEL agreed to include 100 wifi CCTV cameras in their scope with additional servers and accessories with cost implication.
- c) The STP shall also be PLC based.
- d) RCC Pavement for crushed coal storage yard : The crushed coal storage yard may be provided with RCC pavement and drainage with extra cost implications.
- e) BHEL agreed to include Metering CTs and CVTs for GTs and STs in their scope with extra cost implications.
- f) HCSD System for flyash to be included with extra implication. BHEL also confirmed that HCSD system is not in their scope in Patratu.
- g) Coal stockpile measurement through 3-D laser measurement.
- h) 5 Nos. Transformer Oil Tanks, each with a capacity of 20 KL, shall be supplied.
- i) The MIS client stations, including PCs, Laptops and accesories shall be supplied per unit basis. The MIS servers shall be common for all the units. Apart from unit MIS client stations, 12 nos. common clients (for HQ) shall also be provided.



- j) PA system unitwise shall be 5 times that of KTPS (1x800 MW), and for common facilities like water system, CHP, AHP etc which are stage wise, shall be two time that of KTPS (1x800 MW).
- k) Following items in Yadadri are also additional to Patraru and will have price implications:
- I. Valmet DNA (in place of max DNA in Patraru)
 - II. PADO
 - III. IP based EPBAX System – 1000 lines (expandable to 1200 lines)
 - IV. IP based CCTV system
 - V. Walkie talkie system with 150 walky talkies and 10 base stations
14. Quantity of mandatory spares for 5x800 MW YTPS shall be double the quantity of ordered list in 1x800 MW of Kothagedem TPS. However, the quantity of C&I mandatory spares shall be double of the spares listed in the Kothagudem tender specifications.
15. BHEL informed that the value of residual free chlorine (FRC) of 15.9 ppm as indicated in the water analysis furnished by TSGENCO vide mail dated 26.09.17, would not be possible for river water without external chlorination. As such, BHEL has designed water treatment system considering FRC of 0.5 ppm.
16. TSGENCO requested BHEL to explore the feasibility of providing stage wise control rooms. BHEL informed that this may be analysed and finalized during detailed engineering stage.
17. It was agreed that the technical specifications of Kothagudem contract shall be followed, unless otherwise agreed specifically during various meetings till date.

For TSGENCO


 P.V. Seenu
 CE/Telecom/TPC


 S. S. S. S.
 SE/TPC3


 ENE-9KTPC

For BHEL


 (Manoj Shah)

List of Participants**M/sTSGENCO :**

1. Sri. C.Radha Krishna, Director(Projects)
2. Sri B.Lakshmaiah, Executive Director/TPC
3. Sri. A.Ajay, Executive Director/Civil
4. Sri. P.V Srinivas,CE/Telecom/TPC
5. Sri. E.Hanuman, SE/Tech to CMD
6. Sri. P.R.Ekambaram,SE/TPC-3
7. Sri G Srinivas Rao, SE, Coal and Comm
8. Sri. B.Sekhar Babu, EME-9/TPC

M/s.BHEL:

1. Sri. S. Gopalakrishnan, Super specialist.
2. Sri. G.K. Hedao,ED(Marketing)
3. Sri. Manoj shah, General Manager (Marketing).
4. Sri S Chandrasekharan, AGM, Trichy
5. Sri P Seshadri, AGM, Trichy
6. Sri J P Bagla, General Manager PEM, Noida
7. Sri Mukesh Kumar, Dy Manager, MPL, PEM, Noida
8. Sri Nishant Shekhar, Dy Manager, MSE, PEM, Noida
9. Sri Ayan Saha, Manager, Electrical, PEM, Noida
10. Sri T K Mehta, SDGM, Civil, PEM, Noida
11. Sri Girish Bhagchandani, DGM, Max, PEM, Noida
12. Sri V Sahadevan, AGM, ISG, Bangalore
13. Sri Tirupati Rao, AGM, ISG, Bangalore
14. Sri K Balasamy, SDGM, ISG, Bangalore
15. Sri Uttam Singh, Manager, ISG, Bangalore
16. Sri Indrajit Dey, Manager, ISG, Bangalore
17. Sri Rakesh Kumar, Sr Engineer, ISG, Bangalore
18. Sri Anshul Jain, Engineer, ISG, Bangalore
19. Sri Shiv Charan Verma, DGM (Marketing)
20. Sri Balaji, AGM/BAP, Ranipet
21. Sri R Laxman, AGM/BAP, Ranipet
22. Sri Ramalingeshwar, Sr Manager/BAP, Ranipet
23. Sri Branesh Kumar, AGM/BAP, Ranipet
24. Sri Kabhilash, Sr Engineer/BAP, Ranipet
25. Sri B Kerkatta, AGM/ Haridwar
26. Sri Sanjoy Bhattacharya, AGM/ Haridwar



PROJECT :
5X800 MW YADADRI TPS CIVIL SPECIFICATIONS

SPECIFICATION NO. PE-TS-417-600-C001
Annexure-16

VOLUME- B

TITLE: PROJECT INFORMATION

REV-0

DATE - 11/08/2015

SHEET 1 OF 2

TELANGANA STATE POWER GENERATION CORPORATION LIMITED [TSGENCO]



5x800MW YADADRI THERMAL POWER STATION

CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

SPECIFICATION NO. PE-TS-417-600-C001

PROJECT INFORMATION



Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

 BHEL Maharatna Company	PROJECT : 5X800 MW YADADRI TPS CIVIL SPECIFICATIONS	SPECIFICATION NO. PE-TS-417-600-C001 Annexure-16	
		VOLUME- B	
	TITLE: PROJECT INFORMATION	REV-0	DATE - 11/08/2015
		SHEET 2 OF 2	

INTRODUCTION

Yadadri (5X800 MW) is being set up by Telengana State Power Generation Corporation Limited (TSGENCO) at Nalgonda District. The site is located near Virlapalem village in Dameracherla Mandal in Nalgonda District of Telangana.

The Bidder shall acquaint himself by a visit to the site, if felt necessary, with the conditions prevailing at site before submission of the bid. The information given here in under is for general guidance and shall not be contractually binding on BHEL/Owner. All relevant site data /information as may be necessary shall have to be obtained /collected by the Bidder.

APPROACH TO SITE

The site is about 170 KM from Hyderabad city.

Nearest Airport – Hyderabad

1. Owner	Telengana State Power Generation Corporation Limited (TSGENCO)
2. Project Title	Yadadri Thermal Power Station (5x800 MW TPS)
4. Location	30 km from Miryalaguda town.
5. Nearest Railway Stn.	Vishnupuram
6. Ambient Air Temperature	
a. Maximum	41.2 Deg.C
b. Minimum	18.4 Deg.C
7. Rainfall	
a. Average annual	696.8mm

TELANGANA STATE POWER GENERATION CORPORATION LIMITED

From
Chief Engineer/Civil/ Thermal
TSGENCO, Vidyut Soudha,
Hyderabad – 500082

To
✓ The Dy.General Manager,
M/s.BHEL Camp Office,
Vidyut Soudha,
Khairtabad,
Hyderabad – 500082

Lr.No.CE/C/Thermal/KTPSD/E1/F.YTPS-M/s.BHEL/D.No. 247 /2015-16.Dt. 29.08.2015

Sir,

Sub:- YTPS – 5x800MW- Wind load & Seismic zone details - Reg

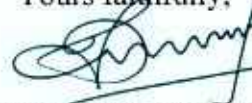
Ref: email: dated.11.08.2015 from M/s.BHEL.

...

With reference to the email cited,the details of wind load & seismic zone pertaining to proposed Yadradri Thermal Power Station (5x800MW) are herewith furnished for taking further action.

Wind load		Seismic zone	
Wind Speed	Terrain category	Seismic zone	Type of soil
44m/Sec	Category-2	Zone-III as per IS 1893:2002	Type of soil may be confirmed at your end after conducting soil investigation in the plant area.

Yours faithfully,



CHIEF ENGINEER/CIVIL/THERMAL

19/8/2015

Copy to the:

Chief Engineer/TPC/TSGENCO/Vidyut Soudha/Hyderabad.

A.S to Director/Projects/ TSGENCO/Vidyut Soudha/Hyderabad

M/s.DESEIN Private Limited, 102, First floor, My Home Sarovar Plaza, Secretariat Road, Hyderabad-500063.

AMENDMENT NO. 3 TO TECHNICAL SPECIFICATION (SECTION VI)

Annexure-16

SL. NO.	SPECIFICATION REFERENCE				EXISTING	READ AS
	SEC/ PART	SUB- SEC.	PAGE NO.	CLAUSE NO.		
					spray. Colour and shade of the Coat shall be as approved by the Employer.	
114.	Section VI, Part B	Civil Works	78 of 447	7.5.1.3	Backfilling around foundations, pipes.....0.6m moorum shall be provided.	Backfilling around foundations, pipes.....0.6m moorum shall be provided. Rock pieces having size less than 150mm and interstices filled with soil may be used for backfilling around foundations, plinths etc. and shall be compacted to minimum of 85% of original stack of material after filling the interstices.
115.	Section VI, Part B	Civil Works	68 of 447	6.3.23.1	g. Temperature variation of +/-25°C for atmospheric temperature variations.	g. Temperature variation will be considered as per Cl. 6.2.7.
116.	Section VI, Part A	Civil Works	4 of 5	7 (g)	g. EAC Compressor House	g. EAC Compressor House (If required as per system requirements)
117.	Section VI, Part A	1-A, Provenness	7.1	27 of 28	List of Parties	List of Parties is attached at Appendix-XII.
118.				Layout of Drains	9579-001-POC-A-003-RC	9579-001-POC-A-003-RD Please refer Appendix-XIII.
119.	VI/F	Chapter-08	16 of 18	Part C 33	Over speed Stop No.	Over speed Stop 1 No.

**BARETHI SUPER THERMAL POWER PROJECT (4X660 MW)
MAIN PLANT TURNKEY PACKAGE
BIDDING DOCUMENT NO.: CS-9579-001(R)-2**

AMENDMENT NO. CS-9579-001(R)-2-AMDT-04

Page 41 of 51



CLAUSE NO.	CIVIL SPECIFICATIONS			Annexure 16
	TECHNICAL REQUIREMENTS			
	Isolated & Raft (BTG Area Footings except ESP Footings)		25 mm	
	Isolated & Strip (Other than BTG Area)		40 mm	
	Raft (ESP Foundations and other Offsite Structures footings)		75 mm	
	Foundations in Weathered rock / rock		12 mm	
	Incase pile foundations are to be adopted the requirements under para "Pile Foundations" shall be adhered to.			
7.3.0	PILE FOUNDATIONS – NOT APPLICABLE			
7.4.0	SPECIAL REQUIREMENTS			
	Chemical test results are well within limits (as per IS: 456). So, no special treatment for foundations / underground structures is required.			
7.5.0	EXCAVATION, FILLING AND DEWATERING			
7.5.1.1.	For excavation works, comprehensive dewatering with well point or deep wells arrangement, if required, shall be adopted. Scheme for dewatering and design with all computations and back up data for dewatering shall be submitted for the owner's information. The water table shall be maintained at 0.5m below the founding depth.			
7.5.1.2.	Excavation for shallow foundations shall be covered with PCC immediately after reaching the founding level. In case of any local loosening of soil or pockets are encountered at founding level during excavation the same shall be removed and compensated by PCC M 7.5. The final layer of about 300 mm thickness above the founding level shall be excavated by suitable means, so as to avoid disturbance to founding stratum.			
7.5.1.3.	Backfilling around foundations, pipes, trenches, sumps, pits, plinths, etc. shall be carried out with approved material in layers not exceeding 300 mm compacted thickness (higher thickness of layers up to 500mm with heavy mechanical compacting equipment) and each layer shall be compacted to 90% of standard proctor density for cohesive soils and to 75% of relative density for non-cohesive soils. In any case, black cotton soil shall not be used in back filling without providing cushion of 1m of non-expansive cohesive soil / moorum around the footings. In case of roads in the area of black cotton soil, minimum 0.6m moorum shall be provided.			
7.5.1.4.	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.			
7.5.1.5.	CBR tests for pavement/road design shall be carried out by the Contractor after earth filling (if applicable) has been completed upto the formation level.			
BARETHI STPP STAGE-I (4X660MW) MAIN PLANT TURNKEY PACKAGE	TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-9579-001(R)-2	SUB-SECTION- CIVIL WORKS	PAGE 78 OF 447	



CLAUSE NO.	CIVIL SPECIFICATIONS			Annexure 16
	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
7.6.0	EXCAVATION IN ROCK Excavation in rock shall be carried out by mechanical means and if blasting is required for founding of some of the structures under this package, control blasting only shall be carried out. For relevant clauses related to excavation in rock, refer civil technical specification given elsewhere.			
7.7.0	SHEETING & SHORING The contractor shall ascertain for himself the nature of materials to be excavated and difficulties, if any, likely to be encountered in excavation while executing the work. Sheet piling, sheeting and shoring, bracing and maintaining suitable slopes, draining etc. shall be provided and installed by the Contractor, to the satisfaction of the Engineer.			
BARETHI STPP STAGE-I (4X660MW) MAIN PLANT TURNKEY PACKAGE		TECHNICAL SPECIFICATION SECTION-VI BID DOC. NO.: CS-9579-001(R)-2	SUB-SECTION- CIVIL WORKS	PAGE 79 OF 447

GEOTECHNICAL INVESTIGATION REPORT

PROJECT: 5X800 MW YADRADRI TPS, NALGONDA

LOCATION: MAIN PLANT AREA (Part 1/Volume I)

DOCUMENT NO: PE-DC-417-602-C001 PART-1/Volume-I

Rev-03

Customer



TELANGANA STATE POWER GENERATION
CORPORATION Ltd.

Submitted by



PROJECT ENGINEERING MANAGEMENT
POWER PROJECT ENGINEERING INSTITUTE
HRD & ESI COMPLEX
PLOT NO.: 25, SECTOR-16A
NOIDA (U.P.) - 201 301

REPORT ON
GEOTECHNICAL INVESTIGATION WORK
AT 5X800 MW YADRADRI TPS, NALGONDA
TELANGANA

PART 1: MAIN PLANT AREA
(Volume I: Methodology, Analysis & Recommendations)

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VOLUME I

**GEOTECHNICAL INVESTIGATION REPORT
FOR
5X800MW YADADRI THERMAL POWER STATION
NALGONDA, TELANGANA**

INTRODUCTION

M/s Telangana State Power Generation Corporation Ltd., Telangana has proposed 5x800 MW Yadradri TPS at Nalgonda, Telangana and the job of civil work awarded to M/s Bharat Heavy Electricals Limited. For layout plan and designing various foundation structures coming under this project. It was necessary to conduct a detail Geotechnical Investigation work to obtain engineering properties of the underlying soil and the job was awarded to M/s Noble Geo-Structs, Mumbai.

This is a part of the whole project and deals with soil investigation around BTG area. The scope of the work comprises of sinking of 163 nos. Bore hole (BH), 16 nos. of Trial pit (TP), 48 nos. of Electrical resistivity test (ERT), 10 nos. Pressure meter test (PMT), 11 nos. of Cross hole shear test (CST), 11 nos. of Plate load test (PLT), 10 nos. of Cyclic plate load test (CPLT), 5 nos. of Block vibration test (BVT) and 8 nos. of Field permeability test (FPT).

The boreholes of 150 mm diameter were advanced by Shell and Auger method in soil. In rock rotary core drilling of "NX" size was adopted. The scope also included conducting standard Penetration Tests, collecting disturbed samples at regular intervals for identification and logging purposes, collecting undisturbed tube samples at suitable intervals or at change of strata whichever is earlier and testing these in laboratory.

Based on the above, this report presents the Bore Logs, Soil Profile, laboratory and field test Results. On the basis of field tests and laboratory test results and their analysis thereof, the most suitable type of foundation is suggested. The field profile is sometimes changed in the light of laboratory test results.

The sub strata is characterized by top soil consists of stiff silty clay / clayey silt layer. After that weathered rock layer was struck followed by fresh rock continues up to the terminating depth of all the boreholes.

Considering the nature of the sub strata as revealed from field tests, shallow foundation is Recommended. However, this is discussed in details later.

The Geotechnical report has been divided into two parts as detailed below.

Part – 1: Main Plant Area

Volume-I: Methodology, Analysis & Recommendations

Volume-II: Bore logs, Trial Pits, Field & Laboratory Test Results

Volume-III: Plate load Tests (PLT), Cyclic Plate Load Tests (CPLT), Cross hole shear Tests (CST), Pressure meter tests (PMT), Electrical Resistivity Test (ERT), Block Vibration Tests (BVT) and Seismic Refraction Tests (SRT)

Part – 2: Coal Handling Plant (CHP) & Ash Handling Plant (AHP) Area

Volume-I: Methodology, Analysis & Recommendations

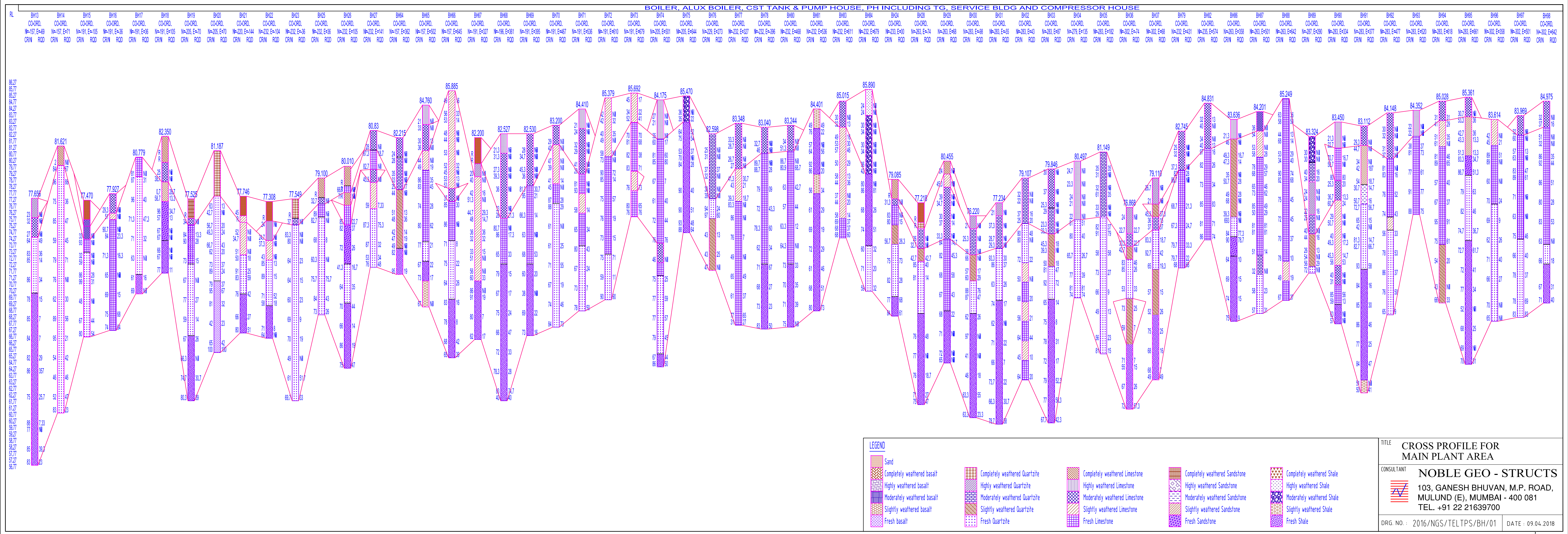
Volume-II: Bore logs, Field & Laboratory Test Results

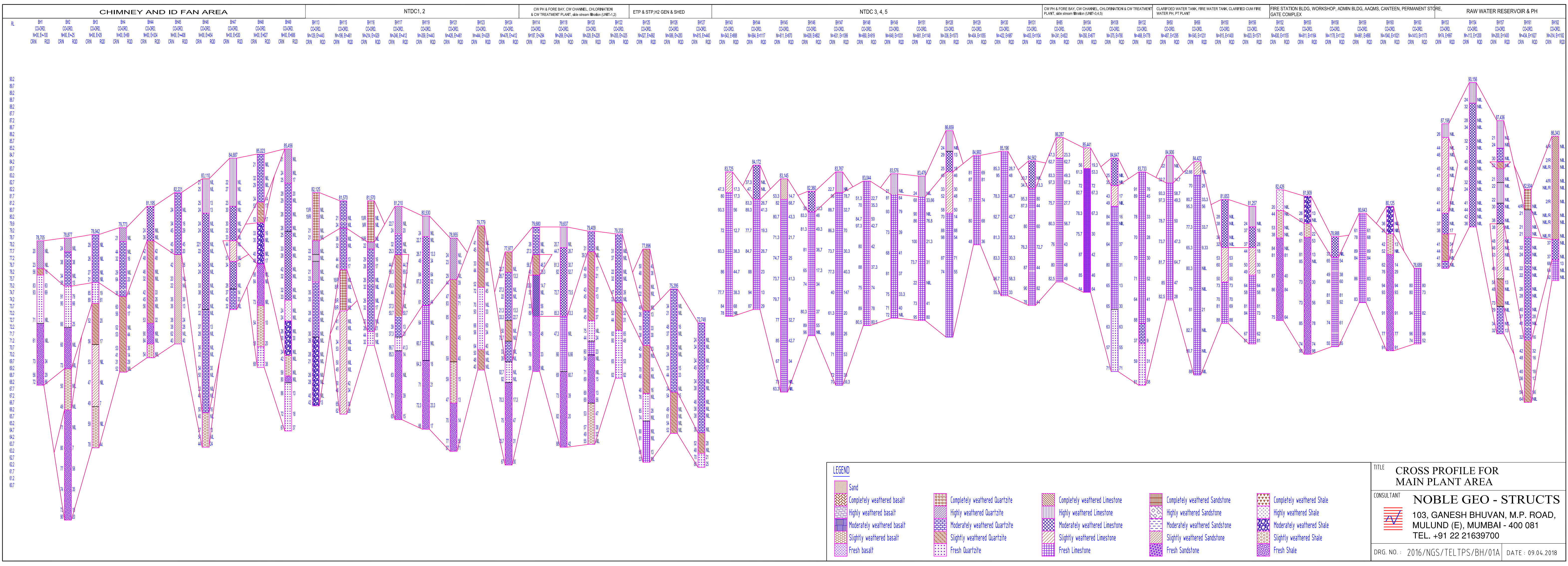
Volume-III: Plate load Tests (PLT), Cyclic Plate Load Tests (CPLT), Cross hole shear Tests (CST), Pressure meter tests (PMT) and Electrical Resistivity Test (ERT)

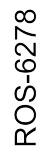
This is Part-1, Volume-I consisting of Methodology, Analysis and Recommendations for the Main Plant area.



CROSS PROFILES OF MAIN PLANT AREA







1.0 FIELD INVESTIGATION**1.1 GENERAL:**

In an attempt for finalisation in the design of foundation for various structures to be constructed at this site, Geotechnical Investigation was envisaged. The entire Investigation programme had been divided mainly into two parts, I) Field works & II) Laboratory tests.

- I) Field works unfold the sub-surface deposit types and their characteristics and
- II) Laboratory tests part would help determining the relevant physical and geotechnical properties of the sub-surface deposits leading to finalisation of foundation depths of the structures and the bearing capacity with particular reference to the sub-surface types and their strength parameters and settlement potentials at the site.

A list of the bore holes with the reduced level and standing water level are presented in a tabular form below: -

Sl. No.	Bore Hole (BH)	Northing (m)	Easting (m)	E.G.L (existing ground level) RL(+) m	Water Table below EGL (m)	Termination depth (m)
1	BH 1	0	-100	78.705	3.0	10.0
2	BH 2	0	-25	78.877	5.5	20.0
3	BH 3	0	29	78.942	4.5	15.0
4	BH 4	0	99	79.773	4.0	10.0
5	BH 5	-69	-112	78.462	3.0	10.0
6	BH 6	-69	29	78.110	2.5	10.0
7	BH 7	-99	-137	78.359	3.5	10.0
8	BH 8	-99	-71	78.048	3.3	20.0
9	BH 9	-99	70	78.336	3.0	20.0
10	BH 10	-99	136	78.751	-	10.0
11	BH 11	-126	-22	79.636	2.0	10.0
12	BH 12	-126	105	79.674	-	10.0
13	BH 13	-157	-69	77.656	2.8	20.0
14	BH 14	-157	71	81.621	-	20.0
15	BH 15	-191	-105	77.470	2.5	10.0
16	BH 16	-191	-36	77.927	4.5	10.0
17	BH 17	-191	36	80.779	-	10.0
18	BH 18	-191	105	82.350	-	10.0
19	BH 19	-205	-70	77.525	2.5	15.0
20	BH 20	-205	70	81.187	4.0	15.0
21	BH 21	-220	-144	77.746	2.0	10.0

YADADRI 5X800MW

Project : 5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
Project No.S16022

CIVIL SPECIFICATIONS

Annexure 16


Sl. No.	Bore Hole (BH)	Northing (m)	Easting (m)	E.G.L (existing ground level) RL(+) m	Water Table below EGL (m)	Termination depth (m)
22	BH 22	-232	-104	77.308	2.5	10.0
23	BH 23	-232	-36	77.549	-	15.0
24	BH 24	-233	0	79.085	-	10.0
25	BH 25	-232	36	79.100	-	10.0
26	BH 26	-232	105	80.010	-	15.0
27	BH 27	-232	141	80.830	5.3	10.0
28	BH 28	-263	-74	77.218	2.5	15.0
29	BH 29	-263	68	80.455	4	15.0
30	BH 30	-283	-98	76.220	3.5	15.0
31	BH 31	-283	-55	77.234	2.8	20.0
32	BH 32	-283	43	79.107	-	15.0
33	BH 33	-283	87	79.846	5	20.0
34	BH 34	-279	135	80.497	5	10.0
35	BH 35	-283	182	81.149	2.5	15.0
36	BH 36	-302	-74	76.868	3	15.0
37	BH 37	-302	68	79.110	4	15.0
38	BH 38	-329	-3	78.515	6	10.0
39	BH 39	-330	110	79.595	4.5	10.0
40	BH 40	-357	-149	75.336	3.90	10.0
41	BH 41	-356	-88	76.978	2.5	10.0
42	BH 42	-360	45	78.785	3.60	15.0
43	BH 43	-369	-5	79.260	3.50	10.0
44	BH 44	0	334	81.195	-	10.0
45	BH 45	0	408	82.221	4.90	10.0
46	BH 46	0	454	83.110	3.10	20.0
47	BH 47	0	530	84.687	4.10	10.0
48	BH 48	0	627	85.023	3.70	15.0
49	BH 49	0	666	85.456	4.20	20.0
50	BH 50	-487	1295	84.906		10.0
51	BH 51	-69	317	80.740	-	15.0
52	BH 52	-69	454	83.724	3	10.0
53	BH 53	-69	604	85.061	5.80	15.0
54	BH 54	-69	711	86.324	4.20	10.0
55	BH 55	-83	284	80.187	3	10.0
56	BH 56	-545	1231	84.422	-	15.0
57	BH 57	-99	361	81.465	3.00	20.0
58	BH 58	-99	501	83.389		20.0
59	BH 59	-99	569	84.480	3.90	10.0
60	BH 60	-99	644	86.059	3.00	20.0
61	BH 61	-126	406	82.135	3.5	15.0

YADADRI 5X800MW

Project : 5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
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Annexure 16



Sl. No.	Bore Hole (BH)	Northing (m)	Easting (m)	E.G.L (existing ground level) RL(+) m	Water Table below EGL (m)	Termination depth (m)
62	BH 62	-126	548	85.648	4.30	15.0
63	BH 63	-126	691	85.921	4.80	15.0
64	BH 64	-157	362	82.215	3	10.0
65	BH 65	-157	502	84.760	3.5	15.0
66	BH 66	-157	645	85.885	3.50	20.0
67	BH 67	-191	327	82.200	3.5	15.0
68	BH 68	-196	361	82.527	5.5	20.0
69	BH 69	-191	395	82.530	4	15.0
70	BH 70	-191	467	83.200	3.5	15.0
71	BH 71	-191	536	84.410	4.20	15.0
72	BH 72	-191	610	85.379	-	15.0
73	BH 73	-191	679	85.692	3.80	9.5
74	BH 74	-205	501	84.175	3	20.0
75	BH 75	-205	644	85.470	-	10.0
76	BH 76	-229	273	82.598	3.5	10.0
77	BH 77	-232	327	83.348	5	15.0
78	BH 78	-232	396	83.040	4	15.0
79	BH 79	-232	431	82.745	4.5	10.0
80	BH 80	-232	468	83.244	4.2	15.0
81	BH 81	-232	536	84.401	-	15.0
82	BH 82	-235	574	84.831	-	10.0
83	BH 83	-232	611	85.015	-	10.0
84	BH 84	-232	679	85.890	-	15.0
85	BH 85	-241	822	86.287	3.2	10.0
86	BH 86	-263	358	83.636	4.5	15.0
87	BH 87	-263	501	84.201	3.80	15.0
88	BH 88	-263	642	85.249	-	15.0
89	BH 89	-287	290	83.324	-	10.0
90	BH 90	-283	334	83.450	4	15.0
91	BH 91	-283	377	83.112	3	20.0
92	BH 92	-283	477	84.148	3.5	15.0
93	BH 93	-283	520	84.352	3.60	7.5
94	BH 94	-283	618	85.028	3	15.0
95	BH 95	-283	661	85.361	3	20.0
96	BH 96	-302	358	83.614	3.2	15.0
97	BH 97	-302	501	83.969	3	15.0
98	BH 98	-302	642	84.975	3.5	15.0
99	BH 99	-330	431	83.808	3	10.0
100	BH 100	-330	541	84.478	3	10.0

YADADRI 5X800MW

Project : 5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
Project No.S16022

CIVIL SPECIFICATIONS

Annexure 16


Sl. No.	Bore Hole (BH)	Northing (m)	Easting (m)	E.G.L (existing ground level) RL(+) m	Water Table below EGL (m)	Termination depth (m)
101	BH 101	-357	341	83.456	3.8	10.0
102	BH 102	-357	479	84.263	3.5	10.0
103	BH 103	-357	599	84.087	2.5	10.0
104	BH 104	-350	877	85.441	5	10.0
105	BH 105	-363	695	84.231	4	10.0
106	BH 106	-370	423	83.926	-	10.0
107	BH 107	-370	538	84.367	4	10.0
108	BH 108	-375	790	84.647	4	15.0
109	BH 109	908	226	89.633	5.6	10.0
110	BH 110	416	485	86.083	5	15.0
111	BH 111	272	472	84.409	4.00	10.0
112	BH 112	141	644	83.379	4	10.0
113	BH 113	-129	-443	82.125	3.80	15.0
114	BH 114	-187	-294	79.680	5	10.0
115	BH 115	-196	-461	81.570	3.80	15.0
116	BH 116	-214	-529	81.570	4.30	10.0
117	BH 117	-246	-412	81.210	5	15.0
118	BH 118	-269	-244	79.637	6.5	15.0
119	BH 119	-359	-443	80.530	4	15.0
120	BH 120	-328	-228	79.409	3	15.0
121	BH 121	-426	-461	78.955	5	15.0
122	BH 122	-355	-325	79.332	3	10.0
123	BH 123	-444	-529	79.779	-	10.0
124	BH 124	-476	-412	77.977	-	15.0
125	BH 125	-527	-692	77.896	-	15.0
126	BH 126	-586	-283	75.295	-	10.0
127	BH 127	-615	-440	72.748	-	10.0
128	BH 128	-336	1073	86.659	4.50	15.0
129	BH 129	-404	1055	84.993	4	6.0
130	BH 130	-422	987	85.196	5.5	10.0
131	BH 131	-453	1104	84.562	5	10.0
132	BH 132	-468	778	83.733	3	15.0
133	BH 133	-510	-18	76.885	3.70	10.0
134	BH 134	-500	312	78.231	-	10.0
135	BH 135	-530	428	81.600	-	10.0
136	BH 136	-532	543	82.124	-	10.0
137	BH 137	-574	580	81.033	-	10.0
138	BH 138	-596	19	73.737	4.10	10.0
139	BH 139	-675	-30	72.522	3.00	10.0

Sl. No.	Bore Hole (BH)	Northing (m)	Easting (m)	E.G.L (existing ground level) RL(+) m	Water Table below EGL (m)	Termination depth (m)
140	BH 140	-673	57	72.791	3.80	10.0
141	BH 141	-662	428	79.542	4.20	10.0
142	BH 142	-665	543	79.919	3.50	10.0
143	BH 143	-543	888	83.725	-	10.0
144	BH 144	-564	1117	84.172	-	10.0
145	BH 145	-611	870	83.145	-	15.0
146	BH 146	-629	802	82.360	-	10.0
147	BH 147	-631	1099	83.767	-	15.0
148	BH 148	-660	919	83.044	-	10.0
149	BH 149	-649	1031	83.576	-	10.0
150	BH 150	-915	1400	81.653	3.50	8.3
151	BH 151	-681	1148	83.476	-	10.0
152	BH 152	-830	1155	82.426	-	9.0
153	BH 153	74	997	87.198	3.50	10.0
154	BH 154	-113	1200	90.156	3.80	10.0
155	BH 155	-911	1164	81.909	-	11.0
156	BH 156	-823	1571	81.257	4.30	9.8
157	BH 157	-200	1400	87.436	4.50	15.0
158	BH 158	-1178	1122	78.988	3.20	7.5
159	BH 159	-961	890	80.643	3.50	6.0
160	BH 160	-1040	1021	80.125	-	10.0
161	BH 161	-434	1627	82.504	3.80	15.0
162	BH 162	-314	1182	86.343	4.10	10.0
163	BH 163	-1413	1173	76.689	3.90	5.0

1.2 BORING:

Boring was carried out by Shell and Auger method to sink nominal 150mm diameter bore holes to depths envisaged by using a mechanical winch. Undisturbed soil samples were collected at suitable intervals or at change of strata whichever is earlier by open drive sampling method since it was intended to ascertain the sub-soil characteristics.

1.3 SAMPLING:

Nominal 100 mm diameter undisturbed samples were recovered. The sampling equipment used consists of a two-tier assembly of sample tubes 450 mm in length fitted at its lower end. The sampling assembly was driven by means of a jarring link to its full length or as far downs as was found practicable. As the soil is very stiff to hard and contains sand mixtures / calcareous

nodules, cutting shoe was used with a area ratio $< 20\%$. After withdrawal the ends of the tubes were sealed with wax and capped before onward transmission to the laboratory. At close intervals in depth disturbed samples were collected for identification and logging purpose. These were tagged and packed in polythene packets and transported to the laboratory.

1.4 STANDARD PENETRATION TESTS:

Standard Penetration Tests were conducted in the bore holes at intervals of 1.5M to 3.0M depth or at change of strata whichever is earlier using a split spoon sampler. The split spoon sampler used is of a Standard design having an outer diameter of 50.8 mm and inner diameter of 35 mm, driven with a monkey weighing 63.5 kgs, falling freely through 75cms. A record of the number of blows required to penetrate every 15cms to a maximum depth of 45cms was made. The first 15cm of drive are considered to be seating drive and are neglected. The total blows required for second & third 15cm of penetration is counted and termed as penetration resistance "N". On completion of a test, the split spoon sampler was opened and soil specimens were preserved in polythene bags for logging purpose.

All the boreholes were sunk with winch. However, raising of hammer for SP Tests were done manually. Hence there will not be any inertia loss and the efficiency of hammer blows should be considered as 100%.

1.5 MEASUREMENT OF WATER TABLE:

Standing water level after 24 hours of removal of casing was also noted and shown in the profile.

1.6 ROTARY CORE DRILLING:

This drilling technique is regarded as the most satisfactory method of assessing the character of rock formations, which lie at depth below the ground surface. Specimens of rock in the form of cylindrical cores are recovered from the drill holes by means of a core barrel. Double barrel technique is adopted according to field condition. The core barrel is provided at its lower end with a detachable shoe or core bit, which is of diamond. All rotary core bits were of NX size.

1.7 TRIAL PITS:

Sixteen (16) nos. Trial Pits were excavated for physical verification of sub strata with depth.

The coordinates of the Trial Pit locations are presented below.

Sl. No.	Trial Pit (TP)	Northing (m)	Easting (m)	E.G.L (existing ground level) RL(+) m	Water Table below EGL (m)	Termination depth (m)
1	TP 1	851	194	89.53	NE	1.5
2	TP 2	357	445	85.62	NE	1.5
3	TP 3	-64	-29	78.58	NE	1.5
4	TP 4	-64	99	79.86	NE	0.6
5	TP 5	-64	396	82.06	NE	0.5
6	TP 6	-64	659	85.63	NE	1.5
7	TP 7	-236	236	81.98	NE	1.4
8	TP 8	-748	1309	82.89	NE	0.5
9	TP 9	-32	931	86.57	NE	1.5
10	TP 10	-318	1693	88.51	NE	1.5
11	TP 11	-280	1	78.51	NE	0.35
12	TP 12	-280	432	82.74	NE	0.6
13	TP 13	-280	585	85.20	NE	0.7
14	TP 14	-313	-361	80.21	NE	0.8
15	TP 15	-404	899	84.45	NE	1.1
16	TP 16	-482	926	84.36	NE	0.6

NE= NOT ENCOUNTERED

1.8 FIELD PERMEABILITY TEST:

Field Permeability Tests were conducted in eight (8) locations using falling head method as per IS: 5529 (Part 1).

