2 x 660 MW NTPC TALCHER TPP, STAGE - III

TECHNICAL SPECIFICATION
FOR
COOLING TOWERS
(TOTAL 2 BOOKS)

BOOK 2 OF 2

Specification No.: PE-TS-497-165-N001 (REV. 0)

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA - 201301

1.00.00 INTENT OF SPECIFICATION

1.01.00 **Scope of the proposal**

The complete scope of the proposal for the Design, Engineering, Manufacture, Supply, Construction, Erection, Testing & Commissioning works for the EPC Package for Talcher Thermal Power Project Stage-III (2X660 MW), shall be on the basis of single point responsibility, completely covering the following activities and services in respect of all the equipment & works specified and covered under the specifications :

a) Basic Engineering of the plant including preparation of Plant Definition Manuals;

b) Detailed design of all the equipment and equipment system(s) including civil, structure steel works included in bidder's scope.

c) Providing engineering drawings, equipment sizing & performance data, instruction manuals, as built drawings and other information;

d) Compliance with statutory requirements and obtaining clearances from statutory authorities, wherever required;

e) Complete manufacturing including shop testing/type testing;

f) Complete Civil, Structural and Architectural works, including survey, providing construction offices, field laboratory and construction equipments, construction water supply, construction power distribution from the supply point of Employer, infrastructure works, construction / permanent roads, drainage arrangements, fencing / boundary wall around the land boundary.

g) Packing and transportation from the manufacturer's works to the site including logistic studies, customs clearance & port clearance, port charges, if any.

h) Receipt, storage, preservation, handling and conservation of equipment at the site;

i) Fabrication, pre-assembly, if any, erection, testing, commissioning and completion of facilities including putting into satisfactory operation all the equipment including successful completion of initial operation;

j) Performance and guarantee tests will be carried out along with the initial operation;

k) Furnishing of spares on FOR site basis;

l) Reconciliation with customs authorities, as required.

m) Conclusion of the contract.

n) Insurance and other requirements for the complete EPC package in accordance with the provisions of general conditions of contract (Section-IV) of the bidding document.

The requirements, conditions, appendices etc. given in Technical Specifications (Section-VI, Parts A, B, C, D and E) shall apply to and shall be considered as a part of this volume as completely as if bound herewith. The work to be carried out as per the above scope shall be all in accordance with the requirements, conditions, appendices, etc., stated in Section GCC, which shall be considered as a part of the Technical Specification (Section VI) as completely as if bound herewith. The Contractor shall be responsible for providing all material, equipment and service, which are required to fulfill the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. It is not the intent to specify herein all aspects of design and construction; nevertheless, the equipments and civil works shall conform in all aspects to high standard of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the Employer, who will interpret the meaning of the specification and drawings and shall have a right to reject or accept any work or material which in his assessment is not complete to meet the requirements of this specification and/or applicable to

Indian/ International standards mentioned elsewhere in this specification.

Bidders are requested to carefully examine and understand the specifications and seek clarifications, if required, to ensure that they have understood the specifications. Such clarifications should be sought within the time period as stipulated in section ITB. Bidder's offer should not carry any sections like clarifications, interpretations and/or assumptions. However, if the bidder feels that, in his opinion, certain features brought out in his offer are superior to what has been specified, these may be highlighted separately.

Bidder may also make alternate offers provided such offers are superior, in his opinion, to the requirements of these specifications in which case adequate technical information, operating feed back, etc. are to be enclosed with the offer, to enable the Employer 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 consumption, etc. shall be clearly brought out. In any case, the base offer shall necessarily be in line with the specifications. Under no circumstances the equipment/systems as specified herein shall be brought out as an alternative offer i.e. the system/equipment specified shall be made as a base offer. In case the above requirements are not complied with, the offers may be considered as incomplete and would become liable for rejection.

1.02.00 This enquiry concerns two (2) power generating units each having a rated output of 660 MW, including but not limited to:

- Steam Generators and Auxiliaries including,
  - Complete pressure parts, structures, platforms, stairs, piping, valves, supports etc.
  - Soot blowing system with piping, valves, controls etc.
  - Coal feeder and complete milling system
  - Coal combustion system including coal / oil burners & scanners.
  - Selective Catalytic Reduction (SCR) System / Hybrid (SNCR+SCR) Ready System as per the scope defined in scope chapter.
  - Air and flue gas ductwork.
  - Primary air fans.
  - Forced draft fans.
  - Induced draft fans.
  - Aux PRDS and piping
  - Start up & circulation system,
  - Air heaters & SCAPH.
  - Fuel oil pressurizing system (Common system)
  - Elevators for Steam generators
  - Chemical LP Dozing system and Oxygenated Treatment system
  - Electrostatic Precipitators.
  - Wet Limestone based Flue Gas Desulphurization System
  - Other systems like tools & tackles etc. as specified.

- Turbo Generators including,
  - Steam turbines.
  - Condensing plant.
  - Complete Regenerative Feed system.
  - HP-LP Bypass system.
  - Low Pressure Chemical Dosing system.
  - Condensate Extraction Pumps.
  - Boiler Feed Pumps
  - Condensate transfer pumps
  - Turbine hall E.O.T. crane.
  - Power cycle piping
  - Low pressure piping.
  - Equipment cooling water system
  - Boiler fill system
- Water Treatment Plant Including,
  - DM plant and CW chemical treatment.
  - Pre treatment and liquid effluent treatment plant
  - Chlorine di-oxide plant
  - Condensate polishing unit including regeneration facility
  - Reverse osmosis plant for waste water
  - Laboratory equipment
- Cooling Water System including,
  - Equipment Cooling water system including ACW pumps.
  - Circulating water system including CW pumps
  - Cooling towers for circulating water system
  - Aux water system including Raw water pumps
- Make- up water system
  - Make up water system including make-up water pumps & piping
- Plant Utilities including,
  - Compressed air system
  - Air conditioning and ventilation system
  - Fire detection and protection system
- Material Handling System including,
  - Mill Reject Handling system.
  - Coal Handling Plant
  - Ash Handling system with AWRS
  - Fuel Oil Handling Plant

- Lime Stone & Gypsum Handling Plant

➢ Elevators, Cranes and Hoisting equipments

➢ Electrical Equipments including,

- Main generator and associated equipment.
- All Transformers.
- Bus ducts.
- Medium and low-voltage switchgear, motor control centres.
- Motors & Cables etc.
- Illumination, Earthing, Lightning protection, DG sets, Batteries, Battery Chargers, Overhead lines etc.
- Electrical systems as required.
- Switchyard

➢ Control and Instrumentation system along with accessories and Instrument Cables.

➢ Civil works for the complete plant covered under bidder's scope shall be as mentioned in Sub-Section II-D, Section VI, Part-A of the specification.

➢ Complete Mechanical, Civil, Electrical & C&I works related to raw water System.

➢ Solar PV Plants on Roof Tops

2.00.00 ADDITIONAL REQUIREMENTS

(a) Before submitting his bid, the Bidder should inspect and examine the site and its surroundings and should satisfy himself as to the nature of the ground and subsoil, the quantities and nature of work, materials necessary for completion of the work and their availability, means of access to site and in general shall himself obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect his offer. No consequent extra claims on any misunderstanding or otherwise shall be allowed by the Employer.

(b) Bidder shall take all necessary precautions to protect all the existing equipment, structures, facilities and buildings etc. from damage. In case any damage occurs due to the activities of the contractor on account of negligence, ignorance, accidental or any other reason whatsoever, the damage shall be immediately made good by the contractor at his own cost to the satisfaction of the Employer. The contractor shall also take all necessary safety measures with specific reference to excavation in rock, at his own cost, to avoid any harm or injury to his workers and staff from the equipment and facilities of the power plant.

(c) For his site office and covered store buildings, the contractor shall adopt pre-engineered / pre-fabricated constructions made of steel with single / double skin, insulated or uninsulated roof and wall coverings (fabricated out of permanently color coated metal sheets). Alternatively, contractor can adopt readymade 'Porta cabin' or similar construction. Contractor shall ensure that all such constructions are well engineered, neatly constructed and overall present a pleasing look.

(d) In line with Gazette Notification on Ash Utilization issued by MOEF and its amendment thereafter, contractor shall use ash and ash based products in works as specified in these specifications, drawings and as per instructions of the Engineer. He shall also use ash and ash based products in construction of his offices, stores, staff quarters and labour huts etc. He shall furnish a compliance report along with all details of use of ash and ash based products along with each bill.

(e) Contractor shall establish/set up at site suitable repair facilities for construction plant, equipment and machinery (like piling rigs, cranes batching plant, dewatering pumps etc.) In case of piling rigs, cranes, batching plant etc. he will also make arrangements / tie up with equipment manufacturers / suppliers for periodic overhaul/maintenance and for major breakdown, if any. He shall also keep adequate stock of spares at site for various plant, equipment and machinery to meet day to day requirements as recommended by the equipment manufacturer/suppliers or as instructed by the Engineer. Contractor shall deploy dedicated qualified, full time mechanical/electrical foreman/supervisors for manning the repair facilities as specified above.

3.00.00 TENDER DRAWINGS

The tender drawings are enclosed along with the specification as Part-E, Section-VI and shall supplement the requirements specified in these technical specifications. The scope and terminal points of the equipment to be furnished under this EPC package shall be as identified in these drawings read in conjunction with text of the specification.

4.00.00 OTHER GENERAL REQUIREMENTS

Items though not specifically mentioned in the specification but needed to complete the equipment/systems to meet the intent of specification, shall also be deemed to be included unless otherwise specifically mentioned in exclusions.

In addition to the scope of supply and services indicated in other Sub-Sections of the scope of supply and services, the other general requirements are covered in this sub-section as part of the scope of the Contractor.

4.01.00 **Paints**

The Contractor's scope of work includes supply of paints and painting of all equipments and structures as per stipulated requirements and the Employer's standard color coding scheme.

4.02.00 **Pre-commissioning and commissioning activities**

The contractor's scope shall include all pre-commissioning and commissioning activities, materials and services as detailed in other portion of technical specifications including supply of all consumables (except coal, oil and limestone), temporary equipment and pipings, instruments, labour / skilled manpower's etc. The scope includes complete requirement of flushing oils including fresh oil refilling during the pre-commissioning and commissioning activities and subsequent initial operation.

Regarding, coal & fuel oil, the Contractor shall quote the total maximum quantity of the coal and fuel oil as required upto the successful completion of “Initial Operation” (as defined in General Technical Requirements, Part-C, Section-VI of Technical Specification) for both the units which shall be issued to it free of charge by the employer for such operation during execution. These quantities for both coal and fuel oil shall be compared with the respective quantities as quoted by various bidders. The quantities over & above the base value (minimum among the quoted figures for coal & fuel oil) shall be used as a loading factor and corresponding computed price (total for coal & fuel oil) shall be added to the quoted bid price for deriving the total bid price. The cost of coal & fuel oil shall be used as Rs. 2108/Ton (Rupees Two Thousand One Hundred and Eight only per ton of coal) Rs. 40,000/KL (Rupees Forty Thousand per KL of fuel oil) for such purpose.

Further, during execution any requirements (of coal & fuel oil) beyond the quoted quantities by the successful bidder would be issued by NTPC but charged back to the contractor as per the prevailing landed rate at site at that time.

There shall be no rebate to the Contractor if the coal & oil quantities as consumed during execution (up to the initial operation as above) remains lesser than the quoted values.

And the total required limestone shall be issued free of charge by the employer for such purposes.

4.03.00	**First Fill of Consumable, Oils & Lubricants**
i.	All the first fills of consumables and one year's topping requirements of consumables such as greases, oil, lubricants, servo fluids / control fluids, gases (excluding H2, CO2 and N2 for Generator) etc. which will be required to put the equipment covered under the scope of specifications, into successful commissioning / initial operation and to establish completion of facilities shall be supplied by the Contractor. Suitable standard lubricants as available in India are desired. Efforts should be made to limit the variety of lubricants to minimum. Bidder shall supply a quantity not less than 10% of the full charge or one (1) year topping requirement mentioned above (Whichever is higher) of each variety of lubricants, servo fluids, gases, etc.(as detailed above) used which is expected to be utilized during the first year of operation. This additional quantity shall be supplied in separate Containers.
ii.	Bidder scope shall supply H2, CO2 and N2 as applicable for the Generator till successful commissioning of the Generator.
4.04.00	**Guarantee Tests** The guarantee tests for various equipment and systems shall be carried out as specified under chapter of Functional Guarantees and Liquidated damages, of this part of technical specification. All special equipment, tools and tackles, instruments, measuring devices required for the successful conductance of Guarantee Tests shall be provided by the contractor. All costs associated with the tests shall be included in bid price.
4.05.00	**Spares** The scope of supply of contractor includes supply of mandatory spares, start-up and commissioning spares, recommended spares, consumable spares and other spares as required for plant erection, testing, commissioning, startup, initial operation etc.
4.06.00	**Special Tools & Tackles and Test/Measuring Equipment** One set of all special tools and tackles including testing, calibrating and measuring instruments required for erection, assembly, disassembly and maintenance and testing of all equipment/systems covered under the scope of the contractor shall be supplied by the Contractor as per relevant clause indicated in Part-C of Section-VI and as specified elsewhere in Part-A of Section-VI of Technical Specifications. The Contractor shall not use these special tools, tackles and testing/measuring equipment for erection/commissioning purposes and shall be in an unused and new condition, when they are handed over to the Employer. A list of all such special tools and tackles shall be submitted along with the offer.
4.07.00	The scope of the Contractor includes complete design and engineering, technical co-ordination (including participation and arranging technical co-ordination meetings), finalization of drawings/documents, submission of engineering drawing/documents and processing of their approvals by the Employer as per requirement indicated in Part-C of section -VI and other relevant clauses given elsewhere in the Technical Specifications. Further, the scope shall also include submission, in proper shape and format, of all types of manuals, handbooks and documents in requisite numbers to the Employer at different phases of the project as per the requirement of Employer.
4.08.00	All the plant layouts shall be made in computerized 3D modeling system as detailed in Part C of the Technical Specification. Contractor shall prepare the model of all the facilities located within plant boundary covering facilities in Main Plant Block area and Balance of plant (BOP) area in an integrated & intelligent 3D software solution. Main Plant Block area shall include, Transformer Yard, TG building (including all facilities), Boiler area, ESP area, chimney area, FGD area and any other facility located in main plant block. BOP area shall include all facilities pertaining to AHP, CHP, LHP, GHP, DM PT plant, pipe & cable racks and any other facility located within plant boundary.