After completion of boring packer's permeability test was carried out as per the IS Method. The water is allowed in the tube well at the pressure intervals of 2 kg/cm², 4 kg/cm² and 6 kg/cm² noted the water meter readings at t = 0, 5, 10 and 15 minutes time interval. Then again water meter mediator was noted at the reduced pressure of 4 and 2 kg/cm². Finally water intake for the every 15 minutes interval is calculated. Then average intake is evaluated. Based on these observations the daily recharging possible is calculated. From all the three methods of recharging, it is concluded that all the methods are within reasonable limits of variance. The test locations are presented below.

Sl. No.	Bore Hole (BH)	Northing (m)	Easting (m)	E.G.L (existing ground level) RL(+) m	Type of Test	Depth of Test (m)
1	BH 3	0	29	78.942	Packer's method	4 & 8
2	BH 20	-205	70	81.187	Packer's method	4 & 8
3	BH 48	0	627	85.023	Packer's method	4 & 8
4	BH 66	-157	645	85.885	Packer's method	4 & 8
5	BH 121	-426	-461	78.955	Packer's method	4 & 8
6	BH 135	-530	428	81.600	Packer's method	4 & 8
7	BH 150	-915	1400	81.653	Packer's method	4
8	BH 161	-434	1627	82.504	Packer's method	4 & 8

1.9 PLATE LOAD TESTS:

Total twenty one (21) sets of Plate Load Tests were conducted (eleven no. tests are of routine type & rest ten nos. are of cyclic type). For Test results of PLT & CPLT, refer Volume-III of the report. The test locations are presented below.

Sl. No.	Plate Load Test (PLT/CPLT)	Northing (m)	Easting (m)	E.G.L (existing ground level) RL(+) m
1	PLT 1	177	552	83.64
2	PLT 2	-118	-105	77.86
3	PLT 3	-124	600	85.12
4	PLT 4	-568	1299	84.27
5	PLT 5	-221	-227	78.68
6	PLT 6	-262	-113	77.24
7	PLT 7	-279	252	82.00
8	PLT 8	-262	681	85.59
9	PLT 9	-513	63	78.56
10	PLT 10	-600	477	81.47
11	PLT 11	-1121	1142	80.23
12	CPLT 1	0	-70	80.85
13	CPLT 2	-27	615	84.43
14	CPLT 3	-152	90	78.47
15	CPLT 4	-148	523	84.42
16	CPLT 5	-151	666	86.27
17	CPLT 6	-210	397	82.52
18	CPLT 7	-262	101	81.09
19	CPLT 8	0	70	83.17
20	CPLT 9	0	361	83.16
21	CPLT 10	0	501	83.45

2.0 CROSS HOLE SHEAR TEST:

Eleven (11) nos. Cross Hole Shear Tests were conducted. For test results of CST refer

Volume-III of the report. The test locations are presented below.

Sl. No.	Cross Hole Shear Test (CST)	Northing (m)	Easting (m)	E.G.L (existing ground level) RL(+) m
1	CST 1	-30	0	79.49
2	CST 2	-30	431	83.24
3	CST 3	-30	644	84.86
4	CST 4	-211	-35	78.81
5	CST 5	-211	538	84.70
6	CST 6	-211	679	85.78
7	CST 7	-290	-62	77.24
8	CST 8	-290	80	79.68
9	CST 9	-290	371	83.35
10	CST 10	-290	514	85.06
11	CST 11	-290	655	85.31

2.1 ELECTRICAL RESISTIVITY TESTS:

Forty eight (48) nos. Electrical Resistivity Tests were conducted. For test results of ERT refer Volume-III of the report. The test locations are presented below.

Sl. No.	Electrical Resistivity test (ERT)	Northing (m)	Easting (m)	E.G.L (existing ground level) RL(+) m
1	ERT 1	-965	1040	81.34
2	ERT 2	-628	-307	75.79
3	ERT 3	-534	-692	80.64
4	ERT 4	-410	-126	74.87
5	ERT 5	-357	-80	76.48
6	ERT 6	-374	-11	78.43
7	ERT 7	-336	79	80.02
8	ERT 8	-400	182	80.03
9	ERT 9	-386	369	83.07
10	ERT 10	-324	463	83.88
11	ERT 11	-359	501	84.40
12	ERT 12	-354	689	84.84
13	ERT 13	-480	771	84.13
14	ERT 14	-927	1496	81.08
15	ERT 15	-341	-226	78.85
16	ERT 16	-290	-97	76.93
17	ERT 17	-283	54	79.24
18	ERT 18	-289	283	82.51



Sl. No.	Electrical Resistivity test (ERT)	Northing (m)	Easting (m)	E.G.L (existing ground level) RL(+) m
19	ERT 19	-296	355	83.55
20	ERT 20	-281	488	83.91
21	ERT 21	-265	636	85.25
22	ERT 22	-181	-233	78.91
23	ERT 23	-238	-70	77.30
24	ERT 24	-218	70	82.64
25	ERT 25	-205	361	82.05
26	ERT 26	-180	501	84.18
27	ERT 27	-151	644	86.09
28	ERT 28	-621	1299	83.62
29	ERT 29	-125	-143	77.99
30	ERT 30	-114	140	78.66
31	ERT 31	-101	285	80.13
32	ERT 32	-78	568	84.47
33	ERT 33	-93	711	86.16
34	ERT 34	-13	0	80.66
35	ERT 35	13	431	83.23
36	ERT 36	226	532	84.21
37	ERT 37	922	261	89.29
38	ERT 38	-492	319	79.71
39	ERT 39	-542	544	82.87
40	ERT 40	-606	378	79.25
41	ERT 41	-642	528	80.93
42	ERT 42	-590	13	76.07
43	ERT 43	-673	21	73.36
44	ERT 44	18	-138	80.48
45	ERT 45	37	213	82.17
46	ERT 46	-24	299	80.48
47	ERT 47	-478	1232	85.12
48	ERT 48	367	473	86.33

2.2 PRESSURE METER TEST:

Ten (10) nos. Pressure Meter Tests were conducted. For test results of PMT refer Volume-III of the report. The test locations are presented below.

Sl. No.	Pressure Meter Test (PMT)	Northing (m)	Easting (m)	E.G.L (existing ground level) RL(+) m
1	PMT 1	-382	-485	79.95
2	PMT 2	-211	36	81.60
3	PMT 3	-600	1071	83.97
4	PMT 4	-211	467	83.14
5	PMT 5	-211	610	85.30
6	PMT 6	-283	-77	77.16
7	PMT 7	25	0	82.52
8	PMT 8	-283	355	83.25
9	PMT 9	25	431	82.92
10	PMT 10	-283	639	85.09

2.3 BLOCK VIBRATION TEST:

Five (5) nos. Block Vibration Tests were conducted. For Test results of BVT refer Volume-III of the report. The test locations are presented below.

Sl. No.	Block Vibration Test (BVT)	Northing (m)	Easting (m)	E.G.L (existing ground level) RL(+) m	Termination depth (m)
1	BVT 1	-283	547	84.64	1.5
2	BVT 2	-283	-21	78.15	1.5
3	BVT 3	-180	72	79.33	1.5
4	BVT 4	-180	644	85.44	1.5
5	BVT 5	-221	-70	77.28	1.5

2.4 SEISMIC REFRACTION TEST:

Seismic Refraction test were conducted in the main plant area as. For test results refer Volume-III of the report. The test locations are presented below.

Sl. No.	Seismic Refraction Test (SRT)	Co-ordinates
1	SRT	30 S / 99 W TO 30 S / 675 E
2	SRT	196 S / 99 W TO 196 S / 675 E
3	SRT	283 S / 99 W TO 283 S / 675 E
4	SRT	30 S / 99 W TO 283 S / 99 W
5	SRT	30 S / 70 E TO 283 S / 70 E
6	SRT	30 S / 361 E TO 283 S / 361 E
7	SRT	30 S / 498 E TO 283 S / 498 E
8	SRT	30 S / 675 E TO 283 S / 675 E

E=East, W=West and S=South

3.1 LABORATORY TESTING

For proper identification and classification of the sub-soil deposits and for deriving adequate information regarding its relevant physical and geotechnical properties at the site under investigation, the following laboratory tests were conducted on the soil / rock samples collected from the exploratory bore holes:

On Soil Samples:

1. Bulk density and moisture content
2. Sieve analysis
3. Hydrometer analysis
4. Liquid limit and plastic limit
5. Shrinkage limit
6. Specific gravity
7. Swell pressure
8. Free swell index
9. Relative density
10. Unconfined compressive strength
11. Direct shear test
12. Triaxial shear test - unconsolidated undrained test
13. One dimensional consolidation test
14. Standard Proctor compaction test
15. Modified Proctor compaction test
16. CBR test
17. Chemical tests on soil and water samples to determine pH value, sulphates, chloride content etc.

On Rock Samples:

1. Moisture content, specific gravity, porosity & density
2. Slake durability index
3. Unconfined compressive strength (both at saturated and in-situ water content)
4. Point load strength
5. Hardness, soundness and deformability (both at saturated and in-situ water content)

4.0 GENERAL NOTES

4.1 Relation between Soil Properties and Penetration Resistance on Basis of Standard Penetration Test for Sand/Non Plastic Silt According to Geotechnique journal Vol XXXVI No.3, Sept. 1986.

Relative Density	Penetration Value	Relative Density I_D %
Very Loose	0 to 4	0-15
Loose	4 to 10	15-35
Medium	10 to 30	35-65
Dense	30 to 50	65-85
Very Dense	50 and above	85-100

4.2 Relation Between soil properties and Penetration resistance on basis of Standard Penetration Test for Clay / Plastic Silt.

Consistency	Number. of Blows (SPT)
Very Soft	0 to 2
Soft	2 to 4
Medium	4 to 8
Stiff	8 to 15
Very Stiff	15 to 30
Hard	30 and above

4.3 Rock quality in terms of Weathering Grades of Rock Mass According to I.S. 4464.

Terms	Description	Grade	Interpretation
Fresh	No visible sign of rock material weathering; perhaps slight discoloration on major discontinuity surfaces.	I	$CR > 60\%$
Slightly Weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. Weathering may discolour all the rock material.	II	CR between 40% to 60%



Terms	Description	Grade	Interpretation
Moderately Weathered	Less than half of the rock material is decomposed or disintegrated to a soil. Fresh or discoloured rock is present either as a continuous framework or as core stones.	III	CR between 25% to 40%
Highly Weathered	More than half of the rock material is decomposed or disintegrated to a soil. Fresh or discoloured rock is present either as a discontinuous framework or as core stones.	IV	CR between 11% to 25%
Completely Weathered	All rock material is decomposed and / or disintegrated to soil. The original mass structure is still largely intact.	V	CR between Zero to 10%
Residual Soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.	VI	CR = Zero % But N > 50

It should be understood that all grades of weathering may not be seen in a given rock mass and that in some cases a particular grade may be present to a very small extent. Distribution of the various weathering grades of rock material in the rock mass may be related to the porosity of the material and the presence of open discontinuities of all types in the rock mass

4.4 Ground Water Limits According to IS 456 – 2000

Test	Value
pH	6 to 8
Cl ppm	500
SO ₃ ppm	400

4.5 Chemical Content Limits for soils According to IS 456 - 2000

Test	Value
pH	6.5 to 8.30
Cl %	0.2
SO ₃ %	0.04
Salinity %	3.30

5.0 SWELLING CHARACTERISTICS

The swelling pressure and Free Swell Index tests were performed and the test results are presented in laboratory test result of soil samples of Volume-2. It is seen that the soil has low to medium swelling characteristics. So, no problem with respect to the swelling of the sub strata is anticipated in general.

6.0 FIELD PERMEABILITY TEST RESULTS

Field permeability test was conducted at two different depths in nine bore holes by falling head method and the test results are presented below. A sample calculation is also enclosed In Volume-2. The summary is presented below.

SUMMARY OF FIELD PERMEABILITY TEST RESULTS			
Sl. No.	Test location	Depth (m)	Permeability (m/s)
1	BH-3	4	21.48x10 ⁻⁵
		8	19.50x10 ⁻⁵
2	BH-20	4	21.35x10 ⁻⁵
		8	14.73x10 ⁻⁵
3	BH-48	4	20.64x10 ⁻⁵
		8	31.86x10 ⁻⁵
4	BH-66	4	47.82x10 ⁻⁵
		8	34.76x10 ⁻⁵
5	BH-121	4	47.81x10 ⁻⁵
		8	24.12x10 ⁻⁵
6	BH-135	4	28.54x10 ⁻⁵
		8	27.28x10 ⁻⁵
7	BH-150	4	0.03x10 ⁻⁵
8	BH-161	4	32.26x10 ⁻⁵
		8	33.65x10 ⁻⁵

7.0 CHEMICAL TESTS

Chemical tests were performed on few soil and water samples for determining the pH value, Sulphate, Chloride content etc. The results are given in a tabular form below:

7.1 CHEMICAL TEST ON SOIL SAMPLES:

TEST RESULTS					
Sl. No.	Test location	Depth (m)	pH value	Sulphate as SO ₄ (%)	Chloride as Cl (%)
1	BH - 15	1.00	7.65	0.027	0.18
2	BH - 21	1.00	7.80	0.032	0.16
3	BH - 22	1.00	7.56	0.030	0.17
4	BH - 28	1.00	7.56	0.033	0.16
5	BH - 67	1.00	7.30	0.036	0.15

7.2 CHEMICAL TEST ON WATER SAMPLES:

TEST RESULTS									
Bore hole No.	Total Carbonates (CaCO ₃)	Sulphates (SO ₄)	Sulphite (SO ₃)	Chloride (Cl)	Nitrate (NO ₃)	Nitrite (NO ₂)	pH Value	Turbidity (NTU)	Total Organic matter
	ppm	ppm	ppm	ppm	ppm	ppm	6.5-8.3	max 1000	ppm
BH 20	154	34	28.33	110	0.032	0.024	7.63	350	54
BH 50	150	35	29.17	111	0.034	0.025	7.71	355	51
BH 74	160	41	34.17	121	0.039	0.029	7.82	360	56
BH 110	160	44	36.67	127	0.044	0.033	7.87	387	61
BH 118	163	43	35.83	124	0.041	0.030	7.68	362	59
BH 140	151	30	25.00	108	0.028	0.021	7.30	333	49

It is seen that the values are within permissible limits (as per IS:456-2000) and so no special treatment for cement/reinforcement steel will be required for foundation concrete.



8.0 POSSIBILITY OF SUBSOIL LIQUEFACTION DUE TO EARTHQUAKE

The project site is located in Seismic Zone-II as per IS 1893 Part-1, 2002. Considering very little soil horizon and predominantly Highly weathered to moderately weathered rock at shallow depth, the possibility of liquefaction is ruled out.

9.0 SUITABILITY OF EXISTING SOIL FOR FILLING AND BACK-FILLING

In general the substrata is characterized by completely to highly weathered rock in the top horizon followed by fresh rock continues up to the terminating depth of all the boreholes. However at few locations, stiff silty clay/clayey silt layer is observed up to about 1.5m depth below EGL. So, the excavated soil/weathered rock can be used for filling and backfilling purposes with necessary compaction as required.

10.0 SUITABILITY OF SOIL FOR CONSTRUCTION OF ROADS

The top horizon is very stiff sandy silt/completely weathered rock. So, the soil/weathered rock can be used for filling and backfilling purposes with necessary compaction as required.

11.0 EXCAVATION SLOPE

For excavation in stratum-I a slope of 1(H):1(V) may be used. For excavation in stratum-II & III (i.e. rock layer), vertical or almost vertical slope may be used. However, to be in the safer side, a nominal side slope of 0.5(H):1(V) for stratum-II and 0.25(H):1(V) for stratum-III should be provided.

Excavation in stratum-II & III can be made with shovels and pick-axe. At lower reaches, pneumatic / jack hammer will be more efficient. Alternatively controlled/open blasting may be required.

12.0 EARTH PRESSURE CO-EFFICIENT

The co-efficient of earth pressure at rest is calculated based on the following formula and the following values can be used.

Stratum II		Stratum III	
For $\phi = 30$		For $\phi = 45$	
K_a	$= \tan^2 (45-\phi/2)$	K_a	$= \tan^2 (45-\phi/2)$
	$= 0.33$		$= 0.17$
K_p	$= \tan^2 (45+\phi/2)$	K_p	$= \tan^2 (45+\phi/2)$
	$= 3$		$= 5.82$
K_0	$= 1-\sin\phi$	K_0	$= 1-\sin\phi$
	$= 0.50$		$= 0.29$



13.0 GENERALIZED PROFILE OF VARIOUS SOIL/ROCK LAYERS ENCOUNTERED AT SITE

Based on the bore log details and laboratory test results of soil & rock samples, it has been observed that the entire project area is having more or less same profile and following design parameters are obtained to arrive Net safe bearing capacity of isolated and raft footings.

Stratum I

In general it consists of completely weathered rock to moderately weathered rock up to 1.5m depth below EGL. The core recovery varies from Nil to 96% and RQD in the range of Nil to 81%. However at few locations, stiff silty clay/clayey silt layer is observed up to about 1.5m depth below EGL.

Stratum II

It consists of highly to moderately weathered light grey fine grained rock from 1.5m to 4.50m depth below EGL. The core recovery varies from Nil to 100% and RQD in the range of Nil to 96%

Stratum III

It consists of slightly weathered to Fresh fine grained rock from 4.50m to 20.0m depth below EGL. The core recovery varies from Nil to 100% and RQD in the range of Nil to 100%

13.1 GENERAL SOIL PROFILE AND SAMPLE CALCULATION OF BEARING CAPACITY

Main Plant area covers – PH including, TG, Service building and compressor, Boiler Auxillary boiler, CST tank and pump house, ESP and ESP control room, Chimney and ID fan Area, Transformer yard and DG building, Switch Yard and control room, NDCT 1 &2, NDCT 3,4,5, CWPH and forebay, CW channel, Chlorination and CW treatment plant, side filtration (Unit 1&2) CWPH and forebay, CW channel, Chlorination and CW treatment plant, side filtration (Unit 1&2), CWPH and forebay, CW channel, Chlorination and CW treatment plant, side filtration (Unit 3,4,5), ETP and STP H2 gen and shed, Clarified water tank, fire water tank, clarified cum fire water PH, PT plant, Fire station building, workshop, admin building, AAQMS, canteen, permanent store, gate complex, Raw water reservoir and PH, Fuel oil complex, DM plant and CPU regen, chemical lab, Fuel oil Unloading AAQMS etc.

The general soil profile for calculation of bearing capacity is listed below.

DESIGN UNCONFINED COMPRESSIVE STRENGTH (UCS) IN SATURATED CONDITION AT 2M DEPTH BELOW EGL		
Sl. No.	Bore hole No.	UCS (MPa) in saturated condition
1	BH23	51
2	BH25	20
3	BH33	22
4	BH35	58
5	BH38	55
6	BH46	115
7	BH48	63
8	BH50	53
9	BH51	97
10	BH56	90
11	BH57	49
12	BH63	55
13	BH72	116
14	BH75	24
15	BH81	22
16	BH102	20
17	BH103	119
18	BH112	27
19	BH120	46
20	BH126	125
21	BH129	38
22	BH132	55
23	BH133	43
24	BH141	61
25	BH155	87
26	BH156	22
AVERAGE =		59
Design value of UCS considered = 34 Mpa		

DESIGN UNCONFINED COMPRESSIVE STRENGTH (UCS) IN SATURATED CONDITION AT 3M DEPTH BELOW EGL		
Sl. No.	Bore hole No.	UCS (MPa) in saturated condition
1	BH2	96
2	BH3	43
3	BH4	27
4	BH19	20
5	BH35	54
6	BH39	116
7	BH50	68
8	BH56	114
9	BH78	32
10	BH88	106
11	BH93	25
12	BH96	23
13	BH105	20
14	BH115	26
15	BH120	86
16	BH126	35
17	BH132	33
18	BH141	55
19	BH155	24
20	BH156	34
AVERAGE =		52
Design value of UCS considered = 40 Mpa		

DESIGN UNCONFINED COMPRESSIVE STRENGTH (UCS) IN SATURATED CONDITION AT 4M DEPTH BELOW EGL		
Sl. No.	Bore hole No.	UCS (MPa) in saturated condition
1	BH2	83
2	BH4	50
3	BH10	110
4	BH19	20
5	BH41	106
6	BH44	35
7	BH56	114
8	BH56	123
9	BH57	74
10	BH78	55
11	BH82	111
12	BH91	40
13	BH96	23
14	BH102	35
15	BH112	68
16	BH115	88
17	BH120	53
18	BH121	88
19	BH123	133
20	BH130	59
21	BH132	24
22	BH135	26
23	BH141	26
24	BH146	78
25	BH151	32
26	BH156	48
27	BH158	48
AVERAGE =		65
Design value of UCS considered = 55 Mpa		

DESIGN UNCONFINED COMPRESSIVE STRENGTH (UCS) IN SATURATED CONDITION AT 5M DEPTH BELOW EGL		
Sl. No.	Bore hole No.	UCS (MPa) in saturated condition
1	BH2	120
2	BH4	61
3	BH5	147
4	BH15	155
5	BH17	59
6	BH30	172
7	BH32	23
8	BH34	164
9	BH35	68
10	BH48	47
11	BH57	68
12	BH74	24
13	BH75	56
14	BH78	100
15	BH91	30
16	BH93	28
17	BH95	40
18	BH102	48
19	BH119	122
20	BH120	70
21	BH122	109
22	BH130	76
23	BH132	39
24	BH146	48
25	BH151	48
26	BH151	106
27	BH158	79
AVERAGE =		78
Design value of UCS considered = 64 Mpa		

DESIGN UNCONFINED COMPRESSIVE STRENGTH (UCS) IN SATURATED CONDITION AT 6M OR BELOW DEPTH FROM EGL		
Sl. No.	Bore hole No.	UCS (MPa) in saturated condition
1	BH2	29
2	BH6	22
3	BH8	31
4	BH21	23
5	BH29	34
6	BH37	111
7	BH58	24
8	BH60	90
9	BH61	114
10	BH62	115
11	BH67	106
12	BH71	98
13	BH80	77
14	BH91	109
15	BH97	58
16	BH104	85
17	BH110	40
18	BH115	112
19	BH117	154
20	BH127	25
21	BH130	28
22	BH144	60
23	BH146	38
24	BH148	79
25	BH161	162
AVERAGE =		86
Design value of UCS considered = 70 Mpa		

13.2 SUMMARY OF DESIGN VALUE FOR BEARING CAPACITY CALCULATION

Existing Ground Level (EGL): varies

Stratum	Description	Depth below EGL (m)	Thickness of layer (m)	SPT N value	CR (%)	RQD (%)
I	Very stiff sandy silt/completely weathered rock	EGL to 1.50 m	1.5	>100	-	-
II	Highly to moderately weathered light grey fine grained rock having UCS value 340 kg/sqcm at 2m, 400 kg/sqcm at 3m and 550 kg/sqcm at 4m depth below ground level.	1.50 m to 4.5 m	3.0	-	NIL to 100	NIL to 96
III	Moderately to slightly weathered fine grained rock having UCS value 640 kg/sqcm 5m and 700 kg/sqcm below or 6m depth below ground level.	4.5 m to 20.0 m	15.5	-	NIL to 100	31 to 100

13.3 SAMPLE CALCULATION OF BEARING CAPACITY**BEARING CAPACITY CALCULATION BASED ON CORE STRENGTH OF ROCK MASS**

As per IS 12070:1987, Clause 6

For rock mass with favourable characteristics:

- 1 rock surface is parallel to the base of the foundation
- 2 load has no tangential component
- 3 rock mass has no open discontinuities

$$q_s = q_o * N_j$$

Where,

q_s = safe bearing pressure (gross)

q_o = average uniaxial compressive strength of rock cores

N_j = empirical coefficient depending on the spacing of discontinuities

$$N_j = \frac{3+S/B_t}{10 \sqrt{(1 + 300 \delta/S)}}$$

δ = thickness of discontinuities = 1 cm

S = spacing of discontinuities = 30 cm

B_t = footing width considered = 1000 cm

$N_j = (3+30/1000) / (10 * \text{SQRT}(1+300*1/30)) = 0.0914$

Relationship valid for rock mass with:

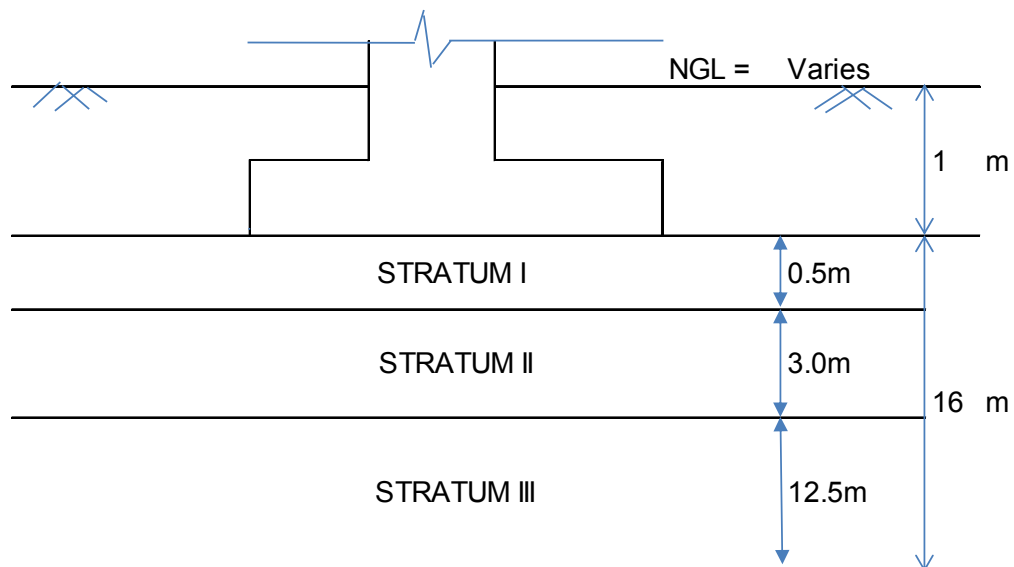
- 1 spacing of discontinuities greater than 0.3m = 30cm
- 2 aperture (opening) of discontinuities less than 10mm
(15mm filled with soil or rock debris)
- 3 foundation width greater than 0.3m = 30cm

Considerations for correction factors			
1	Submergence =	c_1	0.5
2	Cavity =	c_2	0.5
3	Slope =	c_3	0.5

Sl. No	Depth of footing below EGL (m)	UCS (q_o) (kg/cm ²)	$q_s = q_o * N_f$ (kg/cm ²)	Net safe bearing capacity ($q_{ns} = q_s * c_1 * c_2 * c_3$) (kg/cm ²)	Net safe bearing capacity, q_{ns} (t/m ²)
1	2	340	31.062	3.883	38.8
2	3	400	36.543	4.568	45.7
3	4	550	50.247	6.281	62.8
4	5	640	58.469	7.309	73.1
5	6 m or above	700	63.951	7.994	79.9

BEARING CAPACITY CALCULATION BASED ON RMR METHOD FOR ROCK STRATA FOR MAIN PLANT AREA														
Depth (m)	UCS (MPa)	Rating for Compressive Strength	RQD (%)	Rating for Drilling Quality	Spacing of Discontinuity m	Rating for Spacing	Oreintation of Discontinuity	Rating for Oreintation	Condition of Discontinuity	Rating for Condition	Ground water Condition	Rating for Ground water	RMR Value	SBC T/m2
		1		2		3		4		5		6	Col (1+2+3+4+5+6)	
			To											
1.0														
2.0	34	4	0 - 25	3	0.06 - 0.2	8	Fair	-7	*slickened	10			25	66
3.0	40	4	0 - 25	3	0.06 - 0.2	8	Fair	-7	*slickened	10	wet	7	25	66
4.0	55	7	0 - 25	3	0.06 - 0.2	8	Fair	-7	*slickened	10			28	80
5.0	64	7	0 - 25	3	0.06 - 0.2	8	Fair	-7	*slickened	10			28	80
6.0 or below	70	7	0 - 25	3	0.06 - 0.2	8	Fair	-7	*slickened	10			28	80
*slickened = Slickensided wall rock surface or 1-5mm thick guage or 1-5mm wide opening, continuous discontinuity														

*sickened = Slickensided wall rock surface or 1-5mm thick guage or 1-5mm wide opening, continuous discontinuity

BEARING CAPACITY CALCULATION BASED ON SHEAR CRITERIA

LENGTH OF FOOTING = 10.0 m
 WIDTH OF FOOTING = 8.0 m
 DEPTH OF FOOTING = 1.0 m

Shear: General Failure

Dim:

L= 10.0 m
B= 8.0 m
Df = 1.0 m (Depth of the Footing)
Dw= 0.0 m (Depth of Water Table)
 α = 0.0 deg (Incl of Load to the Vertical)
 γ = 1.0 T/m³ (submerged unit weight)
q= 1.0 T/m² (Surcharge)
N= 100.0 (SPT)
 Φ = 34.0 deg
 Φ' = 34.0 deg
Cu = 0.0 T/m² (Cohesion)

B.C. Factors

Nc = 42.92
Nq = 30.3
N γ = 42.9 **N Φ = 3.5**

Shape Factors Rectangle

Sc = 1.16
Sq = 1.16
Sy = 0.68

Depth Factors

$$d_c = 1.0$$

$$d_q = 1.0$$

$$d_y = 1.0$$

$$W' = 0.5$$

water table correction

Inclination Factor

$$i_c = 1$$

$$i_q = 1$$

$$i_y = 1$$

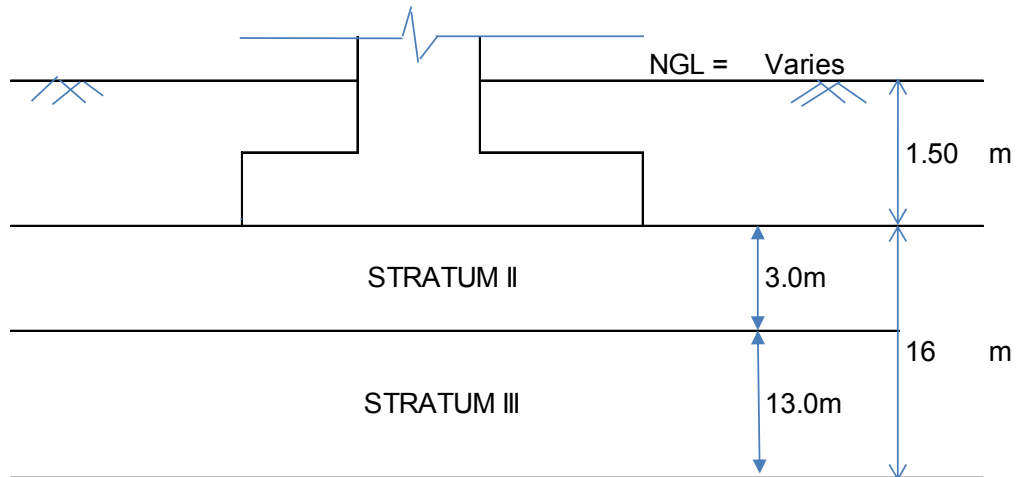
$$UNBC = cN_c S_{cd} i_c + q(N_q - 1) S_{qd} i_q + 0.5 B \gamma N_y S_{dy} i_y w$$

$$UNBC = 95$$

$$F.S = 2.5 \quad NSBC = 38 \quad T/sqm$$

$$NSBC \text{ from shear} = 38.00 \quad T/sqm$$

SETTLEMENT CALCULATION																	
Total settlement (Δ) = Immediate settlement of Stratum I + Immediate settlement of Stratum II &																	
NSBC (from Shear) = 25 T/m^2																	
Settlement of stratum I (Δh) ₁ = q ₁ * B' * (1-μ')^2 * m' * l _s * l _r / E																	
L (m)	B (m)	L' (m)	B' (m)	H (m)	M (m)	N (m)	x (m)	y (m)	(l _p l _r) / (M' * x * y)	l ₂	μ	l _s	m	q ₁ (t/m^2)	E (t/m^2)	l _r	(Δh) ₁ (m)
10	8	5	4	0.5	1.25	0.125	0.0031	0.006044	0.00316	0.02808	0.5	0.0032	4	25	2875	1	0.8
(Δh) ₁ = 0.0003 m																	
Settlement of stratum II & III (Δh) ₂ = q ₂ * B' * (1-μ')^2 * m' * l _s * l _r / E																	
L' (m)	B' (m)	Z (m)	N' (m)	M' (m)	l _a	q ₁ (t/m^2)	m	q ₂ (t/m^2)	l ₂	μ	l _s	l _r	(Δh) ₂ (m)				
5	4	0.5	10	8	0.13	25	4	13									
L (m)	B (m)	L' (m)	B' (m)	H (m)	M (m)	N (m)	x (m)	y (m)	(l _p l _r) / (M' * x * y)	l ₂	μ	l _s	m	q ₂ (t/m^2)	E (t/m^2)	l _r	(Δh) ₂ (m)
10	8	5	4	15.5	1.25	3.875	0.48947	0.740113	0.43034	0.04736	0.25	0.4619	4	13	20160	1	0.8
(Δh) ₂ = 0.00357 m																	
TOTAL SETTLEMENT ((Δh) ₁ + (Δh) ₂) = 3.84 mm																	
l _r =Rigidity factor																	
q ₁ =foundation pressure																	
l _s =influence factor																	
l _r =depth factor (from fig. 12 of IS 8009, Part I)																	
μ=poissons ratio																	
q ₂ (pressure intensity at top of layer 2)=q ₁ * l _a * m , where l _a is an another influence factor .																	
E= Modulus of Elasticity for rock (from geotechnical investigation report)= 20160 T/m^2																	
E= Modulus of Elasticity for sand (from Table 5-6 of Joseph E Bowles book for saturated sand, refer annexure) = 25(N+15) T/m^2 25(100+15)= 2875 T/m^2																	

BEARING CAPACITY CALCULATION BASED ON SHEAR CRITERIA

LENGTH OF FOOTING = 10.0 m
 WIDTH OF FOOTING = 8.0 m
 DEPTH OF FOOTING = 1.5 m

Shear: General Failure

Dim:

L= 10.0 m
B= 8.0 m
Df= 1.5 m (Depth of the Footing)
Dw= 0.0 m (Depth of Water Table)
 α = 0.0 deg (Incl of Load to the Vertical)
 γ = 1.0 T/m³ (submerged unit weight)
q= 1.5 T/m² (Surcharge)
N= 100.0 (SPT)
 Φ = 34.0 deg
 Φ' = 34.0 deg
Cu = 0.0 T/m² (Cohesion)

B.C. Factors

Nc = 42.92
Nq = 30.3
N γ = 42.9 **N Φ = 3.5**

Shape Factors Rectangle

Sc = 1.16
Sq = 1.16
Sy = 0.68

Depth Factors

$$d_c = 1.1$$

$$d_q = 1.0$$

$$d_y = 1.0$$

$$W' = 0.5$$

water table correction

Inclination Factor

$$i_c = 1$$

$$i_q = 1$$

$$i_y = 1$$

$$UNBC = cN_c S_{cd} i_c + q(N_q - 1) S_{qd} i_q + 0.5 B \gamma N_y S_{dy} i_y$$

$$UNBC = 113$$

$$F.S = 2.5 \quad NSBC = 45 \quad T/sqm$$

$$NSBC \text{ from shear} = 45.00 \quad T/sqm$$

SETTLEMENT CALCULATIONTotal settlement (Δ) = Immediate settlement of Stratum II & III

$$\text{NSBC (from Shear)} = 35 \quad T/m^2$$

$$\text{Settlement of stratum II \& III } (\Delta h) = q \cdot B' \cdot (1 - \mu^2) \cdot m \cdot I_s \cdot I_f \cdot I_r / E$$

L (m)	B (m)	L'	B'	H	M	N	x	y	$(I/p_i)(M^* \cdot l_2^{x+y})$	l_1	μ	l_s	m	q (t/m ²)	E (t/m ²)	I_f	I_r	(Δh) (m)
10	8	5	4	16	1.25	4	0.49626	0.748885	0.43583	0.04609	0.25	0.4666	4	35	20160	1	0.8	0.00972

$$(\Delta h) = 0.00972 \text{ m}$$

SETTLEMENT (Δh)

$$= 9.72 \text{ mm}$$

I_r = Rigidity factor
 q_i = foundation pressure
 C_i = influence factor
 N = depth factor (from fig. 12 of IS 8009, Part I)
 μ = poisons ratio
 E = Modulus of Elasticity for rock (from geotechnical investigation report) =

$$20160 \quad T/m^2$$

14.0 SUMMARY & CONCLUSIONS

Based on the field and laboratory tests and the foregoing discussion the following are summarised.

1. In general, the substrata is characterized by completely to highly weathered rock in the top horizon followed by fresh rock continues up to the terminating depth of all the boreholes. However, at few locations, stiff silty clay/clayey silt layer is observed up to about 1.5m depth below EGL.
2. The standing water level was found from 2.0m to 6.50m depth below existing ground level. However, in some borehole water table is not encountered.
3. Considering the sub strata condition and the proposed structure to be constructed at the present site, it is suggested to go for open foundation.
4. The area wise bore holes and their Existing ground levels with FGL are presented below:

Sr. No.	Structure/Area	Bore Hole Nos.	EGL in RL (m)	FGL in RL (m)
1.	Power House & TG Unit-1 and Compressor House	BH-30,31 & 36	76.0	81.0
2.	Power House & TG Unit-2, CCR-1 and Service Building	BH-24,32,33,34,35 & 37	79.0	81.0
3.	Power House & TG Unit-3, Canteen building and Compressor House	BH-89,90,91 & 96	83.0	81.0
4.	Power House & TG Unit-4 and CCR-2	BH-79,92,93 & 97	83.5	81.0
5.	Power House & TG Unit-5, CCR and Simulator cum training building	BH-82,94,95 & 98	84.5	81.0
6.	Boiler and Mill Bunker building Unit-1	BH-15,16,19,21,22, 23 & 28	77.0	81.0
7.	Boiler and Mill Bunker building Unit-2	BH-17,18,20,25,26 & 29	79.0	81.0
8.	Boiler and Mill Bunker building Unit-3	BH-67,68,69,77,78 & 86	80.5	81.0
9.	Boiler and Mill Bunker building Unit-4	BH-70,71,74,80,81 & 87	82.5	81.0
10.	Boiler and Mill Bunker building Unit-5	BH-72,73,75,83,84 & 88	84.5	81.0
11.	FD & PA Fan Unit-1	BH-13	77.5	81.0
12.	FD & PA Fan Unit-2	BH-14	78.25	81.0
13.	FD & PA Fan Unit-3	BH-64	81.0	81.0
14.	FD & PA Fan Unit-4	BH-65	83.0	81.0
15.	FD & PA Fan Unit-5	BH-66	85.0	81.0



Sr. No.	Structure/Area	Bore Hole Nos.	EGL in RL (m)	FGL in RL (m)
16.	ESP, ESP Control Room & Vacuum Pump House Unit-1&2 and CHP Pump House	BH-5,6,7,8,9,10,11 & 12	78.0	81.0
17.	ESP, ESP Control Room & Vacuum Pump House Unit-3 and AHP Compressor House	BH-51,55,57 & 61	80.5	81.0
18.	ESP, ESP Control Room and Vacuum Pump House Unit-4	BH-52,58,59 & 62	83.0	81.0
19.	ESP, ESP Control Room and Vacuum Pump House Unit-5	BH-53,54,60 & 63	85.0	81.0
20.	ID Fan Unit-1 and FGD-MCC & Control Room	BH-1	78.8	81.0
21.	ID Fan Unit-2	BH-4	80.0	81.0
22.	ID Fan Unit-3, Auxiliary Boiler and AHP Electrical Building	BH-44	81.5	81.0
23.	ID Fan Unit-4 and FGD-MCC & Control Room	BH-47	84.0	81.0
24.	Chimney Unit-1&2, Absorber and Gypsum Dewatering building	BH-2 & 3	78.8	81.0
25.	Chimney Unit-3&4, Absorber and Gypsum Dewatering building	BH-45 & 46	81.5	81.0
26.	Chimney, ID Fan Unit-5 and Absorber	BH-48 & 49	85.0	81.0
27.	Transformer yard Unit-1 & 2 and DG building	BH-40,41,42 & 43	75.5	81.0
28.	Transformer yard Unit-3,4 & 5, DG building and Overhead Tank	BH-99,100,101,102,103, 105, 106 & 107	83.5	81.0
29.	Switch yard Unit-1 & 2 and Switch yard control room	BH-133,138,139 & 140	72.5	78.0
30.	Switch yard Unit-3,4 & 5	BH-134,135,136,137,141& 142	78.0	78.0
31.	NDCT – Unit-1	BH- 113, 115, 116 & 117	81.0	80.0
32.	NDCT – Unit-2	BH- 119,121,123 & 124	78.0	80.0
33.	CW Pump house, Fore bay, Channel, Side stream filtration, Chlorination and CW Treatment plant near NDCT-1&2	BH- 114,118,120 & 122	79.0	80.0



Sr. No.	Structure/Area	Bore Hole Nos.	EGL in RL (m)	FGL in RL (m)
34.	STP near NDCT – 1&2	BH- 126	75.0	80.0
35.	Hydrogen generation plant and Cylinder shed	BH- 125	78.0	80.0
36.	NDCT Unit-3, 4 & 5	BH- 104,128,129,131 & 143	83.0	83.0
37.	CW Pump house, Fore bay, Channel, Side stream filtration, Chlorination & CW Treatment plant near NDCT – 3, 4 & 5 and Ammonia storage shed	BH- 108,132,145, 146 & 148	82.5	83.0
38.	~~PT Plant, Fire water tank & pump house and Clarified water tank & pump house~~	BH- 153,154 ,157 & 162	86.0	83.0
39.	Ash slurry pump house, AHP Compressor house, AHP Electrical building for Unit-4 & 5	BH-85	86.0	83.0
40.	Workshop, Store and Weigh Bridge	BH-152,155 & 159	80.5	78.0
41.	Fire station building, Canteen and Admin building	BH-158 & 160	80.0	78.0
42.	Gate complex cum Security building	BH-163	76.5.0	78.0
43.	CST Tank & pump house Unit-1 to 5 and ash slurry pump house Unit-1 to 3,	BH-27 & 76	81.0	81.0
44.	Fuel oil unloading area	BH-109	89.0	85.5
45.	Fuel oil pump house area	BH-110	86.0	85.5
46.	Coal pile run off pond, DM Plant, CPU Regeneration and Chemical lab, PT plant, Clarified water tank	BH-111 & 112	83.5	85.5
47.	Fly ash silo	BH-127	74.0	74.0
48.	Raw water reservoir area	BH-50,56 & 61	81.0	-

5. Minimum depth of foundation shall be 1.0m below EGL in case of soil strata. For rocky strata minimum depth of foundation shall be 0.6m below EGL.

6. The sample calculation for net safe bearing capacity values with various depth of foundation are presented in the previous section. Since the project site is rocky and the sub strata is uniform in nature for all project area, accordingly Net SBC values for open foundations (isolated, strip and raft) are recommended for all areas with respect to EGL and are presented below.

EGL: varies

Sr. No.	Depth of foundation below EGL (m)	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	1	Raft (B >=6 m)		15
3	1.5	Isolated/strip/raft	Weathered rock	25
4	2	Isolated/strip/raft	Rock	35
5	3	Isolated/strip/raft	Rock	40
6	4	Isolated/strip/raft	Rock	55
7	5 m or below	Isolated/strip/raft	Rock	60

Note:

- NSBC = Net Safe Bearing Capacity, EGL = Existing Ground Level and S = Permissible Settlement.
- B = width of foundation
- In case any loose soil is observed at the founding level the same shall be removed and filled up by PCC up to the required founding level.
- Lightly loaded structures having a load intensity up to 5t/sqm may be founded on top of virgin strata/controlled compacted filled up soil.

Structure wise Net SBC recommendations with respect to respective FGL are also presented below

Table-1

Area : Power House & TG Unit-1 and Compressor House

EGL = RL (+) 76.0 M
FGL = RL (+) 81.00 M
EL 0.0 = RL (+)81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	6	(-)6.5	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	6	(-)6.5	Raft (B >=6 m)		15
3	6.5	(-)7.0	Isolated/strip/raft	Weathered rock	25
4	7	(-)7.5	Isolated/strip/raft	Rock	35
5	8	(-)8.5	Isolated/strip/raft	Rock	40
6	9	(-)9.5	Isolated/strip/raft	Rock	55
7	10 m or below	(-)10.5 or below	Isolated/strip/raft	Rock	60

Note:

- NSBC = Net Safe Bearing Capacity, EGL = Existing Ground Level and S = Permissible Settlement.
- B = width of foundation
- In case any loose soil is observed at the founding level the same shall be removed and filled up by PCC up to the required founding level.
- Lightly loaded structures having a load intensity up to 5t/sqm may be founded on top of virgin strata/controlled compacted filled up soil.

Table-2

Area : Power House & TG Unit-2, CCR-1 and Service Building

EGL = RL (+) 79.0 M

FGL = RL (+) 81.00 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	3	(-) 3.5	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	3	(-) 3.5	Raft (B >=6 m)		15
3	3.5	(-) 4.0	Isolated/strip/raft	Weathered rock	25
4	4	(-) 4.5	Isolated/strip/raft	Rock	35
5	5	(-) 5.5	Isolated/strip/raft	Rock	40
6	6	(-) 6.5	Isolated/strip/raft	Rock	55
7	7 m or below	(-) 7.5 or below	Isolated/strip/raft	Rock	60

Table-3

Area : Power House & TG Unit-3, Canteen building and Compressor House

EGL = RL (+) 83.0 M

FGL = RL (+) 81.00 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(-) 1.5	Isolated/strip/raft	Rock	40
2	2	(-) 2.5	Isolated/strip/raft	Rock	55
3	3 m or below	(-) 3.5* or below	Isolated/strip/raft	Rock	60

*For TG foundation NSBC of 60T/m² shall be taken at a depth of 5.0m or below from FGL or EL(-)5.5m or below.

Table-4

Area : Power House & TG Unit-4 and CCR-2

EGL = RL (+) 83.5 M

FGL = RL (+) 81.00 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in case of weathered rock/ rock and 25mm for soil
1	1	(-) 1.5	Isolated/strip/raft	Rock	40
2	2	(-) 2.5	Isolated/strip/raft	Rock	55
3	3 m or below	(-) 3.5** or below	Isolated/strip/raft	Rock	60

****For TG foundation NSBC of 60T/m² shall be taken at a depth of 5.0m or below from FGL or EL(-)5.5m or below.**

Table-5

Area : Power House & TG Unit-5, CCR and Simulator cum training building

EGL = RL (+) 84.5 M

FGL = RL (+) 81.00 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(-) 1.5	Isolated/strip/raft	Rock	55
2	2 m or below	(-) 2.5	Isolated/strip/raft	Rock	60

Table-6
Area : Boiler and Mill Bunker building Unit-1

EGL = RL (+) 77.0 M
FGL = RL (+) 81.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	5	(-) 5.5	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	5	(-) 5.5	Raft (B >=6 m)		15
3	5.5	(-) 6.0	Isolated/strip/raft	Weathered rock	25
4	6	(-) 6.5	Isolated/strip/raft	Rock	35
5	7	(-) 7.5	Isolated/strip/raft	Rock	40
6	8	(-) 8.5	Isolated/strip/raft	Rock	55
7	9 m or below	(-) 9.5 or below	Isolated/strip/raft	Rock	60

Table-7
Area : Boiler and Mill Bunker building Unit-2

EGL = RL (+) 79.0 M
FGL = RL (+) 81.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	3	(-) 3.5	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	3	(-) 3.5	Raft (B >=6 m)		15
3	3.5	(-) 4.0	Isolated/strip/raft	Weathered rock	25
4	4	(-) 4.5	Isolated/strip/raft	Rock	35
5	5	(-) 5.5	Isolated/strip/raft	Rock	40
6	6	(-) 6.5	Isolated/strip/raft	Rock	55
7	7 m or below	(-) 7.5 or below	Isolated/strip/raft	Rock	60

Table-8

Area : Boiler and Mill Bunker building Unit-3

EGL = RL (+) 80.5 M

FGL = RL (+) 81.00 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1.5	(-) 2.0	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	1.5	(-) 2.0	Raft (B >=6 m)		15
3	2.0	(-) 2.5	Isolated/strip/raft	Weathered rock	25
4	2.5	(-) 3.0	Isolated/strip/raft	Rock	35
5	3.5	(-) 4.0	Isolated/strip/raft	Rock	40
6	4.5	(-) 5.0	Isolated/strip/raft	Rock	55
7	5.5 m or below	(-) 6.0 or below	Isolated/strip/raft	Rock	60

Table-9

Area : Boiler and Mill Bunker building Unit-4

EGL = RL (+) 82.5 M

FGL = RL (+) 81.00 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(-) 1.5	Isolated/strip/raft	Rock	35
2	2	(-) 2.5	Isolated/strip/raft	Rock	40
3	3	(-) 3.5	Isolated/strip/raft	Rock	55
4	4 m or below	(-) 4.5*** or below	Isolated/strip/raft	Rock	60

***For Boiler foundation NSBC of 60T/m² shall be taken at a depth of 5.0m or below from FGL or EL(-)5.5m or below.

Table-10
Area : Boiler and Mill Bunker building Unit-5

EGL = RL (+) 84.5 M
FGL = RL (+) 81.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(-) 1.5	Isolated/strip/raft	Rock	55
2	2 m or below	(-) 2.5	Isolated/strip/raft	Rock	60

Table-11
Area : FD & PA Fan Unit-1

EGL = RL (+) 77.5 M
FGL = RL (+) 81.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	4.5	(-) 5.0	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	4.5	(-) 5.0	Raft (B >=6 m)		15
3	5.0	(-) 5.5	Isolated/strip/raft	Weathered rock	25
4	5.5	(-) 6.0	Isolated/strip/raft	Rock	35
5	6.5	(-) 7.0	Isolated/strip/raft	Rock	40
6	7.5	(-) 8.0	Isolated/strip/raft	Rock	55
7	8.5 m or below	(-) 9.0 or below	Isolated/strip/raft	Rock	60

Table-12
Area : FD & PA Fan Unit-2EGL = RL (+) 78.25 M
FGL = RL (+) 81.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in case of weathered rock/ rock and 25mm for soil
1	4	(-) 4.5	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	4	(-) 4.5	Raft (B >=6 m)		15
3	4.5	(-) 5.0	Isolated/strip/raft	Weathered rock	25
4	5	(-) 5.5	Isolated/strip/raft	Rock	35
5	6	(-) 6.5	Isolated/strip/raft	Rock	40
6	7	(-) 7.5	Isolated/strip/raft	Rock	55
7	8 m or below	(-) 8.5 or below	Isolated/strip/raft	Rock	60

Table-13
Area : FD & PA Fan Unit-3EGL = RL (+) 81.00 M
FGL = RL (+) 81.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(-) 1.5	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	1	(-) 1.5	Raft (B >=6 m)		15
3	1.5	(-) 2.0	Isolated/strip/raft	Weathered rock	25
4	2	(-) 2.5	Isolated/strip/raft	Rock	35
5	3	(-) 3.5	Isolated/strip/raft	Rock	40
6	4	(-) 4.5	Isolated/strip/raft	Rock	55
7	5 m or below	(-) 5.5 or below	Isolated/strip/raft	Rock	60

Table-14
Area : FD & PA Fan Unit-4EGL = RL (+) 83.00 M
FGL = RL (+) 81.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(-) 1.5	Isolated/strip/raft	Rock	40
2	2	(-) 2.5	Isolated/strip/raft	Rock	55
3	3 m or below	(-) 3.5 or below	Isolated/strip/raft	Rock	60

Table-15
Area : FD & PA Fan Unit-5EGL = RL (+) 85.00 M
FGL = RL (+) 81.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1 m or below	(-) 1.5 or below	Isolated/strip/raft	Rock	60

Table-16

Area : ESP, ESP Control Room & Vacuum Pump House Unit-1&2 and CHP PH

EGL = RL (+) 78.00 M
FGL = RL (+) 81.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	4	(-) 4.5	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	4	(-) 4.5	Raft (B >=6 m)		15
3	4.5	(-) 5.0	Isolated/strip/raft	Weathered rock	25
4	5	(-) 5.5	Isolated/strip/raft	Rock	35
5	6	(-) 6.5	Isolated/strip/raft	Rock	40
6	7	(-) 7.5	Isolated/strip/raft	Rock	55
7	8 m or below	(-) 8.5 or below	Isolated/strip/raft	Rock	60

Table-17

Area : ESP, ESP Control Room & Vacuum Pump House Unit-3 and AHP Compressor House

EGL = RL (+) 80.50 M
FGL = RL (+) 81.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1.5	(-) 2.0	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	1.5	(-) 2.0	Raft (B >= 6 m)		15
3	2	(-) 2.5	Isolated/strip/raft	Weathered rock	25
4	3	(-) 3.5	Isolated/strip/raft	Rock	35
5	4	(-) 4.5	Isolated/strip/raft	Rock	40
6	5	(-) 5.5	Isolated/strip/raft	Rock	55
7	6 m or below	(-) 6.5 or below	Isolated/strip/raft	Rock	60

Table-18

Area : ESP, ESP Control Room and Vacuum Pump House Unit-4

EGL = RL (+) 83.00 M
FGL = RL (+) 81.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(-) 1.5	Isolated/strip/raft	Rock	40
2	2	(-) 2.5	Isolated/strip/raft	Rock	55
3	3 m or below	(-) 3.5 or below	Isolated/strip/raft	Rock	60

Table-19

Area : ESP, ESP Control Room and Vacuum Pump House Unit-5

EGL = RL (+) 85.00 M

FGL = RL (+) 81.00 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1 m or below	(-) 1.5 or below	Isolated/strip/raft	Rock	60

Table-20

Area : ID Fan Unit-1 and FGD-MCC & Control Room

EGL = RL (+) 78.80 M

FGL = RL (+) 81.00 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. to EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	3.5	(-) 4.0	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	3.5	(-) 4.0	Raft (B >=6 m)		15
3	4.5	(-) 5.0	Isolated/strip/raft	Weathered rock	25
4	5.5	(-) 6.0	Isolated/strip/raft	Rock	35
5	6.5	(-) 7.0	Isolated/strip/raft	Rock	40
6	7.5	(-) 8.0	Isolated/strip/raft	Rock	55
7	8.5 m or below	(-) 9.0 or below	Isolated/strip/raft	Rock	60

Table-21
Area : ID Fan Unit-2EGL = RL (+) 80.00 M
FGL = RL (+) 81.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	2	(-) 2.5	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	2	(-) 2.5	Raft (B >=6 m)		15
3	2.5	(-) 3.0	Isolated/strip/raft	Weathered rock	25
4	3	(-) 3.5	Isolated/strip/raft	Rock	35
5	4	(-) 4.5	Isolated/strip/raft	Rock	40
6	5	(-) 5.5	Isolated/strip/raft	Rock	55
7	6m or below	(-) 6.5 or below	Isolated/strip/raft	Rock	60

Table-22

Area : ID Fan Unit-3, Auxiliary Boiler and AHP Electrical Building

EGL = RL (+) 81.50 M
FGL = RL (+) 81.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(-) 1.5	Isolated/strip/raft	Weathered rock	25
2	1.5	(-) 2.0	Isolated/strip/raft	Rock	35
3	2.5	(-) 3.0	Isolated/strip/raft	Rock	40
4	3.5	(-) 4.0	Isolated/strip/raft	Rock	55
5	4.5 m or below	(-) 5.0 or below	Isolated/strip/raft	Rock	60

Table-23

Area : ID Fan Unit-4 and FGD-MCC & Control Room

EGL = RL (+) 84.00 M

FGL = RL (+) 81.00 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(-) 1.5	Isolated/strip/raft	Rock	55
2	2 m or below	(-) 2.5 or below	Isolated/strip/raft	Rock	60

Table-24

Area : Chimney Unit-1&2, Absorber and Gypsum Dewatering building

EGL = RL (+) 78.80 M

FGL = RL (+) 81.00 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	3.5	(-) 4.0	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	3.5	(-) 4.0	Raft (B >= 6 m)		15
3	4	(-) 4.5	Isolated/strip/raft	Weathered rock	25
4	4.5	(-) 5.0	Isolated/strip/raft	Rock	35
5	5.5	(-) 6.0	Isolated/strip/raft	Rock	40
6	6.5	(-) 7.0	Isolated/strip/raft	Rock	55
7	7.5 m or below	(-) 8.0 or below	Isolated/strip/raft	Rock	60

Table-25

Area : Chimney Unit-3&4, Absorber and Gypsum Dewatering building

EGL = RL (+) 81.50 M
FGL = RL (+) 81.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(-) 1.5	Isolated/strip/raft	Weathered rock	25
2	1.5	(-) 2.0	Isolated/strip/raft	Rock	35
3	2.5	(-) 3.0	Isolated/strip/raft	Rock	40
4	3.5	(-) 4.0	Isolated/strip/raft	Rock	55
5	4.5m or below	(-) 5.0 or below	Isolated/strip/raft	Rock	60

Table-26

Area : Chimney, ID Fan Unit-5 and Absorber

EGL = RL (+) 85.00 M
FGL = RL (+) 81.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1 m or below	(-) 1.5 or below	Isolated/strip/raft	Rock	60

Table-27

Area : Transformer yard Unit-1 & 2 and DG building

EGL = RL (+) 75.50 M
FGL = RL (+) 81.00M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	6.5	(-) 7.0	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	6.5	(-) 7.0	Raft (B >=6 m)		15
3	7	(-) 7.5	Isolated/strip/raft	Weathered rock	25
4	7.5	(-) 8.0	Isolated/strip/raft	Rock	35
5	8.5	(-) 9.0	Isolated/strip/raft	Rock	40
6	9.5	(-) 10.0	Isolated/strip/raft	Rock	55
7	10.5 m or below	(-) 11.0 or below	Isolated/strip/raft	Rock	60

Table-28

Area : Transformer yard Unit-3,4 &5, DG building and Overhead Tank

EGL = RL (+) 83.50 M
FGL = RL (+) 81.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(-) 1.5	Isolated/strip/raft	Rock	40
2	2	(-) 2.5	Isolated/strip/raft	Rock	55
3	3m or below	(-) 3.5 or below	Isolated/strip/raft	Rock	60

Table-29

Area : Switch yard Unit-1 & 2 and Switch yard control room

EGL = RL (+) 72.50 M
FGL = RL (+) 78.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	6.5	(-) 7.0	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	6.5	(-) 7.0	Raft (B >=6 m)		15
3	7	(-) 7.5	Isolated/strip/raft	Weathered rock	25
4	7.5	(-) 8.0	Isolated/strip/raft	Rock	35
5	8.5	(-) 9.0	Isolated/strip/raft	Rock	40
6	9.5	(-) 10.0	Isolated/strip/raft	Rock	55
7	10.5 m or below	(-) 11.0 or below	Isolated/strip/raft	Rock	60

Table-30

Area : Switch yard Unit-3,4 & 5

EGL = RL (+) 78.00 M
FGL = RL (+) 78.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(-) 4.5	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	1	(-) 4.5	Raft (B >=6 m)		15
3	1.5	(-) 5.0	Isolated/strip/raft	Weathered rock	25
4	2	(-) 5.5	Isolated/strip/raft	Rock	35
5	3	(-) 6.5	Isolated/strip/raft	Rock	40
6	4	(-) 7.5	Isolated/strip/raft	Rock	55
7	5 m or below	(-) 8.5 or below	Isolated/strip/raft	Rock	60

Table-31

Area : NDCT – Unit-1

EGL = RL (+) 81.00 M
FGL = RL (+) 80.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(-) 2.5	Isolated/strip/raft	Rock	25
2	2	(-) 3.5	Isolated/strip/raft	Rock	35
3	3	(-) 4.5	Isolated/strip/raft	Rock	40
4	4	(-) 5.5	Isolated/strip/raft	Rock	55
5	5 m or below	(-) 6.5 or below	Isolated/strip/raft	Rock	60

Table-32
Area : NDCT – Unit-2EGL = RL (+) 78.00 M
FGL = RL (+) 80.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	3	(-) 4.5	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	3	(-) 4.5	Raft (B >=6 m)		15
3	3.5	(-) 5.0	Isolated/strip/raft	Weathered rock	25
4	4	(-) 5.5	Isolated/strip/raft	Rock	35
5	5	(-) 6.5	Isolated/strip/raft	Rock	40
6	6	(-) 7.5	Isolated/strip/raft	Rock	55
7	7m or below	(-) 8.5 or below	Isolated/strip/raft	Rock	60

Table-33

Area : CW Pump house, Fore bay, Channel, Side stream filtration, Chlorination & CW Treatment plant near NDCT-1&2

EGL = RL (+) 79.00 M

FGL = RL (+) 80.00 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	2	(-) 3.5	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	2	(-) 3.5	Raft (B >=6 m)		15
3	2.5	(-) 4.0	Isolated/strip/raft	Weathered rock	25
4	3	(-) 4.5	Isolated/strip/raft	Rock	35
5	4	(-) 5.5	Isolated/strip/raft	Rock	40
6	5	(-) 6.5	Isolated/strip/raft	Rock	55
7	6m or below	(-) 7.5 or below	Isolated/strip/raft	Rock	60

Table-34
Area : STP near NDCT – 1&2

EGL = RL (+) 75.00 M
FGL = RL (+) 80.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	6	(-) 7.5	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	6	(-) 7.5	Raft (B >=6 m)		15
3	6.5	(-) 8.0	Isolated/strip/raft	Weathered rock	25
4	7	(-) 8.5	Isolated/strip/raft	Rock	35
5	8	(-) 9.5	Isolated/strip/raft	Rock	40
6	9	(-) 10.5	Isolated/strip/raft	Rock	55
7	10m or below	(-) 11.5 or below	Isolated/strip/raft	Rock	60

Table-35

Area : Hydrogen generation plant and Cylinder shed

EGL = RL (+) 78.00 M

FGL = RL (+) 80.00 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	3	(-) 4.5	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	3	(-) 4.5	Raft (B >=6 m)		15
3	3.5	(-) 5.0	Isolated/strip/raft	Weathered rock	25
4	4	(-) 5.5	Isolated/strip/raft	Rock	35
5	5	(-) 6.5	Isolated/strip/raft	Rock	40
6	6	(-) 7.5	Isolated/strip/raft	Rock	55
7	7m or below	(-) 8.5 or below	Isolated/strip/raft	Rock	60

Table-36

Area : NDCT Unit-3, 4 & 5

EGL = RL (+) 83.00 M

FGL = RL (+) 83.00 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(+) 0.5	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	1	(+) 0.5	Raft (B >=6 m)		15
3	1.5	0.0	Isolated/strip/raft	Weathered rock	25
4	2	(-) 0.5	Isolated/strip/raft	Rock	35
5	3	(-) 1.5	Isolated/strip/raft	Rock	40
6	4	(-) 2.5	Isolated/strip/raft	Rock	55
7	5m or below	(-) 3.5 or below	Isolated/strip/raft	Rock	60

Table-37

Area : CW Pump house, Fore bay, Channel, Side stream filtration, Chlorination & CW Treatment plant near NDCT – 3, 4 & 5 and Ammonia storage shed

EGL = RL (+) 82.50 M

FGL = RL (+) 83.00 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m2) S=12mm in weathered rock/ rock and 25mm for soil
1	1.5	0.0	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	1.5	0.0	Raft (B >=6 m)		15
3	2	(-) 0.5	Isolated/strip/raft	Weathered rock	25
4	2.5	(-) 1.0	Isolated/strip/raft	Rock	35
5	3.5	(-) 2.0	Isolated/strip/raft	Rock	40
6	4.5	(-) 3.0	Isolated/strip/raft	Rock	55
7	5.5m or below	(-) 4.0 or below	Isolated/strip/raft	Rock	60

Table-38

Area : ~~PT Plant, Fire water tank & pump house and Clarified water tank & pump house~~

EGL = RL (+) 86.00 M

FGL = RL (+) 83.00 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m2) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(+) 0.5	Isolated/strip/raft	Rock	55
2	2m or below	(-) 0.5 or below	Isolated/strip/raft	Rock	60

Table-39

Area : Ash slurry pump house, AHP Compressor house, AHP Electrical building for Unit-4 & 5

EGL = RL (+) 86.00 M
FGL = RL (+) 83.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(+) 0.5	Isolated/strip/raft	Rock	55
2	2m or below	(-) 0.5 or below	Isolated/strip/raft	Rock	60

Table-40

Area : Workshop, Store and Weigh Bridge

EGL = RL (+) 80.50 M
FGL = RL (+) 78.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(-) 4.5	Isolated/strip/raft	Rock	40
2	2	(-) 5.5	Isolated/strip/raft	Rock	55
3	3m or below	(-) 6.5 or below	Isolated/strip/raft	Rock	60

Table-41

Area : Fire station building, Canteen and Admin building

EGL = RL (+) 80.00 M

FGL = RL (+) 78.00 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(-) 4.5	Isolated/strip/raft	Rock	40
2	2	(-) 5.5	Isolated/strip/raft	Rock	55
3	3m or below	(-) 6.5 or below	Isolated/strip/raft	Rock	60

Table-42

Area : Gate complex cum Security building

EGL = RL (+) 76.50 M

FGL = RL (+) 78.00 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	2.5	(-) 6.0	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	2.5	(-) 6.0	Raft (B >=6 m)		15
3	3	(-) 6.5	Isolated/strip/raft	Weathered rock	25
4	3.5	(-) 7.0	Isolated/strip/raft	Rock	35
5	4.5	(-) 8.0	Isolated/strip/raft	Rock	40
6	5.5	(-) 9.0	Isolated/strip/raft	Rock	55
7	6.5m or below	(-) 10.0 or below	Isolated/strip/raft	Rock	60

Table-43

Area : CST Tank & pump house Unit-1 to 5 and ash slurry pump house Unit-1 to 3,

EGL = RL (+) 81.00 M

FGL = RL (+) 81.00 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(-) 1.5	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	1	(-) 1.5	Raft (B >=6 m)		15
3	1.5	(-) 2.0	Isolated/strip/raft	Weathered rock	25
4	2	(-) 2.5	Isolated/strip/raft	Rock	35
5	3	(-) 3.5	Isolated/strip/raft	Rock	40
6	4	(-) 4.5	Isolated/strip/raft	Rock	55
7	5m or below	(-) 5.5 or below	Isolated/strip/raft	Rock	60

Table-44

Area : Fuel oil unloading area

EGL = RL (+) 89.00 M

FGL = RL (+) 85.50 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(+) 3.0	Isolated/strip/raft	Rock	55
2	2m or below	(+) 2.0 or below	Isolated/strip/raft	Rock	60

Table-45

Area : Fuel oil pump house area

EGL = RL (+) 86.00 M

FGL = RL (+) 85.50 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m2) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(+) 3.0	Isolated/strip/raft	Rock	25
2	2	(+) 2.0	Isolated/strip/raft	Rock	35
3	3	(+) 1.0	Isolated/strip/raft	Rock	40
4	4	0.0	Isolated/strip/raft	Rock	55
5	5m or below	(-) 1.0 or below	Isolated/strip/raft	Rock	60

Table-46

Area : Coal pile run off pond, DM Plant, CPU Regeneration and Chemical lab

PT plant, Clarified Water tank

EGL = RL (+) 83.50 M

FGL = RL (+) 85.50 M

EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m2) S=12mm in weathered rock/ rock and 25mm for soil
1	3	(+) 1.0	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	3	(+) 1.0	Raft (B >=6 m)		15
3	3.5	(+) 0.5	Isolated/strip/raft	Weathered rock	25
4	4	0.0	Isolated/strip/raft	Rock	35
5	5	(-) 1.0	Isolated/strip/raft	Rock	40
6	6	(-) 2.0	Isolated/strip/raft	Rock	55
7	7m or below	(-) 3.0 or below	Isolated/strip/raft	Rock	60

Table-47

Area : Fly ash silo area

EGL = RL (+) 74.00 M
FGL = RL (+) 74.00 M
EL 0.0 = RL (+) 81.50 M

Sr. No.	Depth of foundation below FGL (m)	Depth of foundation w. r. t. EL 0.0m	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	(-) 8.5	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	1	(-) 8.5	Raft (B >=6 m)		15
3	1.5	(-) 9.0	Isolated/strip/raft	Weathered rock	25
4	2	(-) 9.5	Isolated/strip/raft	Rock	35
5	3	(-) 10.5	Isolated/strip/raft	Rock	40
6	4	(-) 11.5	Isolated/strip/raft	Rock	55
7	5 m or below	(-) 12.5 or below	Isolated/strip/raft	Rock	60

Table-48

Area : Raw water reservoir area

EGL = RL (+) 83.50 M
FGL = N.A.

Sr. No.	Depth of foundation below EGL (m)	Type of foundation	Founding Stratum	Recommended NSBC (T/m ²) S=12mm in weathered rock/ rock and 25mm for soil
1	1	Isolated/strip (B = 1 m to 6 m)	Soil/Weathered rock	15
2	1	Raft (B >=6 m)		15
3	1.5	Isolated/strip/raft	Weathered rock	25
4	2	Isolated/strip/raft	Rock	35
5	3	Isolated/strip/raft	Rock	40
6	4	Isolated/strip/raft	Rock	55
7	5 m or below	Isolated/strip/raft	Rock	60

7. During field investigation, Shale type of rock is encountered at the founding level of following structures/buildings:

S. No.	Building/Structure	Bore hole nos.
1	ID Fan Unit-1	BH-1
2	Chimney Unit-1&2	BH-2
3	ESP Unit-1 & 2	BH-5, BH-6, BH-10 & BH-61
4	Chimney Unit-5	BH-48
5	Boiler & Mill Bunker Unit-4	BH-75 & BH-81
6	Boiler & Mill Bunker Unit-5	BH-84
7	Transformer Yard Unit-3,4 & 5	BH-106
8	CW Pump house near NDCT Unit-1 & 2	BH-114
9	Switchyard Unit-3, 4 & 5	BH-135, BH-136 & BH-137
10	Workshop	BH-152 & BH-155
11	Fire Station	BH-160

In these structures/buildings, while excavating the bottom 500 mm, excavation shall be done just prior to laying of lean concrete. Immediately after excavating down to required depth, lean concrete shall be laid over the excavated surface.

In other places, bottom 300 mm excavation shall be done just prior to laying of lean concrete. Immediately after excavating down to required depth, lean concrete shall be laid over the excavated surface.

8. Chemical tests were carried out on some soil and water samples so as to detect the pH value, Sulphate, Chloride etc. It is seen that the values are within permissible limits. So, no special cement/reinforcement steel will be required for foundation concrete.
9. The sub strata at site consists of silty clay/ completely weathered rock having low swelling properties. So, the excavated soil/weathered rock is suitable for filling and backfilling purposes.



10. Bore logs, Trial Pits (TP), Laboratory test results on soil & rock samples, Standard & Modified proctor test, Chemical test on soil and water samples and CBR test results are presented in volume-II.
11. It is to be noted that roads are to be constructed at FGL level achieved by cutting/filling of the existing strata. Hence lab CBR test on existing soil is not applicable/useful for design of road pavements. For design of road pavements, laboratory CBR tests should be conducted on remoulded soil samples under soaked condition for which soil will be collected from filled up soil/existing ground.
12. Plate load test (PLT), Cyclic plate load test (CPLT), Cross hole shear test (CST), Pressure meter test (PMT), Electrical resistivity test (ERT), Block vibration test (BVT) and Seismic refraction test (SRT) are presented in volume-III.
13. For design of Machine foundations, Cross hole shear test results presented in volume III shall be referred.

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15.0 GEOLOGY

The proposed site for Thermal Power Plant lies over Stage Nandyal shale of Kundair Series in Kurnool System. The Kurnool have been sub-divided into four series, composed mainly of limestones with sub-ordinate shale and sandstones. Outcrops of Kurnool rocks, sometimes called PALNAD SERIES, are developed in Palnad, in the north-east of the Cuddapah basin, stretching on both sides of the Krishna river. They lie unconformable on the Cuddapahs.

GENERAL DESCRIPTION OF ENCOUNTERED ROCK:**Sandstone:**

Sandstone is the abundant rock type encountered within the area of interest. It is essentially composed of quartz with decomposed and altered feldspar and mica as minor constituents; rare dark minerals are not uncommon. Depending on the intensity of weathering the body colour of the rock varies from light grey to brownish grey. The rock is dominantly fine to medium grained, some are very fine; apparently massive and medium spaced bedded. Sometimes thick to moderately thick beds are very thinly inter banded and a few instances shows sets of cross bedding. Grains are mostly sub rounded-to-rounded. Frequently the sandstone contains extremely fine-grained shale clasts of variable sizes and also stringers and layers of it. The orientation of such clasts is dominantly bed parallel. A general trend of fining -up sequence is observed. In general the sandstone is matrix supported, moderately to medium hard, moderately strong (at fresh end), medium to tightly compacted and moderately porous with medium low specific gravity. Depending on weathering the strength parameters also reduced a great extent.

Shale:

The colour of the shale varies depending on degree of weathering though remains reddish brown. Grain size of the rock varies from extremely fine to fine grains contains good amount of silt / very sand size grains particularly at the gradual transition from sandstone to shale. It is very thinly laminated but not cleaved. The shale frequently contains stringers of sand / silt and less frequently clasts of sandstone / siltstone. Mineralogical composition of shale is not identified due to its extreme fine (shale) nature. The rock is soft, densely compacted and depending on degree of weathering it may be weak, usually strong to very strong. Preferably and easily split along the almost horizontal to very low angle ($<5^\circ$) lamination planes. Weathered shale easily breaks under finger pressure or even disintegrates into rock particles when kept in water and at dry conditions the surface of the shale is marked with sun-cracks. Compositionally shale is homogeneous and structurally isotropic but intervention with silt / sand is dominant at some depths. Porosity of the shale is very low and the specific gravity is medium.