	Contractor shall prepare 3D design review model (network ready, which shall include visual interference check, walk-through animation, video simulation for major equipment placement and removal, visual effect, photo realism etc), which is extracted from intelligent 3D model, for employer's review as & when desired by employer. However, all piping layouts, equipment layouts, floor plans, ducting layout (Air/flue gas, A/C, Ventilation etc.) and structural arrangement drawings shall necessarily be extracted from the aforesaid 3D model and submitted for employer's review along with the 3D review model to enable NTPC to review and approve these drawings. The contractor shall prepare the 3D model indicating the control & instrumentation equipments, devices such as location of LIE,LIR, flow elements, instrument tappings, thermowell stubs, JBs , cable trays, Flame scanners, Flame viewing cameras, ASLD, Acoustic Pyrometer, Control valves & actuators, Coal bunker level instruments along with approach / maintenance platform, provided for all these equipment's/devices. The LIE & LIR shall be placed in such a way that the doors can be opened freely from front & back side for ease of maintenance. The cable tray layout shall be implemented in such a way that the fouling to the pipes, ducts and other structures can be avoided. These above drawings are to be extracted from the said 3D model and submitted for employers review and approval along with the 3D model. After the completion of engineering of respective area i.e. TG building/ Boiler/ ESP etc., the corresponding complete 3D review model shall be handed over to the employer for its reference.
4.09.00	The Contractor shall be responsible to undertake some activities related to its Corporate Social Responsibility (CSR) in the immediate vicinity of the project. The Contractor shall undertake such activities after prior consultations with the Employer to ensure that the efforts of the Employer and Contractor are complemented. The vendor / contractor is expected to carry out the CSR activities as per the provision (Rules) under section 135 of the companies Act 2013 relating to CSR and other circulars / instructions of various government departments viz MoEF etc. The share of CSR expenditure to be incurred by the vendor / contractor for this project in the total CSR expenditure incurred by the vendor/contractor as a company will be in the same proportion as the turnover of the project concerned to the total company turnover. This will be certified by the charted accountant once every fiscal year. Such activities will be undertaken by the contractor / vendor in consultation with the Employer.
4.10.00	The Contractor shall also jointly facilitate in resolution of Land Acquisition issues related to the Project. Any due payments arising out of the Land Acquisition process shall however be paid by NTPC to the appropriate Authorities. The vendor / contractor shall visit the site to ascertain the position of land acquisition etc. and it is presumed that the contractor submitted his bid after considering the facts on the ground and that once vendor / contractor is successful in his bid, he will work in cooperation with the client for smooth execution of the project.
4.11.00	The scope of the contractor shall also include supply and installation of e-learning packages for the equipment / system for the Steam Turbine Generator & auxiliaries and Steam Generator & auxiliaries along with associated electrical and C&I system as indicated in Part-C of Section-VI.
5.00.00	**GENERAL ENVIRONMENTAL REQUIREMENTS** The contractor shall execute all work at site as per the general environmental requirement and following the applicable codal provisions and local regulations in this respect. The contractor shall provide and install suitable safeguards and facilities as approved by the Engineer for meeting general environment requirements given herein under.

5.01.00	Protect from damage and disturbance of the existing trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipe lines, drains, sewers, or other surface or sub-surface systems / facilities within or adjacent to the works being carried out given herein below.
5.02.00	Take all necessary precautions against soil erosion, water and environmental pollution and safe disposal of waste material.
5.03.00	Control the ground in the vicinity of all excavations, so that the surface of the ground is properly sloped or dyked to prevent surface water from running into the excavated areas, during construction.
5.04.00	All natural materials arising out of site clearance and excavation shall be the property of owner. All salvaged materials of archaeological importance or of value (in the opinion of the Engineer) shall be segregated from the other materials and stacked separately at locations as indicated by the Engineer.
5.05.00	The method and arrangement of blast cleaning shall conform to factory act, local laws, stipulations of pollution control board, if any.
5.06.00	a) Excavated earth should be stockpiled properly at designated areas so as not to spread and cause air pollution (fugitive dust emission) and water pollution (suspended solids in run-off). Top soil (top 150mm layer of the fertile soil) may be stored separately for future use in landscaping / revegetation / horticulture. b) Solid wastes generated during construction such as construction debris, excess cement / concrete, wrapping materials (e.g. plastic packets and wrappers), timber, tins, cans and drums, wire, nails, glass etc., chemical wastes and hazardous wastes, food and domestic wastes etc., should be properly disposed off so as not to cause any air / water pollution. c) Potential pollutants (such as oils, chemicals) shall be kept, stored, and used in such a manner that any escape can be contained and the surface and ground water resources are not contaminated. d) Water containing pollutants such as cements, concrete, lime, chemicals and oils shall be discharged through a temporary sedimentation and equalization tank. e) The necessary precautions shall be taken to control emission of fugitive dust and suspended solids in effluents leading to sedimentation of receiving water bodies. f) Provide necessary sanitation facilities to the labour camps. g) All vehicles and equipment shall be kept in good working order and serviced regularly to maintain the exhaust emissions and noise levels within reasonable limits. h) Control the movement of all vehicles so as to minimize disruption to regular users of the routes. i) The speed of the vehicles on gravel or earth roads in and around site may be restricted to minimize the emission of fugitive dust. Further, the road surface of gravel or earth roads may be provided with suitable cover to reduce the emission of fugitive dust.

SUB-SECTION–IID

CIVIL WORKS

1.00.00

SCOPE OF CIVIL, STRUCTURAL & ARCHITECTURAL WORKS OF EPC PACKAGE

The scope of civil, structural and architectural works shall include topographical survey, detailed geotechnical investigation, site clearance, ~~dismantling of existing structures/substructures/facilities~~, site levelling, preparation of design documents and drawings and getting approval of the same from the Employer and construction of all civil, structural and architectural works including supply of all construction materials for all buildings, equipment and facilities for the project. The nature of work generally involves detailed geotechnical investigation, piling, earthwork in excavation in all types of soil and rock including controlled blasting/ mechanical means, de-watering, backfilling around completed structures, plinth filling, disposal of surplus earth/rock/excavated material/~~dismantled material~~, concreting including reinforcement and form work, chimney construction using slip form, masonry work, plastering, corrosion protection measures including painting, un-insulated / sandwiched insulated metal wall cladding, roofing and flooring including permanent steel decking, false ceiling, under deck and over deck insulation, acid and alkali resistant lining, fabrication of all structures at factory, pre assembly of fabricated structures at factory, transportation of pre-fabricated structures and erection of steel structures (with bolted field connections) and miscellaneous steel works (i.e., steel staircase, cable supports, pipe supports, ladders, walkways, railing, chequered plate/grating floors, inserts etc.), painting of structures, paving, gravel filling, providing pre-cast covers, damp proofing, roof water proofing, anti-weed treatment, roads, drainage, sewerage, rain water harvesting, final grading and site clearance before handing over and any other item of work required for completion of all systems under the scope of work complete.

The works covered under the scope of the bidder have to be executed in an existing power station. The bidder shall take all necessary precautions to protect the existing equipment, structures, facilities and buildings etc. from damage. In case any damage occurs due to activities of the bidder on account of negligence, ignorance, accidental or any other reason whatsoever, the damage shall be made - good by the bidder at his own cost to the satisfaction of the Owner. The bidder shall take all necessary safety measures to avoid any harm, injury to his workers/staff from the equipment / facilities of the power station.

The scope of Bidder for civil, structural and architectural works as defined above shall include but not be limited to the following buildings/ areas/ systems along with their foundations, super structures and finishes complete:

1. Topographical Survey.
2. Detailed Geotechnical Investigation.
3. Site clearance including cutting of trees of girth less than 30 centimeters.
4. ~~Dismantling~~, removal, and disposal of identified facilities/ structures/ substructures/ foundations of ~~dismantled quarters/buildings/structures~~, reinforcement, pavement/paving, pipes and any underground structure/materials, debris etc. all complete.

   ~~Refer Annexure-P in PART-B along with Tender Drawing No. 4540-999-POC-A-015 - EXISTING FACILITIES / BUILDINGS WITHIN STAGE-III PLANT AREA, for tentative list of existing facilities. The list is only indicative and may not be exhaustive/complete. The list contains structures a) where super structure is to be~~

pump, sump & house and connection up to sewage treatment plants (either of owner or bidder); connection of sewage lines of all buildings under Bidder's scope to the nearest sewerage system.

d. Patrol/inspection road along Ash Slurry pipe corridor as shown in tender drawings.

e. Complete site levelling of entire plant area as shown in drawing no. 4540-001-POC-A-003 Titled 'Site Levelling Plan'.

f. Water supply system for Plant area.

g. Safety Park Building as per tender drawing.

h. Safety Control Room at onset of project works.

i. Plant boundary wall as shown in General Layout Plan (Drg. No.4540-999-POC-F-001)

j. Separate RCC drainage network with GI grating cover and sump pit for plant effluents for all buildings and facilities in Bidder's scope including floor wash water from all the facilities in Plant Area upto Effluent Treatment plant including connection of effluent line from structures under the scope of package.

k. Hard crusting in plant area and preassembly area to facilitate movement of vehicles and erection of equipment.

l. Watch Towers

7. Foundations for all buildings/ area/ systems including machine foundations.

8. All Civil, Structural, Architectural works including underground facilities like drainage, sewerage, trenches, earthing mat/ grounding for entire Plant area covering the following:

a. Boiler and ESP supporting structures and foundations.

b. Elevator pit & Civil Works for Machine Room for Boiler Elevator.

c. Mill Bunker building supporting structures and foundations, floors, roof & side cladding.

d. ESP control room building.

e. Mill reject silo and associated trenches.

f. Compressor house.

g. Coal mill foundations & PA/FD/ID Fan foundations.

h. Seal air fan foundation and all other equipment foundations.

i. Coarse ash hopper tower foundations & FEA tower foundations.

j. Coal transfer points, coal conveyor galleries and supporting trestles in the boiler area – foundations, floors, roof & side cladding, staircases, gravity take up structure for conveyors in the boiler area.

k. Area Paving and miscellaneous foundations in entire area enclosed within the peripheral roads of the entire plant area from edge of drain along peripheral road beyond transformer yard upto road beyond Ash handling facilities area bound by peripheral roads in orthogonal directions, including heavy duty passages, sump pits, drains, culverts, cable slits, fire water trench, including, rail/ road/ drain crossing of fire water trench & pipes etc. (as shown in tender drawing).

l. Bunker MCC including RIO room.

m. Main Power House building.

n. Service Building (including interconnection with Main Power House)

o. Foundations for turbine generator, turbine driven boiler feed pumps and motor driven boiler feed pump(s) including steel helical springs and viscous dampers below RCC top deck (The foundation type can be with/without steel helical springs/ dampers as per option provided in specification)

p. CW Pit, CEP Pit, and all other equipment foundations in Turbine-Generator (TG) area.

q. CW duct /liner including PCC/RCC encasement

r. Transformer yard area foundations including rail track cum road along the entire A-Row extending up to peripheral roads on either side and transformer yard, condensate storage tank foundation, condensate transfer pump foundation, fire barrier wall, pit, sump, pipe and manhole, common oil retention pit/oil-water separation pit, gate and fencing etc.

s. Diesel generator set foundations & stack foundations along with steel support structure and foundations for stack support.

t. Area paving in and around service building.

u. Civil, structural, architectural works for CPU system in Main Power House & regeneration area including Switchgear/MCC and control room building and Transformer foundations.

v. Civil, Structural & Architectural works for rooms for Owner's Electrical equipment like HT/LT switchgear, cable vault, batteries/battery chargers, foundation of service transformers, space for bus ducts and cable trays etc. as listed in Electrical Chapter & Layout Chapter PART-B.

9. Chimney including elevator, electrical works, aviation obstruction lighting.

10. Civil, structural, architectural works of all facilities associated with complete Flue gas desulfurization (FGD) including Gypsum and limestone handling system and DeNOx system.

11. Civil, Structural, Architectural works for all buildings/ structures/ facilities for ash handling and ash water recirculation system along with switchgear building & control room including the following:

    a. Ash Water Pump House open type

    b. Ash Slurry Pump house shed as per system requirement

    c. Ash Water Recirculation Pump House complex including switchgear room, transformer yard, control room, battery room, Disaster management room, boundary wall etc.

    d. Switch gear/MCC and Control Room for all buildings.

    e. Silo area utility building, ash classifier system and bagging plant complex (build type as per system requirement)

    f. Fly Ash Silo foundation, Foundation for Bottom Ash silo, Intermediate silo, Foundation for ash classifier system and bagging plant including base plate and supporting pedestals

    g. Transport air compressor Shed with side sheeting

    h. Conveying air Compressor Shed with side sheeting (if required as per system)

    i. Steel Trestles including foundation for supporting fly ash Piping within plant area and up to silos

j. RCC pedestals for ash slurry disposal pipes lines upto mine voids including garlanding pedestal for mine voids

k. RCC pedestals for supporting ash water recirculation pipe

l. Miscellaneous works like Transformer Foundation, Fencing, Paving etc.

m. Miscellaneous structures including Foundation for settling tank, surge tank BA overflow tank, etc.

n. Culverts/local humps or bridges as per site conditions, for routing of the ash pipes at crossing for nallah /water body crossing /roads/rail lines etc.

o. Weigh Bridge

p. Entire ash pipeline corridor road from plant boundary to mine voids including garlanding road on mine voids and connecting road for Ash Water Recirculation Pump House Complex.

q. Any other buildings/structures if required as per system.

12. Civil, structural, architectural works for fuel oil unloading & storage system namely fuel oil unloading cum pressurizing pump house with switchgear room, MCC cum control room and Fuel oil unloading system civil works including Fuel Oil tanker unloading platform, foundation and dyke wall and all associated works for LDO storage tank.

13. **CW system Civil, Structural and Architectural works**

a) CW pump house with steel superstructure and metal sheeting at roof including pump foundations, maintenance area, forebay and Transition zone

b) CW Switchgear/MCC & control room building including transformer foundation.

c) CW ducts including PCC/RCC encasement from CWPH to TG Hall and from TG Hall up to Cooling Towers.

d) CW Channel from Cooling Towers up to CWPH forebay.

14. **Raw Water system civil Works**

Raw Water Pump House (RWPH) with steel superstructure and metal sheeting at roof including connection with reservoir outlet pipes, pump foundations, maintenance area, Forebay/Sump and associated Switchgear/Control/Remote IO Room building, Transformer foundation etc.

15. Civil, Structural, Architectural works for the following buildings/ structures/ facilities of **Water & Effluent treatment plant**:

a) Pretreatment plant and associated structure and facilities
b) DM plant and associated structure and facilities
c) CW Chemical Treatment Plant and associated facilities
d) Coal slurry settling pond and associated facilities
e) Chlorination(ClO_2) plant and associated facilities
f) Water System Control Room Building and remote I/O room associated with PT plant, DM & CW chemical plant.
g) DM Plant laboratory
h) Zero liquid discharge and associated facilities
i) Liquid effluent Treatment Plant & associated facilities required for disposal of liquid effluent. Effluent quality monitoring system(EQMS)
j) DM, PT & Service Water Switch Gear & Control/Remote I/O Room Buildings, transformer foundation etc

k) DM & CW Chemical plant

l) Station Piping Civil works

Civil, Structural works for pipe /cable /duct supporting structures, trestles and foundations, Condensate Storage Tank and CST pump house, trenches, duct banks, pedestals, thrust blocks, trenches, Hume pipes & culverts, duct banks etc at crossing in offsite area for pipes and cables, buried pipes and crossing, racks, culverts across rail tracks for pipes/ drains/ sewers and any other facility and thrust blocks etc. associated with all systems covered under the scope

16. All civil, structural & architectural works associated with **Natural Draught Cooling Towers (NDCT)** including associated facilities..

17. **Civil Works for 400kV GIS including AIS portion Switchyard.**
All civil, structural & architectural works associated with Switchyard, that is, Switchyard Control Room Building, GIS Building, GIS Duct Support, Towers, Girders, Equipment Supports, Lighting Masts, Lightning Masts, Transformer /Reactor foundations, cable trenches, roads, drains, fence with gate, anti-weed treatment, gravel filling, water supply & sewage system for switchyard buildings, inter-connections to employers facilities etc. and all other related works complete as per system requirement.

18. **Coal, , Lime and Gypsum Handling Plant**
All civil, structural & architectural works associated with coal, Lime and Gypsum handling plant, i.e. track hopper, transfer points, crusher houses, overhead/ground conveyor galleries, tunnels for conveyor galleries, Lime Stone, stacker/reclaimer foundations, pump houses, MCC/Control Buildings, penthouse, Truck tippler, Covered Structural shed over stock pile area, Gypsum storage shed drainage etc.

19. **Makeup water system**
All civil, structural & architectural works associated with Makeup water system including:

i. Clearing and grading of work area including requirement of work areas and access there to and stacking of reference markers.

ii. Intake structure in the river, RCC channel including desilting arrangement, forebay, sump, Stop-logs and Trash Racks, pump house for makeup water pumps including river bank protection.

iii. Trenching for laying of pipes and back filling of trenches.

iv. associate civil works for air release valves.

v. bridges for make water pipe across water bodies, irrigation canal and culvert across roads, railway tracks, highways as indicated in Tender drawing.

vi. MCC cum control room, foundation of all the transformers and associated transmission system including one Bio Toilet block.

vii. approach road to Makeup water pump house area to nearest available road.

j. There is a 3m x 3m, 60m long Box Culvert Bridge inside the In-Plant Yard.
k. There is a 'B' Class Manned Level Crossing. It has to be extended 30m approximately.
l. 2 (Two) nos. of Foot Over Bridges (30m & 40m long approximately) will be provided as per RDSO Standard.
m. An Electronic In-Motion Weigh Bridge will be provided as per RDSO Standard.
n. An entry gate cabin with over head structure for inspection of wagons is to be provided at the plant entry point of the railway siding.
o. Utility Buildings(About 250.00 Sqm Plinth Area): FOIS Room, Crew Rest Room, Signaling Cabins, Entry gate cabin, In motion weigh bridge room , Gumties and other associated buildings with all civil amenities, complete electrification work and approach roads of about 2.0 Km length for all above buildings.
p. In order to deal with the inward & outward Traffic it is proposed to provide an In-plant R&D Yard with 4 (Four) Running Lines, 1 (One) Brake Van Siding, 1 (One) Outhaul Line each for Silo and Track Hopper.
q. Track structure:
   i. Rails: 60Kg/m prime quality rail as per RDSO specifications will be used.
   ii. Track: The tracks will be laid with 60 Kg prime quality rails on PSC sleepers with elastic fastenings and with 300mm ballast cushion.
   iii. Sleepers: PSC sleepers 1660 Nos. per Km.
   iv. Ballast: Ballast as per RDSO specification with a minimum depth of cushion of 300 mm below the sleepers at rail seat is proposed.
r. Points & Crossings: 13 Nos. of 1 in 8.5 and 1 no. of 1 in 12 are required as per RDSO specifications
s. 1 no. of 1 in 8.5 Derailing Switch is required as per RDSO specifications.
t. Total track KM is about 7.1KM.

u. All charges including Deposit works, Codal Charges required for approval, construction and commissioning, payable to Railways for railway siding system are to be paid by the Bidder to the concerned zonal Railways.
v. All spares, tools and plants required for maintenance of complete Railway Siding System.

Above scope of work is not limiting and any increase in the scope with respect to that mentioned in FSR will be compensated as below:-

i) For Civil Engineering works: Applicable Schedule of Rates (SOR) of East Coast Railways (ECoR) as on date of techno-commercial bid opening.

ii) For S&T and OHE works : Applicable RVNL (Rail Vikas Nigam Ltd.) standard BOQ as on date of techno-commercial bid opening.

Agency has to pass on the rebate for reduction in scope, if any on the same basis.

1.00.01 All steel structures shall be fabricated in factory, transported and erected at site. All factory-fabricated structures shall have bolted field connections. Coal bunkers with hoppers**,** lime storage silos, Chimney flue liners, CW duct liners can either be fabricated at factory in segments, transported and welded at site before erection or fabricated at site. For coal bunkers, hoppers and chimney flue liners, to prevent coal dust/flue gas leakages, the applicable field joints shall necessarily be welded.

Note: Steel structures shall mean plant and non-plant building structures, boiler & ESP support structures, Coal, Limestone and Gypsum handling structures, AHP structures, chimney flue liners support platforms & stairs, pipe and cable support structures.

Civil, structural and architectural works though not explicitly mentioned in the above list but required for the completion of the various systems of the package shall also be in the scope of the bidder.

1.00.02 CORROSION PROTECTION

The plant lies in the corrosive category C3 as per ISO 12944. Protection measures shall be provided as specified in Part-B of Technical Specifications.

1.00.03 Supply of earth for filling in site levelling, reservoir embankment, Railway siding embankment (within plant boundary and outside boundary) & disposal of surplus earth/ debris including arranging the borrow pit/disposal site and making payment of royalty, levies, taxes and any other applicable charges etc. shall be in bidder's scope.

2.00.00 LABOUR & STAFF COLONY AND CONSTRUCTION FACILITIES

2.01.00 LABOUR & STAFF COLONY

The following are in the Bidder's scope of work for labour & staff colony:-

a) Development of Bidders temporary staff colony and labour colony along with toilets & fencing etc. Bidder may use Area-A for Labour Colony. For safety of labour, bidder to provide separate approach road for their movement, as per site conditions, which shall be completely isolated from material movement road/path. No material movement shall be allowed on approach road meant for Labour colony.

b) Adequate no. of Rest rooms with toilet for bidder's labour & staff.

c) All Civil and Structural work associated with drinking and service water for Bidder's labour and other personnel at the work site/colony/offices including pump houses, pipes, overhead tank, tube wells etc.

d) The EPC Contractor shall have total responsibility for providing and maintaining facilities for safety, welfare, drinking water and sanitation, hygiene, biennial health checkup etc. for construction workers at their workplaces as well as at labour & staff colonies. The facilities for occupational safety, healthy environment, first aid, drinking water, resting place & toilets, canteen, crèche, etc. shall be provided at the workplace for construction workers by the contractor.

e) Accommodation for Workers & staff colony in adequate numbers as required for the project peak demand shall be made in the form of temporary structures which shall be removed after completion of the project. It shall have facilities for drinking water & sanitation, approach road, dust suppression, drainage, sewage treatment plant, solid waste collection & disposal, fuel for cooking, medical healthcare, creches, etc.

f) Sole responsibility of development and maintenance of above facilities for construction workers hired by the Contractor or his sub-contractors shall rest with the Contractor. Land, water, electricity for the labour & staff colony shall be arranged by the Contractor as stipulated elsewhere in Technical Specification.

2.02.00 CONSTRUCTION FACILITIES

The following are in the Bidder's scope of work pertaining to construction facilities in this package.

1. Construction Water

   Construction water shall be the responsibility of Bidder during all stages of construction.

   However, construction water may be provided by Owner at one point near existing Stage-II reservoir on chargeable basis. Bidder shall arrange for further distribution/transportation to required location by their own.

2. Construction Power

   Scope of supply of construction power is specified in SECTION – VI, PART-B, SUB SECTION B-19 of Technical specification.

3. Construction of following temporary facilities of bidder

   a) Construction office,

   b) Construction stores (covered) & open stores as per his requirement.

   c) Workshops for maintenance of construction plant and equipment.

   d) Material/field testing laboratory facilities and any other temporary building.

4. Providing all necessary fire-fighting devices/equipment/fire tender etc. required during the project execution stage in project areas including laydown/pre-assembly yard area.

5. Providing all tools and tackles required for the work.

6. The Bidder shall arrange skilled/semiskilled/unskilled labour (from local source(s) as far as available) and supervisory staff for quality execution of all civil, structural and architectural works.

7. Development of hard crusted / paved fabrication yard for onsite structural steel fabrication work where permitted.

8. Area lighting at the construction / erection site, fabrication, pre-assembly and storage yard, office areas, labour and staff colony etc.

9. Providing first aid facilities at the construction / erection sites, workshops, laboratories, fabrication, pre-assembly &storage yard, Offices and other places of work as per the requirement.

10. Use of ash and ash based products.

    In line with Gazette Notification on Ash Utilization issued by Ministry of Environment & Forest and its amendments, Bidder shall use ash and ash based products in all construction. He shall furnish a compliance report along with all details of use of ash and ash based products along with each bill. The above requirements shall be applicable to his sub-vendors also and Contractor shall be responsible for enforcing the same on his sub-vendors

    Fly ash is not available within plant boundary. Bidder to procure Fly ash from TSTPP-Kaniha. Bidder to collect and transport the same meeting environmental norms/ local regulations at his own cost as per operation schedule for fly ash collection.

    A nominal amount of Rs 1 per MT shall be charged by TSTPP Kaniha.

11. Repair & Maintenance Facilities by the Bidder :

    Bidder shall establish/set up at site suitable repair facilities for construction equipment and machinery (like cranes, hydra, forklifts, welding equipment, dumpers, rollers, etc.) Bidder shall also make arrangements /tie-up with manufacturers / suppliers of such construction plant, equipment & machinery, for periodic overhaul/ maintenance and for repair of major breakdown, if any. Bidder shall also keep adequate stock of spares at site for various construction plant, equipment and machinery to meet day to day requirements as recommended by the manufacturer / suppliers or as instructed by the Engineer. Bidder shall deploy dedicated qualified, full time mechanical / electrical foreman & supervisors for manning the repair facilities as specified above.

12. Water sprinkling in construction area and roads, as per requirement/directions of Engineer-in-Charge, to arrest fugitive construction dust.

13. Dewatering in construction area during construction period for any seepage water as well as accumulated rainwater.

14. Housekeeping of all construction area and disposal of construction/demolition waste. This also includes cutting and removal of vegetation including dry vegetation to avoid fire hazard in the entire project construction area.

NTPC Limited

(A Government of India Enterprise)

TALCHER THERMAL POWER PROJECT
STAGE-III (2 X 660 MW)

TECHNICAL SPECIFICATION

FOR

EPC PACKAGE

PART – B

(BOOK 4 OF 5 – CIVIL WORKS)

SECTION - VI

BIDDING DOCUMENT NO.: CS-4540-001A-2

D-1-1 GENERAL

1.01.00 This specification is to cover, survey works, site leveling works, design, preparation of general arrangement drawings, construction and fabrication drawings, supply of labour & materials and construction of all civil, structural and architectural works by the Bidder.

Description of various items of work under this specification and nature of work in detail are given hereinafter. The complete work under this scope is referred to as civil works. Various buildings, structures, plant and systems, facilities, etc., covered under the scope is given in Part-A and herein.

The work to be performed under this specification consists of design, engineering, construction, erection and providing all labour, materials, consumables, equipment, temporary works, temporary storage sheds, temporary colony for labour and staff, temporary site offices, constructional plants, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the plant, all in strict accordance with the specifications including revisions and amendments thereto as may be required during the execution of work.

All construction materials including cement, reinforcement steel, coarse & fine aggregate, structural steel and construction water etc., shall be arranged by the Bidder.

The scope shall also include setting up by the Bidder a complete testing laboratory in the field to carry out all relevant tests for structural steel, reinforcement steel & reinforced concrete (RCC) works.

Preliminary geotechnical investigation in the proposed area has been carried out by the Owner and the bore-log data is furnished in Annexure ‘C’.

The work shall be carried out according to the design/drawings to be developed by the Bidder and approved by the Employer. For all buildings, facilities, systems, structures, etc., necessary layout and details are to be developed by the Bidder keeping in view the statutory and functional requirements and providing enough space and access for operation, use and maintenance. The Bidder’s work shall cover the complete requirements as per IS codes, fire safety norms, requirements of various statutory bodies, International Standards, best prevailing practices and to the complete satisfaction of the Employer.

The Bidder shall make the layout and levels of all structures from the general grid of the plot and the nearest GSI benchmark or other acceptable benchmark of Government department. As per the directions of the Engineer. The Bidder shall be solely responsible for the correctness of the layout and levels and shall also provide necessary instruments, materials, access to works, etc., to the Engineer for general checking of the correctness of the civil works.

All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to.

The Bidder shall fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, soil conditions, local conditions and site-specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications.

In case of any conflict between stipulations in various portions of the specification, most stringent stipulation would be applicable for implementation by the Bidder without any extra cost to the Employer.

Wherever there is an anomaly in the design concept between the data furnished in the General Design Criteria & Design Concept of Buildings, the data furnished in the design concept of buildings shall be treated as final.

Bidder or his agencies engaged as detailer for fabrication drawings should have the experience of detailing for powerhouse structures or steel plant or Industrial structures like Petro/ Chemical/Refinery/Cement etc.

D-1-2 SCOPE OF WORK

The scope of work for the EPC contractor shall include the analysis, design, construction, erection of all civil, structural & architectural works and all other items mentioned in Part-A of this Specification.

2.01.00 **Construction Facilities**

For details of construction facilities refer to Part-A of this specification.

2.02.00 **Exclusions:**

The details of exclusions and terminal points, refer to Part-A of this specification.