Limestone:

The color of the limestone varies depending on degree of weathering though remains white in colour. Limestone consist essentially of calcium carbonate with some magnesium carbonate and quartz grains. Limestones are bedded rock often containing many fossile ; they are readily scratched with a knife , effervesce on the addition of cold dilute hydrochloric acid (except dolomite). They are formed both chemically and organically.

Calcium carbonate is present in the form of crystals (aragonite and calcite) and as amorphouse calcium carbonate , and also as the hard parts of organisms (fossils) such as shells and calcareous skeletons, on their broken fragments.Thus consolidated shells isa limestones by virtue of the calcium carbonate of which the shells are made. Onthe other hand chemically deposited calcium carbonate builds limestone under conditions where water of high alkalinity has restricted circulation as in a shallow sea or lake. Impurities commonly present in limestone include clay, silica in colloidal form or as quartz grains on the other hand detrital grains. Though usually grey or white in colour the rock may be tinted by iron compounds or finely devided carbon or by bitumen.

Quartzite

It is formed by contact or hydrothermal metamorphism. It is composed of quartz grains so firmly cemented that when broken, it fractures through the grains instead of around them.

The colour of the rock varies according to the nature of the impurities, pure impurieties, pure quartzite is white. Quartzite is quite resistant action. It is used for paving blocks and for manufacturing of silica bricks.

STRATIGRAPHY OF THAT REGION:

<u>Series</u>		<u>Stages</u>
Kurnool System	Kundair	Nandyal shale Koikuntla Limestone
	Paniam	Pinnacled quartzites Plateau quartzites
	Jammalamaduga	Aku shales Narji limestone
	Banganapalali	banganapalali sandstone

16.0 REFERENCES

IS : 2131	-	Standard Penetration Test
IS : 2720 Part – II	-	Determination of Moisture Content of soil.
IS : 2720 Part – III	-	Determination of Specific Gravity of Soil.
IS : 2720 Part – V	-	Determination of Liquid Limit and Plastic Limit of Soil.
IS : 2720 Part – VI	-	Determination of Shrinkage Limit of Soil.
IS : 2720 Part – IV	-	Grain Size Analysis of Soil.
IS : 2720 Part – XXVII	-	Determination of Sulphate Content of Soil.
IS : 2720 Part – XXVI	-	Determination of pH Value of Soil.
IS : 3025 Part – 24	-	Determination of Sulphate Content of Water.
IS : 3025 Part – 32	-	Determination of Chloride Content of Water.
IS : 1498 – 1970	-	Indian Classification system.
IS : 8009 Part – I	-	Calculation of settlements of foundations for shallow foundations subjected to symmetrical static vertical loads.
IS : 6403 -1981	-	Determination of bearing capacity of shallow foundations
BIS 13030 : 1991	-	Determination of Water Absorption and Porosity on Rock
BIS 13030 : 1991	-	Determination of Unit weight of Rock.
Dr. N. V. Nayak	-	Foundation Manual



17.0 ANNEXURES:

Equations for stress-strain modulus E_s by several test methods

E_s in kPa for SPT and units of q_c for CPT; divide kPa by 50 to obtain ksf. The N values should be estimated as N_{55} and not N_{70} . Refer also to Tables 2-7 and 2-8.

Soil	SPT	CPT
Sand (normally consolidated)	$E_s = 500(N + 15)$ $= 7000 \sqrt{N}$ $= 6000N$ $— — —$ $\dagger E_s = (15\,000 \text{ to } 22\,000) \cdot \ln N$	$E_s = (2 \text{ to } 4)q_u$ $= 8000 \sqrt{q_c}$ $— — —$ $E_s = 1.2(3D_r^2 + 2)q_c$ $*E_s = (1 + D_r^2)q_c$
Sand (saturated)	$E_s = 250(N + 15)$	$E_s = Fq_c$ $e = 1.0 \quad F = 3.5$ $e = 0.6 \quad F = 7.0$
Sands, all (norm. consol.)	$\P E_s = (2600 \text{ to } 2900)N$	
Sand (overconsolidated)	$\dagger E_s = 40\,000 + 1050N$ $E_{s(OCR)} \approx E_{s,nc} \sqrt{OCR}$	$E_s = (6 \text{ to } 30)q_c$
Gravelly sand	$E_s = 1200(N + 6)$ $= 600(N + 6) \quad N \leq 15$ $= 600(N + 6) + 2000 \quad N > 15$	
Clayey sand	$E_s = 320(N + 15)$	$E_s = (3 \text{ to } 6)q_c$
Silts, sandy silt, or clayey silt	$E_s = 300(N + 6)$ If $q_c < 2500$ kPa use $\S E'_s = 2.5q_c$ 2500 < q_c < 5000 use $E'_s = 4q_c + 5000$ where $E'_s = \text{constrained modulus} = \frac{E_s(1 - \mu)}{(1 + \mu)(1 - 2\mu)} = \frac{1}{m_v}$	$E_s = (1 \text{ to } 2)q_c$
Soft clay or clayey silt		$E_s = (3 \text{ to } 8)q_c$

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

GENERAL SPECIFICATION

FOR

**ERECTION, COMMISSIONING, PG TEST & HANDING OVER
OF WATER SYSTEM PACKAGES
YADADRI 5x800MW**

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1.0 **SCOPE OF WORK ON SERVICES**

The scope of Erection and Commissioning services covers erection, commissioning of Water treatment system which comprises of receipt of materials & equipment at site, unloading, storage, transportation to erection spot, erection of complete system including site fabrication, stage clearance, testing, commissioning, Performance Guarantee Test, handing over of the system.

NOTE

- I. Successful commissioning means, erection of entire system, trial run / trial operation till achieving the performance, both in terms of Quality (including electrical power consumption) and Quantity to prove the agreed performance of the system and the system is ready for PG Test. Once this stage is reached, Bidder will inform to BHEL that they are ready for PG Test. If BHEL's & Customer's Engineer is satisfied in commissioning, PG test can be conducted within 30 days from the date of such notification by Bidder to BHEL and till such time the running of the system to be taken care of by the Bidder. Conduct of PG Test shall be the responsibility of the Bidder. Necessary consumables and chemicals required for the trial run / trial operation till PG Test shall be followed as specified elsewhere in the Tender specification. In case of chemical supply by BHEL, Bidder to intimate the same to BHEL well in advance (min. 4 months) before commissioning. In case, supply of Chemicals is in Bidder's scope, Bidder to ensure the readiness of consumables and chemicals before commissioning. Further any testing chemicals for testing / calibration of instruments, consumables required for PG test shall also be ensured 4 months' in advance before commissioning, failing which the Bidder has to take the responsibility of providing the same without any commercial implication.
- II. The equipment after inspection at manufacturer's works shall be transported to BHEL site and shall be received, unloaded and stored by Bidder as detailed in the supply specification and commercial terms of the tender. Bidder shall store all high value items & critical items (such as instruments, UPS, battery, etc.) under lock & key, using containers only. The applicable materials shall be drawn from Bidder stores as per the relevant procedure. The equipment shall be erected sequentially and shall be interconnected with the applicable piping and valve system. Necessary hydraulic testing of piping, valves etc. shall also be carried out as per supply specification. Necessary pump, blind-flanges, fasteners etc. required for the hydraulic testing are in Bidder's scope.

The scope of major equipment covered for the erection & commissioning of the Water treatment system at site is covered in Technical Specification.

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Apart from the scope mentioned in Technical specification, the foundation grouting materials including foundation fasteners, packing shims and final grouting shall be in the scope of bidder.

The quantity and the details given are only indicative. However, the bidder shall supply required quantity to fully cater to the system requirement and carry out the erection of all the items to meet the system requirement as complete without any commercial implication to BHEL.

- 2.0 The Intent of this specification is to provide erection, commissioning & trial operation services for execution of projects according to most modern and proven techniques and codes. It is not the intent to specify completely herein, all aspects of the entire system. Nevertheless, the entire system shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation. The contract services towards installation of the Plant shall not relieve the contractor of the responsibility of providing such services, facilities to complete the project of portion of project awarded to him. The quoted rate shall deem to be inclusive of all such contingencies.
- 3.0 The Contractor shall carry out the work in accordance with instructions/ drawings/ specification/ standard practices provided / approved by BHEL from time to time.
- 4.0 Modification / Rectification / repair / replacement of defective components if any shall be under bidder's scope within specified time.
- 5.0 Bidder to submit the erection schedule along with stage check data sheets. Each and every stage the bidder to get clearance from the BHEL Engineer / Consultant Engineer / Customer Engineer.
- 6.0 Establish the site co-ordination for identification of materials, storing and issue of materials, stage clearance for erection & commissioning.
- 7.0 Identification of consignment at Bidders stores, verification of the same in the presence BHEL official, taking delivery, co-ordination for the movement from store to erection work, safe custody, erection, commissioning and trial operation.
- 8.0 All the equipment and materials shall be stored at Bidder's store. Field storage quality plan shall be submitted for BHEL approval. It shall be the responsibility of the Bidder to take delivery from their stores and transport the same to the site. Bidder shall take fully responsibility for the custody of the supplied material till the handing over of the complete system to the end Customer. Bidder to arrange the necessary Insurance for the materials during storage, erection & commissioning, and up to handing over.

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- 9.0 Necessary clearance for stage check, hydraulic test, leak check obtained from the customer engineer & pre – commissioning tests shall be carried out by the bidder.
- 10.0 Commissioning and putting into satisfactory operation of all the equipment at site including successful completion of trial operation and handing over of the system to the end user.
- 11.0 Finish coat (final coat) for all the equipment before hand over of the system to BHEL/Customer as per painting specification.
- 12.0 The responsibility of making the system complete in all respects, including the shortage of materials shall be with the Bidder (as Bidder is the Custodian for the material at site till handing over of the plant)

13.0 EXCLUSIONS

The following are excluded from the scope of supplier and will be arranged by BHEL

- 13.1 All civil works pertaining to Water treatment system.
- 13.2 Service water/ construction water at one point near Water treatment system
- 13.3 Construction power supply at one point near Water Treatment System
- 13.4 Supply of service / instrument air at one point as applicable
- 13.5 Bidder shall provide the shipping list with details of dispatchable units. The requirement shall be specified by the bidder in their technical offer and the supply shall be limited to the specified quantities.

14.0 Specification, Standards & Codes:

All equipment shall be designed, tested and supplied as per the specification, relevant national / international standards & statutory codes.

15.0 Name plates, labels and directional marks:

Each equipment shall be provided with nameplate details designating the tag no., service of the item etc. Necessary directional arrow marks shall be provided.

16.0 Tools and Tackles:

All the Tools & tackles required for the complete erection of components shall be arranged by the contractor at his cost. The bidder shall have & own a complete set of special tools and tackles required for erection, assembly, disassembly and maintenance. The bidder shall also supply any special tools and tackles that may

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be required additionally during commissioning. All tools & tackles shall be of reputed make acceptable to the Purchaser and shall be handed over to BHEL after the completion of erection & commissioning.

17.0 Commissioning Consumables / Spares:

The bidder shall supply all consumables like lubricating oil, Teflon tape, m-seal, cotton waste, tissue paper roll, sampling bottles, mugs, buckets etc required for commissioning the equipment.

The bidder shall consider sufficient quantity of the commissioning spares so that the commissioning of the system will not be delayed. The bidder shall also supply any spare components that may be required additionally during commissioning. These commissioning spares shall be included in the basic scope of supply.

18.0 Inspection & Testing:

All the stage checks & materials shall be offered to BHEL / Customer/ BHEL'S authorized representative for inspection. No material shall be dispatched without obtaining written clearance from BHEL. During inspection, the internal inspection reports shall be submitted to BHEL / customer for information.

19.0 Packing & Dispatch:

- 19.1 All equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at site, till the time of erection. Each packing shall have necessary handling marks
- 19.2 Each packing shall contain a packing slip indicating the details of item like item description, quantity, weight etc.
- 19.3 Details of handling & Storage instruction shall also be provided in each packing.
- 19.4 All items shall be properly packed with adequate cushioning material to prevent damages due to rough handling and inland transport. The packing shall be in such a way so as to avoid seepage of water into the packing.
- 19.5 Special care shall be given to prevent damage to the fragile components.

20.0 Additional requirements

- 20.1 After completion of all erection and commissioning works, the left out items shall be handed over to BHEL site stores.

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20.2 During commissioning at site some smaller equipment may get added or Logics may have to be changed. The bidder shall carryout these changes at site without any commercial implications to BHEL.

21.0 GENERAL INSTRUCTIONS TO THE BIDDER

21.1 Bidder shall quote for complete work specified in the document. Incomplete quotations for the part of the work will not be considered even if the quoted rates/price is lower.

21.2 Bidder shall contact BHEL and obtain additional details/data if any required to submit proper quotation.

21.3 The BHEL reserves the right to omit any one or more items of work at any time of the contact without assigning any reason what so ever.

21.4 The Bidder shall include all necessary commissioning spares in his basic scope of supply and the left out spares shall be handed over to BHEL after the completion of E & C.

21.5 Adequate lighting facilities such as low volt hand lamps shall be arranged by the contractor at the site of construction etc. at his cost.

21.6 All the lifting tackles including wire ropes, slings, shackles and electrically operated equipment shall be produced for inspection by BHEL Engineer before they are actually put on use. Test certificate obtained from the statutory authority should be submitted before their usage.

21.7 All equipment so used by contractor shall be of proven quality and safe for operation as approved by BHEL Site Engineers from time to time.

21.8 At periodic / intervals of work, complete and detailed account of the equipment so erected shall be submitted to the BHEL Engineer. The required format shall be submitted to BHEL Officials for approval.

21.9 All equipment shall be handled very carefully to prevent any damage and loss. No bare wire ropes, slings etc., shall be used for unloading and / or handling of equipment without the specific written permission of the BHEL engineer. The equipment from Bidder's storage yard shall be moved to the actual site of erection / location at the appropriate time as per the direction of BHEL Engineer so as to avoid damage for such equipment at site.

21.10 The nature of work covered under the specification is highly sophisticated, requiring best quality / precision workmanship, engineering and construction management. Contractor should also ensure successful and timely commercial

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operation of equipment installed. The contractor must have adequate quantity of precision tools, construction aids in possession. Contractor must also have adequate trained qualified and experienced supervisory staff and skilled personnel.

- 21.11 All the necessary certificates, licenses, and statutory clearances required to carry out this scope of work are to be arranged by the contractor then and there, at no extra cost.
- 21.12 When the work is temporarily suspended contractor shall protect all construction materials equipment and facilities from causing damage to existing property interfering with the operations of the station when it goes into services. The contractor shall comply with all applicable provisions of the safety regulations clean – up programme and other precautionary measures which the BHEL has in effect at the site.
- 21.13 It will be the responsibility of the contractor to ensure the safe lifting of the equipment taking due precautions to avoid any accidents and damage to other equipments and personnel.
All piping shall be adequately supported and protected to prevent damage during handling and erection.
- 21.14 Sometimes it may become necessary for the contractor to handle certain un-required components in order to take out the required materials. The contractor has to take this contingency also into account. No extra payment is payable for such contingencies.
- 21.15 It shall be contractor's responsibility to arrange for required labour, brush, paint and other consumable like thinner, cotton waste, cloth etc., for carrying out preservative painting. The quoted rates shall be inclusive of above work.
- 21.16 Due to atmospheric conditions erected materials are likely to get rusted more frequently. It is the responsibility of the contractor to preserve the erection materials drawn from their stores for erection till these are commissioned and handed over to customer. The required paint, thinner all other consumables like painting brush, emery paper, cotton waste, cloth etc., have to be arranged by the contractor at his cost. The contractor should ensure that the materials are not rusted on any account till they are handed over to customer. The decision of the BHEL Engineer is final with regard to adequacy of application of paint.

22.0 SITE CLEANLINESS AND SAFETY REQUIRMENTS:

- 22.1 Contractor shall strictly follow all safety regulations / conditions as per general conditions of contract booklet enclosed with this tender.

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- 22.2 Non – conformity of safety rules and safety appliances will be viewed seriously and the BHEL has right to impose fines on the contractor as under.
- 22.3 Contractors shall ensure that the quality is maintained in all the works connected with this contract at all stages of the requirement of BHEL.
- 22.4 Contractor shall ensure that all Inspection, Measuring and Testing equipment that are used, whether owned by the contractor or used on loan, are calibrated by the authorized agencies and the valid calibration certificate will be available with them for verification by BHEL. A list of such instruments possessed by contractor at site with its calibration status is to be submitted to BHEL Engineer for control.
- 22.5 Contractors shall arrange for the inspection of the works at various stages as required by BHEL. Immediate corrective action shall be taken by the contractor for the non-conformances if any, observed and pointed out by BHEL.

23.0 PAYMENT TO CONTRACTORS

- 23.1 All payment due to the contractors shall be paid by “E-payment” only.
- 23.2 All recoveries due from the contractor shall be effected in full from his bills unless specific approval from the competent authorities is obtained otherwise.
- 23.3 The bill shall be prepared in the proforma prescribed for the purpose based on the certificate issued by BHEL Engineer that entire work as stipulated in the tender specification has been completed in all respects to the entire satisfaction of BHEL. Contactor shall give unqualified “No Due” and “No Demand” certificates. Quantities / Weight erected shall be prepared and paid as per agreed payment terms. The quantities and financial value shall be entered in Measurement Book and signed by both the parties to the contract.

24.0 OTHER STATUTORY REQUIREMENTS:

- 24.1 Contractor shall follow & adhere to all the statutory & safety laws, rules & regulations for labour deployed in executing erection works as amended time to time.
- 24.2 Principle employer’s security rules & regulations are to be followed by the contractor scrupulously in executing the contract works.
- 24.3 Contractor shall also adhere to the requirements of the principle employer in respect of minimum wages, provident fund, insurance, etc. as applicable to the contract labour.

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24.4 Contractor should get the clearance from the principle employer (TSGENCO) & BHEL for wages etc. paid to the labour submitting the necessary proof for the same. Suitable records to be maintained by the contractor for a minimum of 3 years.

24.5 The contractor shall submit a copy of labour license obtained from the licensing Officer.

24.6 The contractor shall submit monthly running bills along with the copies of monthly wages (of the preceding month) as per contract labour rules, copies of monthly return of PF contribution with remittance challans and copy of renewed WC insurance policy or copies of monthly return of ESI contribution with challans (if applicable) in respect of the workmen engaged by them.

24.7 It is advisable that Contractor shall visit the site to have adequate knowledge of all the above rules & regulations before bidding for the tender. No claim shall be entertained for any ignorance of the above rules & regulations during execution of work.

24.8 BHEL shall have the right to with-hold suitable amounts from contractor bills for not making payments to labour engaged by them and not adhering to the statutory, safety rules & regulations till the contractor complies with them.

25.0 TIME OF COMPLETION

25.1 The time schedule as prescribed in the contract is the essence of the contract. The time for completion shall always be reckoned from the date of commencement of work as certified by the BHEL Engineers.

25.2 The entire work shall be completed by the contractor with in the time schedule or within the such extended time as may be allowed under relevant clause.

26.0 ENGAGEMENT OF LABOUR

26.1 The contractor will be directly responsible for provision of health and sanitary arrangements more particularly described in contract labour (regulations & Abolition) Act, safety precautions etc., as may be required for safe and satisfactory execution of the contract.

26.2 The contractor shall be responsible for proper accommodation including adequate medical facilities & transportation to the work spot and back for the personnel employed by him.

General Specification extract from TSGENCO

Following details are general specification requirements from TSGENCO which are to be met.

1. Technical specification for Pressure & storage vessels
2. Technical specification for piping, fittings and valves
3. Technical specification for Horizontal centrifugal pumps
4. Technical specification for Vertical centrifugal pumps
5. Technical specification for Positive displacement pumps
6. Technical specification for screw pumps
7. Sump pumps, drives and accessories
8. Extract from ETP specification from Kothagudam 1x800MW is attached. This document shall be referred for design conditions only. For scope of supply, working & standby equipment, please refer to Approved Design memorandum & P&ID attached with the specification (Annexure-6)

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SECTION-VII

**TECHNICAL SPECIFICATION
FOR
PRESSURE AND STORAGE VESSELS**

SECTION-VII

**TECHNICAL SPECIFICATION
FOR
PRESSURE AND STORAGE VESSELS**

C O N T E N T S

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SECTION-VII

TECHNICAL SPECIFICATION FOR PRESSURE AND STORAGE VESSELS

1.00.00 INTENT OF SPECIFICATION

This specification covers the design, manufacture, shop testing, shop testing, construction, fabrication, erection, testing, inspection & commissioning of pressure and storage vessels at works & site.

2.00.00 CODES AND STANDARDS

The design, manufacture, shop testing, site fabrication and erection, testing and commissioning of the pressure vessels and atmospheric storage tanks vessels shall conform to the latest revisions of the following standards, in addition to other standards addressed elsewhere in the Bid Specification subject to any modification and requirement, as specified elsewhere:

a)	ASME Section VIII	Rules for Construction of Pressure Vessels
b)	ASTM Standards	Standards published by American Society for Testing and Materials
c)	BS EN 12285-2	Workshop fabricated steel tanks. Horizontal cylindrical single skin and double skin tanks for the aboveground storage of flammable and non-flammable water polluting liquids
d)	IS-803	Code of Practice for Design Fabrication and Erection of Vertical Mild Steel Cylindrical Welded Oil Storage Tanks
e)	IS-816	Code of Practice for Use of Metal Arc Welding for General Construction in Mild Steel
f)	IS-817	Code of Practice for Training and Testing of Metal Arc Welders
g)	IS-822	Code of Procedure for Inspection of Welds
h)	IS-1363 Part 1 to Part 3	Hexagon Head Bolts, Screws and Nuts of Product Grade C
i)	IS-1367 Part 1 to Part 16	Technical Supply Conditions for Threaded Steel Fasteners
j)	IS-2002	Steel Plates for Pressure Vessels for Intermediate

		and High Temperature Service including Boilers
k)	IS-2062	Hot Rolled Medium and High Tensile Structural Steel
l)	IS-2825	Code for Unfired Pressure Vessels
m)	IS-3133	Manhole and Inspection Openings for Chemical Equipment - General Requirements
n)	IS-4049 Part 1 & Part 2	Formed Ends for Tanks and Pressure Vessels
o)	IS-4682 Part 1 to Part 10	Code of Practice for Lining of Vessels and Equipment for Chemical Processes
p)	IS-4864 to IS-4870	Shell Flanges for Vessels and Equipment

3. 00.00 **GENERAL DESIGN FEATURES**

3. 01.00 Design of all pressure vessels shall conform to IS 2825 or ASME Section VIII Division-I or equivalent code / standard (subject to approval by Purchaser).

3. 02.00 Design of all vertical cylindrical atmospheric storage tanks containing water, acid, alkali and other chemicals shall conform to IS-803.

Supporting frame where required for design of Demineralized Water Storage Tanks shall be in accordance with IS-800. The tank shall be "Non-pressure" fixed roof type with atmospheric vents.

3. 03.00 Design of all horizontal cylindrical atmospheric storage tank containing decationized water, acid, alkali and other chemicals shall conform to BS EN 12285-2.

3. 04.00 Design temperature of all pressure vessels and atmospheric storage tanks shall be 10 deg. C higher than the maximum temperature that any part of the vessel / tank is likely to attain during operation.

3. 05.00 Design pressure shall be the maximum expected pressure to which the vessels may be subjected to plus 5% additional margin. Maximum expected pressure for vessels placed in the discharge line of pumps shall be based on the shut-off head of the pumps plus static head at pumps suction, if any.

3. 06.00 In case, tank is subjected to vacuum under any situation, the same shall be duly considered as one of the criteria for design of the tank.

3. 07.00 Each pressure vessel / atmospheric storage tank without inside rubber lining shall have a corrosion allowance of minimum 2.0 mm.

3. 08.00 Mill tolerance as per applicable code (minimum 0.3 mm) shall be duly considered for each shell as well as dished end.

3. 09.00 Thinning allowance of 2.0 mm (minimum) shall be considered for each dished end.

3. 10.00 Effective liquid volume for an atmospheric storage tanks tank shall be considered as the liquid volume in between the design highest operating level / design highest level switch set point and design lowest operating level / design lowest level switch set point.
3. 11.00 A liquid volume (corresponding to a minimum of 100 mm shell / liquid height in between design lowest operating level / design lowest level switch set point and top of side mounted outlet nozzle / bottom of tank) below the required effective liquid volume shall be considered & provided for satisfactory functioning of concerned level switch.
3. 12.00 Each atmospheric tank shall have sufficient free board (minimum 300 mm unless specified otherwise) above the design highest level / design highest level switch set point.
3. 13.00 The invert of overflow nozzle shall be kept at least 50 mm or 5 % of total height whichever is higher above the design highest level / design highest level switch set point for each of the atmospheric tanks, except for the Demineralized Water Storage Tanks.
3. 14.00 For Demineralized Water Storage Tanks, the invert of overflow nozzle shall be kept at least 500 mm or 5 % of total shell height whichever is higher above the design highest level / design highest level switch set point.
3. 15.00 A minimum 100 mm shell height shall be provided above the top of overflow nozzle of each atmospheric storage tank.
3. 16.00 Wall thickness of each of atmospheric tanks shall not be less than 6 mm. If higher thickness for any atmospheric storage tank is specified elsewhere in this Specification, the same shall be provided.
3. 17.00 Vessels coming under preview of IBR shall be designed accordingly.
4. 00.00 **MATERIAL OF CONSTRUCTION**
4. 01.00 The pressure vessels shall be designed as Class 3 vessels (as per IS-2825) and fabricated of steel as per IS-2062 / IS-2002 Grade 3 or SA-515 / 516 Grade 60 / 70 In case, the vessels are designed as Class 1 or Class 2 vessels (as per IS-2825), the material of construction shall conform to IS-2002 Grade 3.
4. 02.00 Atmospheric storage tanks shall be fabricated of mild steel as per IS-2062.
4. 03.00 The material of construction for various connections, for all the lined or unlined vessels/tanks shall be same as that of interconnecting piping material suitably lined wherever required. The pipe flanges, manhole/manhole covers, reinforcement pads etc. shall be fabricated out of the same material as that one used for the vessel / tank. However, screwed fittings for instrumentation, sample connection, drain connection of size 25 mm NB and less shall be of stainless steel construction (SS-316).

5. 00.00 **FABRICATION**

5. 01.00 All pressure vessels and storage tanks except the large tanks like Demineralised Water Storage Tanks should preferably be fabricated and tested completely at manufacturer's works to ensure better workmanship.
5. 02.00 The plates to be used for fabrication shall preferably have a minimum width of 1500 mm.
5. 03.00 Ends of pressure vessels shall be of dished design and constructed of forging, pressing or spinning as per IS-4049.
5. 04.00 Interior surfaces of all atmospheric storage tanks shall be clear of stiffeners and other structural supports. Tanks shall be reinforced and stiffened externally as required.
5. 05.00 Plates to be used for fabrication of atmospheric vertical storage tanks shall be accurately formed in bending rolls to the diameters called for and cold rolled through plate bending machine by several number of passes to true curvature and joined by welding.
5. 06.00 The atmospheric vertical storage tanks shall have flat bottom.
5. 07.00 Ends of atmospheric horizontal storage tanks shall be of dished design and constructed of forging, pressing or spinning as per IS-4049. Conical or Flat Ends shall not be accepted.
5. 08.00 All welding shall be as per IS-816 or equivalent code (subject to approval by Purchaser). The qualification of the welders should be as specified in IS-817 and welding electrodes shall be as per relevant Codes / Standards.
5. 09.00 Bidder shall state clearly in his proposal the make and type of welding rods necessary for fabrication / construction work.
5. 10.00 Welding sequence shall be adopted in such a way so as to minimize the distortion due to welding shrinkage. The Bidder shall indicate in drawing, the sequence of welding proposed which should meet prior approval of the Purchaser. Welding shall not be carried out when the surface of the parts to be welded are wet from any cause and during periods of rain and high winds unless the welder and work are properly shielded.
5. 11.00 All seams shall be so positioned that they do not pass through connections of vessel / tank. The connections shall be flushed with inner surface of vessel / tank and welded continuous on both sides of the vessel / tank. Sharp inside edges shall be rounded to a minimum 3 mm radius. Inside seam weld shall be ground smooth, suitable for application of corrosion resistant coating / lining.
5. 12.00 All the joints (circumferential / longitudinal) shall be double butt welded with full penetration or single butt welded without backing strip. For joints involving small thickness 6 mm or less, back chipping to metal followed by DP test and re-welding shall be done to have full penetration.
5. 13.00 All internal baffles, wear plates, pipes etc. shall be continuously welded on both sides at all contact points with full fillet welds which shall be free of voids, gaps,

- craters, high spots, sharp edges, and undercutting. Sharp edges shall be ground to a 3 mm minimum radius.
5. 14.00 All welds on inner surface of vessel / tank shall be free of voids, gaps, craters, pits, high spots, sharp edges, abrupt ridges and valleys or undercut edges. High spots, irregularities and sharp edges shall be removed by grinding.
5. 15.00 Weld splatter shall be removed.
5. 16.00 Inspection of all welds shall be carried out in accordance with IS-822 'Code of Practice for Inspection of Welds.'
6. 00.00 **APPURTENANCES**
6. 01.00 Internals for pressure vessels and atmospheric storage tanks shall be provided as detailed out elsewhere in the specification and as further required.
6. 02.00 All the pressure vessels and atmospheric storage tanks shall be provided with drain connections along with drain valves of suitable size.
6. 03.00 All the pressure vessels and atmospheric storage tanks shall be provided with the vent connections. The design shall be as to offer adequate area for venting. Venting area shall be such that over pressure/vacuum is not created during maximum filling / withdrawal rate. The maximum withdrawal rate for the Demineralized Water Storage Tanks shall be intimated later at detail engineering stage to the Bidder.
6. 04.00 Various instrumentation and the fittings required for the pressure vessels and atmospheric storage tanks shall be provided as elaborated elsewhere in the specification.
6. 05.00 **Manholes / Hand Holes**
- 6.05.01 Manholes shall be provided for all pressure vessels and atmospheric storage tanks to provide easy access into the same. The diameter shall be minimum 500 mm and each manhole will be provided with cover plate, nuts, bolts and gaskets to ensure leak tightness at the test pressure. Manholes shall be davit type for rubber lined vessels.
- 6.05.02 Each of the pressure vessels and horizontal type storage tanks shall be provided with at least one manhole at the top.
- 6.05.03 Each of the vertical type atmospheric storage tanks with diameter 1200 mm or more shall be provided with a manhole on the top. For the Demineralized Water Storage Tanks, manholes shall be provided as per IS-803.
- 6.05.04 Each of the pressure vessels filled with ion exchange resins shall be provided with a handhold of diameter at least 150 mm at a level in the vicinity of bottom of resin bed.
- 6.05.05 The required lining / coating for the inside surface of the manhole / handhold, nozzle and cover plate of the manhole/ handhold shall be same as that of the respective vessel/tank.
6. 06.00 **Nozzle Connections**

- 6.06.01 Bidder shall furnish all materials required for nozzle connections with reference to system requirements. In addition to these, additional nozzle connections, if required by the Purchaser for the inter-connection with other systems / piping / instruments etc. shall also be provided. Such additional requirements may be intimated to the Bidder later at detail engineering stage and Bidder shall provide the same complete with necessary supports and other accessories without any sort of price implication whatsoever.
- 6.06.02 Nozzle wall thickness shall be as per relevant code for design to be followed for the vessel/tank in questions.
- 6.06.03 All flanged connections should be supplied complete with matching counter flanges, bolts, nuts and gasket materials. The flange design (thickness and drilling etc.) shall match with the interconnected piping flanges.
- 6.06.04 Bolts and nuts to be used externally to the vessels shall be of hexagonal head conforming to IS-1367. However fasteners if any within tanks shall be of SS-316 / SS-304 or Hastalloy-B as per the duty conditions / requirements.
- 6.06.05 Gaskets shall be of full face type.
6. 07.00 Sight glasses shall be provided for the tanks/vessels as specified elsewhere in the specification. The material for sight glass shall be high quality transparent PLEXIGLASS of sufficient thickness to withstand the test pressure. The sight glass shall be provided with suitable gaskets and bolts to ensure leak tightness at the test pressure.
6. 08.00 **Vessels Supports / Lifting Lugs**
- 6.08.01 Adequate supporting arrangements like legs, straps, saddles, skirt boards, pillars etc. for the pressure vessels and atmospheric storage tanks shall be provided to transfer all loads to civil foundation. All foundation bolts, inserts etc. shall also be provided.
- 6.08.02 All vessels shall be provided with lifting lugs, eye bolts etc. for effective handling during erection.
- 6.08.03 All vessels of internal, diameter of 1200 mm or greater shall be provided with minimum four (4) lifting lugs for safe and effective handling during erection. Smaller vessels shall be provided with atleast two (2) lifting lugs.
- 6.08.04 Material of construction for these vessel supports, saddles, lugs shall conform to IS-2062.
6. 09.00 **Special Accessories for Tanks**
- 6.09.01 Each of all the tanks shall be provided with over flow connection designed for the filling rate of the respective tank.
- 6.09.02 Water Seal shall be provided for the overflow line of Demineralized Water Storage Tanks. Vent line of Demineralized Water Storage Tanks shall be provided with Carbon-Di-Oxide Absorber / Breather of proven design to prevent contamination from atmospheric air. Carbon-Di-Oxide Absorber / Breather shall preferably be located at finished floor / pavement level.

- 6.09.03 The vent and overflow lines of Acid Bulk Storage / Day / Measuring Tanks shall be provided with fume absorber using suitable packing material, such as pall rings / raschig rings.
- 6.09.04 The vent and overflow lines of Alkali Bulk Storage / Preparation / Day / Measuring Tanks shall be provided with Carbon-Di-Oxide Absorber / Breather as addressed under clause no. 6.05.02 above.
- 6.09.05 Conservation Vent Valve shall provided on each of Demineralized Water Storage Tanks to ensure minimum contact with air. The valve should normally be closed. With vacuum or pressure to the extent of 65mm water gauge into the tank, the valve shall open to relieve the vacuum or pressure.

Material of construction should be as follows:

Body & valve disc	-	Die cast aluminium.
Spindle	-	Steel
Spring	-	Phosphor Bronze
Seal	-	Rubber

7.00.00 **ERECTION**

- 7.01.00 Each of all pressure vessels and atmospheric storage tanks should be directly placed on the civil foundation when supplied in fully fabricated form.
- 7.02.00 All fabricated part, before assembly, shall be transported by the Bidder to installation at site. All preliminary work and fabrication in part or full shall be done at the Bidder's fabrication yard or shop.
- 7.03.00 All material before final installation over the foundation at the respective locality shall be inspected and faired as necessary to ensure that any damage received during transportation is corrected before erection to the satisfaction of the Purchaser. Particular attention shall be given towards removal of buckles and other form of distortion in shell and bottom plates of vertical atmospheric storage tanks. Irregularities and dirt which would prevent metal to metal contact at the jointing faces shall be removed.
- 7.04.00 The method of holding the plates in position during welding and all devices used for this purpose should be approved by the Purchaser. All lap joints shall be held in close contact during welding and the surface in contact shall be thoroughly cleaned before assembly.
- 7.05.00 Holes in plate work to assist in erection should be avoided as far as possible. The location of the holes shall be indicated in the fabrication drawing. The method of filling holes shall be approved by the Purchaser. Lugs attached by welding to the tank and required only for the purpose of erection shall be removed and any projections of weld metal shall be chipped and grounded flush with the plate surface.
- 7.06.00 In the construction of the shell, every care shall be taken to minimize distortion or lack of circularity due to welding or for any other reason.

- 7.07.00 Tanks shall be safeguarded against damage due to wind or any other external causes by providing suitable steel cable guys until completion.
- 7.08.00 All materials used by the Bidder such as electrodes, gaskets, bolts and nuts, paints and any other appurtenance shall be conforming to relevant Indian Standard Code of Practice or equivalent (subject to approval by the Purchaser). Manufacturer's test certificate for guaranteed performance shall have to be provided when called for.
- 7.09.00 The finished bottom plate of vertical atmospheric tanks shall be crowned from the outer periphery to the centre with a slope of 1:36. Sufficient number of plugged holes shall be provided in bottom plate of the tanks for bottom testing.
8. 00.00 **PROTECTIVE LINING AND PAINTING**
8. 01.00 Inside surfaces of all pressure vessels and atmospheric storage tanks shall be protected by anticorrosive paints or rubber lining as required / specified. External surfaces of all pressure vessels and atmospheric storage tanks shall be protected by anti corrosive painting.
8. 02.00 The supply and application of Protective Lining and Painting with reference to pressure vessels and atmospheric storage tanks need to be as per **Sub Section: M7 – Technical Specification for Protective Lining and Painting**, attached herewith.
9. 00.00 **TESTS AND INSPECTION**
9. 01.00 All pressure vessels shall be hydraulically tested at 1.5 times design pressure or 2 times the maximum working pressure whichever is higher, for a period not less than one (1) hour.
9. 02.00 All atmospheric storage tanks shall be tested for leak tightness by filling up with water up to the highest level for a period not less than 8 hours.
9. 03.00 Full rubber lining is to be tested as per IS-4682 Part I for the following tests:
- (a) Adhesion tests
 - (b) Tests to check resistance to bleeding
 - (c) Measurement of lining thickness
 - (d) Shore hardness test
 - (e) Spark test at high voltages 5 KV / mm of thickness with a gap of 8 mm between the probe and lining.
9. 04.00 Thickness of painting shall be checked with dry type thickness gauge.
9. 05.00 Vessels as per IBR shall be tested accordingly.
9. 06.00 DP test after back gauging and on complete welds on atmospheric tanks and pressure vessels need to be carried out.
9. 07.00 All non-destructive tests shall be carried out as per the applicable design code / standard for all pressure vessels and atmospheric tanks.