D-1-3 **SUBMISSIONS**

3.01.00 The drawings included in the Bidding Document provide a general idea about the work to be performed under the scope of this contract. These are preliminary drawings for bidding purposes only and are by no means the final drawings or show the full range of the work under the scope. Work has to be executed according to drawings prepared by the contractor. The following documents and drawing shall be submitted and got approved before commencement of detailed engineering. The list given below is not exhaustive but indicative only.

a) Project design intent, design criteria which shall cover all design aspects, design parameters, material of construction and its specifications, structural idealization including framing system for gravity loads and lateral loads(wind and seismic), load cases, load combinations, assumptions, references, basis of analysis & design of all buildings, machine foundations, facilities, systems and structures etc.

b) Survey drawings indicating spot levels for the area under the scope of work.

c) Plants 'General Layout Plan' drawing with coordinates of roads, boundary wall, buildings and facilities, pipe/cable corridors, railway lines, Green Belt etc..

d) Geotechnical investigation scheme

e) Geotechnical Investigation report including foundation system recommendations.

f) Typical design of pile, if applicable, in terms of type, rated capacity, length, diameter and the termination criteria to locate the founding level.

g) Scheme for initial and routine load test of Pile foundation high strain dynamic load test and pile integrity test methodology.

h) Details of corrosion protection measures for all structures, foundations etc.

i) Architectural concept designs which shall cover all concept plans and elevations, finishes and area statements of all buildings and facilities

j) The following sequence of submission of drawings/ documents is to be followed:
- Architectural drawings, wherever applicable
- Relevant GA drawings & loading document
- Analysis & design of structures/ buildings/ facilities with drawings.
- Analysis & design of foundations with drawings.

3.02.00 Detailed construction drawings and design calculations for all civil works for static as well as dynamic analysis shall be submitted for approval prior to undertaking construction work.

3.03.00 Design calculations shall be done in M.S. Office (latest version) and Drawings shall be prepared in Auto Cad (latest version). The analysis shall be done by using STAAD PRO / ANSYS/SAP2000 (latest version). However, design may be carried out manually, using computer work sheets or by using suitable software programs, as mutually agreed by Employer. Final calculations and drawings shall be submitted as mentioned in General technical specification.

3.04.00	Civil Task drawings indicating various equipment loading and supporting arrangement and floor loads shall be submitted along with design calculations. Soft copies of all STAAD/Other Softwares input and output files shall be submitted along with the design calculations for all revisions.
3.05.00	Structural steel fabrication drawings to be prepared by the contractor will not be approved by the Employer. However, the Contractor shall submit all fabrication drawings for Employer's reference. Copy of detailed bar bending schedule as prepared by contractor shall also be submitted to Engineer in charge for the reference.
3.06.00	Approval of construction drawings prepared by the contractor shall not relieve the Contractor of his responsibility regarding the safety and adequacy of design and correctness of the drawing.

D-1-4 GENERAL LAYOUT PLAN

4.01.00 The preliminary layout plan proposed for the project is shown in the drawing no 4540-999-POC-F-001 titled "General Layout Plan".

It shall form the basis for further elaboration by the Bidder for the plant facilities, which are in his scope. Area identified for facilities remain same as indicated in GLP, however, minor modification of location of building may be done to optimize layout.

Bidder shall prepare the detailed layout of the plant facilities which are in his scope and shall submit the same for Owner's approval.

While preparing the detailed layout, planning his facilities and deciding upon the transportation and erection strategy he shall ensure the following aspects.

a) All Statutory requirements including safe distances between various facilities as per applicable rules/acts/laws including local bye-laws are met.

b) Face of the buildings and facilities are located in such a way so as to have an offset of minimum 15 to 20m with respect to center line of road.

c) The entire construction activity shall take into account the commissioning of the units in phases matching with the phased commissioning of the plant.

d) The interface requirements with the plant construction/erection activities of other contracting agencies engaged by Owner. These agencies engaged will be working simultaneously with the Bidder within the plant premises.

e) Available Area for laydown, preassembly and batching plant have been earmarked on the General Layout Plan.

f) No permanent facility shall be located within the safety zone limit around the fuel Oil storage tanks etc., except those permitted by Owner.

g) Transportation of all equipment and materials shall be by road as envisaged. Any other mode envisaged by the bidder may be proposed.

h) All parts of the buildings and facilities shall be approachable by fire tenders.

i) Main roads /peripheral roads are only shown in GLP and road layout tender drawing. Approach made of heavy-duty paving/passage to buildings/structures/facilities in the scope of bidder from nearby plant road/peripheral road/grid road/internal access road shall be provided. Multiple numbers of access to different parts of any building /facility like main plant building, control room, transformer yard, service building etc. should be provided.

j) Facilities are to be planed considering the diverted route of transmission line as shown in General Layout Plan.

4.02.00 DELETED

4.03.00 Site Levelling and Slope Protection Work

4.03.01 Complete levelling of entire plant area as shown in drawing no. 4540-001-POC-A-003 Titled ‘Site Levelling Plan’ shall be done by the Bidder. Filling in reservoir area below the bed of reservoir and for the reservoir embankment shall also be done by the Bidder. Detailed requirements for the same are specified under head 'Raw Water Reservoir' elsewhere in the specifications.

Bidder shall carry out the topographical survey before he commences detailed design and site leveling. This survey shall cover the entire plant area including the areas earmarked for administration building, ash based units, ash silos, railyard, raw water pump house & associated facilities, reservoir and the diversion drains in Bidder's scope of work. Based on field observations the contractor shall prepare and submit the survey maps of the surveyed

site on suitable scale, indicating grid lines, contour lines and demarcating all permanent features like roads, railways, water-ways, buildings, power lines, natural streams, trees etc. For each area survey maps shall be prepared and submitted, one showing the spot levels and contours with grid lines and the other showing the grid lines, contours and permanent features.

Established methods of surveying like triangulation, traversing, fly leveling etc. shall be adopted for the survey work. Spot levels shall be taken at 25 meter interval and at closer intervals where pits, undulations etc. are met with. These levels shall be taken in two orthogonal directions. Contours shall be plotted at 5m interval.

It is proposed that for the purposes of site leveling the entire plant and associated areas will be divided into various blocks as defined in the drawing no. 4540-001-POC-A-003 titled, "Site Levelling Plan". Each block shall be finished to the formation level as specified in drawing. Bidder shall deploy adequate number of experienced site leveling contracting agency(s) with requisite earth moving and compacting equipment to complete the work as per schedule.

Preparation of leveling & grading as per proposed finished ground level (FGL) is in the Bidder scope.

Bidder shall ensure that road access and drainage facilities for each block is available when site leveling in that block is completed. Unless otherwise mentioned, all roads and drains within a block shall be constructed by the bidder within a month from the date of completion of site leveling of that block.

The specified formation level(s) shall be achieved either by excavation where the existing ground levels are higher than the specified formation level or by raising by controlled filling with borrowed earth where the existing ground levels are lower than the specified level.

The excavation shall be in all types of soils or rock or a mixture of these. Bidder should assess and satisfy himself about the actual nature of soil present at site, before submitting his bid.

All natural materials arising out of site clearance and excavation shall be the property of owner. They shall be dealt with in the manner specified by the Engineer. Earth / boulders / rock etc. excavated and useful portion (serviceable materials) of trees cut shall be stacked at suitable places within Owner's acquired land for the plant including the reservoir and the ash disposal area in a manner as directed by the engineer. Woods, branches, trunks of trees shall be termed as serviceable material. Other materials like twigs, leaves, roots, vegetable and organic matters etc. shall be termed as unserviceable material and shall be sorted out from the serviceable materials before disposal. They shall be cleared from the area and disposed off at places within Owner's acquired land for the plant including the reservoir and the ash disposal area in a manner as directed by the engineer.

If the excavated material is suitable and accepted by the Engineer as fill material, the same can be used for filling in other areas were raising by filling is required. Otherwise, the same shall be taken and stacked at places(s) within the plant boundary as directed by the Engineer.

Filling with rock shall be done only after the written permission of the Engineer in the following manner:

For filling the areas involving water bodies, dewatering, removal of much, dismantling of existing slope protection of water including all other scope of work required for filling of area to be done by the bidder.

- Filling with rock shall be done only in areas identified for laydown and preassembly and ash based units.
- Maximum size of rock used for filling should not be more than 150mm in all direction.

- Original ground after removal of all organic and vegetable matters shall be consolidated by rolling as directed by the engineer subject to a minimum of six passes of 8-10 tonne roller.
- Over the compacted layer of rock (300mm), soil shall be filled in horizontal layers not exceeding 300mm in compacted thickness. The soil shall be compacted as specified elsewhere.
- It shall be ensured that the top soil layer is in minimum 3 layers of 300 mm each. To achieve this the thickness and number of rockfill layers below can be suitably adjusted.

Contour map and spot levels of the area based on the preliminary survey carried out by Owner is enclosed for the purpose of guidance of Bidder. Refer tender drawing no. "4540-999-POC-F-002". However, Owner does not lake any responsibility about the accuracy of the survey details furnished and any variation of the said data shall not constitute a valid reason for changing the terms and conditions of the contract. Bidder is requested to carry out his independent assessment of the existing ground levels before furnishing his bid. Detailed survey shall be carried out by Bidder after award of work and all findings as stated earlier shall be submitted for Owner's review.

4.03.02 All existing drains/channels in the plant and other areas associated with the plant except those proposed to be constructed by the Owner shall be suitably diverted by the Bidder before taking up any construction. These diversions shall be so designed as to ensure effective disposal of water without any accumulation or flooding within the limits of overall land acquisition line and in adjoining areas.

4.03.03 Before commencement of cutting/filling, all organic and vegetable matters like grass, plants, shrubs bushes, weeds, trees etc. in the areas to be filled, shall be completely removed along with their roots and disposed off. It shall also be ensured that the area to be filled is clear of any water, slush etc. Original ground shall be compacted by rolling as directed by the Engineer subject to a minimum of six passes of 8 to 10 tonne roller. The earth shall then be spread in horizontal layers not exceeding 300 mm in compacted thickness. Each layer shall be watered and compacted with proper moisture content and with such equipment as may be required to obtain a compaction of 95% or more of Standard Proctor's maximum dry density. The moisture content of the fill material shall be controlled to obtain near optimum moisture content during compaction. The fill material shall be tested for determining optimum moisture content and maximum dry density by Standard Proctor Test as per IS: 2720 (Part-VII). The fill material shall also be tested for determining moisture content before compaction as per IS: 2720 (Part-II). For each of the above tests, one sample for every 10,000 cubic metre of fill material shall be tested. Additional samples shall be tested, whenever there is a change in the source or type of fill material. The compacted soil shall be tested for its dry density as per IS: 2720 (Part-XXIX) or Part-XXVIII). Samples shall be taken at the rate of one sample for every 10,000 sq.m. area for each compacted layer. In addition, random checks shall be carried out in compacted soils by means of Proctor needle penetration. Bidder shall submit to the Engineer, the test results immediately after completion of the tests. A sample shall be deemed to have passed the test when the in-situ dry density is equal to or more than the specified percentage of maximum dry density. If a sample taken from a layer fails to pass the test, the layer shall be further compacted till two samples taken and tested from this layer pass without any negative deviation. Only after this. spreading of further layers shall be taken up.

4.03.04	Before start of filling, the Bidder shall submit to the Owner his proposal for the methodology to be adopted for compaction for each type of fill material. The Bidder shall also carry out compaction trials to establish the proposed methodology. The Bidder shall start the compaction work only after approval of the methodology by the Owner
4.03.05	The surface of the cut/filled up areas after reaching final level shall be dressed to the required levels and slopes. The difference in levels shall not be more than +/- 10cm locally.
4.03.06	The borrow areas outside the overall plant boundary limits for obtaining suitable fill material which is required over and above the earth available after cutting high grounds within the plant area, for site levelling shall be arranged by the Bidder himself and all expenses in respect of royalties, taxes, duties, etc. for borrow areas/fill material shall be borne by him. He shall also obtain and submit to the Owner the necessary clearances/permission from the concerned authorities for the borrow areas/fill material.
4.03.07	Material suitable for filling shall be loaded and transported to the filling site by the Bidder. Any coarse grained or fine grained low plastic soil, free from shingle, salts, organic matter, sod or any other foreign substances, may be used for filling. The Bidder shall test the fill material to establish its suitability and submit its results to the Owner. Fill material shall be approved by the Owner. The following types of materials shall not be used for filling: a) Material from swamps, marshes and bogs. b) Expansive clays c) Peat, logs, stumps, sod and perishable materials. d) Materials susceptible to combustion e) Any material or industrial and domestic produce which will adversely affect other materials in the work. a) Materials from prohibited areas
4.03.08	Bidder shall include in his offer any extra filling that may be required on account of subsidence of the original ground due to overburden of filling above and/or compaction works for site levelling.
4.03.09	After levelling, the contractor shall establish concrete pillars at the intersection points of the grid lines for future reference. These pillars shall project at least 450 mm above the formation level and shall be labelled permanently with their respective coordinates and reduced levels.
4.03.10	Filling upto the specified formation level shall extend at least 2.0 m beyond the outside face of boundary wall/fence. Thereafter, it shall be finished at a suitable slope (not steeper than 1 Vertical: 2 Horizontal).
4.03.11	For site levelling of railway siding area (as marked in site levelling drawing) shall also comply to Railway Design & Standards Organisation (RDSO) guidelines.

D-1-5 **SALIENT FEATURES & DESIGN CONCEPT**

This section of specification covers salient features and design concepts of Civil, Structural and architectural works pertaining to Power Plant components as detailed below.

5.01.00 **Architectural Concepts &Design:**

a) All the Architectural design works shall be carried out by professionally qualified architects having adequate experience (minimum five years) in the design and detailing of architectural work of power plant buildings. Bidder may have in-house Architects with the required experience for the above or engage Architect Consultant having similar experience.

b) Power plant buildings shall be architecturally treated, based on functional requirements, in such a way that they retain the desired scale, and present a pleasing composition of mass and void. The overall impact of the buildings shall be one of aesthetically unified architectural treatment having a comprehendible scale, blending colour scheme with the surroundings.

c) All buildings and structures shall be architecturally treated in such a way so as to be in complete harmony with the main plant building, surrounding structures and environment. Due considerations shall be given to orientation, landscape design, and interior design. All finishes for floors, walls, ceiling, structural elements, partitions for offices and industrial areas shall be suitable for their aesthetics, durability and functional requirements and shall include the latest building material & technology. Consideration shall be given for achieving standardization & fast track construction.

d) Overall colour scheme of the buildings shall be designed judiciously and in a comprehensive manner taking into account the mass and void of buildings, its facade, equipment, exposed structural elements, piping, trestles, bus ducts, and other service elements. Architectural design of all power plant buildings shall be suitable for installation of photovoltaic panel on rooftop for renewable energy purpose.

e) For adequate light and ventilation, National Building Code recommendations shall be followed. All buildings having height more than 4.0 m shall have fixed glazed ventilators.

f) Architectural design of all Power Plant Building shall be suitable for installation of solar photovoltaic panels on roof tops for renewable energy purpose.

g) All the buildings shall be architecturally designed to meet the National Building Code requirement & Fire Safety Regulations.

h) All public buildings shall be designed incorporating the provision of barrier free environment for physically disabled persons.

i) All the buildings and site development including landscaping shall be designed to take care of rain water harvesting & ground water recharging. Development of rainwater harvesting scheme for the project and obtaining approval of the scheme from Central Ground water board is in bidder's scope

j) For Control Rooms, CER, UPS Charger Room area in MPH dry wall construction technology shall be incorporated. Control room shall be designed as designer control room with ACP Cladded wall paneling for housing LVS.

k) Full glass wall partition with aluminium frame over solid wall with skirting 150 mm high to be provided between CCR and CER of AHP CR, WS CR & CHP control room and MPH Control room.

l) All control room shall be provided with air lock lobby.

m) The development of green belt is not in bidder scope. However, bidder has to plan the facilities leaving the space for green belt as indicated in "General Layout Plan". In addition to that laydown areas and other vacant land of the plant will be used by owner for the development of green belt.

n) All floor areas indicated in subsequent pages shall be total floor area required.

5.02.00 **Main plant Buildings/Structures shall comprise of:**

a) Mill Bunker Building
b) Transfer Points, Conveyor Galleries & Trestles
c) Machine Foundations in Main Plant
d) Boiler Structure
e) Compressor House
f) ESP Structure
g) ESP Control Building
h) Pipe & Cable Gallery
i) Main Power House
j) Service Building

The, Main Power House, Bunker building, transfer points, conveyor galleries and trestles, boiler supporting structure, compressor house, ESP supporting structures including inlet and exhaust duct support structures, Pipe cable Galleries & trestles shall have structural steel framed super structure.

All other buildings may have either RCC or structural steel framework.

Brief description of the above mentioned Main Plant Buildings is furnished herein:

5.02.01 **Mill and Bunker building**

i. Salient Features

The mill bunker building shall house coal mills, feeders, Cylindrical Coal Bunker & Conical Hopper, Tripper Conveyor & its drive and monorails. All columns, main beams and secondary beams shall be made of structural steel. The RCC floor slabs (supporting the Feeder and Tripper Conveyors) shall comprise RCC slab supported on profiled metal deck sheet (to be used as permanent shuttering) not to be considered for design of RCC slab as composite slab) and shear anchor studs welded to the top flange plate of secondary & main structural steel beams, (which supports the RCC slab & metal deck sheet).

Bidder shall integrate the Mill & Bunker Building with boiler supporting structure.

Foundation for trestles and pedestal foundations, for supporting the pipes, shall be provided wherever required, at appropriate spacing. At pipe bends, necessary thrust resisting arrangement shall be provided.

The entire fuel Oil Handing area shall be fenced all round with minimum 1.50m high metal fencing with provision for gates at key locations.

Seismic design shall be carried out for the Fuel Oil Storage Tank foundation, Fuel Oil Unloading Pump House & the Oil water separator.

5.12.06 **Architectural Features of Fuel Oil Handling Buildings**

Spaces for Pump Rooms, MCC Rooms, Control Rooms etc. shall be provided as per functional requirement. One Toilet block with drinking water facility shall be provided in each building.

External finishing shall be of Premium Acrylic Smooth Paint with Silicone additives over suitable primer of water proof cement.

5.13.00 AREA PAVING

RCC paving of minimum 150 mm thick with M25 grade concrete, over an under bed as specified herein shall be provided for areas mentioned below. RCC paving shall be designed as rigid reinforced concrete pavement for the crane/ vehicular/ equipment movement loads which the paving has to bear. The under bed for paving shall consist of preparation and consolidation of sub-grade to the required level, laying of stone soling of 200mm compacted thickness for normal duty paving and 400mm compacted thickness for heavy duty paving with 63 mm and down aggregate with interstices filled with selected moorum/ non-expansive soil followed by 75 mm thick 1:4:8 PCC (1 part cement, 4 parts sand and 8 parts stone aggregate) with 40 mm nominal size aggregate. For normal duty paving, reinforcement of the RCC paving shall consist of minimum 8mm diameter bars @ 200 mm c / c in both directions at the centre of the slab. For heavy duty paving/ passage, reinforcement of the RCC paving shall consist of minimum 10mm diameter bars @ 200 mm c / c in both directions at the centre of the slab.

Paving areas shall be provided with the metallic hardener floor finish as specified elsewhere in the specification.

Passages shall be provided inside the main plant block connecting to the outer periphery road to have access to the various facilities/buildings. These passage areas shall be provided with heavy duty paving for movement of heavy vehicles. The top surface of the passages shall be finished with 50 mm thick metallic hardener topping. Heavy duty paving shall also be provided for the areas in the complete Mill bunker building and handling areas for PA/FD/ID fans with 50 mm thick metallic hardener topping.

Ground floor area in the boiler shall be provided with normal duty paving and shall be finished with 50 mm thick metallic hardener topping.

Ground floor area in the ESP envelope shall be provided with normal duty paving with neat cement punning. Wherever paving is envisaged to be provided, RCC paving shall be provided. However, corridors below trestle where no traffic movement is envisaged and in the area over the buried fire water pipes shall be provided with interlocking concrete blocks of minimum M35 grade and minimum 80 mm thickness underlain by 20mm thick layer of sand followed by 200mm thick 63 mm and down aggregate with interstices filled with selected moorum/ non-expansive soil.

All other areas inside the Main plant block shall be provided with normal duty paving without metallic hardener topping.

Suitable open RCC drains shall be provided to dispose off storm water drain. Separate open RCC drains shall be provided to dispose off floor wash and plant effluents into RCC sump pits. Separate RCC sump pits shall be provided for different types of effluents. The paving shall be provided with slope of 1:500 to dispose the surface water/wash water to the nearest drain. All drains/pits shall be provided with Heavy duty electro forged GI grating cover.

Sewer lines (Cast Iron), interconnected by sewer manholes (RCC) at regular intervals (not exceeding 30 meter centre to centre) shall be provided to dispose off sewage from main plant block.

For the purpose of area paving, Main plant block is defined as the entire area enclosed between peripheral roads encompassing the Transformer yard area, Main Plant Building area, Service Building area, Boiler area, ESP area, Chimney area & FGD area.

5.13.01 **Ground Floor Slab of Buildings**

In all buildings including main plant building, the ground floor slab shall consist of minimum 150mm thick RCC M25 grade base slab over an under bed as specified below. The under bed for ground floor slab shall consist of 75mm thick 1:4:8 PCC on stone soling of 200mm compacted thick with 63 mm and down aggregate with interstices filled with well graded selected sand/ moorum/ non-expansive soil on compacted and dressed sub - grade. Reinforcement for the slab shall consist of minimum 8mm diameter bars @ 200 mm c/c at top & bottom of the slab in both directions. However, at passages, unloading & maintenance bays, stone soiling of minimum 400mm thick and minimum 10mm diameter bars @ 200 mm c/c at top and bottom in both directions shall be provided.

Further, top surface of ground floor slabs shall be finished with 50mm thick metallic hardener topping.

5.13.02 **Civil Works for Fire Detection & Protection System in Ground Floor/ Paving**

Fire water pipes shall be provided with either RCC trench/buried underground/on pedastal.

Fire water trenches shall be open RCC type trench with removable RCC cover. RCC valve pit alongside trenches and RCC fire trenches crossing drains shall also be provided as per requirement.

Interlocking concrete block paving shall be provided over the buried fire water pipes as specified elsewhere in the specification.

At road/ drain crossings, NP3 class hume pipe encased in RCC shall be provided as per requirement at a depth of minimum 1m from FGL for routing of fire water pipes.

In case of rail crossings, NP4 class hume pipe encased in RCC shall be used instead of NP3 class hume pipe.

Each of the outdoor deluge valve and accessories shall be provided with housing comprising of Brick wall and RCC roof.

5.14.00 GATE COMPLEX

The Gate Complex shall comprise two (2) mild steel vehicle entry gates of minimum 8.0m width and height 3.0m and shall be electrically operated. Minimum one room for security personnel shall be located at each end of the gates.

Two (2) separate mild steel pedestrian gates minimum 3.0m high and 3.0m wide shall be provided at each end.

Gate Complex shall include Central Industrial Security Force (CISF) building. The CISF Building shall be a two (2) storied RCC super structure with office complex in ground floor & first floor. The building shall be constructed with 250mm thick brick wall with provisions for doors, windows & ventilators. The first floor shall also have a viewing gallery. The floor area and architectural details shall be as per the Arch spec. mentioned hereafter in this Specification.

Design Concept:

The CISF building shall be designed as moment resisting sway frame in both orthogonal directions and shall be designed as per IS: 456, IS: 1893 and IS: 13920 (for seismic ductility requirement) and as per design criteria mentioned hereafter in this specification.

Architectural Features

The CISF Building shall be 2-storied building. It shall be of RCC Frame structure & brick masonry. The floor area of this building shall be minimum 700 sq m. Gate Complex Building shall be designed based on Tender drawing incorporating local architectural features.

The Gate Complex shall have sufficient no: of guards rooms to regulate movement of men and material and overall security, using latest modern technology like turnstile type/ boom type access control with magnetic cards and close circuit TV sets, computerized time and security office, etc shall be made. For any other gate provided for entry or exit, provision for a suitable small security hut/shed shall be made.

Space provision for CISF personal staff, time office including time machine, reception, lounge, Arms store, Detention Room, Conference room, Toilets and pantry shall be provided as per functional requirement including toilets for Ladies, Gents, physically handicapped.

The provision for covered parking shall be made for 20 nos. Cars (23 sq.m./car including driveway) and 20 nos. Scooters (5 sq.m./Scooter).

In addition to above, provision for space for open parking for 5 trucks, &20 cycles shall be made.

5.15.00 WATCH TOWERS

Watch Towers shall be RCC construction with all-weather enclosure at 6M height. Watch Towers shall be provided at 600 m interval along the Boundary as well as at corner turning points of the plant boundary. Watch Towers shall be provided with caged MS ladders.

5.16.00 SAFETY PARK BUILDING

Safety park shall be one storey building and as per the tender drawing.

5.17.00 NATURAL DRAUGHT COOLING TOWER (NDCT)

The civil works for cooling towers are related mainly to following areas, but not limited to:

The design and construction of reinforced concrete double curvature hyperbolic shell, raker columns, ring beams, foundations including piling work (if applicable, vertical/ raker piles), cold water basin with partition walls, hot water ducts, drain sumps, external drain chamber with associated pipe work, cold water discharge channels for each cooling towers (as specified elsewhere) along with trash rack & stop-log gate and its lifting arrangement, hoists and monorails, primary and secondary hot water distribution troughs, fill support systems including columns & beams, testing of cold water basin for water tightness, external stairs, ladders, platforms, walkways as specified or required for operation and maintenance, access doors, Two (2) numbers Pultruded FRP staircase for approach to hot water distribution level of each cooling tower. RCC Paved walkway of minimum 10 m clear width all around the periphery of each cooling tower, Doors and suitable permanent walkways for access into distribution system, drift eliminator and fill packs shall be provided for each cooling tower, Pultruded FRP handrails, steel fittings/fixtures/inserts including fabrication, galvanizing and erection of associated steel work, providing protective measures in concrete and steel materials against effects of chemicals on the completed structure etc. all complete as per specifications, drawings and directions of Engineer. Wind tunnel model test for Natural Draught Cooling Tower shall be carried out by the bidder as per technical specifications. Any other works not mentioned herein, but sufficiently implied and are necessary for completion and proper functioning of the cooling tower.

5.17.01 **GENERAL DESIGN CRITERIA**

5.17.01.01

Loading

The following loads shall be considered for the design of cooling towers

a) Dead Loads

b) Wind loads

c) Earthquake forces

d) Loads due to temperature and shrinkage effects. Temperature effects due to solar radiation shall also be considered.

e) Construction load.

f) Foundation settlement etc.

g) Any other load likely to come on cooling tower.

A. Dead Load

All other dead loads shall be assessed in accordance with relevant codal provision. Dead load shall include the self weight of structure, weight of fill material, weight due to algae growth & salt deposit , weight due to plugging/chocking of fills, weight of falling water, weight of hot water pipe, weight of water in hot water channel and distribution system including the self weight of channel and distribution system, weight of drift eliminators, etc.

Secondary stresses, if any, due to permanent fixtures on the shell shall also be considered.

B. Wind Pressure

The wind pressure on the towers shall be assessed on theoretical basis as well as with the help of Model tests in a wind tunnel of turbulent boundary layer.

All the theoretical methods outlined hereunder for estimating wind loads on cooling tower shell shall be valid only if the towers spaced at clear distance of greater than 0.5 times the base diameter at the finished graded ground level. The theoretical method outlined herein forms the basis only for assessing lowest limit of wind forces and shell structure interaction.

For conducting Model tests, bidders should survey the whole terrain and make their own assessment of likely critical wind forces & wind-structure interaction. It is pertinent to note that at the project the general topography of the area is uneven with adjacent existing/proposed plant structures of comparable height, and other natural topographical features are present in the vicinity of the plant area. Such model tests shall also include all adjacent topographical features, buildings and other structures which are likely to influence the wind load pattern on the tower significantly including all tall structures/NDCTs/chimneys of earlier stages of project (If applicable). The model test shall be carried out in a well reputed institute/testing laboratory after obtaining prior approval from the owner. The testing agency selected by the bidder shall have requisite experience and should have successfully carried out tests in the past for atleast one cooling tower of similar capacity. The model tests shall be duly witnessed and approved by the Engineer. The model test results shall be made available before final approval of the design.

The complete cooling tower shall be designed for all possible wind directions and on the basis of worst load conditions as obtained from Model test and theoretical methods.

Under the theoretical method, the circumferential net-wind-pressure distribution and wind pressure coefficient (p1) for the tower shell (without Meridional ribs) shall be obtained from the "Criteria for Structural design of Reinforced concrete Natural Draft Cooling Towers" IS: 11504. The above circumferential net wind pressure coefficient (p1) shall be increased by multiplying it by 1.43 to account for turbulence in the incident wind and load intensification due to turbulence induced by the adjacent cooling tower or the other structures of significant dimensions. Therefore, the actual design circumferential net wind pressure coefficient (p) shall

be computed as p=1.43 multiplied to (p1), where (p1) is the wind pressure coefficient as per IS: 11504.

This design net pressure coefficient (p) and the distribution along the circumference of tower shall be used at all heights of the tower. The above design net pressure coefficient (p) includes the effect of internal suction.

In order to compute the quasi-static design wind pressure at a given height along the circumference of the tower, the design net pressure coefficient (p) shall be multiplied by the wind pressure acting at that height [P(z)]. For details, reference shall be made to "Criteria for Wind Resistant Design of Structures and Equipments" placed under Annexure-II of this sub-section.

The wind pressure at a given height [P(z)] shall be computed as per the stipulations of IS:875 (PART 3).The bidder shall also compute the wind pressure (pz) along the wind direction by Gust Factor (GF) or Gust effective factor method (GEF). Method for estimating the wind load on the tower and other elements, shall be based on IS-875 (part-3). While calculating the gust factor, the term `b' shall be taken as the diameter of the throat in Fig. 10 of IS:875 (Part-3).