- 9. 08.00 Butt welds if any on the dished ends shall be radio graphed after dishing and shall be stress relieved.
- 9. 09.00 All dished ends for pressure vessels shall be stress relieved after dishing.
- 9. 10.00 All weld procedure and welder qualification certificates shall be verified.
- 9. 11.00 All painting on vessels and tanks shall be checked for the thickness as per the specification mentioned elsewhere.
- 9. 12.00 All materials to be used for the pressure vessels and atmospheric tanks and accessories should be of tested quality and test certificates shall be made available to the Purchaser.

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SECTION-VIII

**TECHNICAL SPECIFICATION
FOR
PIPING, FITTINGS AND VALVES**

C O N T E N T S

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SECTION: VIII

**TECHNICAL SPECIFICATION
FOR
PIPING, FITTINGS & VALVES**

1.00.00 INTENT OF SPECIFICATION

This specification covers the design, manufacturing, inspection, shop testing, erection, testing and commissioning at site of all the piping, fittings, valves and all other accessories as specified and as further required.

2. 00.00 SCOPE

The items & materials to be supplied shall include but not be limited to the following:

- 2. 01.00 Pipes, bends, elbows, tees, branches laterals, crosses, reducing unions, couplings, cap, expansion joints, flanges, blank flanges, saddles, shoes, sampling connections etc. necessary for making a reliable piping system.
- 2. 02.00 Gaskets, ring joint, backing rings, jointing material etc. as required.
- 2. 03.00 Instrument tapping connection, stub and thermowells.
- 2. 04.00 Supply and machining work of flanges, pipe spools and matching pipes to connect flow measuring orifice nozzles etc., pressure accumulators as necessary.
- 2. 05.00 Valves and Isolation Gates, to start/stop and control / regulate flow.
- 2. 06.00 Strainers.
- 2. 07.00 Anchor blocks (for buried / over ground piping), support brackets, clamps, support trestles, hangers, vibration dampener etc. for the piping under the scope of contract.
- 2. 08.00 Bolts, nuts, fasteners as required for interconnecting piping, valves and fitting as well as for terminal points.
- 2. 09.00 Steel for pipe supports and embedded steel. Also pipe supports and necessary embedment required to be embedded in concrete for underground / above ground pipes.
- 2. 10.00 Painting, anti-corrosive coatings, etc. inside and outside of pipes as necessary and as specified.
- 2. 11.00 All embedded parts required for all tanks/water retaining structures made of RCC including puddle pipes shall be supplied by the Bidder.

3. 00.00 **CODE & STANDARDS**

The design, manufacture, fabrication shop testing & inspection, erection, testing and commissioning of piping fittings and valves shall conform to the latest revisions of the following Indian / International codes / standards and other applicable statutory codes / ordinances, rules, regulations as well as safety codes, in addition to other codes / standards if any as addressed elsewhere in the Tender Specification.

Other National / International Standards may also be considered acceptable (subject to specific approval by Purchaser) with reference to any specific situation / requirement provided they are recognized to be equivalent or superior to the Standards as stipulated in the Tender Specification.

ANSI	-	B 16.5	:	Steel pipe flanges and flanged fittings.
ANSI	-	B 16.9	:	Wrought steel Butt welding fittings
ANSI	-	B 16.11	:	Forged steel socket welding and screwed fittings
ANSI	-	B 16.21	:	Non Metallic Gaskets for Pipe Flanges
ANSI	-	B 16.25	:	Butt welding ends
ANSI	-	B 16.28	:	Wrought Steel Butt Welding short radius elbows and returns
ANSI	-	B 31.1	:	Power Piping code.
ANSI	-	B 36.10	:	Welded & seamless wrought steel pipe
ANSI	-	B 36.19	:	Stainless steel pipe
API	-	5L	:	Specification for Line Pipe
ASME	-	Section II	:	Ferrous Materials Specification
ASTM	-	A 53	:	Seamless carbon steel.
ASTM	-	A 106	:	Grade C Seamless carbon steel pipe.
ASTM	-	F441 / F441M - 09	:	Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM	-	F439 - 11	:	Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80

AWWA	-	C-203	:	Coal tar protective coatings and linings for steel water pipe lines - Enamel and Tape - Hot Applied
AWWA	-	C-208	:	Dimensions for Steel Water pipe fittings
AWWA	-	C-504	:	Standard for butterfly valve.
BS	-	1868	:	Specification for steel check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries
BS	-	5158	:	Specification for cast iron plug valves
BS	-	5353	:	Specification for steel plug valves
BS EN	-	593	:	Industrial valves. Metallic butterfly valves
BS EN	-	1796	:	Plastics piping systems for water supply with or without pressure. Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP)
BS EN	-	13397	:	Industrial valves. Diaphragm valves made of metallic materials
BS EN	-	13789	:	Industrial valves. Cast iron globe valves
BS EN	-	14364	:	Plastics piping systems for drainage and sewerage with or without pressure. Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP). Specifications for pipes, fittings and joints
BS EN ISO	-	16138	:	Industrial valves. Diaphragm valves of thermoplastics materials
DIN	-	16966	:	Glass fibre reinforced polyester resin (UP-GRP) pipe fittings and joint assemblies - Requirements for and testing of bushes, flanges, and flanged and laminated joints
IS	-	210	:	Grey Iron Castings
IS	-	318	:	Leaded Tin Bronze Ingots and Castings
IS	-	458	:	Precast Concrete Pipes (with and without reinforcement).
IS	-	554	:	Pipe Threads where Pressure Tight-Joints are made on the Threads – Dimensions, Tolerances and Designation.

IS	-	778	:	Copper Alloy Gate, Globe and Check Valves for Waterworks Purposes.
IS	-	783	:	Code of Practice for Laying of Concrete Pipes.
IS	-	1239 Part 1	:	Steel Tubes, Tubulars and other Wrought Steel Fittings - Specification Part 1 Steel Tubes
IS	-	1239 Part 2	:	Specification Steel Tubes, Tubulars and other Steel Fittings Part 2 Steel Sockets Tubular and other Steel Pipe Fittings
IS	-	1363	:	Hexagon Head Bolts, Screws and Nuts of Product Grade C.
IS	-	1364	:	Hexagon Head Bolts, Screws and Nuts of Product Grades A and B.
IS	-	1367	:	Technical Supply Conditions for Threaded Steel Fasteners.
IS	-	1536	:	Indian Standard for Centrifugally Cast (Spun) Iron Pressure Pipes for Water, Gas and Sewage.
IS	-	1537	:	Vertically Cast Iron Pressure Pipes for Water Gas and Sewage.
IS	-	1538	:	Cast Iron Fittings for Pressure Pipes for Water, Gas and Sewage.
IS	-	1703	:	Water Fittings - Copper Alloy Float Valves (Horizontal Plunger type)
IS	-	1879	:	Malleable Cast Iron Fittings
IS	-	2016	:	Plain washers
IS	-	2062	:	Hot Rolled Low, Medium and High Tensile Structural Steel.
IS	-	2629	:	Recommended practice for Hot dip galvanising of iron and steel
IS	-	2633	:	Method for testing uniformity of coating on zinc coated articles.
IS	-	2379	:	Colour Code for Identification of Pipe Lines.

IS	-	2685	:	Code of Practice for Selection, Installation and Maintenance of Sluice Valves.
IS	-	2712	:	Gaskets and Packings- Compressed Asbestos Fibre Jointing.
IS	-	2825	:	Code for Unfired Pressure Vessels.
IS	-	3006	:	Chemically Resistant Glazed Stoneware Pipes and Fittings.
IS	-	3042	:	Single Faced Sluice Gates (200 to 1200 mm size).
IS	-	3114	:	Code of Practice for Laying of Cast Iron Pipes.
IS	-	3589	:	Steel Pipes for Water and Sewage (168.3 to 2540 mm Outside Diameter).
IS	-	4038	:	Foot Valves for Waterworks Purposes.
IS	-	4682 (Part I)	:	Code of practice for lining of vessels and equipment for chemical - rubber lining.
IS	-	4736	:	Hot-dip Zinc Coatings on Mild Steel Tubes.
IS	-	4984	:	High Density Polyethylene Pipes for Potable Water Supplies.
IS :	-	4985	:	Unplasticized PVC Pipes for Potable Water Supplies.
IS :	-	5312	:	Swing Check Type Reflux (non-return) Valves for Water Works Purpose.
IS :	-	5822	:	Code of practice for laying of electrically welded steel pipes for Water supply.
IS :	-	8062	:	Code of practice for cathodic protection (Part-II) of steel structure
IS :	-	10221	:	Code of practice for coating and wrapping of underground mild steel pipes
IS :	-	14846	:	Sluice Valve for Water Works Purposes (50 to 1200 mm Size).

4. 00.00 **DESIGN, MANUFACTURE, FABRICATION AND ERECTION**

4.01.00 The piping system, fittings and accessories supplied shall conform to high standards of engineering, design, workmanship and be capable of performing in continuous commercial operation in a manner acceptable to Purchaser.

4.02.00 All the piping systems, fittings and accessories supplied under this package shall be designed to operate without replacement and with normal maintenance for a plant service life of 25 years and shall withstand the operating parameter fluctuations and cycle variations which can be normally expected during this period.

4.03.00 Material of construction for pipes under different services shall be as below:

Service	Recommended Material of Construction
River Water	Carbon Steel
Clarified Water	Carbon Steel
Filtered Water	Carbon Steel (inside rubber lined)
Degassed Water	Carbon Steel (inside rubber lined)
Demineralised Water	Carbon Steel (inside rubber lined)
Service Air	Galvanized Steel
Instrument Air	Stainless Steel (schedule 40)
Potable Water	Galvanized Steel
Chlorine (liquid under pressure)	Seamless Carbon Steel (schedule 80)
Chlorine (dry gaseous under pressure)	Seamless Carbon Steel (schedule 80)
Chlorine under vacuum	CPVC (schedule 80)
Chlorine in water	CPVC (schedule 80) / Carbon Steel (inside rubber lined)
Sodium Hydroxide Solution	CPVC (schedule 80) / Carbon Steel (inside rubber lined)
Alum Solution	CPVC (schedule 80) / Carbon Steel (inside rubber lined)

Service	Recommended Material of Construction
Lime Solution	Galvanized Steel
Polyelectrolyte Solution	CPVC (schedule 80) / Carbon Steel (inside rubber lined)
Hydrochloric Acid (concentrated)	Carbon Steel (inside rubber lined)
Hydrochloric Acid (dilute)	Carbon Steel (inside rubber lined)
Sodium Hydroxide (concentrated)	Carbon Steel (inside rubber lined)
Sodium Hydroxide (dilute)	Carbon Steel (inside rubber lined)
Sulfuric Acid Solution (concentrated)	Carbon Steel
Sulfuric Acid Solution (dilute)	Carbon Steel (inside rubber lined)
Scale Inhibitor Solution	Stainless Steel (schedule 40) / CPVC (schedule 80)
Corrosion Inhibitor Solution	Stainless Steel (schedule 40) / CPVC (schedule 80)
Biocide Solution	Stainless Steel (schedule 40) / CPVC (schedule 80)
Filter Backwash Wastewater	Carbon Steel
Ammonia Solution	Seamless Stainless Steel (304 grade)
Hydrazine Solution	Seamless Stainless Steel (304 grade)
Oxygen Line	Aluminum
Crude Condensate	Carbon Steel (inside rubber lined)
Treated Condensate	Carbon Steel (inside rubber lined)
Demineralized Water with ion exchange resins	Stainless Steel (304 grade)
Non Oily Sludge	Cast Iron (underground) Carbon Steel (overground)
Neutralized Wastewater	Carbon Steel (inside rubber lined)

Cooling Tower Blowdown	Carbon Steel
Boiler Blowdown	Carbon Steel
Crude Oily Wastewater	Seamless Carbon Steel
Treated Oily Wastewater	Seamless Carbon Steel
Rainfall Runoff	Carbon Steel
Equalized Wastewater	Carbon Steel
Oily Sludge	Seamless Carbon Steel

The portion of pipe lines at the downstream of isolation valves, conveying flushing water shall be of the material & type same as those of the pipelines which are being flushed.

4.04.00 Material & Dimensional Standards for Piping and Fittings

4.04.01 The welded Carbon Steel Pipes shall conform to the following codes / standards:

Pipes	Material Code / Standard	Dimension Code / Standard
50 mm NB and below	Mild Steel, ERW, IS-1239 Part-1 / ASTM-A 53 Grade B (Welded), Type-E, Schedule 80.	IS-1239 Part-1. Plain ends for Socket Welding.
65 mm to 150 mm NB	Mild Steel, ERW, IS-1239 Part-1 / ASTM-A 53 Grade B (Welded), Type-E, Schedule 40.	IS-1239 Part-1. Bevelled ends for Butt Welding.
200 mm to 450 mm NB	Mild Steel, ERW, IS-3589 Grade Fe 410 / ASTM-A 53 Grade B (Welded), Type-E, Schedule 40.	IS-3589. Bevelled ends for Butt Welding.
500 mm NB and above	Rolled and Butt Welded from IS-2062 Grade A plates or SA-285 Grade C or Equivalent (subject to approval by Purchaser). / Spiral Welded pipes.	IS-3589. Bevelled ends for Butt Welding.

Elbows (R=1.5 D)	Material Code / Standard	Dimension Code / Standard
50 mm NB and below	Forged carbon steel from ASME-SA 105 / Carbon Steel to IS-1239 Part-2 (Heavy grade).	SW ends to ANSI-B 16.11 (3000#) / IS-1239 Part-2.
65 mm to 150 mm NB	ASME-SA 234 Grade WPB / Carbon Steel to IS-1239 Part-2 (Heavy grade).	BW ends to ANSI-B 16.9 / IS-1239 Part-2.
200 mm to 350 mm NB	ASME SA-234 Grade WPB	BW ends to ANSI-B 16.9 / IS-1239 Part-2.
Mitre Bends (R=1.5 D)	Material Code / Standard	Dimension Code / Standard
400 mm NB and above	Fabricated from parent pipe.	ANSI-B 31.1 / AWWA-C 208. 90° - 3 cut, 4 piece constructions. 45° - 2 cut, 3 piece constructions.
Tees	Material Code / Standard	Dimension Code / Standard
50 mm NB & below	Forged Carbon Steel to ASME-SA 105 / ASME-SA 234 Grade WPB / Carbon Steel to IS-1239 Part-2 (Heavy grade).	SW ends to ANSI-B 16.11 (3000#) / IS-1239 Part-2.
65 mm to 150 mm NB	ASME-SA 234 Grade WPB / Carbon Steel IS-1239 Part-2 (Heavy grade).	BW ends to ANSI-B 16.9 / IS-1239 Part-2.
200 mm NB and above	ASME-SA 234 Grade WPB / Fabricated from parent pipe.(set in / set on type).	ANSI-B 16.9
Reducers	Material Code / Standard	Dimension Code / Standard
50 mm NB & below	Forged carbon steel to ASME-SA 105 / ASME-SA 234 Grade WPB / Carbon Steel to IS-1239 Part-2 (Heavy grade).	SW ends to ANSI-B 16.11 (3000#) / IS-1239 Part-2.
65 mm to 150 mm NB	ASME-SA 234 Grade WPB / Carbon Steel to IS-1239 Part-2 (Heavy grade).	BW ends to ANSI-B 16.9 / IS-1239 Part-2.

200 mm NB and above	ASME-SA 234 Grade WPB / Fabricated from parent pipe.(set in / set on type)	ANSI-B 16.9
Slip On Flanges / Blind Flanges	Material Code / Standard	Dimension Code / Standard
All sizes	IS-226 / IS-2062 Grade A / ASME-SA 105 / ASTM-A 216 Grade WCB. Flanges shall be either machined or forged from plate / casting.	Dimensions / Drilling as per ANSI-B 16.5, Pressure rating 150# / 300# or otherwise as applicable, generally Flat face.
Bolts & Nuts	Material Code / Standard	Dimension Code / Standard
All sizes	IS -1367 CI 4.6 for bolts IS-1367 CI 4 for nuts	IS -1367
Gaskets	Material Code / Standard	Dimension Code / Standard
All sizes	3 mm thick wire reinforced rubber. Material shall contain no asbestos.	ANSI-B 16.21.

- 4.04.02 Seamless Carbon Steel Pipe shall conform to ASTM-A 106 Grade C (Schedule 80) / ASTM-A 53 / API 5L. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe.
- 4.04.03 Galvanized Steel Pipes and Fittings shall conform to the clause 4.02.01 above and be galvanized to IS-4736. Ends of all fittings will however be screwed as per IS-554. Mitre Bends shall not be used. Pipe joints shall be screwed for lower size and flanged for higher size. No hot work on G.I. pipes shall be done. Flanges shall be screwed and hot dipped galvanized.
- 4.04.04 Pipes and Fittings which shall be rubber lined, need to conform the clause 4.02.01 above. The inside surfaces of the items shall be completely deburred and made suitable for lining. The items will be inside rubber lined with 3 mm thick (minimum) natural rubber in two layers as per IS-4682. Flanges shall be flat face as per ANSI-B 16.5 and full face rubber lined. Pipe to Pipe joint will be flanged only. For small size fittings, SS-316 fittings shall be used if rubber lined carbon steel fittings are not available.
- 4.04.05 Stainless Steel Pipe shall conform to ASTM-A 312 of specified grade (Schedule 40) with dimensions as per ANSI-B 16.39. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe. Mitre Bends shall not be used. Elbows / Tees / Reducers shall be of Forged Stainless Steel (ASME-SA 182) with SW ends to ANSI-B 16.11 (3000#).

- 4.04.06 Cast Iron pipes shall conform to IS-1536. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe.
- 4.04.07 PVC Pipes shall conform to IS-4984 Class 4. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe.
- 4.04.08 High density Polyethylene Pipes shall conform to IS-4984 Class 5. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe.
- 4.04.09 CPVC pipe (Schedule 80) shall be produced from compounds which conform to and are specified in ASTM-D 1784. CPVC Pipe shall be manufactured in strict compliance with ASTM-F 441. Pressure-Rated CPVC Pipe shall be manufactured in strict compliance with ASTM-F 442. All CPVC piping shall be manufactured from NSF approved compounds and NSF Listed for potable water use. CPVC Fittings (Schedule 80) shall be as per ASTM-F 437 and F 439.
- 4.04.10 Pipe lines carrying water, chemicals, air etc. shall be sized generally based on the following ranges of velocities. However pipe size if any for any particular service is addressed in the Tender Drawings / Data Sheets, the selected size for the applicable service shall not be less than the specified size.

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		1.5 - 2.4	2.1 - 2.4
Compressed air below 2 Kg/cm ² (g)	15 - 20	20 - 30	25 - 35
Compressed air 2 Kg/cm ² & above	20 - 30	25 - 40	35 - 45
Suction to compressor/ Blowers		7 - 8	
Pump Suction for Chemical Solution	1.0 - 1.2	1.1 - 1.3	
Pump Discharge for Chemical Solution	1.2 - 1.4	1.3 - 1.5	

- 4.05.00 Pipe line under gravity flow shall be restricted to a flow velocity of 1 m/sec generally. Channels under gravity flow shall be sized for a maximum flow velocity of 0.6 m/sec.

- 4.06.00 The following "C" Value shall be used in WILLIAM & HAZEN formula for calculating the friction loss in piping and fittings.

i)	Carbon Steel Pipe	:	100
ii)	C.I Pipe	:	100
iii)	Carbon Steel Pipe (inside rubber lined)	:	120
iv)	PVC / HDPE / GRP / CPVC pipes	:	140

For calculating the pump head, atleast 10% margin shall be taken over the pipe friction losses.

- 4.07.00 Piping Layout

- 4.07.01 Piping shall be grouped together as far as practicable and routed to present a neat appearance and orientation. All piping shall generally be installed perpendicular or parallel to the major equipment, building structure and floor. Pipe routing shall be such as to provide sufficient clearance for removal and maintenance of equipment, easy access to valves, instruments and other accessories. The piping shall not encroach on the withdrawal space of other equipment. Piping shall be routed to avoid interferences with other pipes, hangers, structures, equipment electrical trays, HVAC ducts etc. Convenient supporting points, adequate flexibility for thermal expansion and neat appearance shall be considered in piping layout work.

- 4.07.02 Provision shall be made while preparing piping layout to accommodate all system accessories such as valves/ expansion bellows/instrument stubs/instruments/ specialties as per P&ID.

- 4.07.03 All local instruments on the pipeline shall be located such that the reading can be observed without inconvenience.

- 4.07.04 Overhead indoor piping shall have a vertical clearance of minimum 3.0 m above finished floor level of working areas / walkways. Overhead outdoor piping shall have a vertical clearance of minimum 4.0 m above finished ground level and minimum 7.5 m above finished road level unless addressed otherwise elsewhere in this specification. When several pipe lines are laid parallel, flanged joints must be staggered. Welded and flanged joints should as far as possible located at one third span from supports. If the support is situated right under the welded joints this joint must be reinforced with a strap. Flanged and welded joints must be avoided in the middle of the span. Valves should be located in such a manner so as to ensure their convenient operation from the floor or the nearest platform.

- 4.07.05 In specific cases (subject to instruction by Purchaser for any site specific reason), pipes may be routed overground on RCC pedestals with bottom of pipes minimum 300 mm above finished ground level.

- 4.07.06 Pipe, when specifically addressed, shall be laid in trenches or buried. All buried pipes in general shall be laid with the top of the pipe 1.2 m to 1.5 m below the finished ground level unless mentioned otherwise. Full length of buried piping shall be provided with 100 mm thick sand bed.

- 4.07.07 Openings provided to accommodate pipelines must be closed with bricks and mortar with 10 mm to 12 mm clearance between brick work and pipe. The clear space must

be filled with felt or approved filling compound. The details of wall sealing arrangement shall be approved by Purchaser.

4.07.08 Drains shall be provided at low points and at pockets in piping such that complete drainage of system is possible. Vent connections shall be provided at high points where air or gas pockets may occur. Vent for use during hydrostatic test shall be plugged after the completion of the test. Vents shall not be less than 15 mm size. Plugs / cocks required for vent/drain system shall form part of the piping system and shall be supplied by Bidder as per finalized flow diagram. All vent valves & drain valves shall be arranged with easy reach of operation. All pipelines shall be given proper slope towards the drain points.

4.07.09 To facilitate dismantling of piping at the valves and equipment, break up flange/unions shall be provided. The location shall be decided as per the system requirement during detailed engineering.

4.08.00 Line Joints

Line Joints shall be envisaged as follows:

CS and SS pipes	:	Welded (socket welded for 50 mm NB & below & butt welded for 65 mm NB and above)
Galvanized Pipes	:	Screwed
Rubberlined Pipes	:	Flanged

4.08.01 Welded joints

For making welded joints (socket weld or butt weld) the welding shall be performed by manual shielded metal arc process. Any welder employed for carrying out welding shall be qualified as per ASME-Section IX for the type of joints to be welded. Jointing by butt weld or socket weld shall depend upon the respective piping material specification.

For Stainless Steel piping atleast the root run shall be welded with Tungsten Inert Gas (TIG).

Butt welding edge preparation shall be done as per ANSI-B 16.25.

All welding electrodes and welding rods including special ones, if any shall be furnished by the Bidder.

4.08.02 Screwed joints

Threading of pipes shall be carried out after bending, heat treatment etc. If not possible, threading may be done prior to these operations but proper care should be taken to protect them from damage. Threads shall be to ANSI-B 2.1 (taper) NPT / IS 554, unless specified otherwise.

Teflon tapes shall be used to seal screwed joints and it shall be applied to the male threads only. Threaded parts shall be wiped clean of oil or grease (with appropriate

solvent if necessary) and dried before applying the sealant. Pipe ends shall be reamed or filed out to size of bore and all chips shall be removed. Screwed flanges shall be attached by screwing the pipe through the flange and the pipe as well as the flange shall be refaced accurately.

4.08.03 Flanged joints

All flanges and flange drilling shall be to ANSI-B 16.5 of applicable pressure/temperature class. However in case of interface with the pipe of Purchaser, the flange/interconnection details shall be designed to match the applicable interface piping and concerned details.

When weld neck or socket weld flanges are used, their bore must be made the same as that of the pipe being welded to. Socket welded or threaded flanges may be used, with the appropriate piping system for connection of pipe to the flanged equipment.

Drilling of flanges on piping must match with the drilling of flanges on the valves /equipments to which the piping is to be connected.

While fitting the mating flanges, care shall be taken to properly align the pipes and to check the flanges to trueness so that the faces of the flanges can be pulled up together without producing any stress on the adjacent pipes and equipment flanges.

Flanges shall be generally Slip-On / Blind Flat Face type. The packing ring or gasket of the flanged joint shall be of full face type. Flanged joints shall not be buried.

4.08.04 With reference to maintenance for carbon steel pipes, three piece socket welded unions for sizes 50 mm NB and below shall be used. For higher sizes, flanged joints shall be used.

4.09.00 Fabrication of Pipes

4.09.01 General Requirements

The Bidder shall prepare necessary fabrication drawings based on approved piping layouts.

Flanges and their contact surfaces shall be concentric with the pipe axis and shall be accurately machined and drilled true to template.

Where welded pipe and fittings are used, the longitudinal weld seams of adjoining sections shall be staggered by 90 degree.

Prefabrication shall be carried out in the fabrication shop to ensure quality of work and to minimize work on the field.

Where fabricated reducers have been specified, they shall be fabricated from parent pipes by the 'cut and shut' method.

All bends, tees and reducers shall be fabricated as per the latest edition of power piping code, ANSI-B 31.1 or approved equivalent. Reinforcement wherever required, shall be provided.

Only shop fabricated mitre bends or mitre fittings shall be acceptable. Mitre bends will not be accepted for steel pipes of 350 NB and below. For sizes 400 mm NB and above, the mitre bends shall conform to BS-534.

For easy handling & removal of equipment, valves etc. and for maintenance purpose, break up flanges shall be provided for 65 mm NB and above. For flanged joints of 50 mm NB and below, suitable type of compression flexible coupling shall be provided.

4.09.02 Rolled and Welded /Spiral Welded Pipes

Pipes of larger diameter shall be fabricated from steel plates conforming to IS-2062 by rolling and welding or spiral welded pipes shall be used.

Where pipe lengths need to be erected before the circumferential joints is welded, the pipe ends at these joints shall be beveled so that the top half is welded mostly from outside and the bottom half mostly from inside of pipe.

Beveled (single V / double V) ends shall be provided for butt welding as per Welding Procedure Specification.

4.09.03 Fabrication of flanges for large diameter pipes (sizes 600 mm NB and above)

Flanges fabricated from plates shall conform to AWWA-C 207 / BS-4504 / ANSI-B 16.47.

All welds in fabricated flanges shall be subjected to 10% radiographic examination.

Flanges shall be flat faced machined to 10 microns surface finish. Back face of the flanges shall also be machined to 25 microns surface finish.

Inspection holes shall be provided at suitable locations for pipes 800 mm NB and above as required for periodic observations and inspection purposes.

4.09.04 Rubber Lined Pipes

All rubber lined pipes shall be seamless or bead removed ERW pipes. Inside surface of the pipes shall be completely cleaned and made suitable for lining.

All rubber lined pipes shall have flanged joints. Pipes shall be welded with flanges before rubber lining.

For rubber lined pipe, natural rubber lining should be applied in two (2) layers on the inside surface of pipes, giving a total thickness not less than 3 mm. Surface hardness of rubber lining shall be 65 $\pm$ 5 Shore A class.

4.09.05 Welding

Welding shall be carried out by manual shielded metal arc and Tungsten Inert Gas

Welding process. Electrodes used shall be of Purchaser approved make. Electrodes shall be kept dry and electrode containers shall be protected against moisture. Electrodes that show sign of deterioration or damage shall not be used. Automatic or semiautomatic welding shall be done with the specific approval of Purchaser.

The Bidder shall submit procedures for welding, stress relieving, dye penetrant testing radiography etc. for prior approval of the Purchaser.

Weld shall not be made in pipe bends.

4.10.00 Supports for Overground Pipe

4.10.01 Complete supporting system for the pipe line shall be designed, fabricated and supplied by the Bidder. Inside the building, the overhead portion of the pipe line may be supported from the building structures. No support shall be taken from the brick wall. Outdoor pipes shall run on steel trestles wherever required. All the steel structure for the pipe rack and the supporting posts/trestles along with all necessary hangers, clamps, connecting steel, fixing bolts, nuts etc. shall be supplied and erected by the Bidder.

4.10.02 Hangers and supports shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipe line movements as necessary. All guides, anchors, braces, dampener, expansion joint and structural steel to be attached to the building/structure, trenches etc. shall be provided. Type of hangers and components for all piping shall be selected and approval obtained from the Purchaser.

4.10.03 The supports shall meet the general guidelines indicated in the following code / standards:

MSS-SP 58	:	Pipe hangers & supports - Materials, design and manufacture.
MSS-SP 69	:	Pipe hangers & supports Selection and application.
ANSI-B 31.1	:	Power Piping Codes

4.10.04 Bidder shall locate, design, fabricate, supply and erect all supports, restraints and anchors required for supporting of over ground portion of piping under this contract

4.10.05 Support drawings for piping shall be got approved from the Purchaser. BOM for each support shall also be submitted.

4.10.06 All material for supports shall be of tested quality.

4.10.07 All structural steel required for supports shall be provided by the Bidder at no extra cost to the Purchaser.

4.10.08 All pipe supporting element, guides, sliding support, beams, channel section, attachment to supports, beam clamps etc. shall be provided by the Bidder.

4.10.09 Support locations will be shown in the layout drawing to be submitted by the Bidder.

4.10.10 Fabrication, supply and installation of brackets, pipe shoes, saddles etc. shall be

- included in the scope of Bidder and the same shall be carried out as per approved drawings.
- 4.10.11 If an outdoor saddle support is assumed to permit sliding movement of piping over the support, consideration shall be given in selection of supporting material at the interface so that no rust formation takes place and the actual sliding movement is feasible in practice.
- 4.10.12 All pipe supports shall be designed to fully sustain the pipe in normal operating position, allow free and ample expansion or contraction except where anchored and prevent excessive stress.
- 4.10.13 Sway braces, cushioned clamps or other vibration control equipment shall be used in order to prevent unwanted movements of the piping due to vibration, shock or other causes. These shall be of such design as to protect piping against these movements regardless of direction.
- 4.10.14 The supports shall be so interspaced as to minimize sagging of the pipes and to keep them within permissible limits where pipes are full with the conveying media.
- 4.10.15 All piping supports shall be designed to avoid interference with other piping hangers, electrical conduits equipment and structures etc.
- 4.10.16 Saddles, supports etc. shall be capable of carrying the sum of all concurrent acting loads and shall be fabricated from plates/pipes sections conforming to SA 53 / IS-2062 or equivalent. They shall be designed to provide the requirement of supporting effects and allow pipe line movements as necessary. The structural work shall be as per IS-800 / BS-4360.
- 4.10.17 The maximum spans of the supports of straight lengths shall not exceed the recommended values indicated in ANSI-B 31.1. The spans shall be suitably reduced considering the following:
- a) Point loads due to valves and specialties, branch lines etc.
 - b) Pipe bends
 - c) Structural Steel beams.
 - d) Facilities for maintenance of flanged joints.
 - e) Minimum loads on equipment.
- 4.10.18 All vertical lines shall be properly supported on the vertical run and additionally provided with adequate number of lateral-restraints where the length of vertical run exceeds 5M.
- 4.10.19 At all sliding surfaces of restraints and supports Bidder shall provide a teflon lining to minimize sliding friction.
- 4.10.20 Pipe clamps shall have a minimum thickness of 5 mm for indoor piping and 6 mm for outdoor piping.
- 4.11.00 Erection

- 4.11.01 The Bidder shall coordinate the erection of the piping system as required with the erection schedule of other concerned systems. The sequence of work shall be carefully planned to minimize interference with other groups working in the same area. The actual sequence to be followed shall be to the approval of Purchaser who may at any time, direct the Bidder to reschedule his work as per the status of work site
- 4.11.02 Prior to making interface connections with equipment / system supplied by others, the Bidder shall obtain the approval of the concerned authority.
- 4.11.03 All workmanship shall be accomplished using accepted methods and procedures of the highest recognized fabrication and erection code / standards. Workmanship not conforming to the intent of this specification shall be liable to rejection by the Purchaser at any time, during the progress of work. The Bidder shall correct the workmanship immediately at no extra cost to the Purchaser.
- 4.11.04 The Bidder shall make all interface joints of the piping system, covered under this specification at the connecting points with equipment/piping supplied by others.
- 4.11.05 It is the responsibility of the Bidder to ensure correct orientation of all valves, instrument stubs etc. in line with final piping drawings.
- 4.11.06 The Bidder shall utilize the existing structures if any, to support the piping as far as practicable. All auxiliary steels required shall be supplied by the Bidder.
- 4.11.07 Before performing any welding, all corrosion products, dust, grease and other foreign material shall be cleaned from the surfaces to be joined.
- 4.11.08 Piping on both sides of the joint shall be adequately supported during all welding. Temporary supports, if used shall be so designed that no stress due to pipe weight comes on the joints during the joining.
- 4.11.09 All pipes shall be located and laid in accordance with the approved layout drawings. No deviation will be allowed unless written consent is issued by Purchaser in specific case(s).
- 4.11.10 Before laying the pipes, the coordinates and levels of the pipes shall be checked by the Bidder. Any discrepancies between the execution and approved drawings shall be brought to the notice of the Purchaser and corrections shall be carried out as per his instructions.
- 4.11.11 During erection of piping, the Bidder shall provide proper number and size of bolts and nuts as per drawings and specification. The Bidder shall provide approved quality of grease mixed with graphite powder thoroughly on all the bolts, nuts and washers immediately after erection and when the flange joints are dismantled for flushing, testing and alignment of equipment etc. to prevent rusting of nuts, bolts and gaskets. The grease and graphite powder shall be supplied by the Bidder
- 4.12.00 Cleaning and Flushing
- The exterior and interior surface of all piping shall be thoroughly cleaned of all sand, mill scale, grease, oils, dirt and other foreign materials. After cleaning, the interior surfaces of all piping shall be thoroughly blown dry and protected with a completely

water soluble preventive coating.

Flange faces shall be coated with an easily removable rust preventive coating.

Machined surface shall be coated with rust preventive paint. The paint shall be consumable in the welding process.

4.13.00 Pipes and Fittings if any, coming under purview of IBR, should meet its requirements and getting the approval from IBR in respect of the same shall be under the scope of the Bidder.

4.14.00 Valves & Isolation Gates

Valves will be used to start/stop or control flow.

All valves, shall be suitable for service conditions i.e. flow, temperature and pressure under which they are required. The valves shall be of standard pressure rating as per the applicable code/ standard. The pressure rating of diaphragm valves shall be selected considering the maximum expected operating differential pressure. Sample valves will be used in sample collection lines.

Gates will be primarily used for isolation of flow in open channels although these should be capable of throttling the flow too.

For location and type of Valves / Isolation Gates, Bidder need to refer to the P&I drawings enclosed with this specification.

4.14.01 Sluice / Gate Valves (for river water / clarified water / filtered water / similar application)

Sluice / Gate valve shall conform to IS-14846 PN1.6 minimum. Stem, seat ring and wedge facing ring shall be of stainless steel construction. Other parts shall be as per IS-14846. Valves shall be of outside screw and rising stem type. Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges.

Sluice / Gate valves for sizes 50 mm NB and below shall conform to IS-778 Class-2 / ANSI-B 16.34 straight, rising stem; with outside screw.

Sluice / Gate valves shall be provided with the following accessories in addition to the standard items.

- a) Hand wheel
- b) Gear Reduction Unit Operator for valves 250 mm NB and above.
- c) Bypass valve for valve of sizes 300 mm NB and above.
- d) Draining / Flushing arrangement wherever required.
- e) Arrow indicating flow direction.
- f) Position indicator.

Sluice / Gate Valves shall be provided with back seating bush to facilitate gland renewal during full open condition.

For lower sizes, the gate valves will be screwed bonnet with outside screw rising stem as per IS-778. The material of construction will be gun metal body, with brass stem and trim. Ends will be screwed to ANSI-B 2.1.

Gate valve on galvanized iron pipe shall be gun metal construction as per IS-778 Class 2. Ends will be screwed to ANSI-B 2.1.