Dynamic effects on the tower due to wind action shall also be investigated to ascertain the wind induced oscillation such as ovalling and excitation along and across the wind direction. Bidder shall carry out detailed analysis for the tower and consider the worst combination of static and dynamic effects.

Design of the tower shall satisfy quasi-static method & GEF method. In case the bidder proposes to adopt aerodynamic rough surface such as provision of meridional ribs in the cooling tower shell, the pressure coefficients as given in the VGB-BTR KUHLTUMRE GERMAN SPECIFICATIONS (latest) (structural design of cooling towers) shall be permitted. The provisions of BTR may be adopted for choosing the value of circumferential wind pressure coefficient (p1) only. The wind pressure coefficient (p1), as obtained from BTR after accounting for internal suction, shall be multiplied by a factor 1.43 to arrive at the net design pressure coefficient (p). The bidder shall furnish authorized English Translation of VGB-BTR KUHLTURME GERMAN SPECIFICATIONS (latest) for the review of the owner. All other stipulations as specified in these specifications shall be met with.

Entire analysis and designs adopted shall be fully supported with authenticated literatures/documents along with relevant references where the same has been successfully implemented.

The wind load as specified in clause 5.17.01.01 above shall be the minimum loading to be considered for analysis and design. The bidder shall also carry out the entire analysis & design on the basis of BS 4485 (latest) for smooth shell surface or BTR (latest) in case of ribbed shell surface. The design of entire tower including foundation shall be checked as per BS 4485/BTR as the case may be.

The final design shall be based on the worst case situation i.e. each element including foundation of the tower shall be designed on the basis of highest loading/ stresses computed as per above. However, the basis of wind speed shall be as per clause given Cl. 5.17.01.01 above. The loading/stresses obtained by model studies shall govern in case they show high values than the theoretical design values obtained as above.

C. Earthquake Forces

Earthquake forces shall be as per the site specific seismic study result enclosed as Annexure-I of this sub-section. The seismic analysis shall be carried out in accordance with IS: 1893 by modal analysis for the hyperbolic cooling towers or any other method as approved by the owner. The earthquake analysis of the shell and its support columns including the foundations shall be carried out by response spectrum method. For the fill supporting structures (RCC frames) response spectrum method is permitted. The modulus of elasticity for concrete shall be obtained from IS:456. All the analysis shall be carried out as per the theory of elasticity.

Entire analysis and designs adopted shall be fully supported with authenticated literatures/documents along with relevant references where the same has been successfully implemented.

D. Loads due to temperature effects

Stresses due to temperature effects:

The cooling tower shell shall be designed for stress due to axi-symmetric temperature distribution corresponding to external ambient temperature variation from 3 °C to 50 °C. However, the detailed analysis of actual thermal gradient by considering temperatures inside the tower and external ambient temperatures shall be carried out furnishing detailed references and justification for the same.

The shell shall also be checked for thermal stresses arising due to partial operation of the tower in case the operational philosophy so demands. The analysis for the stresses resulting from non-axisymmetric temperature loading shall be carried out. In such non-symmetric temperature loading, the calculation shall be based upon the operating specification. Besides, the shell shall be designed for one sided solar radiation effect also. Nevertheless an effective temperature difference of at least 25°C across the shell thickness constant over the height and following a sine functions along half the circumference shall be considered.

Entire analysis and designs adopted shall be fully supported with authenticated literatures/documents along with relevant references where the same has been successfully implemented

E. Constructional Loadings

The method of construction and the type of formwork to be used shall be decided by the bidder in advance and should be enclosed in the bids submitted. Construction loadings that may occur during execution of work shall be considered in the design of the cooling tower structure. Factors causing temporary loading may include the following depending upon the method of construction.

a) Barrowing of concrete

b) Scaffolding and formwork

c) Loads produced by anchoring devices of climbing scaffolds.

d) Hoist fixings

e) Storage of materials on scaffolding

f) Temporary access

f) Tower Crane fixings

h) Works temporarily omitted for access purposes.

Computations shall be provided to verify the stability of the shell at various levels of construction to ensure that a satisfactory margin of safety always exists during shell construction.

F. Any other load such as foundation settlement

All loads likely to act on cooling tower but not specified herein shall also be considered for the design of cooling tower structures.

In case different degrees of subsoil stiffness exist, effect of the same shall be taken into account. In such a case, for computing settlements, load distributing capacity of the shell may be considered. Differential settlement between adjacent sections of foundation shall be considered under most unfavorable load combination.

5.17.01.01.01 Load Combinations

Following minimum load combinations shall be considered for the design of cooling towers structures

A) DL + WL + SL

B) DL + SeL

C) DL + TL

D) DL + WL + TL + SL

E) DL + SeL+ TL + SL

F) 1.0 DL + 1.5 WL

Where DL = Dead Load,

WL = Wind load,

SL = Settlement Load.

SeL = Seismic Load,

TL = Thermal Load,

In addition to above, construction loads shall be duly accounted for. Under TL various types of thermal loads, as described above, shall be considered separately. Besides above load combination, other load combinations as per relevant IS codes shall also be followed.

5.17.01.02 **Tower Design Consideration**

5.17.01.02.01 **General**

(a) The complete cooling tower, including the shell, columns, ring beam and foundation, shall be structurally analyzed using a proven finite element modeling technique or an approved alternative method including validation of software used for analysis. For elastic analysis, concrete may be assumed to be uncracked, homogenous and isotropic. The design geometric profile, thickness variation and support conditions of shell shall be considered in the structural analysis.

(b) Regardless of analysis method adopted, the equilibrium checks of internal forces and external loads should be performed.

(c) Analysis based on a recognized bending theory of the elastic shells shall be adopted for the design of the tower and supporting structures.

(d) Geometric imperfections, if exceed the permissible limit, then the analysis of shell shall take into account of such imperfections and resubmitted for owner's approval.

(e) Boundary conditions shall be realistic and based on actual configuration.

(f) The magnitude of the calculated displacements should be within limits of the applied theory.

(g) A detailed dynamic analysis shall be carried out for the complete tower for seismic forces by response spectrum method.

(h) Cooling tower shall also be designed for cross wind oscillations (Wind induced vibration) if the fundamental natural frequency of the tower is less than or equal to 1 Hz. Frequency calculation for free vibration analysis shall also be furnished by bidder during detailed engineering.

5.17.01.02.02 **Size and Shape**

The base diameter, air intake opening height, tower height and throat diameter shall be determined by thermal design consideration by the bidder and submitted to Owner for approval.

As the range of possible hyperbolic shell shapes is infinite, the same shall generally conform to the following major proportions which have been extensively adopted in cooling tower constructions.

H/D=1.2 to 1.55

Where H is the total tower height above basin sill level

Hb/H = 0.75 to 0.85

Hb is the vertical distance from the throat to basin sill level and `D' is the base diameter at basin sill level. However, other proven profiles may be permitted subject to approval from the owner. Bidders shall submit along with the offer complete details of the profile, in case the profile is not within the limits stated above, and the names of the sites where such shell profiles have been successfully constructed. Notwithstanding what is stated above, the owner reserves the right to accept /reject the shell profile.

5.17.01.02.03 **Tower Shell Boundary conditions**

A. Shell Analysis and Design

The following boundary conditions shall be assumed for the design of cooling tower shell:

a) At upper Edge

The top edge of the shell shall be gradually thickened to form a ring beam to guard against possible instability of the top of the shell due to high velocity wind gusts. Top edge shall be considered as a free edge in the analysis.

The thickness transition from shell to upper ring beam shall be smooth.

b) At Lower Edge

The lower edge of the shell shall be thickened to form a lower ring beam. The thickness transition from shell to lower ring beam shall be smooth and shall be considered as an integral part of the shell. The lower boundary of the shell shall be considered as elastically supported by discrete columns.

The influence of both support structure flexibility and foundation settlement shall be considered in the analysis and design of cooling tower shell. The shell analysis should include following information at every 10^{o} plan angle and at not more than 0.05 of the shell height interval:

a) Meridional and circumferential direct stress resultants and the tangential shear stress resultants.

b) Meridional and circumferential bending moments.

c) Displacements normal to the shell mid-surface.

B. Buckling of Tower shells

Critical dynamic pressure (wind pressure), at buckling shall be as given below:

$$Pcr = 0.07\ E_c \frac{(d)^{7/3}}{r_{th}}$$

Pcr = Critical dynamic pressure.

Ec = ısticity Modulus of concrete of the shell (short term modulus)

d = Thickness of the shell

r_{th} = Throat radius of the shell

The shell buckling shall be checked using the design dynamic wind pressure and other relevant loads acting on the tower. The factor of safety against buckling shall be not less than 5 for the completed tower as well as whilst under construction.

Besides above, a buckling analysis with wind forces should be made using the theoretical tower geometry and boundary conditions, including the influence of dead weight, by the method of buckling stress state (BSS) approach in accordance with the provisions of VGB.

The buckling safety factor shall be at least 5.0 for load combinations of dead load + wind load.

When imperfections in the shell geometry are larger than specified tolerances, the analysis should be rechecked to account for such imperfections and ensure that the desired buckling capacity remains.

C. Openings in shells:

Opening through the shells should be avoided as far as possible. They should be of smallest required dimensions and shall be shaped such that stress concentration is minimized at the boundary of the opening. Should thickening of the edges be necessary, it shall be smoothly tempered back to the shell thickness.

Openings shall be provided with additional edge reinforcement of a minimum cross sectional area at each edge equal to 75% of the reinforcement intercepted by the openings in the direction parallel to the edges. In addition, diagonal reinforcement shall be provided at each comer as close as possible. The total cross-sectional area in cm^2 of this reinforcement shall be 0.5 d, at each comer where 'd' is the shell thickness in cm.

No horizontal thrust due to the inlet piping shall be transmitted to the shell.

D. Minimum Thickness of Shell (for smooth shell towers without Meridional ribs):

The minimum thickness of the NDCT shell shall not be less than **350 mm**.

E. Minimum Reinforcement in Shell, Spacing and Placement:

The Minimum reinforcement to be provided shall be as follows:

Top one third portion of shell	0.4% of concrete cross - sectional area along circumferential direction and 0.35 % of concrete cross sectional area along meridional direction.
Remaining two-third portion	0.35% of concrete cross-sectional are in both of shell meridional and circumferential directions.

Minimum bar diameter shall be 8 mm in transverse direction and 10 mm in meridional direction.

Spacing of reinforcing bars should not exceed 200 mm in circumferential direction and 250 mm in meridional direction.

The two layers of reinforcing meshes shall be adequately joined by s-hook over the total shell surface. Atleast two S-hooks in each square metre area of shell surface shall be provided. The hooks shall be of minimum 6 mm diameter bars.

The clear concrete cover to all reinforcement including links shall be 45 mm minimum which shall be ensured by suitable means and frequent quality checks. No leftovers in form of wooden pieces, plastics or any other foreign objects shall be left in concrete. All leftovers holes of scaffoldings/ shuttering or other wise shall be suitably plugged with rich cement-sand pressure grout (minimum one grade higher than concrete) and coated with epoxy paint on either surface. No binding wires wooden pieces, shuttering pieces, cement bags should be left in the concrete.

The relevant provisions of IS:2210 - "Criteria for the design of reinforced concrete shell structures and folded plates" and IS:2204 "Code of practice for construction of reinforced concrete shell roof shall also be deemed to be applicable. All other design criteria for the cooling tower shell which are not specified above shall be in accordance with BS:4485 Part 4 and BTR.

F. Provision of meridional ribs in Cooling Tower Shell

Meridional ribs in the cooling tower shell may be provided subject to the following conditions :

a) Minimum thickness of shell excluding ribs shall not be less than **350 mm**.

b) Co-efficients for pressure distribution around the cooling tower circumference including suction may be taken as per VGB-BTR KUCHLTURMEN GERMAN SPECIFICATIONS (latest) : All other factors including load intensification factors shall be as specified else where in these specifications.

c) Shell buckling and strength shall be checked as per clause-b above without considering the effect of ribs.

d) All other stipulations as specified in these specification shall be met with.

e) Bidder shall furnish an authorized English translation of the VGB-BTR KUHLTURME GERMAN SPECIFICATIONS (Latest).

5.17.01.02.04 **Raker Columns**

Inclination of the column shall closely match the meridional slope at the shell so that the load transfer to foundation takes place through predominantly axial force in columns. Raker columns shall be designed for the most critical forces transferred to an individual raker column from super-structure considering various load combination as under Cl. 5.17.01.01.01 For selecting effective length of the raker columns, following restraints shall be considered:

a) In case columns restrained at both the ends, the effective length shall be 0.8 and 0.6 times the length of the column radially and tangentially respectively.

b) In case columns are restrained at one end only, the effective length of columns shall be 0.9 and 0.7 time the length of columns radially and tangentially respectively.

c) The columns shall be designed based on working stress method except for the forces from DL+1.5 WL which shall be designed as per limit state of strength method of IS:456.

5.17.01.02.05 **Pre-stressed Concrete Members**

Design, construction and workmanship of Pre-stressed concrete, members shall be in accordance with IS:1343. Steel wire for pre-stressing shall conform to IS:1785 (Part I) or IS:6003.

Particular attention shall be paid to achieve an effective bond of the wires in pre-tensioned concrete units. For this purpose, indented wire shall be used. Wires shall be corrosion resistant for specified duty conditions.

5.17.01.02.06 **(I) Design Criteria for Structures (Other than Tower Shell foundation)**

Corresponding to load combination (A) to (E) of Cl. 5.17.01.01.01 above,

(a) The design of all liquid retaining/conveying structures of cooling tower like C.W. basin, sump, outlet channel, sludge drain, pits and pedestals for raker column shall be designed by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2) : 2009. These structures shall be designed for following conditions :-

1. Water filled inside upto the designed level and no earth outside.

2. Earth pressure plus 2.5 T / M^2 surcharge (Vertical and equivalent horizontal direction) plus ground water table at Finished Graded ground Level (FGL) outside and no water inside.

3. Hot water distribution channel/basin shall be designed by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2), considering loads such as dead load, live loads, seismic/wind load, temperature loads, water load etc. for full and empty condition.

4. The pedestals for raker columns shall also be designed for the load transferred by raker columns in addition to the above conditions.

(b) The design of all structures other than liquid retaining/conveying structures of cooling tower above Cold Water basin slab such as Raker Columns, Shell structure, fill/drift eliminator support columns, beams, walkways, slabs, partition wall, precast beams etc. shall be carried out by limit state method as outlined in Clause 4.4 of IS: 3370 (Part 2). Further, for limiting the crack width, the stress for the reinforcement steel shall be limited to 130 MPa (on all faces) as per clause 4.4.3.1 of IS: 3370 (Part 2): 2009 using the partial safety factor for serviceability condition as per clause 4.4.1.3.