4.14.02 Butterfly Valves (for river water / clarified water / filtered water / similar application)

Butterfly valves shall be of double flanged or lugged wafer type of low leakage rate conforming to AWWA-C 504 class 150 (min.) or BS-5155 PN 10 / class 150 (minimum)

The various components of butterfly valves shall be of the following:

i)	Body	:	Cast Iron – ASTM-A 48 Cl.40; BS-1452 Grade220 SG Iron – BS-2789. Cast Iron IS-210 Grade FG 260 Cast Steel – ASTM-A 216 Grade WCB; BS- 1504 or Equivalent grade (subject to approval by Purchaser).
ii)	Disc	:	Cast Iron – ASTM-A 48 Cl.40; BS-1452 Grade220 SG Iron – BS-2789. Cast Iron IS-210 Grade FG 260 Cast Steel – ASTM-A 216 Grade WCB; BS-1504 or Equivalent grade (subject to approval by Purchaser).
iii)	Shaft	:	ASTM-A 296 Grade CF 8M / AISI 316; AISI-420; BS-970 Grade 316; BS-970 Grade 420 S45.
iv)	Seat rings	:	Nitrile rubber, EPDM (Ethylene propylene rubber), Hypalon.

Butterfly valves shall be fitted with sleeve type bearing such as PTFE. Valves of size 350 mm NB and above shall be provided with one or two thrust bearings to hold the disc securely in the centre of valve seat without hydraulic or external axial shaft loads. Sleeve and other bearings fitted into the valves body shall be of self lubricated materials that do not have any effect on the fluid handled and other components of the valves.

All the butterfly valves shall be provided with Hand wheel or lever/wrench operated as per the requirements.

The use of lever operators shall be limited to valves requiring a maximum of 90 degree stem rotation from full open to full closed position. For lever/wrench operated valves, means shall be provided for positively holding the disc in not less than three intermediate positions

For larger sizes i.e. 150 mm NB and above, hand wheel shall be provided.

Manually operated valves shall be provided with reduction gear unit for valves of size 250 mm NB and above. Valve provided with motorised or pneumatic actuator shall be provided with a hand wheel for manual operation.

All the valves shall be equipped with adjustable mechanical stop-limiting devices to prevent over travel of the valve disc in the open and closed positions. The valve operators (Handwheel or Gear reduction unit or Motor actuator etc.) shall be designed as per applicable International Standard.

All the butterfly valves shall be provided with an indicator to show the position of the disc.
Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges.

4.14.03 Butterfly Valves (for decationized water / deanionized water / demineralized water / desalinated water / similar application)

The butterfly valves shall conform to the requirements addressed under Cl. No. 4.14.02 above along with the requirements delineated below:

- a) Body shall be lined (minimum 3 mm) with natural rubber, ebonite, polypropylene or PVDF.
- b) Disc shall be either lined with PVDF, polypropylene, or natural rubber or shall conform to ASME-SA 479 Grade 316.

4.14.04 Ball Valves (for river water / clarified water / filtered water / similar application)

Ball valves may be used for sizes 40 mm NB and below. Ball valves shall conform to the following technical specifications:

a)	Design Standard	BS:5351
b)	Type	Screwed / Welded / Flanged ends; Full Bore: Split Body & Seat supported construction
c)	Material of Construction	
	Body	Carbon Steel to ASME-216 WCB / Cast Iron to IS-210 Grade 220 or better.
	Ball	Stainless steel ASME-SA 479 Grade 316 or 410.
	Seat ring	PTFE
	Stem	Stainless steel ASME-SA 479 Grade 304 or 316 or 410.
	Seats	Nitrile rubber; PTFE

- d) Valves shall be designed to be directly operable by a wrench / hand lever.

- e) Suitable stops shall be provided for both the fully open & close condition.
- f) All the valves shall be provided with an indicator for showing the position of the ball port.
- g) Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges

4.14.05 Globe Valves (for river water / clarified water / filtered water / similar application)

Globe valves shall conform to the following technical specifications:

For sizes 50 mm NB and below

- i) Design Standard : IS-778 Class-2 / BS-1873
- ii) Type : Straight, rising stem, with outside screw.
- iii) Material of Construction

i)	Body, Bonnet, Stuffing Box & seat rings	Leaded Tin Bronze conforming IS-318 Grade 2
ii)	Stem	Stainless Steel, AISI-316
iii)	Disc	IS-318 Grade 2/AISI-316

Note: However, valves in the flushing water lines shall be of type and material specified for the chemicals which are being flushed by the line.

For sizes above 50 mm NB

- i) Design Standard : BS-13789 PN 10 (minimum).
- ii) Type : Double Flanged or wafer body, outside screw and rising stem type.
- iii) Material of construction

a)	Body	: Cast iron: IS-210 Grade FG260 / BS-1452 Grade14.
b)	Stem	: Stainless steel AISI-410 / 13% chrome steel.
c)	Disc	: Cast iron IS-210 Grade 260 / BS-1452 Grade 14.

d)	Packing	:	PTFE
e)	Seat & seat rings	:	13% chromium steel
f)	Gland & gland nut	:	AISI-420
g)	Hand wheel	:	Cast Iron or Malleable Iron

- iv) Back seat shall be provided on the stem or on the disc.
- v) Renewable disc assembly shall consist of disc holder, disc, disc guide, check nut and disc retaining nut with washer.
- vi) Disc of globe valve may be provided with renewable rubber seating ring.
- vii) Handwheels shall be marked with the word. OPEN or SHUT with arrow to indicate direction of opening or closing.

Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges

Globe valve on galvanized iron pipe shall be gun metal construction as per IS-778 class 2. Ends will be screwed to ANSI-B 2.1.

Note: However, valves in the flushing water lines shall be of type and material specified for the chemicals which is being flushed by the line.

4.14.06 Diaphragm Valves (for river water / clarified water / filtered water / similar application)

Metallic Unlined Diaphragm valves (manual / auto as specified elsewhere in this specification) may be used for isolation purposes.

The Metallic Unlined Diaphragm valves shall conform to the requirements addressed under Cl. No. 4.14.07 below except the requirements with reference to lining for body and integral flanges.

4.14.07 Diaphragm Valves (for decationized water / deanionized water / demineralized water / desalinated water / dilute and concentrated acidic solution / dilute and concentrated alkaline solution / similar application)

Metallic Diaphragm valves (manual / auto as specified elsewhere in this specification) may be used for isolation purposes.

The metallic diaphragm valves shall conform to the following requirements.

- a) Design Standard : BS EN-13397 or Equivalent (subject to approval by Purchaser) of required

rating/class. (minimum rating of valves should be PN 10).

- b) Type : Flanged and lined body ends, sealed bonnet, weir pattern, tight shut off type.
- c) **Material of Construction**
- Body/Bonnet : Cast Iron IS-210 Grade FG.260 or Equivalent (subject to approval by Purchaser).
- Cast steel ASTM-A 216 Grade WCB.
- Body lining : Soft Natural rubber - 3 mm thick as per IS-4682 (hardness 85-90 on shore A), Ebonite polypropylene, PVDF.
- Diaphragm : Reinforced rubber, Hypalon
- Handwheel : Cast Iron
- Compressor : Stainless Steel
- Stem & Bush : Stainless Steel
- d) Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (min.) piping flanges, full face rubber lined and shall be cast / integral with the body.
- e) Handwheels shall be marked with the direction of closure.
- f) Valves shall be provided with a position indicator to show the open and closed condition.
- h) Valves provided with pneumatic actuators shall be provided with a handwheel for manual operation. The valves operators shall be designed as per applicable International Standard.
- i) The testing of valves will be as per BS EN-13397 and rubber lining will be tested as per IS-4682.

Note: For valves which may come in contact with concentrated acid/ alkali, the material of construction of diaphragm shall be as follows:

Diaphragm shall be of reinforced Teflon, EPDM for acid services and reinforced Neoprene / Hypalon for alkali services.

Use of Nonmetallic Diaphragm Valves for any specific / critical application shall be subject to approval by Purchaser and shall conform to the requirements of BS EN ISO 16138 - Industrial valves. Diaphragm valves of thermoplastics materials.

4.14.08 Plug Valves (for lime solution / sludge / similar application)

The plug valves shall conform to the following requirements.

a)	Design Standard	BS-5158 or Equivalent (subject to approval by Purchaser)
b)	Type	Flanged and non lubricated, regular pattern, plug valves.
c)	Material of Construction	
	Body	Cast Iron IS-210 Grade FG 260 or Equivalent (subject to approval by Purchaser)
	Plug	Stainless Steel AISI-316
	Body Sleeve or Seat	PTFE
	Seat	PTFE
	Gland	AISI-304 / AISI-316
	Cover	Cast Steel ASTM-A 216 Grade WCB
	Gland Nut	AISI-304 / AISI-316

- d) Valves shall be operated by permanently fitted wrench or Hand lever. Wrench shall be mounted so that they are parallel to the valve bore axis when the valve is in fully open condition.
- e) All valves shall be provided with an indicator for the position of the plug part.
- f) Suitable stops shall be provided for the fully open and fully closed positions of the valve.
- g) Valves of size of 250 mm NB and above shall be provided with a suitable reduction gear unit.
- h) Ends will be flanged and compatible with AISI-16.5 Cl. 150 (minimum) piping flanges.

4.14.09 Non Return or Check Valve (for river water / clarified water / filtered water / similar application)

Non return valves shall be of swing check (reflux) type or dual plate type.

The valves shall conform to the following specifications.

- i) Design Standard : IS-5312, BS-1868, BS-5153, API-594 / API-60 or equivalent (subject to approval by Purchaser)
- ii) Type : Swing check Type and Flanged ends.
- iii) Material of Construction:

a)	Body & Cover Hinge Disk/Door	Cast iron IS-210 Grade FG 260 / Cast Iron BS-1452 Grade 220 or equivalent (subject to approval by Purchaser)
b)	Hinge Pin and Door / Disc Pin	Cast steel ASTM-A 216 Grade WCB High tensile Brass IS-320 HT 2 or BS-2872 equivalent (subject to approval by Purchaser)
c)	Disc facing ring	Stainless steel
d)	Body Seat ring	Stainless steel
e)	Bearing bushes	Leaded Tin Bronze IS-318 Grade 2
f)	Bolts	Carbon Steel

Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges. .

Body shall be permanently marked with an “arrow” inscription indicating the direction of motion of the fluid for all the check valves.

For sizes 50 mm NB and below, check valves shall be gun metal body swing type as per IS-778. Ends will be screwed type to ANSI-B 2.1.

4.14.10

Non Return Valve (for decationized water / deanionized water / demineralized water / desalinated water / dilute and concentrated acidic solution / dilute and concentrated alkaline solution / similar application)

The valves shall conform to Cl. No. 4.09.00 above along with the following requirements:

- The body, cover & Disc shall be lined with natural Rubber, PTFE or Viton. The Hinge, Hinge Pin & Disc Pin shall be coated with PVDF, or suitable elastomer. The bearing bushes shall be PTFE or Equivalent (subject to approval by Purchaser) material (subject to approval by Purchaser). Bolting shall be of stainless steel. In the absence of lining/coating, the complete valve shall be of stainless steel construction (AISI-316).
- For only acid services Non- Return valves shall be of lined construction & Flap type.
- For alkali services, the complete valve shall be stainless steel construction (AISI-316) or of lined construction as specified above.

4.14.11

Valves for Sampling / Instrument Isolation Service

Each sampling valve / instrument isolation valve shall be full bore ball type.

Ball valves shall conform to the requirements stipulated under Cl.4.04.00 above. However, Body material shall be Stainless Steel (AISI-316).

4.14.12 Valves for Air Service

For Air services globe valves or Ball valves may be used for sizes 50 mm NB and below.

For sizes higher than 50 mm NB, either Butterfly valve or Ball valves shall be used.

Globe valves shall generally conform to Cl. 4.05. 00 above.

Ball valves shall conform to the requirements stipulated in Cl.4.04.00 above. However, Body material shall be leaded Tin Bronze (IS-318 Grade2) or stainless steel (AISI-304 / 316).

Butterfly valves shall conform to the Cl.4.03.05 to 4.03.09 of this section. However, the body & Disc shall be either cast iron lined with elastomer such as PVDF or PTFE or stainless steel construction (AISI-304 / 316).

4.14.13 Safety / Relief Valves

The safety valves / relief valves at the downstream of positive displacement type metering pumps shall be of the standard type manufactured by the pump manufacturer and the material of construction shall suit to the fluid handled.

4.14.14 Valves for Resin Transfer Line

In resin transfer line two way eccentric plug valve shall be used. The valves, shall have type 316 stainless steel body and bearings, resilient faced plug and flanged ends.

4.14.15 Isolation Gates

Design standard for gates shall be IS-3042 or Equivalent (subject to approval by Purchaser).

The gates shall be rectangular or square sluice, rising spindle type conforming to class-1 of IS-3042.

Material of Construction

i.	Frame and Door	Cast Iron IS-210 Grade 20
ii.	Spindles, bolts & nuts	M.S. to IS-2062
iii.	Face & seat rings	Gun metal (as per IS-3042).

All the parts of gates shall be applied with the coats of heavy duty bitumastic paint.

Each of the gates shall be provided with handwheel, and a position indicator.

The gates for DM plant drains shall be rubber lined to a minimum thickness of 4.5 mm.

4.15.00 Strainers
4.15.01 Basket Strainers

- a) Basket strainers of simplex design shall have the following materials of construction for raw/clarified/filtered water application.

i.	Body	Fabricated mild steel : IS-2062 (Tested quality)
ii.	Strainers	Wire shall be stainless steel (AISI:316 18 BWG 30 mesh suitably reinforced. Reinforcement material shall also be of stainless steel construction.
iii.	Drain Plug / Nuts	Gun metal

- b) Inside and outside of basket body shall be protected with one coat of high build zinc phosphate primer and three coats of Chlorinated rubber paint to a total thickness of 200 microns.
- c) Suitable Vent and drain valves shall be provided for the strainers.
- d) Screen (strainer) flow area shall be at least four times pipe sectional area. Flow area in any portion of Basket strainer assembly shall not be less than the pipe cross sectional area.
- e) Pressure drop in clean condition shall not be more than 1.0 mwc at full flow.
- f) Basket Strainer shall be provided with lifting lugs and suitable mounting arrangement.
- g) For DM water service, body shall be rubber lined to minimum 4.5 mm thickness (soft rubber of shore Hardness $65 \pm 5^\circ\text{A}$).

4.15.02 Y-Type Strainer

- a) Y-Type strainer for water application shall be constructed of following materials:

i.	Body	Cast Iron IS-210 Grade FG 260
ii.	Strainers	Wires of stainless steel AISI-316, 18 BWG 30 mesh suitably reinforced. Reinforcement material shall also be of stainless steel construction.
iii.	Drain Plug / Nuts	Gun metal (threaded construction)

- b) Y-Type strainers shall also conform to Cl. 4.15.01 (b), (c), (d), (e) and (f).
- c) Body of the Y-type strainers of alkali, and demineralised water shall be of Cast Iron (IS-210 Grade FG 260) and lined with soft or hard rubber to a thickness of 3 mm.

- d) For acid services, apart from the rubber lined body material, the screen material, shall be Polypropylene or HDPE wire cloth of suitable mesh and thickness.

4.16.00 Resin Traps

The resin traps for the Ion exchange vessels shall be provided for the collection of Ion exchange resin shall conform to the following:

- 4.16.01 The body shall be of mild steel (IS-2062) and lined internally with rubber (Hard/Soft rubber), Saran or polypropylene. The internals (rod and screen) for all resin traps shall be of AISI-316 construction. All screen components shall be welded at each intersection of wire and support rod for good strength, Resin traps screen opening shall not exceed 120 percent of the associated process vessel under drain/backwash collection header nozzle screen opening and shall be suitably selected to retain even the minimum size of the resin selected for the process.

- 4.16.02 The resin traps shall be provided with a draining arrangement with a valve for collection of trapped resins. Resin trap body shall have lifting lug for easy handling during maintenance/erection.

4.17.00 General Requirements for Valves, Gates, Strainers and Resin traps

- 4.17.01 All the items shall be suitable for service conditions i.e. flow, temperature and pressure to which they may be subjected to.

- 4.17.02 All the items shall be of proven design for the duty conditions and the Bidder or manufacturer shall have sufficient experience in using the above equipment in water treatment application in the plants supplied earlier by them.

- 4.17.03 In case Purchaser desires, the experience list/feedback from the users shall be made available to Purchaser for any or all the equipments during the detailed engineering phase.

- 4.17.04 Valves will be used to start/stop or control flow. Gates will be primarily used for isolation of flow in open channels although these should be capable of throttling the flow too. Sample valves will be used in sample collection lines.

- 4.17.05 All valves shall be suitable for service conditions i.e. flow, temperature and pressure under which they are required. All the valves shall be of standard pressure rating of the applicable design code / standard. Non standard pressure rating shall not be accepted. The pressure and temperature rating of the valve shall not be less than the maximum expected pressure and temperature plus 5% additional margin of the system in which valves are proposed to be installed.

- 4.17.06 Valves pressure classes, sizes, types, body materials, and end preparation shall generally be as described herein, unless mentioned otherwise elsewhere in Bid Specification. All valves shall conform to the requirements of the governing codes, and the requirements specified.

- 4.17.07 Valves (including safety, relief and control valves) body materials shall be compatible with the piping with which they are used. If the body material is not of the same type as the material of the connecting pipe work, the valves shall be fitted with suitable welding nozzles to avoid dissimilar butt welds at site.

- 4.17.08 Each modulating control valve shall be provided with isolation valves. Manual bypass valve shall be provided for each modulating control valve to achieve safe and reliable manual operation.
- 4.17.09 All the actuators of the valves shall be designed to handle the maximum expected pressure differential across the valves and to overcome friction forces and unbalance forces due to the flow through valve.
- 4.17.10 Valve bodies and bonnets shall be designed to support the valve operators (handwheel, gear, or motor) with the valve in any position without external support.
- 4.17.11 Valve ends and size limitations are as follows:
- a) 50mm NB and smaller valves - Class 800 minimum with socket weld ends. (For instruments connections/ isolation valves screwed ends may be acceptable)
 - b) 65mm NB and larger size valves - Class 150 minimum (butt-weld ends or flanged or wafer style).
 - c) Flanged steel butterfly valves - 750mm and larger size; pressure class per AWWA / BS-5155.
- 4.17.12 Gate, globe and angle valves shall be outside stem and yoke construction.
- 4.17.13 Valves sizes 65 mm NB and larger shall have a non-rising handwheel.
- 4.17.14 All the actuator operated valves shall be fitted with handwheel for manual operation. The pneumatic actuators shall be selected based on the available air pressure and operating air pressure (maximum and minimum). The supporting calculations for selection of actuators shall be furnished for Purchaser's approval before finalization of all the actuators.
- 4.17.15 Valves coming under the purview of IBR if any shall meet its requirements and the approval of the same shall be obtained by the Bidder.
- 4.17.16 Sizes of the valves shall be same as that of the interconnected pipe sizes except for the control valves.
- 4.17.17 The various items shall be installed such so that they are easily approachable for the operating and maintenance personnel. All valves shall be accessible without chain pulls, as far as possible. Generally Valves shall be located about 1.2 meter to 1.5 meter from the operating platform and also they shall not be located below the ground level such as beneath the trenches etc. In such cases, extended spindle shall be provided with chain operating from operating floor. Valves which are installed below the ground floor shall be provided with a floor mounted pedestal at the top of the operating floor. Valves which are installed below the ground floor shall be provided with a floor mounted pedestal at the top of the operating floor. The position indicator for such valves shall be also provided along with the stand.
- 4.17.18 All valves shall be provided with hand wheels. Wherever necessary, chain operator shall be provided so that the valve may be operated from the ground floor.
- 4.17.19 All valves shall be provided with cast heat marks on casting of Body and Bonnet.

- 4.17.20 Whenever screwed valves will be installed in a pipe line, it will always be followed by screwed three piece union of same material as that of pipe.
- 4.17.21 Short pieces used for welding of different pipe fittings and valves shall not be less than 80 mm in length.
- 4.17.22 However valves which are provided (in the buried pipe line) with a valves chamber shall have manual operator/Handwheel inside the valve chamber. The valve chamber shall be provided with built in ladders/staircases and sufficient operating space within the chamber shall also be provided for easy operation of such valves.
- 4.17.23 All the valves, strainers, resin traps etc. shall be provided with external painting as that of the interconnected piping as specified in Clause 3.03.14 above. However, surfaces such as Stainless Steel, aluminium, copper, brass, bronze and other non-ferrous materials shall not be painted. No paint or filter shall be applied until all repairs, hydrostatic tests and final shop inspections are completed, but shall be applied prior to shipment.
- 4.18.00 Rubber Expansion Joint
- 4.18.01 The inner cover (i.e. the tube) and also the outer cover shall be made up of natural or synthetic rubber of adequate thickness. The carcass between the tube and the cover shall be made up of high quality cotton and rayon cord having suitable number of plies and impregnated with rubber or synthetic compounds. Moreover, to ensure adequate strength, reinforcements consisting of metal rings embedded in the carcass, shall be provided.
- 4.18.02 In all cases, the expansion joints shall be integral flanges at both ends complete with split retaining rings.
- 4.18.03 Each of the expansion joint shall be provided with adequate number of limit rod assemblies which shall be tightened after erection of the entire suction branch of the pumps, in order to avoid transmittal of undue pressure thrust on to the pump foundation. Each of these limit rod assemblies shall consist of a long bolt and two connecting plates which are, in turn securely bolted to opposite flanges. Each plate is to be drilled with three holes, two for bolting to the flange, the third for passage of the stretcher belt. Rubber washers backed with metal washer shall be placed under the head of the bolt and under the nut.
- 4.19.00 Protective Lining and Painting
- The supply and application of Protective Lining and Painting with reference to Piping, Fittings and Valves need to be as per **Sub Section: Section-XIII of V.III-C- Technical Specification for Protective Lining and Painting**, attached herewith.
- 5.00.00 **TESTS AND INSPECTION**
- 5.01.00 Tests & Inspection for Pipes and Fittings
- 5.01.01 Shop Tests
- Shop test shall include all tests to be carried out at supplier's work, works of sub

suppliers and at works where raw materials supplied for manufacture of equipment are produced. The supplier shall carryout a comprehensive inspection and testing program during manufacture at works. Necessary Manufacturing and Field Quality Plans shall be prepared by supplier and submitted for approval by Purchaser for all checks conducted on raw materials, fabrication etc.

Calibrated instruments required for measuring / testing of pipes shall be arranged by manufacturer at their works during inspection.

Purchaser shall be given full access to all tests. The manufacturer shall inform Purchaser of the testing well in advance so that Purchaser at own option may witness the test.

All the test certificates and reports shall be submitted to Purchaser for approval.

All the mechanical and chemical tests including optional tests if any as per the applicable codes / standards shall be carried out and the test certificates for the same shall be submitted for approval by Purchaser. Material Certificate shall be furnished for each grade / lot of pipes. All material test certificates shall carry material specification, size, class, length, chemical composition, physical properties and heat number or other acceptable reference to enable correlation of the certificate with the pipe. IBR / CCE / TAC approval certificates / any other statutory approval certificates as required shall be furnished.

Welding procedure and welder performance qualifications shall be carried out. Mechanical and chemical tests shall be carried out as per code. Spot radiography check shall be carried out for all butt welds. D.P.T shall be carried out for all root run welds. Segmented flanges exceeding 30 mm thickness shall be stress relieved. Tensile test, eddy current test, bend test, flattening test and dimensional checks as per applicable code shall be carried out.

All rubber lining is to be subjected to the following tests as per IS-4682 Part I:

- a) Adhesion test.
- b) Tests to check resistance to bleeding.
- c) Measurement of thickness of lining.
- d) Shore hardness test.
- e) Spark test at High voltage 5 KV / mm of thickness.

Galvanizing shall be carried out as per IS-4736 / IS-2629 and tested as per IS-2633 / BS- 729. The test shall include weight of coating, uniformity of thickness and adhesion test.

All pipes and fittings shall be subjected to hydraulic tests as per applicable code / standard. When rubber lined, hydraulic tests shall be carried out before and after rubber lining.

Buried pipes where wrapping and coating is done, material for wrapping and coating shall be tested as per applicable code. Procedure for wrapping and coating and its testing shall be submitted for approval by Purchaser. Entire wrapping and coating shall be checked for thickness and Holiday test. Peel test shall be done to ensure

proper bonding of coating to surface.

5.01.02 Site Test

Hydraulic tests of the piping system at 1.5 times the design pressure or twice the working pressure whichever is higher shall be carried out for a period of minimum 30 minutes. However, if the Code / standard of supplied piping specifies more stringent requirements than the above criteria, then the hydraulic tests shall be conducted as per the applicable piping code / standard.

Pneumatic tests shall be carried out for all pressure piping that shall not be subjected to water filling.

The Bidder shall make all temporary closures/connections as required for hydro-static/pneumatic testing and clean/remove the same after successful completion of the test.

The procedure for hydro test and pneumatic test shall be submitted by the Bidder for review and approval by Purchaser.

All tests as indicated in FQP approved by Purchaser shall also be carried out.

5.02.00 Tests & Inspection for Valves / Gates / Strainers

5.02.01 Shop Tests

Chemical composition of all material, castings, forgings, etc. shall be tested for various components of the valves, gates, strainers and test certificates shall be submitted for approval by Purchaser.

Mechanical tests including optional tests if any shall be performed as per the applicable code / standard and the test certificates for the same shall be submitted for approval by Purchaser. The performance requirements of the valves shall also be tested as per the applicable code / standard.

Elastomer wherever coated or lined for the valves shall be tested for the corrosion resistance against the medium for which those are selected as per applicable code / standard and the test certificates shall be furnished for approval by Purchaser.

Rubber lining on Valves / Gates / Strainers / Resin Traps shall be checked in accordance with IS-4682 Part I including Spark Testing at high voltage (5 KV/mm of thickness).

All the valves shall be hydraulically tested for the body, seat, back seat and all valves shall be pneumatically tested for seat as per the applicable code / standard to which these are designed irrespective of the working pressure for which valves are selected.

Wherever specifically required, pressure drop across each type and each size of the valve at various flows shall be conducted, and test reports shall be submitted for approval by Purchaser. Type test report for this test (if already carried out by the manufacturer) may be submitted to fulfill this requirement.

Gates shall be tested against leakage and strength as required in the code / standard.

Strainer shall be hydraulically tested its strength and the pressure drop across the strainer assembly shall be verified at design flow for clean condition.

5.02.02 Site Tests

All valves, gates, resin traps, strainers and other fittings after erection at site shall be tested to hydraulic test pressure of two times the operating pressure or 1.5 times the maximum allowable pressure whichever is higher for a period of 120 minutes.

All valves / gates (Manual / Automatic) shall be operated throughout 100% of the travel manually and as well as from control panel and these should function without any trouble whatsoever.

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SECTION-IX

**TECHNICAL SPECIFICATION
FOR
HORIZONTAL CENTRIFUGAL PUMPS**

SECTION: IX
TECHNICAL SPECIFICATION
FOR
HORIZONTAL CENTRIFUGAL PUMPS

C O N T E N T S

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SECTION : IX

TECHNICAL SPECIFICATION FOR HORIZONTAL CENTRIFUGAL PUMPS

1.00.00 INTENT OF SPECIFICATION

The specification covers the design, performance, manufacturing, shop testing, erection, testing and commissioning at site, of the horizontal centrifugal pumps.

2.00.00 CODES AND STANDARDS

2.01.00 The design, manufacture and performance of the horizontal centrifugal pumps shall conform to the latest revisions of the following codes and Indian standards, in addition to other stipulations and standards mentioned elsewhere in the specification :

- a) IS-1520 : Horizontal centrifugal pumps for clear cold fresh water.
- b) IS-5120 : Technical requirement rotodynamic special purpose pumps.
- c) IS-5639 : Pumps handling chemicals and corrosive liquids.
- d) IS-5659 : Pumps for process water.
- e) Standards of Hydraulic Institute, U.S.A.

2.02.00 The material of construction for the various components of the pumps shall conform to the applicable standards like "American Society of Testing & Materials (ASTM)" and Indian Standards.

3.00.00 DESIGN AND CONSTRUCTION

3.01.00 Pumps shall be of horizontal/vertical split casing with speed preferably be limited to 1500 RPM. Design and construction of various components of the pumps shall conform to the following general specifications. For material of construction of the components, data sheets in Appendix-I of SECTION-III may be referred to.

3.01.01 Casing

The casing shall be structurally sound to provide housing for the pump assembly and shall be designed hydraulically to minimize radial loads at part load operations.

3.01.02 Impeller

The impeller shall be as per the proven design of the manufacturer. It shall be keyed to the shaft and locked in position. The rotor assembly shall be statically and dynamically balanced and designed with critical speed substantially above the operating speed.

3.01.03 Impeller/Casing Wearing Rings

Replaceable type wearing rings shall be provided at suitable locations for each pump. The rings shall be so fitted as to prevent turning while the pump is in operation.

3.01.04 Shaft

The shaft shall be adequately sized to withstand all stress from rotor weight and hydraulic loads etc. The shaft shall be ground and polished to final dimensions.

3.01.05 Shaft Sleeves

Pump shafts shall be protected by renewable type shaft sleeves which shall extend well beyond the pump glands. The sleeves shall be highly polished and shall be securely fastened to the shaft to prevent any loosening.

3.01.06 Bearings

Heavy duty bearings, adequately designed for the type of service specified and for long and trouble-free operations, shall be furnished. The design shall be such that the bearing lubricating oil does not contaminate the liquid being pumped.

3.01.07 Thrust Bearings

Adequately designed thrust bearings to absorb pump thrust or other unbalanced force, if any, shall be provided.

3.01.08 Lubrication system shall be designed in such a way that in case of total power failure, there will not be any damage while coasting down to stop.

3.01.09 Stuffing Boxes

Stuffing boxes of packed ring construction or of mechanical seal type as desired in the Data Sheet - Appendix-II attached with this specification shall be provided. The necessary piping, valves, fitting etc. for the gland sealing connection shall be provided. For mechanical seals, the mating surfaces shall be suitably hard faced to ensure long life.

3.01.10 Pump Shaft-Motor Shaft Coupling

The pump shaft and motor shaft shall be connected with a suitably designed flexible coupling of approved design preferably with a spacer to facilitate dismantling of the

pump without disturbing the motor. Necessary coupling guards for the coupling shall also be furnished.

3.01.11 Base Plate

A common base plate for mounting the pump and the corresponding driver motor shall be furnished. The base plate shall be of fabricated steel and of rigid construction, properly ribbed as required. Driplip with drain tap suitable for type of service specified shall be furnished.

3.01.12 Drain, Vent and Priming Connections

Each pump shall be provided with a casing drain, vent and priming connection at suitable locations.

3.01.13 Drive Motor and Its Control

Please refer Electrical Specification enclosed herewith this specification.

3.01.14 Anchor Bolts, Sleeves, Inserts, Lifting Lugs, Eye Bolt, etc.

All anchor bolts, foundation plates, sleeves, nuts, inserts etc. to be embedded in concrete for the equipment are to be supplied. The length of the foundation bolts shall be liberally sized to reach below the reinforcement level.

Each equipment shall be provided with suitable lifting lugs, eye bolts etc. to facilitate maintenance.

3.02.00 Consistent with good operating characteristics and high efficiency, each pump shall have a continuously rising head capacity characteristics curve without any zone of instability. Power flow characteristic shall preferably be non-overloading type beyond rated duty point. The characteristic curves of each set of pumps shall match each other for equal sharing in case of parallel operation. The pump motor set shall be designed in such a way that there is no damage due to reverse flow through the pump which may occur due to any mal-operation of the system.

3.03.00 The pumps shall be suitably designed also for smooth and trouble free continuous solo operation in the event of trip out of the remaining pumps running in parallel.

3.04.00 The pumps shall be designed to have best efficiency at the rated duty point. The pumps shall be suitable for continuous operation within a wide range above and below the rated duty point. Such range of operation within which category of pumps can satisfactorily operate on continuous basis, shall be clearly indicated.

3.05.00 Drive motors for each category of pumps shall be suitable for use on 415V $\pm 10\%$, 3 ϕ , 50 Hz $\pm 5\%$ and neutral grounded system. Drive motors shall have 15% spare margin over the maximum power requirement of the pump within the range of operation.

4.00.00 TESTING

4.01.00 **Testing and Inspection at Manufacturer's Works**

4.01.01 All tests required shall be conducted to ensure that the equipment furnished shall conform to the requirements of this specification and in compliance with requirements of the applicable codes.

The particulars of the proposed tests and the procedures for the tests shall be submitted for approval before conducting the tests.

4.01.02 The representatives of Purchaser shall be given full access to all tests. Prior to pump performance tests, the manufacturer shall inform the Purchaser allowing adequate time so that if the Purchaser desires, his representatives can witness the test.

4.01.03 All materials and casting used for the equipment shall be of tested quality. The test certificates shall be made available to Purchaser.

4.01.04 The pump casing shall be hydraulically tested at 200% of pump rated head or at 150% of shut-off head, whichever is higher. The test pressure shall be maintained for at least half an hour.

4.01.05 The pump rotating parts shall be subjected to static and dynamic balancing tests.

4.01.06 All pumps shall be tested at the shop for capacity, head efficiency and brake horse power and cavitation. The tests are to be done according to the requirement of the "Hydraulic Institute" of USA, ASME Power Test Code PTC-8.2 (latest edition) and Indian Standards as applicable.

4.01.07 The pump accessories e.g. the thrust bearing, the motor pump shaft coupling etc. will be subjected to tests as per Manufacturer's standard.

4.01.08 The combined vibration of pump and motor should be restricted to the limits specified by Hydraulic Institute Standards, USA, when the pump is in operation at any load singly or in parallel.

4.01.09 Tests on motors shall be conducted as per electrical specification enclosed herewith this specification.

4.01.10 The reports and certificates of all the above mentioned tests to ensure satisfactory operation of the system shall be submitted to the Purchaser before despatch.

4.01.11 Cast heat marks are to be provided on castings for casing and impeller.

4.02.00 Tests at Site

After erection at site, pumps under different services shall be operated to prove satisfactory performance as individual equipment as well as a system.

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SECTION-X

**TECHNICAL SPECIFICATION
FOR
VERTICAL CENTRIFUGAL PUMPS**

SECTION : X
TECHNICAL SPECIFICATION
FOR
VERTICAL CENTRIFUGAL PUMPS

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SECTION: X

TECHNICAL SPECIFICATION
FOR
VERTICAL CENTRIFUGAL PUMPS

1.00.00 INTENT OF SPECIFICATION

The specification covers the design, performance, manufacturing, shop testing, erection, testing and commissioning at site, of the vertical centrifugal pumps.

2.00.00 CODES AND STANDARDS

2.01.00 The design, manufacture and performance of the vertical centrifugal pumps shall conform to the latest revisions of the following codes and Indian Standards in addition to other stipulations and standards mentioned elsewhere in the specification :

- a) IS-1710 : Vertical turbine pumps for clear, cold, fresh water.
- b) IS-5120 : Technical requirement for rotodynamic special purpose pumps.
- c) IS-5639 : Pumps handling chemicals and corrosive liquids.
- d) IS-5659 : Pumps for process water.
- e) Standards of Hydraulic Institute, USA.

2.02.00 The material of construction for the various components of the pumps shall conform to the applicable standards like "American Society of Testing & Materials (ASTM)" and Indian Standards.

3.00.00 DESIGN AND CONSTRUCTION

3.01.00 Pump Type

The pumps shall be vertical wet pit type with open shaft or enclosed shaft construction depending on the type of liquid to be pumped. Material of construction shall be as per the data sheets in Appendix-II. The pump shed shall preferably be limited to 1500 RPM.

3.02.00 Discharge Head Assembly

The pump shall have fabricated discharge head disposed above the ground. The head shall be capable of supporting the pump and motor on the foundation; expansion joint shall be provided immediately at the pump discharge; but no thrust block shall be provided for the unbalanced hydraulic thrust thus developed. The anchor bolts and pump fixing arrangement shall be suitably designed to take up the back thrust due to the expansion joint.

The head shall contain a packed type stuffing box to prevent any leakage.

A water stinger may be fitted to the top shaft to protect the motor from water spray.

3.03.00 Bowl

In addition to housing the impellers properly, the bowls shall provide a smooth path to water passage and shall be hydraulically designed to minimise radial thrust.

3.04.00 Impeller

The impeller shall be closed or open as per standard design of the manufacturer. All rotating parts including the impeller shall be statically and dynamically balanced. The critical speed of all the rotating parts shall be substantially above the design speed.

3.05.00 Pump Shaft and Motor Shaft Coupling

The pump shaft shall be connected to motor shaft by a heavy duty flexible coupling.

3.06.00 Column Pipe and Shaft

The line shaft and the shaft enclosing tube shall be made in convenient sections and shall be joined securely by union couplings. The column pipe shall also be made in sections and shall be joined by flanged coupling. In case of flanged joint gaskets shall be provided at each connection.

For sludge handling, vertical cantilever pump with no submerged bearing shall be provided.

3.07.00 Shaft Sleeves

Replaceable shaft sleeves shall be furnished. The shaft sleeve shall be securely locked to shaft to prevent loosening while in operation.

3.08.00 The necessary supporting frame, base-plates, sole-plates, mounting-plates, etc. as required shall be supplied under this specification, alongwith anchor bolts, foundation bolts, pipe sleeves etc.

3.09.00 Thrust Bearings

Thrust bearing of adequate design shall be furnished for taking the pump weight as well as maximum hydraulic thrust. The bearing may be lubricated by grease or oil. The design should be such that the bearing lubricating oil does not contaminate the liquid being pumped. Cooling of thrust bearing, if necessary, shall be done by liquid tapped from the discharge of the pump itself. The thrust bearing shall be designed on the basis of 20,000 working hours minimum for the load corresponding to the duty point.

3.10.00 Line Shaft and Bowl Bearing

Adequate number of properly designed bearings shall be furnished to prevent undue vibration.

3.11.00 Lubrication system shall be designed in such a way that in case of total power failure, there will not be any damage while coasting down to stop.

3.12.00 Shaft Enclosing Tube

For sludge/turbid/dirty water/chemical services, the pump shaft shall be of enclosed tube construction. For the lubrication of shaft necessary clarified/filtered water required shall be arranged. Necessary piping, valves, fittings, booster pumps etc. as required shall be included in scope.

- 3.13.00 **Suction Bell**
- The pump shall be complete with adequately dimensioned suction bell to guide and streamline intake fluid.
- 3.14.00 **Adjustment of Impeller**
- The pump shaft shall have suitable arrangement for vertical adjustment of impeller position from an accessible point.
- 3.15.00 **Pump Characteristics**
- Head capacity curve should be rising upto the shut-off head condition. Power versus capacity curve shall be non-overloading type beyond rated duty point.
- The characteristic curves of each set of pumps shall match each other for equal load sharing in case of parallel operation. The pump shall however, be also designed for smooth and trouble-free continuous solo operation in the event of trip-out of the remaining pumps running in parallel.
- 3.16.00 The pumps shall be designed for reverse flow through them. The drive motor shall be capable of bringing the pump to its rated speed in the normal direction from the point of maximum possible reverse speed when power to the drive is restored.
- 3.17.00 The pumps shall be designed to have best efficiency at the rated duty point.
- The pumps shall be suitable for continuous operation within a wide range above and below the rated duty point. Such range of operation within which the pumps can satisfactorily operate on continuous basis, shall be clearly indicated.
- 3.18.00 Drive motors for the pumps shall be suitable for use on 415V $\pm$ 10%, 3 ϕ , 50 Hz, $\pm$ 5% and neutral grounded system. Drive motors shall have 15% spare margin over the maximum power requirement of the pump within its range of operation.
- 4.00.00 **TESTING**
- 4.01.00 **Testing and Inspection at Manufacturer's works**

- 4.01.01 All tests required shall be conducted to ensure that the equipment furnished conforms to the requirements of this specification and is in compliance with requirements of the applicable codes. The particulars of the proposed tests and the procedures for the tests shall be submitted to Purchaser for approval before conducting the tests.
- 4.01.02 The representatives of Purchaser shall be given full access to all tests. Prior to pump performance tests, the manufacturer shall inform the Purchaser allowing adequate time so that if the Purchaser so desires, his representative can witness the test.
- 4.01.03 All materials and casting used for the equipment shall be of tested quality. The test certificates shall be made available to the Purchaser.
- 4.01.04 The pump casing shall be hydraulically tested at 200% of pump rated head or at 150% of shut-off head, whichever is higher. The test pressure shall be maintained for at least half an hour.
- 4.01.05 The pump rotating parts shall be subjected to static and dynamic balancing.
- 4.01.06 All pumps shall be tested at the shop for capacity, head, efficiency, brake horse power and cavitation. The tests are to be done according to the requirements of the Hydraulic Institute of USA, ASME Power Test Code, Indian Standards, as applicable.
- 4.01.07 The pump accessories e.g. the thrust bearing, the motor pump shaft coupling etc. will be subjected to tests as per manufacturer's standards.
- 4.01.08 The combined vibration of pump and motor should be restricted within limits specified by Hydraulic Institute Standards, USA when the pump is in operation at any load singly or in parallel.
- 4.01.09 Tests on motors shall be conducted as per electrical specification enclosed with this specification.
- 4.01.10 Test reports and certificates of the above mentioned tests to ensure satisfactory operation of the system shall be submitted to the Purchaser before despatch.
- 4.01.11 Cast heat marks shall be provided on castings for casing and impeller.
- 4.02.00 Test at Site

After erection at site, pumps under different services shall be operated to prove satisfactory performance as individual equipment as well as a system.

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SECTION-XI

**TECHNICAL SPECIFICATION
FOR
POSITIVE DISPLACEMENT PUMPS**

SECTION : XI
TECHNICAL SPECIFICATION
FOR
POSITIVE DISPLACEMENT PUMPS

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SECTION: XI

TECHNICAL SPECIFICATION FOR POSITIVE DISPLACEMENT PUMPS

1.00.00 INTENT OF SPECIFICATION

This specification covers the design, performance, manufacturing, shop testing, erection, testing & commissioning at site, of the positive displacement pumps.

2.00.00 GENERAL DESIGN FEATURES

This specification provides guideline for design, manufacturing and testing of positive displacement pumps with variable capacity to inject chemicals, generally used in the treatment of water in metered amounts.

2.01.00 Pumps shall be simplex/duplex type, positive displacement hydraulically operated diaphragm design, driven by squirrel cage induction motor through suitable speed reduction unit.

2.02.00 The stroke shall be continuously adjustable to give a capacity variation 0-100% range, while the pump is running or stopped. Adjustment of capacity shall be done automatically, wherever required, by pneumatic stroke positioner in proportion to a 0.2 - 1.0 Kg/Sq.Cm air signal or manually. For automatic pumps, in addition to the automatic control, manual control facility shall also be provided. Manual control facility shall be of micrometric adjusting type.

2.03.00 Capacity variation may be effected by changing eccentricity of the driving crank or by suitable hydraulic circuit. Pump accuracy shall be industry standard, $\pm 1\%$ of capacity setting.

2.04.00 Pumps shall be provided with an integral relief valve, spring operated, to release pressure when delivery line blockage occurs.

2.05.00 Crank case shall be constructed of high quality cast iron, which will also house the gear box and guides for cross head.

2.06.00 Material of construction should be as follows :

◆ Crank case	Cast iron.
◆ Pump head	Polypropylene.
◆ Valve and valve housing	Polypropylene.
◆ Wheel	Cast iron to a 48.

◆ Worm	AISI 4142.
◆ Shafts (worm)	En 19.
◆ Diaphragm	Chemically inert teflon.
◆ Base plate	MS.
◆ Foundation bolts	MS.

- 2.07.00 Suitable gland seal should be provided to prevent leakage.
- 2.08.00 Electric drive motor particulars should follow Electrical Specification, enclosed herewith.
- 3.00.00 TESTING
- 3.01.00 Testing and Inspection at Manufacturer's Works
- 3.01.01 The Manufacturer shall conduct all tests required to ensure that the equipment furnished conforms to the requirements of this specification and is in compliance with requirements of the applicable codes.
- The particulars of the proposed tests and the procedures for the tests shall be submitted to Purchaser for approval before conducting the tests.
- 3.01.02 The representatives of Purchaser shall be given full access to all tests prior to pump performance tests. The Manufacturer shall inform the Purchaser allowing adequate time so that if the Purchaser so desires, his representatives can witness the test.
- 3.01.03 All materials and castings used for the equipment shall be of tested quality. The test certificates shall be made available to Purchaser.
- 3.01.04 The pump casing shall be hydraulically tested at 200% of pump operating pressure or 15 Kg/Sq.Cm(g) whichever is higher. The test pressure shall be maintained for at least half an hour.
- 3.01.05 The rotating parts of pump drive shall be subjected to static balancing.
- 3.01.06 All pumps shall be tested at the shop for capacity volumetric accuracy, repeatative accuracy, power and volumetric efficiency. The tests are to be done according to the requirements of the "Hydraulic Institute" of U.S.A. ASME Power Test Code and Indian Standards or as per API.- 675.
- 3.01.07 The pump accessories e.g. gear box, speed reduction unit etc. will be subjected to tests as per Manufacturer's standards.
- 3.01.08 The combined vibration of pump and motor should be restricted within limits specified by Hydraulic Institute Standards, USA, when the pump is in operation singly or in parallel.

- 3.01.09 Test reports and certificates of all the above mentioned tests to ensure satisfactory operation of the system shall be submitted to the Purchaser before despatch.
- 3.01.10 Performance test shall be carried out for the setting of pressure relief valve.
- 3.02.00 Test at Site
- After erection at site, pumps under different services shall be operated to prove satisfactory performance as individual equipment as well as a system.

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SECTION-XII

**TECHNICAL SPECIFICATIONS
FOR
SCREW PUMPS**

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SECTION-XII

TECHNICAL SPECIFICATIONS FOR SCREW PUMPS

01.00.00 GENERAL

This section covers general requirement of design, construction features, manufacture, inspection and performance testing of screw / gear pump for water, oily water, fuel oil and sludge applications.

2.00.00 CODES AND STANDARDS

The equipment supplied shall comply with the latest applicable Indian Standards listed below. Other national standards are acceptable provided they are established to be equal or superior to the Indian Standards mentioned herewith.

IS : 5120. 1977	Technical requirements of rotodynamic purpose pumps
BS : 599. 1966	Method of testing for pumps
HIS	Hydraulic Institute Standards, USA
API: 676. 1980	Positive Displacement Pumps - Rotary
VDMA 24284. 1970	Positive Displacement Pumps - Code for Acceptance
	Test
IS: 210.1993	Grey Iron Castings
IS : 2062, 1992	Steel for general structural purposes
ANSI B16.5	Pipe flanges and flanged fittings
ASME Sec II	Engineering
	Materials

03.00.00 TECHNICAL REQUIREMENTS

03.01.00 Design & Performance Requirements

- 03.01.01 The pump shall be horizontal, rotary, positive displacement type with gear or screw as rotary element.
- 03.01.02 The pump shall be capable of developing the required total head at rated flow under continuous operation. The maximum efficiency of the pump shall be within $\pm 10\%$ of rated flow.
- 03.01.03 Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load sharing. Components of identical pumps shall be Interchangeable.
- 03.01.04 Pumps shall run smoothly without undue noise and vibration. The noise level at a distance of 1 m from the equipment shall not exceed 85 dBA.
- 03.01.05 The pumps shall be suitable to handle fluid of characteristics as indicated in technical data sheet.
- 03.01.06 The pumps shall be suitable to handle the specified fluid for the complete range of operating conditions. The pump capacity shall be selected based on lowest possible viscosity and driving motor power shall be selected based on highest possible viscosity.
- 03.01.07 Each pump shall be connected to its drive motor directly and shall be mounted on a common base plate. The pump set along with drives shall be designed to permit rapid and economical maintenance.
- 03.01.08 All pumps shall be provided with suitable mechanical seals of proven design and material.
- 03.01.09 The supplier shall assume full responsibility in the operation of pump and motor as a unit.
- 03.02.00 Construction Requirements
- 03.02.01 Pump Casing
- Casing and supports shall be designed to have sufficient strength and rigidity to prevent any adverse effect on internal clearances and to limit change of alignment to 50 micrometers at the coupling

flange caused by the worst combination of pressure, torque or allowable piping stress.

Pump casing shall be provided with a vent connection along with piping, fittings & valves unless pump is self-venting by the arrangement of nozzles. Casing drain, as required, shall be provided complete with drain valves, piping and plugs. It shall be provided with a connection for suction and discharge pressure gauge as standard feature.

Jacket for cooling or heating shall be provided, if specified in technical particulars. Passages shall not open into casing joints.

Inlet and outlet connections shall be flanged. Flanges shall be raised face and shall conform to ANSI B 16.5. Counter flanges with necessary bolts. nuts. gasket etc. shall be supplied along with the pump.

03.02.02 Rotating Elements

Rotating parts shall be properly aligned. Rotor and shaft shall be stiff enough to prevent contact between the rotor bodies and the casing. It shall be of material that have wear, corrosion and erosion resistance compatible with the application.

03.02.03 Mechanical Seals

The Pumps shall generally be employed with mechanical seals, which shall be arranged that replacement of seal should be possible with minimum downtime. T sealing faces should be highly lapped surfaces of materials known for their frictional coefficient and resistance to corrosion against the liquid being pumped

The seal end plate or rotating cover and bolting shall be designed to retain the SI with sufficient rigidity to prevent distortion that might impair seal operation. T stationary seal member shall be positively retained to prevent its rotation. For 1 seals under vacuum service, the seal design must ensure sealing against atmospheric pressure even when the pumps are not operating.

If seal flushing and cooling is provided by the pumped fluid, the pump supplier shall ensure that sufficient flow reaches the primary seal faces to provide for cooling and maintenance of a stable film at

the seal faces.

03.02.04 Stuffing Box

Stuffing box, if provided, should permit replacement of packing without removing any part other than the gland. Asbestos shall not be used as a packing material.

Stuffing Boxes of packed ring construction type preferably to accommodate five rings of packing (minimum four rings of packing) plus a lantern ring shall be provided wherever specified. Packed ring stuffing boxes shall be properly lubricated and sealed as per service requirements and manufacturer's standards. If external gland sealing is required, it shall be done from the pump discharge. The Bidder shall provide the necessary piping valves, fittings etc. or the gland sealing connection.

03.02.05 Bearing

Heavy duty antifriction bearings, adequately designed for the type of service specified in the technical data sheet and for long, trouble free operation shall be furnished.

The bearings offered shall be capable of taking both the radial and axial thrust coming into play during operation. Antifriction bearings shall be designed for a rated life of either 25000 hours with continuous operation at rated conditions or 16000 hours at maximum axial and radial loads and rated speed.

Proper lubricating arrangement for the bearings shall be provided. The design shall be such that the bearing lubricating element does not contaminate the liquid pumped. Where there is a possibility of liquid entering the bearings suitable arrangement in the form of deflectors or any other suitable arrangement must be provided ahead of bearing assembly.

Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearing housing.

03.02.06 Pump & Motor shaft Coupling

The pump and motor shafts shall be connected with an adequately sized flexible coupling of proven design with a spacer to facilitate dismantling of the pump without disturbing the motor. Necessary coupling guards shall also be provided.

03.02.07 Base plate

A common base plate for the pump and motor shall be provided. The base plate shall be of fabricated steel (minimum 6 mm thickness) and of rigid construction suitably ribbed and reinforced. Base plate and pump supports shall be constructed and the piping unit so mounted as to minimize misalignment caused by mechanical forces such as normal piping strain, internal differential thermal expansion and hydraulic piping thrust. The base plate shall be suitably drilled for the anchor bolts. The base plate shall have drip pan and suitable draining arrangement.

03.02.08 Relief Valve

To protect against damage due to accidental closure of discharge valve, each pump shall be provided with a relief valve of adequate capacity,

Relief valve shall be able to handle the pump rated capacity when fully open, at a pressure not more than 10 percent above the set pressure.

03.02.09 Material of Construction

The material of construction of various components shall be as indicated in technical particulars. These are to be considered as minimum requirement and it is the responsibility of supplier to select and offer proper material of construction for the required service,

03.02.10 Assembly and Dismantling

Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouted base plate or alignment.

03.02.11 Drive Motor

The motor shall be sized to meet the maximum specified operating conditions. including external gear and/or coupling losses. Continuous Motor rating (at 50 ° C ambient) shall be atleast ten percent (10%) above the maximum load demand of the pump in the entire operating range including the run out condition to take care of the system frequency & voltage variation.

The enclosure of motor shall comply various requirements of flame proof construction as per IS-2148 and degree of protection shall be as per IP-55.

Other design and construction features of the drive motor shall be as specified, elsewhere, under Standard Electrical Specifications.

4.00.00 TESTS

Material test certificates from recognized laboratories shall be furnished for review\for various components.

Following are the minimum shop and site tests to be conducted by the supplier:

4.01.00 Shop Tests

4.01.01 Hydrostatic Test

Pressure containing parts, including cooling and heating jackets, shall be test hydrostatically with liquid at a minimum of 1.5 times the maximum allowable working pressure but at not less than 1.38 bar gauge.

Tests shall be maintained for a sufficient period of time to permit complete examination of parts under pressure. The hydrostatic test shall be considered satisfactorily when no leaks are observed for a minimum of 30 minutes.

4.01.02 Mechanical Balancing

All rotating components of the pumps shall be subjected to static and dynamic balancing at shop as per ISO 1940. The dynamic balancing shall be done at or near the operating speed and the supplier shall furnish its acceptance norms for approval before conducting the test.

4.01.03 Non-destructive Testing

Non-destructive testing of the pump components shall be conducted in accordance with relevant standards. Prior to testing, the test procedure and repair procedure shall be submitted for approval. All components subjected to testing shall be identified and only those which are tested successfully shall be used for the manufacture of final product. All test results shall be submitted by the supplier for approval

All cast iron parts shall be tested in accordance with IS - 210. Test bars shall be cast or physical tests from the same ladle of metal as the casting they represent.

Steel forgings used in pump shall be tested for both physical properties and chemical composition. steel forgings shall be ultrasonically tested.

4.01.04 Performance Testing

All pumps shall be performance tested at the Manufacturer's Works as per testing code. The test shall be conducted to determine the following characteristics:

- a) Speed
- b) Discharge Pressure
- c) Suction Pressure
- d) Capacity
- e) Power

The test shall be conducted preferably with the tested job motor.

04.02.02 Noise and vibration shall be measured during the performance testing, for reference purposes.
For pumps operating in parallel, the load sharing should not vary by more than 5%.

The pumps showing any abnormal behaviour during the performance testing or the pumps as required shall be stripped down for a thorough examination after the performance test. The performance test report shall be prepared by the supplier and submitted for approval, before despatch of the pumps.

04.02.00 Site Tests

04.02.01 After installation, the pumps supplied shall be operated to prove satisfactory performance as individual equipment as well as a system. The noise and vibration level of the pumps shall be measured and it should be within the design values. For pumps operating in parallel, the load sharing should not vary by more than 5%. If performance at site is found to be unsatisfactory, then the supplier shall rectify or replace the equipment.

04.02.03 Test Procedure Instruments

The test procedures to be followed and instruments to be used for testing shall be subject to the approval. All instruments to be used for stage and performance testing shall be calibrated at reputed third party laboratories.

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SECTION-I

SUMP PUMPS, DRIVES AND ACCESSORIES

CONTENT

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2.00.00	CODES & STANDARDS
3.00.00	GENERAL PERFORMANCE REQUIREMENT
4.00.00	SCOPE OF WORK
5.00.00	DESIGN AND CONSTRUCTION
6.00.00	INSPECTION AND TESTING
7.00.00	DRAWINGS, DATA, INFORMATION REQUIRED

ATTACHMENTS

ANNXURE-I	DATA SPECIFICATION SHEET
ANNXURE-II	SCHEDULE OF SUMP PUMPS

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SECTION-I

SUMP PUMPS, DRIVES AND ACCESSORIES

1.00.00 GENERAL INFORMATION

1.01.00 Sump pumps specified hereinafter shall be used to dewater various sump pits in the power house and other plant area where gravity draining will not be envisaged and to ensure general housekeeping. Sump pumps of coal handling plant and ash handling plant are being covered under specification of respective packages.

1.02.00 Sump Pumps under this specification have been divided into following four (4) groups according to different duty envisaged and location of sumps/pits. Also Sewage Transfer Pumps are considered separately which will be located in the sewage lifting stations.

1.02.01 Group - A

The Group - A pumps shall be electric motor driven permanently installed vertical wet pit bottom suction volute type and will handle drainage water, containing solid particles with sludges, polluted liquid etc. from the area where they are installed. These pumps will run continuously by the use of high and low level switches in the sump. Particle size in the water will not exceed 15 mm. These pumps should be installed in the sumps/pits at the following locations:

- a) Power house ground floor sump pit near condenser.
- b) Underground Conveyor tunnel in the Mill Reject System
- c) Drain oil pit in transformer yard.

The pumps under serial no. (c) above should be capable to handle significant amount of transformer / fuel oil also.

Group-A pumps shall also be provided to all indoor sumps of the plant and outdoor sumps of capacity 5 cu.m and above and underground cable vaults except Ash Handling Plant.

1.02.02 Group - B

These pumps shall be horizontal centrifugal electric motor driven portable type. Each pump set along with control panel etc. shall be mounted on a trolley for ease of transportation. These pumps shall be suitable for handling drainage water containing hard solid particles, sludge, polluted liquid, significant amount of fuel oil etc. and particle size will not exceed 20 mm. These types of pumps shall be used in different plant areas e.g. fuel oil pressurizing pump house.

1.02.03 Group - C

The Group - C pumps shall be vertical submersible portable type pump motor sets with suitable arrangement for carrying to any place and for lowering to and raising from various water reservoirs and pits. The pump motor set shall be suitable for handling water containing muds/sludge, solid particles, cotton waste, silica, ash particles, coal particles, polluted liquid etc. The particle size in water will not exceed 20 mm. These pumps will be utilised to dewater various deep sumps/pits (e.g. C.W pump house, Plant Service water pump house etc.) in case of any eventuality.

1.02.04 Group - D

These pumps shall be similar to Group - A pumps except that these pumps will be used to handle water containing solid particles, sludges, ash polluted liquids, etc. Particle size in the water will not exceed 25 mm. These pumps should be installed in the sumps/pits at the Ash Handling Plant Buildings.

These pumps shall also be provided to all other indoor sumps and outdoor sumps of capacity 5 cu.m and above.

1.02.05 Sewage Transfer Pumps shall be located in the sewage lifting stations which will transfer sewage from sewage lifting station to sludge collection pit. These pumps shall be vertical submersible type. The capacity, head and no. of pumps shall be finalized by the bidder.

NOTE: Total numbers and rating of all the groups of sump pumps are given in Annexure- II and Annexure-III enclosed with this specification. However, the number of permanently installed sump pumps shall be 15 (minimum) for usage and portable sump pumps shall be 10 (minimum) conforming to the standards.

2.00.00 **CODES AND STANDARDS**

2.01.00 The design, manufacture and performance of the sump pumps and drives specified, hereinafter, shall comply with the requirements of all applicable codes, the latest applicable Indian/British/American/DIN Standards, in particular the following:

2.01.01 IS-1710 : Vertical Turbine Pumps for clear cold and fresh water.

2.01.02 IS-5120 : Technical Requirements - Rotodynamic special purpose pumps.

2.01.03 IS-5600 : Sewage and drainage pumps.

2.01.04 Hydraulic Institute Standards of USA.

2.02.00 The materials of the various components shall conform to the applicable IS/BS/ASTM/DIN Standards.

3.00.00 GENERAL PERFORMANCE REQUIREMENT

- 3.01.00 The pumps shall be designed to have best efficiency at the specified duty point. The pump set shall be suitable for continuous operation at any point within the "Range of Operation" as stipulated by the manufacturer.
- 3.02.00 Pumps shall have a continuously rising head capacity characteristics from the specified duty point towards shut off point, the maximum head being at shut off.
- 3.03.00 Permanently installed vertical pumps shall be suitable for parallel operation. The head vs capacity, the BHP vs capacity characteristics etc. shall match to ensure equal load sharing and trouble free operation throughout the range. Drive Motor shall not be overloaded when pump discharge is more than rated condition.
- 3.04.00 The static head requirement of portable submersible type sump pump may have a considerably wide range of variation depending upon the depth of pit being dewatered. While the pump shall have adequate capacity at the maximum head, the motor shall be sufficiently rated to cater for any overloading during the pump operation at its minimum possible head, i.e., maximum discharge.
- 3.05.00 Pump motor set shall run smooth without undue noise and vibration. Acceptable peak to peak vibration limits shall generally be guided by Hydraulic Institute Standards (latest edition).

4.00.00 SCOPE OF WORK

- 4.01.00 Pumps under groups A, B, C, and D as listed in the - II along with drive motors, couplings and other accessories mentioned below, as also those needed to make the pump-motor sets complete in all respect, for proper operation and maintenance. All motors in outdoor duty will be provided with IP-55 enclosure. The accessories shall include among other things of the following :

4.02.00 For the Vertical Group - A Sump Pump Motor Sets

- a) Discharge of sump pump under sl. no. 'a', 'b' & 'c' shall be led to the nearest surface drain, Common Effluent Treatment Drain (CETD) & oil water separator respectively. This shall include a non-return valve and an isolating valve for each pump, necessary pipes, fittings, flange connections and counter flange with bolts, nuts and gaskets.
- b) A common baseframe for the purpose of supporting the pump motor sets in each sump, utilising embedded curb angle around the top of the sump. The base frame shall also be used to support each discharge piping.
- c) Three (3) nos. electrode type capacitance level switches per sump; one for low level, the second for high level and the third for very high

level, along with necessary junction box, local control panel, control cables etc. to achieve automatic startings/stopping of the sump pumps, and also ON/OFF indication for sump pump shall be monitored at DCS. The entire assembly being mounted on the same base frame as mentioned above (item "b"). The control panel shall also be equipped with start/stop push button for starting/stopping individual sump pumps manually. Local control panel and cable shall be as per Volume-V of the specification.

4.03.00 For each of the Trolley Mounted Horizontal Group-B Sump Pump Motor Sets

- a) One (1) no. 7.5 meters long hose for the pump suction and one (1) no. 30 meters long hose for the pump discharge, either ends of each hose being provided with female hose coupling.
- b) One (1) no. 500 mm long straight pipe piece, with both ends flanged, one end matching with the pump suction nozzle.
- c) Two (2) nos. male type hose couplings, one of which is suitable for coupling with the above mentioned 500 mm pipe piece on one side and the 7.5 meters long suction hose on the other side, whereas the other is suitable for coupling with the pump discharge nozzle on one side and the 30 metres long hose on the other side. The pump suction pipe-piece and discharge nozzle shall be of flanged type. As such each coupling end that is to match with the pipe/pump nozzle shall also be flanged and shall be equipped with necessary bolts, nuts & gaskets.
- d) A foot valve (of Bidder's recommended size) with suction strainer, necessary coupling and matching piece/reducer (if necessary) to couple with the 7.5 meter long suction hose end.
- e) A starter panel complete with incoming switch/contact, fuse, overload relays, start-stop push button, O/L reset push button, cable gland, wiring terminals, red and green indication lamps (LED type), necessary control cables etc., and also 50 metres length of flexible power cable with power plug at one end and arrangement to connect the other end with the starter panel.
- f) The pump motor set with a baseframe along with the starter panel, power cable, suction & discharge hoses etc., as mentioned above, shall be mounted on a suitable trolley with swivelling front wheel and having adequate fixing arrangement for all equipment, for operation without any undue vibration and with facility for being handled by a single operator.

4.04.00 For each of the portable submersible Group-C sump pump motor sets.

- a) Two (2) nos. 30 metres long discharge hose, having female hose coupling at both ends.

- b) One (1) no. 500 mm long pipe piece with both ends flanged, one end connected by necessary bolts, nuts & gaskets with the flanged discharge nozzle of the sump pump.
 - c) One (1) no. male type hose coupling, one end of which is suitable to couple with the discharge hose and the other end is flanged, matching with the above mentioned 500 mm long pipe end and connected therewith by necessary bolts, nuts & gaskets.
 - d) Suitable attachment for temporary seat of the pump motor set on the floor at sump bottom.
 - e) One (1) no. 25 metres long submersible type power cable having a power plug at one end and a hermetically sealed (water proof) cable gland for connection with the pump drive- motor at the other end.
 - f) Suitable lugs and other attachments on the pump motor assembly frame, for hoisting and lowering of the pump motor set from and to the sump.
 - g) One starter panel, having a plug socket as receptacle of the above mentioned power plug (item "e"), a 25 metre long incoming power cable with switch/contactor and fuse, start- stop push buttons, red and green LED type indication lamps, over load relays, O/L reset push button, cable gland etc., and also a suitable arrangement for temporarily mounting the starter panel, near the sump, where the portable sump pump-motor set is to work. The incoming 25 metre long power cable shall also be provided with a suitable power plug at one end.
- 4.05.00 For the vertical Group - D sump pump motor sets, the scope of supply should be similar to Group - A sump pump motor sets, except that the discharge piping from pump nozzles should be taken upto the following areas:
- a) For ESP Control Building, the sump pump discharge shall be taken to Ash Slurry Sump.
- 4.06.00 Vertical submersible pump and motor along with accessories shall be provided for sewage lifting stations. Each sewage lifting station shall have 2x100% capacity pumps. The pump capacity, head and total no. of pumps in the plant shall be finalized by the bidder based on number of sewage lifting stations in the power plant.
- 4.07.00 Other accessories to be supplied with the pump-motor sets are as follows :
- a) One discharge pressure gauge with 3 way SS isolating valve for each pump of Group-A and Group-D and all other instrumentation as required for safe and trouble free operation. Suction and discharge pressure gauge for Group-B pump.
 - b) All integral/internal piping, valves, fittings etc. for lubrication, cooling and sealing for each pump wherever required.

- c) All equipment, accessories and consumable required for erection, testing and commissioning.
- 4.08.00 All electrical equipment and accessories supplied shall meet the technical requirements covered under "Electrical Equipment and Accessories, Volume-V" of this specification.
- 4.09.00 All control & instrumentation complete with all accessories as addressed in technical specification of control & instrumentation Volume-VI of this specification.
- 4.10.00 Lubrication of one (1) initial fill and one additional fill after commissioning.
- 4.11.00 Rust inhibitor paint at Manufacturer's works.
- 4.12.00 Any additional accessories not mentioned hereinabove but specified in enclosed technical specification for sump pumps, as applicable and those indicated in sump pump data specification sheets and electric motor specification should also be supplied.
- 5.00.00 **DESIGN AND CONSTRUCTION**
- 5.01.00 The design, construction testing and other details of the sump pumps and related accessories shall be in line with the stipulations and data in this section and the lead specification (Vol. II A)
- 5.02.00 Each sump pump shall be equipped and coupled with a drive motor, with rating so selected as to have at least 15% margin over the maximum power required by the pump, throughout its range of operation. All other requirements of the drive motors shall be as stipulated in the Volume-V.
- The discharge rate of sump pump is uncontrolled. As such pump should be capable to operate even under a condition of as low as 25% of specified total head. Motors of group-B pumps should be designed to cater such eventuality.
- 5.03.00 All electrical items shall conform to the stipulations of Volume-V.
- 5.04.00 All piping shall be as per IS-1239 of medium or heavy grade (as suited for the maximum operating pressure) and shall be either galvanised or painted with approved rust inhibiting paint. Pipe size shall be as per Annexure-II. Any matching piece/reducer required to match the pipe with pump nozzle, hose, etc. shall be provided.
- 5.05.00 All valves shall be steel body type as per applicable IS/BS/ANSI standard, with pressure class compatible with the maximum working pressure.
- 5.06.00 All hoses shall be of steel wire reinforced type. Pump suction hose shall be suitable for working under vacuum. Pump discharge hose shall be suitable to withstand the maximum pressure that it may be subjected to in all working conditions, including hydrostatic testing of the sump pump discharge line.
- 5.07.00 Pump suction strainer shall have openings large enough just to permit the

entry of solids having maximum size as stipulated under clause no. 1.02.00.

5.08.00 Pressure gauges shall be of Bourdon type, with sealing diaphragm to prevent ingress of the working fluid. Selected range of pressure gauge shall be such that the entire range of working pressure covers about 1/3rd to 2/3rd to its range. Accuracy of measurement shall be within $\pm 1\%$ of scale range. The suction pressure gauge shall be compound type. Pressure gauge dial size shall be 100 mm or more.

5.09.00 **Pumps**

5.09.01 Pumps under Group-A shall be wet pit type, vertical shaft, centrifugal, vertical submerged suction, non-clog volute type complete with enclosed shaft, discharge pipe, head assembly thrust bearing and drive assembly, cover plates etc.

5.09.02 Pumps under Group-B shall be of horizontal shaft, single stage, end suction, radially split casing, centrifugal, non-clog design complete with common base plate, drive assembly etc. These pumps shall be trolley mounted portable type.

5.09.03 Pumps under Group-C shall be submersible pump-motor type, single stage and non-clog design and shall be portable type.

5.09.04 Pumps under Group-D shall be similar to Group-A pumps.

5.09.05 Casing

- a) Casing shall be so designed to allow free passage of specified maximum size of solid.
- b) Casing shall be designed to withstand the maximum shut-off pressure developed by the pump.
- c) The casings shall be cast, free from blow holes, sand holes, other detrimental defects. The casing shall be complete with suction and discharge connections.
- d) For pumps under Group-A and Group-D adequate seal arrangement shall be made to keep leakage of liquid from casing to column assembly to minimum and adequate drain shall be provided in column assembly to permit escape of the leakage flow. The casing shall also include the bearing housing of the bottom pump shaft bearing.
- e) Casing of pumps under Group-B shall be provided with vent connections and drain connections with valves. These pumps shall be manually primed.

5.09.06 Impeller

- a) The impeller shall be open/semi-open non clog type, cast in one piece and specially designed to pass large solids or unscreened liquids. The clearance between stationary and moving parts should be such

as to allow sustained performance without exclusive maintenance.

- b) Impellers of pumps under Group-A and Group-D shall have provision for adjustment from an accessible location and for pumps under Group-C shall be capable of passing fibrous material like cotton waste, jutes, etc.

5.09.07 Pump Shaft

- a) Shaft size selected shall be such that critical speed is at least 20% away from the operating speed and the runaway speed.
- b) The shaft shall be ground and polished to final dimension and of ample size to withstand all stresses resulting from rotor weight, hydraulic loads and across the line starting. Shaft shall be provided with renewable sleeves particularly under stuffing boxes and other locations as recommended by pump manufacturers.
- c) The coupling between shafts shall be so designed that they become tight during pump operation.

5.09.08 Column Pipe (for pumps under Group-A and Group D)

The discharge pipe shaft assembly shall be flanged or screwed as per manufacturer's standard and standard length of each piece of column pipe shall be in conformity to the shaft piece lengths from consideration of easy handling.

5.09.09 Bearings

- a) Adequate nos. of properly designed bearings shall be furnished. Bearings for pumps shall be antifriction type and lubricated by grease. Line shaft bearings of vertical pumps shall also be grease lubricated. All necessary grease gun, grease cup and tubing shall be included.
- b) Thrust bearing of adequate design shall be furnished for taking the entire pump thrust arising from all probable conditions of continuous operation through out its "range of operation" and also the shut-off condition. The life of thrust bearing shall be 20,000 working hour minimum for the load corresponding to the duty point. The bearings shall be lubricated by grease from a location conveniently accessible. Design shall be such that the lubricant cannot contaminate the handling liquid.

5.09.10 Wearing Ring/Liner Plate

Renewable wearing rings/liner plates shall be provided either on impeller or on the casing or on both impeller and casing.

5.09.11 Stuffing Box

Stuffing Box of pumps under Group-A and Group-D shall be of mechanical packing type. For pumps under Group-B and Group-C mechanical seal of

reliable design shall be provided.

5.09.12 Coupling

Pump and motor shall be connected with a suitable flexible coupling. Coupling shall be provided with coupling guard.

5.09.13 Mounting Plate for Group-A and Group-D Pumps and Base Plate for pumps under Group-B.

Each pump under Group-A and Group-D shall be provided with a suitable mounting plate. The mounting plate shall be adequately sized to accommodate the level switches, discharge pipe, grease cups etc. if any. Pumps and motor under Group-B shall be mounted in one base plate. Base plate shall be of rigid construction properly ribbed as needed. Suitable drain with valve and drain funnel shall be furnished by the Bidder.

The necessary supporting plate, mounting frame, base plate etc. as required shall be supplied under this specification, along with anchor bolts, foundation bolts, pipe, sleeves etc. Lifting lug, eye bolts, etc. as required for the proper handling of each pump set shall be furnished.

5.09.14 Suction Bell

The pumps under Group-A, C and D shall be complete with adequately dimensioned suction bell to guide and streamline intake fluid.

5.09.15 Material of Construction

For material of construction of various parts of data specification sheet -1 shall be referred to.

6.00.00 **INSPECTION AND TESTING**

6.01.00 All pumps shall be tested at the shop for capacity, head, efficiency and brake horse power. These tests are to be done according to the requirements of "Hydraulic Institute Standard" and as per MQP to be approved by Owner during detail engineering.

6.02.00 The pump integral accessories like thrust bearing, pump motor coupling etc. shall be subject to tests as per manufacturer's standard and / or applicable national / international standard.

6.03.00 Test on motors, control panels, starter panels, cables shall be conducted as per the requirement of Volume-V of this specification and as per MQP to be approved by Owner during detail engineering.

6.04.00 After delivery/erection at site, pumps shall be operated to prove satisfactory and trouble free performance.

6.05.00 In addition to these tests also refer lead specification Vol. IIA.

7.00.00 **DRAWINGS, DATA, INFORMATION REQUIRED**

- 7.01.00 Location and dimension of all sumps which requires assisted evacuation, present in the areas covered under Main Plant Package.
- 7.02.00 General Arrangement drawing & Cross-sectional drawing of sump pump.
- 7.03.00 For Mandatory Spares, Spares required for erection and commissioning, Recommended Spares, Special Tools And Tackles, fixtures etc., as required for regular operation and maintenance of the equipment offered and supply of first charge of lubricating oil, inhibitor oil and also adequate quantity of the consumables, please refer Technical Specification Volume-II A.
- 7.04.00 List of location of Group-A and Group-D pumps.
- 7.05.00 Characteristic curves of pumps showing effective head, pump input power, efficiency, submergence and NPSH, against capacity ranging from shut-off condition to 125% or rated capacity for Group A, B & D pumps and to 150% of rated capacity for Group C pumps.
- 7.06.00 Speed vs. torque curve of the pump corresponding to recommended mode of pump starting, super-imposed on speed vs. torque of the motor, corresponding to 80% and 100% rated voltage.
- 7.07.00 Diagram showing the type of lubrication system etc.