(c) Wherever, the foundation raft of fill/drift eliminator support structure of cooling tower is same as Cold Water basin slab, the foundation shall be designed by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2) (all faces). However, if the fill/drift eliminator support structure foundation is not the same as the Cold Water basin slab and a separate foundation for the cooling tower is provided below the Cold Water basin slab due to founding level requirements, the Cold Water basin slab (both faces, including beams at Cold Water basin slab level) shall be designed as structural slab by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2) and the structures below Cold Water basin slab shall be designed as per IS:456. However, the size of the fill/drift eliminator support column below Cold Water basin slab upto foundation shall be maintained same as the size of the columns just above Cold Water basin slab. Under the action of horizontal forces transferred at foundation/ pile levels, the passive earth pressure generated from soil surrounding the piles/ foundation shall not be accounted for in arriving the numbers of piles for the tower shell.

(d) The design of staircase, pipe trestle foundation, and peripheral water drain shall be designed as per IS: 456 (2000).

(e) For uplift due to ground water table the Cold Water basin shall be checked against uplift for basin empty condition with ground water table at FGL. Stability against uplift shall be ensured both for construction & operating stage with no water inside. The provision of flap valve / pressure release valves is not permitted. The factor of safety against uplift shall be as per IS: 3370.

(f) Loads during construction, erection and maintenance stage shall also be considered.

(g) Temperature fluctuations from operation shall be obtained from the design data. Hot water temperature inside and cold air temperature outside shall be considered.

(h) Minimum thickness of basin slab shall be 300 mm with minimum reinforcement 0.35 % of gross sectional area in both the directions. Reinforcement shall be placed in two layers, top and bottom surface.

(i) In the space underneath the basin floor slab a layer of at least 100 mm thick P.C.C. of grade M10 shall be provided.

(j) Permissible stress for steel structures shall be as per IS:800 based on working stress.

For Load combination (F) 1.0 DL + 1.5 WL of Cl. 3.08.00 above, design of elements shall be carried out by limit state method as outlined in Clause 4.4 of IS: 3370 (Part 2).

(II) Design Criteria for Tower Shell foundation.

(a) The design of the tower shell foundation below the pedestals for raker column shall be designed for worst load combination as per clause 3.08.00 of this specification by IS:456. In case of load combination (F) DL + 1.5WL of clause 3.08.00, limit state method of design as per IS 456 shall be adopted.

(b) Foundation shall be checked for safety against overturning, sliding and uplift for all load combinations specified at clause 3.08.00. While checking stability of the structure, favorably acting loads from water fill, soil cover beyond the edge of the foundation shall be neglected. High ground water level upto final graded ground level shall be considered to take into account buoyancy effect.

(c) Generally net tension should be avoided in the foundations/piles for the shell support foundation unless specifically permitted by the Owner.

(d) While accounting for over burden of the soil for checking the foundation against up-lift, dead weight of the soil directly above the pile cap or ring raft, as the case may be, shall only be considered, neglecting the weight of soil in the cone of up-lift above the foundation. Under the action of horizontal forces transferred at foundation/ pile levels, the passive earth pressure generated from soil surrounding the piles/ foundation shall not be accounted for in arriving the numbers of piles for the tower shell.

(e) The foundation structure will be subjected to following loading and extreme load combination case shall be considered in design:

1) Most critical forces transferred from superstructure for the various load combinations.

3) Loading due to foundation settlement

4) Concentrated local loading from column nodes.

5) Thermally induced local loading where hot water ducts pass through the foundation structure without structural isolation.

6) Surcharge of 2.5 tonnes/sq. m.

C.W. basin surcharge load shall also be considered in addition to the other relevant loads for the design. No increase in permissible safe bearing capacity during wind load shall be done.

In the design of the cooling tower shell, column, pile caps, pedestals, ring beams etc. no increase in the strength with the age of the concrete shall be permitted.

5.17.01.02.07 **Water Distribution System**

The structural design of the water distribution system shall consider the worst combination of following loadings:

i) Self weight, other imposed loads and live load.

ii) Hydraulic pressures during normal operations including pressure surges.

iii) Hydraulic pressure due to mal-operation of the tower or supply pumps.

The water distribution system shall be provided with adequate pressure surge relief facilities to prevent pressure loading in excess of values used in the design. If such facilities are not provided, a further increase in loading shall be considered in the design.

The design of water distribution system and its supports shall be capable of accommodating all thermal stresses and movements due to changes in inlet water temperature and ambient temperature.

The possibility of vibrations being imposed on the distribution system shall be investigated in the design. Seismic loading on the water distribution system shall also be taken into account.

Strength check for worst loading including malfunctioning shall be carried out with stress limitations as per IS:3370. The construction shall be completely water tight without the used of fillets, sealing compounds etc. The method of construction shall be such so as to avoid excessive rise in temperature of concrete due to release of heat of hydration.

5.17.01.02.08 **Platforms, Walkways, Stairways, Staircases, Internal Grillage Etc.**

A minimum live load of 400 kg/sq.m shall be considered for the design of all platforms, Walkways, Staircases, etc. in addition to their own weight. Platforms shall be minimum 1.2 M wide and walkways shall have 1.5 M wide.

5.17.01.02.09 **Steel Structures**

These structures shall be designed, fabricated and erected as per IS:800 and other relevant Indian Standard codes for structural steel work. All steel structures shall be coated with anti-corrosive system.

5.17.01.02.10 **STOPLOG GATES AND TRASH RACK FOR COOLING TOWER**

Stoplog gates

The stoplog gate shall cover the clear opening of the cold water channel and effectively stop the water leakage. Clear size of the stoplog gates shall be equal to the clear opening size (freeboard of minimum 300mm over the maximum water level in stop log depth shall be ensured.). The capacity of the hoist (Min 2 ton capacity) shall be decided to match with provided size units of the stoplog gate. Structural design of stoplog gate shall conform to IS : 5620 and IS : 4622 (latest). Maximum water level for designing the stoplog gates shall be taken as maximum water level in the CT basin indicated in the tender drawing.

Stoplog gate and its lifting arrangement shall designed for a condition when basin is empty and water upto full level on the other side. Proper rubbers seal shall be provided in the stoplog to avoid any leakage of water. All gates shall be painted with sealed spray zinc coating conforming to BS:5493 (Table – 3, Part-8) for very long (20 or more) years of maintenance interval.

The design criteria and material specification for Stoplog gates and Trash racks shall be as specified for Circulating Water Pump House.

Leakage Tests of Stoplog Gates

Leakage tests shall be carried out with the stoplog gates lowered onto the sill. Before observation for leakage, the stoplog gate shall be raised and lowered about one meter several times in order to dislodge any debris that might have lodged in the side and bottom seals, The leakage shall then be measured and it should not be more than 5 Liters / Minute / Meter length of seal under maximum head.

5.17.01.02.11 All deliverable / drawings shall include the BOM in all submissions.

5.17.01.02.12 **FILL SUPPORT STRUCTURES**

The self weight of the fill pack support structure shall be based on the weight of the packing including weight of standing, running and dripping water in accordance with manufacturer's data.

Live load of 400 kg/sq.m on the walkways and platforms shall be considered. Hand railings shall be designed for horizontal load of 60 kg/m.

Wind deflector walls and any other structural elements shall be designed for a horizontal wind load of 80 kg/sqm. or as per manufacturer's recommendations, whichever is higher. Thermal loading shall be as per manufacturer's recommendations. Earth quake loading shall be considered based on criteria given for cooling tower. Response spectrum analysis shall be carried out.

The foundation shall be designed for the most critical forces transferred from CW basin & fill supporting structure including loadings introduced by constructional equipments and crane deployed for fill supporting structure or shell erection.

5.17.02.00 **REQUIREMENTS FOR CONSTRUCTION MATERIAL**

All concrete work for the cooling tower shall comply with the requirements given in technical specification for Cement Concrete (Plain & reinforced)

Structural concrete shall be of design mix complying with the relevant provisions of IS Codes or any International Code of Practice as approved by the owner.

Durability of the concrete shall confirm to severe exposure category as per table 19 of IS:456 except noted specifically otherwise. Minimum cement content of all RCC structures shall be 360 kg/Cu. M.

Column reinforcing bars shall be carefully anchored in the shell and foundation. The anchoring length shall not be less than 80 times the diameter of the bars.

All foundations structures shall be provided on all sides with a minimum reinforcement of 0.12 % of gross cross-sectional area distributed over top and bottom faces.

5.17.02.01 The minimum grade of concrete for structural component s of cooling towers shall be as follows in accordance with IS:456 :-

a)	Precast pre-stressed elements	-	M-35 grade
b)	Entire tower shell, columns and basin	-	M-30 grade
c)	PCC encasement	-	M-20 grade
	(Except levelling course)		
d)	Mud Mat PCC	-	M-10 grade
e)	Piles/Tower foundation	-	M-25 grade
	(with OPC/PPC/PFC)		
f)	All other RCC elements	-	M-30 grade

5.17.02.02 Coarse and fine aggregates shall be specially selected to ensure that they are not susceptible to alkali/chloride attack or prone to disintegration at high temperatures. The maximum size of coarse aggregate shall not be larger than 1/8th narrowest dimension between reinforcement bars nor more than 20 mm.

5.17.02.03 Washing and screening of coarse and fine aggregates to remove fines, dirt or other deleterious materials shall be carried out by approved means if desired by the Engineer-in-Charge.

5.17.02.04 The water cement ratio by weight shall be as given in IS:456 for severe exposure conditions including free moisture in the aggregates, and slump should be suitably decided to provide good quality concrete work.

5.17.03.00 **REQUIREMENTS FOR STAGING AND FORMS**

5.17.03.01 Automatic Climbform scaffolding system or Jumpforms shall be used for tower shell construction. Slipform with proven record for similar towers may used subject to specific

	approval of Owner. The design and detailed construction of the form work and the scaffolding system shall be based on the relevant IS code/International Code. In absence of the same, DIN 4420/ACT 347 shall be followed. Realistic loads shall be considered for platforms with regard to the classification of scaffolding system used. For material transport, it shall be designed by accounting for all transportation loads. The connection between individual scaffolding units shall be made in such a way that in case of collapse of one unit, the adjoining units are not affected. Scaffolding system should have atleast two independent safety measures against collapse. Concrete shall have sufficient strength to withstand the anchoring loads of scaffolding system. The concrete strength shall be continuously checked and documented during the climbing process of the scaffolding.
5.17.03.02	Bidder shall prepare at his own cost, detailed scheme, design calculations. detailed working drawings showing all details of form work, staging, scaffolding, member section, connection details and other arrangements for the concreting work and submit the same for approval within one (1) month from the award. Only on receipt of the approval by the Engineer the work shall be taken up. However approval of the same by Engineer in no way relieves the Bidder of his responsibility for the proper functioning and safe working of the scaffolding system.
5.17.03.03	**Hoisting for Personnel** The arrangement and method of raising and lowering of personnel, concrete, reinforcement and other materials to various levels for the cooling tower shell shall also be detailed by contractor. Details of equipment and procedure shall be submitted for information to the Engineer by the Bidder.
5.17.03.05.01	For shuttering, following provisions shall be complied with: a) Self weight of (scaffold + platforms) + minimum superimposed load of 370 kg/m^2 on total working platform areas at various levels. b) Self weight of (scaffold + platforms) + minimum superimposed load of 50% of 370 kg/m^2 on total working platform area at various levels + earthquake loads. c) Self weight of (scaffold + platforms) + superimposed load of 370 kg/m^2 on total working platform areas at various levels + wind load. For load combination (a) above, no increase in the permissible stresses shall be allowed. For load combinations (b) and (c) above increase of 33.3% in permissible stresses shall be permitted.
5.17.03.05.02	Design and execution of form work, stagings, shutterings and scaffolding shall conform to National Safety Council and all relevant IS Code provisions, i.e. IS 2750, IS:4014, IS:4923, IS:800 etc. In case the IS Codes do not cover the specific type of shuttering system, then any International Code of Practice, as approved by the Engineer, may be followed.
5.17.03.05.03	Notwithstanding the stipulations contained in various codes, safe slenderness ratio shall be determined as follows: a) Vertical members: Effective length shall be taken equal to the maximum distance between consecutive horizontal runners in any plane. b) Horizontal and diagonal member: Effective length shall be taken equal to centre to centre distance between two nodes
5.17.03.05.04	If the support from shell for scaffolds are to be taken, following provisions shall be adhered to:

	a) Members connecting/joining scaffolds with shell shall act as propping supports. Use of pre-tensioned or pre-compressed members for propping action shall not be permitted under any circumstances. Connection of propping members with shell shall be designed complying with the above stated requirements.
	b) All prop supports shall be taken at nodal points of scaffolds only.
5.17.03.05.05	Splicing joints in vertical pipes shall be such that the joints shall be rigid and the entire cross section area of the pipe takes part in load transference.
5.17.03.05.06	Special inspection hoist shall be provided by the Contractor for regular inspection. The hoist should be so placed that the inspection, checking of scaffolding members, joints etc. are easily carried out. Regular check at every fortnight of the joints and other elements of scaffolds shall be carried out by the Contractor along with representatives of the Engineer. Detailed inspection record shall be maintained by the Contractor and same shall be produced to the Engineer wherever required.
5.17.03.05.07	For design of structural members, IS:800 shall be complied with.
5.17.03.05.08	Not withstanding the approval from Engineer, the Contractor and his collaborator will be solely responsible for the safety, security, functioning proper functioning and the speed of the construction work.
5.17.03.05.09	The formwork for shell shall be capable of adjusting to shell profile and thickness accurately, and shall be rigidly braced to prevent deflection or movement during concreting.
5.17.03.05.10	Forms shall be designed to produce hardened concrete having the shape, lines and dimensions indicated on the drawings. Forms shall be constructed and maintained in proper position and accurate alignment. Accurate alignment shall include maintaining hyperbolic shape, round cross section, and plumbness of concrete shell.
5.17.03.05.11	Forms shall maintain vertical alignment of form seam marks. Forms for the exterior of the shell shall produce surfaces having a smooth uniform appearance.
5.17.03.05.12	Forms shall be specially designed and installed so as to prevent leakage of mortar, produce a smooth exterior surface, and permit removal without injury to the adjoining work.
5.17.03.05.13	The insides of the forms shall be coated with an approved non-staining parting agent that will not impair the blend coatings. The Contractor shall ensure that the parting agent is not applied to the reinforcement.
5.17.03.05.14	Forms shall not be removed until the concrete has adequately hardened and attained sufficient strength to maintain its shape with no spalling and to support safely its own weight together with any construction loads likely to be imposed.
5.17.03.05.15	All details of formwork staging, placing, tying etc.; shall be subject to the approval of the Engineer and the Contractor shall submit drawings, when required, showing details of procedure of construction. Contractor shall be responsible for the adequacy of the form work to withstand the pressure of freshly placed concrete or other loads imposed without, movement or deflection of the parts.
5.17.03.05.16	For concrete surfaces that are exposed to view and for all other concrete surfaces that are to be finished smooth, the lining of forms shall be of smooth non-absorbent lining material. All edges of panels shall be square and straight in both directions and all panels shall match perfectly in length, width and alignment as required.
5.17.03.05.17	Minimum time of form work shall be approved by the Engineer for RCC shell depending upon weather conditions, quality of cement, etc.
5.17.03.05.18	Outer ends of the permanently embedded portions of form ties shall be at least 25 mm recessed from the adjacent outer concrete faces.
5.17.03.05.19	All MS embedments in concrete shall have anti-corrosive treatment as per Tech. Spec.