ANNEXURE-I

DATA SPECIFICATION SHEET

		Group-A	Group-B	Group-C	Group-D
1.	Pumps				
1.1	Rated Capacity (Cu.M/hr.)	<----- Refer - II ----->			
1.2	Total Head at rated Capacity (MLC)	<----- DO ----->			
1.3	Nos. Required	<----- DO ----->			
1.4	Duty	<----- Intermittent ----->			
1.5	Pump Design Standard	<----- IS-5120/ IS:1710----->			
1.6	Parallel operation required	Yes	No	No	Yes
1.7	Material of Construction				
	a) Base plate/Cover Plate	<----- M.S. IS-2062 / Equivalent ----->			
	b) Column Pipe	<----- M.S. IS-2062 / Equivalent ----->			
	c) Casing	<----- 2% NiCl, IS-210, FG-260 (*)----->			
	d) Impeller	<----- 2% NiCl, IS-210, FG-260 (**)------>			
	e) Pump/Impeller Shaft	<----- SS. AISI-316 ----->			
	f) Shaft Sleeve	<----- SS. AISI-316 (Hardened) ----->			
	g) Shaft Coupling	<----- SS. AISI-410 ----->			
	h) Shaft Bearing	BUSH GM as per IS-306 Gr.1 / Equivalent			
	i) Gland	<----- C.I., IS-210, FG-260/Equivalent ----->			
	j) Gland Packing	<----- Braided Graphite-free Teflon --> ***			
	k) Fasteners coming in contact with water	<----- SS. AISI-304 ----->			
	l) Fasteners not coming in contact with water	<----- Carbon Steel ----->			

Note : * Alloy CI (min 30 mm thick) BHN 350 min
** Ni-hard (min 25 mm thick) BHN 550 min.

		Group-A	Group-B	Group-C	Group-D
*** S.S. Wire reinforced/impregnated graphite teflon.					
	m) Discharge pipe	MS IS-1239/Equivalent	--	--	MS IS-1239/Equivalent
	n) Motor stool	<----- Close Grained C.I.----->			
1.8	Range of Operation	<----- Refer -II ----->			
1.9	Tests and Inspection	<-- As per Cl. No. 6.00.00 and lead specification -->			
1.10	Supply of Accessories & Services (Wherever Applicable) for each group and each rating of Pumps				
	a) Base plate		Yes		
	b) Sole Plate		Yes		
	c) Foundation bolts, nuts, sleeves etc.		Yes		
	d) Companion flanges with nuts, bolts & gaskets		Yes		
	e) Unions for external water for cooling/sealing/lubrication		Yes, if required		
	f) Cooling/ sealing/lubrication system with all accessories, complete with pipes, valves and with instruments		Yes, if required		
	g) Discharge pressure gauge		Yes		
	h) Suction pressure gauge		Yes, for Group-B only		
	i) Pump-motor coupling and guard		Yes		
	j) Eye bolts, lifting tackle etc		Yes		
	k) Pre-lubrication tank and accessories		Yes, if required		
	l) Suction bell		Yes		

ANNEXURE-II

SCHEDULE OF SUMP PUMPS

GROUP-A PUMPS : PERMANENTLY INSTALLED VERTICAL SUMP PUMP

Sl. No.	Location	Numbers required (Total)	Capacity (cum/Hr.) Each	Total head (MLC)	Pit size in which pumps are to be installed (in mm)	Type of liquid to be handled	Remarks
1.	These pumps should be located in the following areas as minimum : i) Power house ground floor sump pits near condenser ii) Underground conveyor tunnel in mill reject system iv) Any other places felt necessary by Bidder. These pumps will also be provided in all indoor sumps and outdoor sumps of capacity 5 cu.m.& above and	Two pumps (100% capacity) are to be located in each sump pit	Capacity of each pump should be so selected to empty the sump pit in 10 to 15 minutes	To be calculated with 10% margin over total dynamic head (TDH = static head + friction losses)	To be decided by the bidder	As described in cl. no. 1.02.01	Discharge pipe sizing should be done taking minimum water velocity to be 2m/sec but should not be less than 50 NB. One gate valve and one non return valve should be provided at pump discharge.

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Sl. No.	Location	Numbers required (Total)	Capacity (cum/Hr.) Each	Total head (MLC)	Pit size in which pumps are to be installed (in mm)	Type of liquid to be handled	Remarks
	underground cable vaults (if any) except Ash Handling Plant.						

GROUP-B PUMPS : HORIZONTAL CENTRIFUGAL TROLLEY MOUNTED PORTABLE SUMP PUMP

Sl. No.	Location	Numbers required (Total)	Capacity (cum/Hr.) Each	Total head (MLC)	Pit size in which pumps are to be installed (in mm)	Type of liquid to be handled	Remarks
1.	Pumps will be used in various sumps of the plant area like fuel oil transfer and pressurising pump house	Two (2)	Ten (10) (Working Range: 0 to 125%)	Six (6)	To be finalised by the Bidder	As mentioned in clause no. 1.02.02	To be supplied with suction & discharge pressure gauge and other accessories as specified and shall be trolley mounted. Suction hose should be of 80 NB size. Discharge hose should be of 65 NB size.

GROUP-C PUMPS : VERTICAL SUBMERSIBLE PORTABLE SUMP PUMP

Sl. No.	Location	Numbers required (Total)	Capacity (cum/Hr.) Each	Total head (MLC)	Pit size in which pumps are to be installed (in mm)	Type of liquid to be handled	Remarks
1.	Pumps will be used in various deep sumps / pits (e.g. CW pump house, Clarified Water pump house, etc.) in case of eventuality.	Two (2)	100 (Working range as per pump characteristic curve for full range of head variation).	Twenty (20) (Range 5 to 25)	To be finalised by the Bidder	As mentioned in clause no. 1.02.03	To be supplied with discharge pressure gauge and 500 mm M.S. pipe spool at discharge as specified. Discharge hose should be of 100 NB size.

GROUP-D PUMPS : PERMANENTLY INSTALLED VERTICAL SUMP PUMP

Sl. No.	Location	Numbers required (Total)	Capacity (cum/Hr.) Each	Total head (MLC)	Pit size in which pumps are to be installed (in mm)	Type of liquid to be handled	Remarks
1.	These pumps should be located in the Ash Handling Plant Buildings ii) Any other places felt necessary by the Bidder.	Two pumps (100% capacity) are to be located in each sump pit	Capacity of each pump should be so selected to empty the sump pit in 10 to 15 minutes	To be calculated with 10% margin over total dynamic head (TDH = static head + friction losses)	To be decided by the Bidder	As described in cl. no. 1.02.04	Discharge pipe sizing should be done taking minimum water velocity to be 2m/sec but should not be less than 80 NB. one gate valve and one non return valve should be provided at pump discharge.

Sl. No.	Location	Numbers required (Total)	Capacity (cum/Hr.) Each	Total head (MLC)	Pit size in which pumps are to be installed (in mm)	Type of liquid to be handled	Remarks
	These pumps will also be provided in all indoor sumps and outdoor sumps of capacity 5 cu.m and above.						

ANNEXURE-II

DATA SPECIFICATION SHEET OF SEWAGE TRANSFER PUMP

1.0	Number required in each sewage lifting station	Two (2) [One working and one stand-by].
2.0	Type	Vertical Submersible
3.0	Location	Outdoor
4.0	Fluid to be handled	Sanitary Waste water
5.0	Duty	Continuous
6.0	Suction Condition	Flooded suction
7.0	Rated capacity, m ³ /hr	By Bidder
8.0	TDH at rated capacity, MLC	By Bidder
9.0	Range of Operation (%)	30-120
10.0	Pump Speed, RPM	1500 preferred
11.0	Material of Construction	
	• Casing	SS 316
	• Impeller	SS 316
	• Shaft	SS 316

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**SECTION-IV
TECHNICAL SPECIFICATIONS
FOR
WASTE WATER TREATMENT SYSTEM**

1.00.00 GENERAL REQUIREMENTS

The Bidder shall develop and design the Waste Water Treatment System adopting the philosophy of 100% recycling of collected / treated effluent for implementation of "Zero Discharge" concept.

Each identified waste stream and further if any shall be taken into consideration for design of Waste Water Treatment System.

All waste streams except the oily-waste streams and waste streams from Coal Handling System shall be directly routed to a Central Monitoring Basin for equalization.

Oily-waste streams waste streams after treatment shall be taken to Central Monitoring Basin.

Waste streams from Coal Handling System after treatment shall be recycled / reused in Coal Handling System.

The treatment facilities will be such that quality of treated waste from each treatment facility meet applicable stipulations as laid down in the "General Standards for Discharge of Environmental Pollutants Part-A : Effluents" as well as those specified in "Standards for Discharge of Liquid Effluents from Thermal Power Plants" as provided in the Environment (Protection) Rules, 1986, Schedule-VI (vide GOI's Extra Ordinary Gazette Notification dated 31.12.1993 as well as in Schedule – I of the said Rules). Further improvement in quality if required for any particular waste stream with reference to recycle / reuse within the plant boundary shall be duly taken into consideration by the Bidder and all necessary equipment along with accessories as required in this regard shall be considered as included.

2.00.00 ENVIRONMENTAL STIPULATIONS

2.01.00 The Waste Water Treatment System shall fully comply with all requirements and limits specified in Environmental (Protection) Rules, 1986, along with all latest amendments to it, requirements and stipulations of the Central Pollution Control Board (CPCB), Ministry of Environment and Forests (MOEF); Government of India and Andhra Pradesh Pollution Control Board (APPCB) for the project, and any other central or local statutory requirements regarding environmental pollution and its abatement. As regards cases for which no Indian Standard exists, internationally accepted standards like the World Bank's standard, OSHA standards etc. shall be applicable. The Purchaser will decide such applications.

The basic requirements for this project are indicated below for reference. However, it shall be the responsibility of the Bidder to ensure full compliance with the latest amendments of all applicable regulations.

Relevant conditions of the permits already obtained / to be obtained for the project shall be passed on to the Bidder. Bidder shall ensure full compliance with the same. The Bidder shall be responsible for obtaining all other necessary consents, licenses and permissions, which are related to design, construction, installation and operation of the plant. These shall be obtained in appropriate time to ensure that the construction and commissioning program can be achieved.

3.00.00 **SYSTEM DESCRIPTION & GENERAL INFORMATION**

The wastewater streams from different sources of 1 x 800 MW Unit Power Station will be collected, treated as required and then reused within the Plant. Various waste waters, which are to be handled and treated are described herein:

P&ID for Waste Water Treatment System has been enclosed with this specification.

3.01.00 **DM Regeneration Waste**

DM Plant Regeneration Waste will be generated due to periodic regeneration of resin-beds by acid or alkali. It will contain high amount of dissolved solids and also may be acidic or alkaline based on sequence of the regeneration.

The regeneration waste comprising of acid, alkali and backwash water from the DM plant is led to the Neutralization Pit through drain channels. The pH of neutralized waste is maintained in the range of 7.2-8.0.

Once the pH level in the waste is achieved within desirable range the same is pumped to the Central Monitoring Basin by means of Neutralized Waste Disposal Pumps. As the treatment of regeneration waste of DM Plant is carried out in DM Plant itself, no further treatment scheme for control of pH has been envisaged.

3.02.00 **Cooling Tower Blow Down**

Cooling Tower Blow Down (CTBD) is done to maintain the level of dissolved solids in the Circulating Cooling Water. This effluent will contain dissolved solids and chemicals/biocides used for prevention of scale formation /corrosion / bio fouling. The major part of CTBD would be used up in Ash Handling Plant. The balance part of CTBD would be led to Central Monitoring Basin.

3.03.00 **Boiler Blowdown**

The Boiler Blow Down shall be collected and quenched in Boiler Blow Down Drain Pit at around 60 degree C temperature. The water from Drain Pit shall be pumped to Central Monitoring Basin for equalization.

The System viz. Boiler Blow Down Drain Pit, Boiler Blow Down Transfer Pumps etc. shall be located outdoor.

3.04.00 Boiler /TG Area Wash Water

Boiler /TG Area Wash Water is generated from floor washings, leakages from bearing cooling systems, leakage from pumps etc. This waste basically contains suspended solids. An underground Retention Pit shall be provided to collect the waste from Boiler /TG Area. From Retention Pit, the waste shall be transferred by Pumps to Central Monitoring Basin for equalization.

3.05.00 Oily Wastes

The oily waste run off during rains and regular washing/cleaning, leakage and draining from Fuel Oil Unloading Area shall be treated in Oily Waste Treatment System. An underground Retention Pit shall be provided to collect run off water. Oily waste from the above Retention Pit shall be directed to a Pre Oil Water Separator Collection Pit, which also receives service oily waste effluent from Power House area (TG area and Lub Oil area) and oily waste from Transformer Yard area.

From the Pre Oil Water Separator Collection Pit the oil contaminated effluent shall be pumped to plate or tube type Oil Water Separator for removal of oil and suspended solids. Separated oil shall be collected in a Slop Oil Storage Tank. The treated water from OWS may be discharged in another collection pit from where treated water shall be pumped to Central Monitoring Basin.

Sludge produced from CPI will be collected in a pit and then transferred by means of CPI Sludge Transfer Pumps for land filling purpose.

Oily effluent from the Transformer Yard Area will be led to the Pre Oil Water Separator Collection Pit equalization and further treatment.

Power House area (TG area and Lub Oil area) oily waste is generated from oil leakage from oil burners etc. This effluent basically contains suspended solids and some oil and grease. An underground Retention Pit shall be provided to collect oily waste from Power House area (TG area and Lub Oil area). From Retention Pit, the waste shall be transferred by Pumps to Pre Oil Water Separator Collection Pit as addressed above.

The Oily Waste Treatment System viz. Pre Oil Water Separator Collection Pit, Pre Oily Waste Feed Pumps, Oil Water Separator, Slop Oil Storage Tank etc. shall be located outdoor.

3.06.00 Backwash Waste Water from Side Stream Filtration

Backwash waste from Side Stream Filters will be collected in a pit and then transferred to inlet of Central Monitoring Basin by means of Backwash Water Transfer Pumps.

The System viz. Backwash Waste Water Pit, Backwash Waste Water Transfer Pumps etc. shall be located outdoor.

~~3.07.00 Coal Pile Rainfall Runoff~~

~~Rainfall run off from the coal piles shall be collected by a drainage system around the coal pile and led by gravity to a Coal Particle Settling Basin.~~

~~The Coal Particle Settling Basin will have two chambers, one operating and one standby. One chamber will be kept under operation and the other will be kept under maintenance.~~

~~Coagulant aid/ polymer dosing facility shall be provided at the inlet to the Settling Basin, if required.~~

~~The Coal Particle Settling Basin should be sized based on maximum rainfall run off per hour and the area of Coal Handling Plant. A provision for by pass with reference to Coal Particle Settling Basin shall be provided for discharge of the run off to the nearby storm water drain in case of any emergency.~~

~~The decanted water shall be discharged to nearby storm water drain. As and when required a part of decanted water shall be collected in a Decanted Water Sump and thereafter pumped for use in CHP area.~~

~~The System viz. Coal Particle Settling Basin, Decanted Water Sump, Decanted Water Transfer Pumps etc. shall be located outdoor and Coagulant Aid/ Polymer Dosing Facility shall be located inside Chemical House for CHP Waste Treatment.~~

~~3.08.00 Condensate Polishing Unit Effluent~~

~~Condensate Polishing Plant (condensate polishing plant is located at ground floor of Power House) and will cause regeneration effluent also. This effluent shall be collected in separate neutralization pit to be constructed around the Boiler / Power House area. This effluent will be generated once in every 7 days or so. Neutralized effluent from the above area shall be transferred to the Central Monitoring Basin.~~

3.09.00 Central Monitoring Basin Waste Treatment & Recycling System

Waste water streams after required treatment as addressed above will be led to a Central Monitoring Basin, which acts as an equalization basin.

From Central Monitoring Basin wastewater will be pumped by means of Two (2) numbers Central Monitoring Basin Effluent Transfer Pump to two (2) numbers Flash Mixers. From Flash Mixers, water would be directed to two (2) numbers Flocculation Tanks. From Flocculation Tanks water will then flow to two (2) numbers Inclined Surface Settlers. Alum solution will be added to water.

Normally, all two (2) Flash Mixers, two (2) Flocculation Tanks and two (2) Inclined Surface Settlers will operate in under-load condition. However, in case any one hook-up, consisting of Flash Mixer, Flocculation Tank or

Refer Approved design memorandum & P&ID for scope of supply, working & standby equipment.

Inclined Surface Settler is taken out for maintenance, the other two streams with 20 % overload will be able to cater for the total water requirement.

The treated water from Inclined Surface Settlers shall be stored in a Clear Water Reservoir. From the reservoir water shall be distributed to Coal Handling, Plant Cleaning and Green Belt development.

The sludge generated from Inclined Surface Settlers as addressed above will be collected in a local Sludge Sump and used up for land filling purpose. Two (2) numbers Air Blowers shall be provided for the sludge sump for proper agitation.

A Chemical House shall be provided to handling, storage, solution preparation and injection of chemicals for treatment of waste water.

3.10.00 Clarifier Sludge from River Water Pre-Treatment System

The sludge from Clarifiers will be taken by gravity to a Sludge Sump for storage purpose and subsequently will be pumped to a gravity type Sludge Thickener. Under flow from the Thickener will be collected in a pit, from where the sludge will be pumped to Centrifuge by Centrifuge Feed Pumps. Supernatant from the Thickener will be taken back to the inlet of the Stilling Chamber as envisaged under Pre-treatment Plant. Concentrate from the Centrifuge will be taken back to the inlet of the Thickener. Solid cakes from Centrifuge will be collected in the Sludge Dumpers for ultimate disposal. In order to increase the efficiency of solid/liquid separation suitable polymer of edible grade shall be dosed in the centrifuge/ inlet line to centrifuge.

4.00.00 SCOPE OF SUPPLY AND SERVICES

The equipment and accessories to be supplied, installed as well as put into operation and all other required services are outlined herein under. The items, though not specifically mentioned but needed to make the system complete in all respects and reliable for safe and smooth operation and guaranteed performance shall also be treated as though included and the same shall be furnished, unless otherwise specifically excluded elsewhere.

Overall scope of work under this package shall be as specified in various specifications attached subsequently and as described in the following clauses. The Tenderer shall also refer to the various drawings enclosed with the specification for general guidelines of the minimum requirement under this specification.

EQUIPMENT AND ACCESSORIES

4.01.00 Equipment and accessories as envisaged but not limited to, are in follows:

- i. Backwash Waste Water from Auto Valve less Gravity Filtration
 - a) One (1) number Retention Pit complete with all accessories for backwash wastewater from Side Stream Filtration System.
 - b) Two (2) numbers Backwash Waste Water Transfer Pumps,

- h) Two (2) nos. Polyelectrolyte Dosing Tanks, each complete with agitator, electric drive motor and all other accessories.
 - i) Three (3) nos. Polyelectrolyte Dosing Pumps, each with drive motor and all other accessories.
- 4.02.00 All integral and interconnected pipe works, valves, strainers, pressure relief valves, instrument stubs, specialties, sumps, gates, all types of pipe supports, pipe racks, pipe bridges etc. for the entire system.
- 4.03.00 All Sump Pits must have redundant level switches, connected to ETP PLC, the transfer pumps shall be operated through level interlock from PLC.
- 4.04.00 Supply and application of shop painting and final painting at manufacturer's works and at site for the entire system as specified elsewhere in Volume III-C of this Bid Document.
- 4.05.00 All instrumentations and controls complete with accessories as addressed in Technical Specifications for Instrumentation and Control - Volume -VI of this Bid Document.
- 4.06.00 All electrical equipment and accessories as required for this system shall be supplied. These equipment and accessories shall meet the technical requirements of individual equipment specification covered under "Electrical Equipment & Accessories - Volume -V" of this Bid Document.
- 4.07.00 All civil as well as structural design, construction and architectural works as addressed in General Specification and Design Criteria for Civil and Structural Work - Volume -VII/A, General Specification and Design Criteria for Architectural Work - Volume -VII/B & Technical Specification for Civil, Structural and Architectural Work - Volume -VII/C of this Bid Document.
- 4.08.00 All consumables (lubricating oil, inhibitor for oil), mandatory spares, recommended spares, 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 in Lead Specification - Volume II-A of this Bid Document.
- 4.09.00 Services included under this Specification
- All services as addressed in Lead Specification - Volume II-A of this Bid Document need to be considered as included with reference to Waste water Treatment System, under the scope of Specification:

5.00.00 SYSTEM BOUNDARIES

Not Applicable

6.00.00 DESIGN AND CONSTRUCTION

6.01.00 Oil Water Separator

- i. The system shall be designed to handle rated flow. Hydraulics of the plant shall be such as to take an occasional overloading of 20% of the design flow rate.
- ii. The separator shall be of Steel construction/RCC and of proven design. It shall be provided with Walkway Bridge and platform to approach all the internals. Clear width of the bridge shall not be less than 1200 mm.
- iii. Suitable means for collection shall be provided for sludge emanating from the tube / plate separator. Further suitable system for treatment and disposal of this sludge shall be offered.
- iv. Suitable means for collection shall be provided for sludge emanating from the tube / plate separator. Further suitable system for treatment and disposal of this sludge shall be offered.
- v. The separator periphery shall have sufficient width to have an easy walkway along with hand railing for general inspection. Access ladders with platforms and hand railing shall be provided in the separator for good approach. Permanent ladders (if required) shall also be provided (not rungs) for approaching the sludge pipe line valves for maintenance.
- vi. Suitable sampling connections shall be provided for performance monitoring.
- vii. The tube/plate type separator shall be circular/ rectangular with distinct tube/plate separation zone, sludge thickener zone, clear water zone and oil skimming zone.
- viii. The separator shall be counter flow or cross flow type. Co flow type units are not acceptable.
- ix. The unit shall be designed with minimum side water depth of 4 M. The overall area of unit shall be based on an average flow velocity not more than 5 m³/hr./m².
- x. The inclined tubes/plates shall be spaced such that stable flow conditions are available. The flow through the tubes/plates shall be viscous / laminar. The cross sectional area of each tube shall be such that the effective hydraulic diameter is 80 mm (min.). The material of tube pack shall be UV inhibited virgin PVC. In case of plate type separator the distance between the successive plates shall be 50 mm (min.). The plate shall be made of GRP (glass reinforced plastic). The resin for the manufacturing of GRP plates shall be orthophthallic type.
- xi. The length of the tubes / plates through which the water flows shall not be less than 1.5 m.
- xii. The tubes / plates shall be inclined by 50 – 60 deg. Angle to the horizontal. The tubes / plates shall be arranged such that the complete water travels through the tubes all across the cross section of separator.

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- xiii. To remove settled particles from the plates/tubes suitable water jet arrangement shall be provided. Pumping and piping arrangement shall be separately provided for this purpose. The tube / plates shall be easily accessible for the cleaning purpose. The tube pack plates shall be placed inside the separator such that these may be individually removed for maintenance even when separator is operating. The entire pack shall be rigid and shall not deflect by self weight, water load or operator movement over the pack.
- xiv. Treated water shall be collected in a trough provided with adjustable weir.
- xv. The unit shall be capable of delivering constant effluent water quality without any sludge / oil carryover, even at the time of rapid increase in influent water flow or change in influent water quality, or changes in raw water temperature.
- xvi. The Tenderer shall justify the design basis of entire plate/tube type separator unit and individual components of all the unit with back up calculations and also by means of supplying documentary evidence from their earlier installed plants in the form of drawings, certificates, etc.
- xvii. The separator shall employ positive sludge system of consistent density, central sludge concentrating sump, water flushing nozzles etc. as per the standard design of manufacturer. Sludge removal system shall be designed to thicken the sludge to min. 2% consistency before disposing from separator bottom. All the pipelines carrying the sludge shall be provided with flushing connection. The pumps and piping required for flushing purpose shall be separately provided.
- xviii. Sludge blow-off shall be affected by the static head of water in the separator. Sludge outlet pipe from the concentrated sludge hopper shall be branched into main disposal line. Main sludge disposal line should consist of blow-off valve which would be operated manually and drain sludge to the sludge disposal sump or the drain as specified.
- xix. This would be an intermittent operation. Continuous sludge disposal line shall consist of a telescopic stand pipe, the top of which would be maintained at a desired elevation to ensure trickle flow of water or sludge water mixture to the sludge sump.
- xx. The plant shall operated from a relay logic based panel with all safety interlocks, alarms and annunciations built into the system.

~~6.02.00 Coal Particle Settling Basin~~

- ~~i. Coal pile runoff water during rainstorm will contain quantity of coal particles. Apart from this the waste water from the CHP area also contain coal particles. The coal particles need to be arrested by sedimentation before the waste is finally disposed.~~
- ~~ii. For this purpose Coal Particle Settling Basin will be provided. All drains emanating from coal stockyard and coal handling plant will be routed to the Coal Particle Settling Basin by gravity channels. A provision for by pass with reference to Coal Particle Settling Basin shall be provided for discharge of the~~

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~~run off to the nearby storm water drain in case of any emergency.~~

~~Decanted water will be disposed to nearby storm water drain by gravity channels. As and when required a part of decanted water shall be collected in a Decanted Water Sump and thereafter pumped for use in CHP area.~~

- iii. ~~The Coal Particle Settling Basin shall be underground and sized to provide adequate residence time for gravity settling of the coal particles associated with the storm water emerging from the coal pile area. The coal settling pond will have a settling chamber followed by decanted water sump.~~
- iv. ~~The arrangement shall be provided to prevent the tendency of short circuiting of the incoming coal pile run off water in which there are chances of sliding through the top surface of the stored water. By provision of a separate wall / distribution chamber, the area of cross section will be utilized flow of water and this will maintain desired low flow velocities in the Coal Particle Settling Basin. Adequate step / stairs shall be provided for access inside Coal Particle Settling Basin so that settled coal particles can be removed whenever required. Various regular drains of the coal handling plant shall be led to the Coal Particle Settling Basin by gravity and the drains shall be suitably designed and routed for this purpose.~~
- v. ~~Coal Particle Settling Basin shall be designed to treat the rain storm water run off from the coal pile and other areas at maximum rainfall rate with the potential of discharging coal particle laden run off water. Sizing calculations shall support the selected capacity by the contractor.~~
- vi. ~~The exit for run off water from the Coal Particle Settling Basin shall be such that short circuiting of water is avoided. For this purposes, water shall be allowed to traverse under a breast wall located about 5 meter ahead of outlet side of the Basin~~
- vii. ~~2x100% Settling Basin shall be provided along with isolation gates at the inlet. This shall permit dislodging of one pond while the other is in use. Manual dislodging shall be carried out and rung ladder shall be provided for this.~~
- viii. ~~The settling pond shall be designed as per relevant codes and supporting calculations shall be submitted for approval. Polymer dosing facility shall be provided in case the same is required.~~
- ix. ~~Further specific salient design features of major equipment and accessories have been furnished under Annexure - I
In addition to above, required general technical features for Pressure Vessels, Storage Vessels, Piping, Fittings, Valves, Miscellaneous Pumps, Protective Lining, Painting, Mechanical Erection, Testing and Commissioning have been addressed under Sections VI to XIII as attached elsewhere in Volume III-C of this Bid Document.~~

~~6.03.00 Sludge Thickener~~

~~The specification is intended to cover specific technical requirements for sludge thickener using the technique of solid liquid separation by gravity~~

~~settling and thickening.~~

- ~~i) The thickener shall be used for thickening of the sludge. The thickener by thickening the sludge, reduces the sludge quantity to be handled by downstream equipment i.e. solid bowl type centrifuge.~~
- ~~ii) The thickener shall be of gravity settling type. The thickener shall be capable of handling the specified flow rate of sludge and produce thickened sludge and supernatant clear water of quality as specified elsewhere in this specification.~~
- ~~iii) All the components of sludge thickener and associated equipment shall be (proven engineering design, as supplied by the supplier or his sub supplier for the projects operating successfully.~~
- ~~iv) Thickener shall be provided with Walkway Bridge and platform for operation and maintenance of the mechanical drives & equipment. Clear width of the bridge shall not be less than 1.2 m and shall be provided with hand railing on both sides.~~
- ~~v) Hydraulics of the plant shall be such as to take on hydraulic overloading of 20% which would be the maximum flow condition for the thickener.~~
- ~~vi) All valves used with the equipment shall be arranged in accessible position, to facilitate manual operation of the valves. Suitable operating platforms and cross over platforms shall be provided wherever required.~~
- ~~vii) Suitable permanent flushing and drain connections shall be provided for all pipelines carrying sludge and chemicals.~~
- ~~viii) Sampling, drain and vent connections with isolation valves shall be provided in the sludge lines at inlet and outlet of supernatant line and in the chemical dosing lines to the thickener.~~
- ~~ix) Suitable sampling connections from three different levels shall be provided for performance monitoring of Thickener. The sampling pipe shall be provided with isolation valves and terminated at ground level.~~
- ~~x) Necessary GI conduit pipes shall be supplied and erected by supplier, for cables for the thickener. Each of the cables shall be laid in separate conduits.~~
- ~~xi) All metallic parts inside the thickener coming in contact with water shall be painted in accordance with 'the painting scheme as specified in Technical particulars.~~
- ~~xii) The thickener periphery shall have peripheral walkway with hand railing for general inspection. Access ladders (at least from four locations) with platforms and hand railing shall be provided for the thickener for good approach. Access ladders for entry inside the thickener shall also be provided. Permanent Ladders shall also be provided for approaching the sludge pipeline valves for maintenance. Sludge valves shall be operable from the top of the sludge chamber through headstock and extended spindle arrangement. The sludge pipeline valves shall be housed in an RCC pit, in case the same is underground.~~

- ~~xiii) Design of the sludge removal system should be for minimum 5% sludge concentration. The thickened sludge from the thickener is pumped to the Centrifuge. Thickener is provided. Screw pumps / Centrifugal pumps (with open impeller) may be employed for pumping thickener sludge to downstream sludge treatment equipment.~~
- ~~xiv) The clear water shall flow by gravity from the thickener to the Supernatant Collection Sump, as specified elsewhere in the specification, through open channel: of RCC construction or pipelines. Channels shall be covered with precast slab.~~
- ~~xv) A freeboard of 500 mm (min) shall be provided for the sludge thickener.~~
- ~~xvi) The unit shall be capable of delivering consistent thickened sludge and clear water quality, even at the time of rapid increase in influent flow or change in sludge quality or changes in temperature.~~
- ~~xvii) Polyelectrolyte (Polymer) shall be dosed in the inlet line or in the sludge thickener, for improving the effectiveness of thickener.~~
- ~~xviii) The bottom of the thickener shall be sloped (10 to 20 deg with horizontal) towards the centre. Mechanically drive sludge scraper and collector shall be used to remove settled sludge to the central sludge concentrating sump. The scraper blade shall be of MS construction provided with rubber squeezer and driven by an electric motor through reduction gear unit. The scraper arm shall be suitable braced to provide rigidity. The drive equipment for turbine drive including gearbox, shaft etc shall be sized with minimum service factor of 3.0 and 15 % margin over maximum power requirement shall be taken while selecting the motor.~~
- ~~xix) The thickener shall be designed for maximum overflow loading rate of 15 m³/day/m² and maximum solid loading rate of 100 kg/day/m² Minimum side water depth should be 3.5 meter. Hydraulic circuit shall be such that overflow from thickener shall flow by gravity to the Supernatant Collection Sump.~~
- ~~xx) The thickener shall be capable of thickening the sludge to more than 5% solid consistency.~~
- ~~xxi) The thickener shall employ positive sludge removal system of consistent density from the central sludge concentrating sump, by using rotating pickets, water flushing nozzles, etc. as per the standard design of manufacturer. Sludge shall be removed through a sludge blow off pipe at the bottom of the thickener tank. Sludge blow off shall be effected continuously by the static head of water in the thickener. The sludge disposal pipe from the central sludge concentrating sump shall lead to the suction of thickened sludge pump (normally of screw type). The sludge disposal line shall incorporate timer initiated auto valves and manual blow off valves. The valves shall be of knife gate type.~~
- ~~xxii) Semi automatic rake lifting mechanism shall be provided in the thickener. Rake shall lift automatically at pre set adjustable overload torque and remain lifted until manually lowered.~~
- ~~xxiii) Poly electrolyte (Polymer) which is required for proper coagulation and for meeting guaranteed sludge consistency and quality, shall be selected by~~

~~supplier. The same shall be indicated in the bid along with the technical literature and dosage rate. The type and dosage rate shall be decided based on jar test results to be carried out by the supplier.~~

~~xxiv) Poly electrolyte (Polymer) shall be prepared in a solution preparation tank. The tank shall be of CSRL construction. Each tank shall be fitted with electrically operated stirrer with reduction gearbox, level indicator, sampling connection, drain, overflow arrangement etc. Material for shaft & impeller for stirrer shall be as per AISI 316. Poly electrolyte (Polymer) solution shall be dosed in the inlet line of thickener and in sludge thickener by means of metering pumps. There should be arrangement for manually changing the dosage rate by adjusting the of metering pumps stroke length.~~

~~xxv) Colour coding shall be as per the requirements of the Specification.~~

6.04.00 Centrifuge

- i. The thickened sludge from Sludge Thickener shall be pumped to the Centrifuge. The Centrifuge shall be capable of separation of solids from solid-liquid mixture. The centrifuge shall be designed for continuous operation. The equipment shall be designed to operate satisfactorily for 20 % to 150 % of rated solid inlet concentration.
- ii. The centrifuge shall be either co-current or counter-current design as per manufacturer's standard.
- iii. The solids shall be discharged from the centrifuge by gravity.
- iv. Centrifuge shall be comprised of a horizontal bowl with a screw conveyor. The rotating parts shall be enclosed in a casing with a cover. The sludge shall be pumped inside the rotating bowl through a stationary feed tube. The feed zone should be designed in such a way so as to cause minimum turbulence in the liquid pond and give smooth acceleration to the feed up to bowl speed. Suspended solids shall be settled against bowl wall due to very high centrifugal force. These settled solids need to be conveyed inside the bowl towards the conical end by helical screw conveyor rotating at slightly lower rpm than the bowl speed through a gear box. The conveyor and bowl need to rotate in the same direction for counter current design and vice versa in co-current design. Towards the conical end the solids coming out of the liquid level, shall get dewatered under high centrifugal force and shall continuously be discharged from the solid discharge port through a suitable chute. At the same time the clarified liquid shall overflow the adjustable weir into the casing and shall get continuously discharged at the opposite end of the solid discharge side through a liquid outlet.
- v. In order to increase the efficiency of solid /liquid separation suitable polymer shall be dosed in the centrifuge / inlet line to centrifuge. The recovery of solid shall be at least 98%. The solid cake discharged from centrifuge shall have minimum 25 % solids and shall be disposed. The elevation of the centrifuge platform shall be at least 5 m above ground level so that clearance below the chute shall be suitable for truck/trolley movement and the supernatant centrate shall be sent to the Thickener by gravity.

- vi. The performance of the centrifuge shall vary with the differential speed between conveyor and bowl and the pond depth in the bowl. Optimum separation efficiency shall be achieved by adjusting the feed rate. rotation speed. polymer type and polymer dosage.
- vii. The centrifuge shall be provided with washing / flushing lines which shall be used for cleaning of centrifuge, connected piping, etc.
- viii. An electric motor and V-Belt transmission is provided to drive the bowl. Power is transferred to the conveyor by means of a two stage planetary gear. The speed difference between the bowl and the conveyor shall be obtained by fully automatic back drive system that compensates for variations in incoming solids.
- ix. The centrifuge shall be provided with anti-vibration arrangement with vibration isolators provided under the frame for reducing the vibrations.
- x. Overload safety for the gear box shall be provided as per manufacture standards. The gear box shall be equipped with an overload protection device which can be quickly reset without disassembly
- xi. The critical speed shall be well away from the operating speed and in case less than 130% of the rated speed.
- xii. Centrifuge shall run smoothly without undue noise and vibration. Peak to peak vibration limits shall be restricted to the following values during operation

Speed	Sleeve bearings	Anti-friction bearings
1500 rpm & below	75 microns	75 microns
3000 rpm	65 microns	50 microns

- xiii. The noise level at a distance of 1 m from the boundary of the equipment shall not exceed 85 dBA.

~~7.00.00 OPERATION AND CONTROL PHILOSOPHY~~

Refer E,C & I spec.

~~The control concept for Waste Water Treatment System shall be such that the operation of the total Treatment System can be monitored and controlled from a PLC based Local Control System. PLC Remote I/Os shall be provided at suitable locations as described hereinafter. Remote I/O Panels shall be provided with push buttons, indicating lamps and PLC driven hardwired annunciation system for local operation & monitoring (LCP). 2 nos LVS shall be provided for operation purpose.~~

~~PLC shall be connected to the common BOP network for remote operation / maintaining from CCR. BOP network shall be interfaced with DDCMIS through soft links.~~

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/variations</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