5.17.03.05.20 All temporary construction facilities such as office, warehouse tool room storage shed, casting yard etc. required by the Contractor shall be constructed by the contractor within the area allocated by Engineer at no extra cost to the Owner.

5.17.04.00 **Setting out of the shell**

Survey of absolute position of the shell shall be carried out using the following method:

The shell shutters of known radius shall be accurately located through the peg at the base of the tower using a special optical plumb. The optical plumb shall be installed permanently inside of the tower by the bidder. The plumbing of the ring shall be checked at least once per day and shall not be left in the same position for more than four consecutive lifts. The tape used shall be fitted with a spring balance and constant pull of not less than 10 kg shall be applied while reading the tape. No taping shall be undertaken during high wind conditions.

5.17.04.01 Deployment of vertical laser-ray equipment for measuring the dimensions and controlling the shape of the tower at all elevations and plan angles shall be carried out.

Measurements shall be taken by vertical laser-ray technique at different points along the circumference of the tower (number of such points shall be approved by the Engineer depending upon the formwork system used) for each lift before placing the concrete and again after concreting.

Wherever required adjustments shall be made through spindling of the formwork. The intermediate points between two laser measuring points shall be chord measured i.e. the gauges are measured off a chord taut string. The measurements shall be taken of the inner form work. The outer formwork shall be aligned accordingly.

All measuring points on the shell and the chord gauges shall be predetermined by the contractor and got approved by the Engineer. Depending on the number of laser measuring points, a corresponding number of radial lines on the concrete floor shall be provided and reference points shall be marked for the purpose of placing the laser device. The perpendicular shall be checked once in a week or earlier, as required by the Engineer, from outside points.

5.17.04.02 Tolerances for the cooling tower construction shall be in accordance with the following:

i) Shell wall center line in horizontal plane measured radially at mid point on a 3m wide chord : +/- 15 mm

ii) Shell wall centre line in meridional plane measured over a height of 1m

: +/- 10 mm

iii) Shell thickness : + 10 mm or- 5 mm

iv) Horizontal radius of shell at any section other than shell base :

+/- 50 mm

v) Horizontal radius at shell base : +/- 40 mm

Checking of shell geometry

Check for absolute positions may be carried out from ground stations arranged at not more than 10 degree plan angle apart. Readings of horizontal radius shall be taken at every 6 m height or weekly during construction period whichever is more frequent.

If the permissible dimensional tolerance are exceeded, the Engineer will instruct the contractor, in writing, to stop construction of the shell. The Contractor shall then examine the situation and submit a report to the Engineer who may require the contractor to demonstrate by calculations that the structural integrity of the shell will not be impaired as a result of the imperfections. The calculations shall be submitted to the Engineer, for approval, before construction will be permitted to proceed.

If in the opinion, of the engineer the calculations show that the integrity of the shell could be threatened, the Contractor will be required to submit to the Engineer detailed arrangement and supporting calculations to set right the shell geometry for approval, before construction will be permitted to Proceed.

The cost of carrying out the calculation, any remedial work required and idle time or any delays to the construction programme as a result of dimensional tolerances being exceeded will be borne by the contractor.

Adjustment to the tower shell line on the basis of the survey results shall be made gradually, limiting the maximum change of direction from the existing vertical shell profile to be not more than an angular change of 10 mm measured over 1 m of height. Any such adjustment shall be made with full knowledge and consent of the Engineer.

5.17.04.03 The Contractor shall carry out an as-built-survey of each lift of the shell. The results of these checks will be recorded on a suitably developed drawing of the shell from which it will be possible to locate the survey check point. A copy of these results will be presented to the Engineer prior to commencing the next shell pour.

5.17.04.04 The Contractor's shell construction procedures shall include for providing the Engineer with the facilities and a reasonable time period as may be required to carry out an independent check of the completed works.

5.17.04.05 Suitable communication system such as telephone, wireless equipments, etc. shall be provided by the contractor so that the communications are possible at different elevations of the tower from the ground during construction.

5.17.05.00 **GENERAL REQUIREMENTS**

5.17.05.01

i) In case the basin slab is divided, the same shall be divided into two equal parts by a partition wall designed to withstand full hydrostatic pressure, with one side empty. The basin construction joints shall be made watertight by injection of chemical grout through nipples. The basin construction shall be tested for water tightness, in accordance with IS:3370 (Part-1) (Latest edition). The cost of the test and any rectification and re-test if required is deemed to be included in the Contractor's quoted price. Any cost of filling and emptying of the basin and to rectify defects shall also be borne by the Contractor.

(ii) PVC ribbed water stops with central bulb shall be used where expansion joints are envisaged. The minimum thickness of PVC ribbed water stops with central bulb will be 10 mm and minimum width 230 mm.

(iii) The basin floor of each compartment shall be provided with a slope of not less than 1 in 120 towards a peripheral drain of minimum width 500mm and minimum depth of 500mm at the starting point running along the periphery of the cold water basin. Further, this drain shall be sloped 1 in 500 towards collecting sump as indicated elsewhere in the specification. From sump, the water will be drained by. C.I. drain pipe, embedded below the basin floor, into a drain chamber outside the tower basin or as per the arrangements described elsewhere in the tender document. Suitable operating platform with access ladders for operating the gate valve(s) shall be provided in the drain chamber.

(iv) A 250 mm high sill shall separate the pond floor from the tower outlet.

(v) Uniform surface on the top of basin floor shall be provided. In case undulated surface is observed, a top of layer of minimum 25 mm thick 1:3 mix mortar to be provided to achieve uniform surface.

(vi) The level of top of basin wall shall be kept at least 300 mm higher than the top surface of paving outside the cooling tower.

5.17.05.02 A screed or concrete layer not less than 100 m a thick of concrete grade M10 conforming to IS:456 shall be provided below the cold water basin and other liquid retaining structures.

Lean concrete below other foundations and underground structures, unless noted otherwise, shall be of concrete grade M10 (with aggregate of nominal size 40 mm maximum) and shall be at least 75 mm thick.

5.17.05.03 This specification envisage following anti-corrosive measures for various concrete structures and elements of the cooling tower:

All inside concrete surfaces of CW basin floor/slab, walls and interior surfaces of hot water distribution ducts/basin including inside surfaces of CW channel and sludge pit shall receive High Performance Moisture Compatible Corrosion Resistant Coating System. The detailed specification of High Performance Moisture Compatible Corrosion Resistant Coating System on concrete surfaces is given in Annexure-M.

5.17.05.04 Exterior surfaces of cooling tower shell and all surfaces of raker columns shall be given three coats of waterproof cement paint of approved make and colour. No painting is envisaged for internal surfaces of cooling tower shell and internal grillage columns and beams.

5.17.05.05 Water proofing and plasticizer admixtures conforming to relevant IS Codes may be added as per manufacturer's instruction to the concrete subject to approval of the Owner.

5.17.05.06 All mild steel parts of structures including embedments shall be hot dip galvanized. The minimum coating shall be 610 gm/sq.m and shall comply with relevant IS Codes. Galvanizing shall be checked and tested in accordance with IS:2629. All welding shall be done before galvanizing. Any site joints required to be carried out after galvanizing shall be either flanged or screwed joints. Nails, nuts, bolts and all components coming in direct contact with water shall be of stainless steel of AISI 304 or equivalent.

5.17.05.07

(i) The tower shall be provided with two numbers external FRP Staircase, leading to a heavy duty door giving access to the distribution system. Staircase shall be minimum 1000 mm wide (clear), with landings of minimum width of 1000 mm at not more than 2500 mm height intervals unless approved otherwise. The steps shall have a rise of about 175 mm and tread of about 250 mm. Anti - skid nosing at each step shall be provided.

(ii) Minimum size of all doors shall be 2100 mm high (clear) and 1200 mm wide (clear). The door shall be of FRP material. The door shall be air tight when closed.

(iii) The hand railing on both sides of the staircase shall be FRP and shall have rails spaced not more than 1200mm centers. The top hand rail shall be at 1000 mm above the steps. Safety kerbs/toe plate with 100 mm (minimum) width shall be provided along each edge.

(v) In case the hot water pipes of cooling tower are extended upto inner surface of shell, they shall be supported over the RCC brackets which are cast integral with the shell. Alternatively, these brackets and its fixing bolting arrangement shall be of stainless steel SS316L grade to ensure trouble free operation.

5.17.05.08 Walkways and platforms, atleast two in each orthogonal direction, shall be provided inside the tower at distribution pipe level. walkways shall be at least 1000mm wide with 50 mm (minimum) safety kerbs along each edge. These walkways and platforms shall provide safe and clear access to all sprayers and all distribution pipes. A FRP platform of 1500 mm clear width shall be provided around the tower periphery which will be a means of access to next walkways and all end valves. Access ways shall be clear of all obstructions such as distribution pipe support beams, drift eliminator support beams, etc. The walkways shall be provided with transverse slots or other opening which will permit the free passage of air and water.

FRP handrails shall be provided on all sides of over ground platforms and around hot water basin and cold water outlet.

5.17.05.09	Platforms of size 1.5m x 1.5m clear dimensions shall be provided on the cooling tower for maintenance of aviation warning lights at levels specified elsewhere. At least two (2) diametrically opposite galvanized MS caged ladders, 600 mm wide, made out of 6 mm x 10 mm flats for full height of the tower shall be provided. Additional cage ladders for access to aviation obstruction lights at intermediate levels shall be provided at required locations upto the required height. Galvanization shall be provided for all MS components of ladder & caging as per specifications. All fastening bolts and anchor fasteners shall also be of galvanized finish. The ladder shall have 20 mm dia rungs at 300 mm centers, with stays at every 2250 mm, connected to the concrete shell and galvanized M.S. caging consisting of 50 mm x 70 mm vertical cage flats on the exterior surface of each cooling tower. The caged ladder shall be provided with intermediate landing of 1000 x 1200 mm wide at every 4500 mm height interval and further, the ladder shall be staggered at each such landing by a horizontal distance of 600 mm to avoid continuous climb. Some of the landing levels shall be suitably adjusted to give access to aviation warning beacons for maintenance. Handrails as described above, shall be provided on all platforms and landings. The ladder leading to the top platform shall have approach form the ground via the FRP staircase.
5.17.05.10	Steel gratings, where required, shall be fabricated out of steel flats with minimum thickness of 6 mm. Thickness of fabricated grating shall be 32 mm with flats so arranged as to have a maximum opening of 25 mm or less. Treads for staircases, where needed, shall be of similar grating construction but provided with toe flats of 6 mm thick, and non-skid nosing in an approved manner extending upto 100 mm above the walkway surface.
5.17.05.11	The finished ground level shall be paved for 10.0 Meter width all-round the outer edge of the cold water basin. The paving shall consist of 150 thick RCC slab of M-25 grade. The minimum reinforcement shall be 10 mm dia spaced 150 mm centre to centre both ways top and bottom. The RCC slab shall be laid over 75 mm thick PCC and 500mm well compacted layer of crushed hard stone aggregates (63mm to 45mm) with interstices filled with sand. A RCC peripheral drain on outer periphery of paving around cooling tower basin shall be provided to collect the water loss due to wind gust and shall be connected to nearest main plant drain.
5.17.05.12	Mild Steel Hot Dip Galvanized (610gm/sq-m) fixtures shall be erected on top ring beam of shell to facilitate future maintenance of interior and exterior of shell. The details and minimum requirements are stipulated in tender drawings. The entire assembly shall be checked for a minimum vertical load of 1500kg. The minimum thickness of plates for fixtures shall be 16mm.
5.18.00	**CW SYSTEM, RAW WATER SYSTEM AND MAKE-UP WATER SYSTEM CIVIL WORKS**
5.18.01	**Circulating Water Pump House (CWPH), Raw Water Pump House (RWPH) and Make-up water Pump House (MUWPH)**
5.18.01.01	A circulating water pump house (CWPH) for housing circulating water pumps and Raw water pump house (RWPH) for housing raw water pumps shall be provided. Separate bays shall be provided for each pump by providing intermediate dividing piers of RCC between the pumps. a) The pump houses shall be provided with minimum two sets of stop-logs for each opening sizes along with electrically operated hoisting arrangements. Steel embedments required for stop-logs shall be provided for all the bays. b) All bays of pump houses shall be provided with a removable trash rack including electrically operated hoisting arrangements and cleaning arrangements. Moreover, one spare trash rack for each opening sizes shall also be supplied. Steel embedments required for trash-racks shall be provided for all the bays. c) Stop-logs, trash-racks and hoists shall be supplied in accordance with the specifications covered elsewhere.

shall be carried out to ensure proper separation of natural frequency of the structure and pump operating frequency

5.18.01.05 **C.W. Ducts**

CW ducts shall be concrete encased steel lined ducts. The concrete encasement shall be of minimum 500mm thick with square shape outside. Generally, M20 grade PCC encasement shall be provided. At locations of duct crossing road, rail in transformer yard or any other facility, RCC encasement of grade M25 shall be provided. Minimum two layers of reinforcement (On both faces) of 12 mm diameter bars @ 200 mm c/c shall be provided for RCC encasement of CW Duct. Top of CW duct encasement shall be minimum 1.5 m below finished ground level.

The minimum thickness of steel pipes shall be as follows including corrosion tolerance of 2 mm:

a. For pipes above 1800 mm upto and including 2300 mm dia. - 12 mm

b. For pipes above 2300 mm upto and including 3200 mm dia. - 14 mm

c. For pipes above 3200 mm upto and including 3750 mm dia. - 16 mm

d. For pipes above 3750 mm upto and including 4000 mm dia. - 20 mm

However, for ducts running below rail line in transformer yard/road, minimum thickness of CW liner shall be 20 mm.

Suitable tap-offs shall be provided in the duct to connect CW blow down, ACW tapping etc. Based on the transient analysis, sufficient number of stub connection shall be provided in the duct to fix air release valves.

All duct installation & jointing shall be strictly in accordance with the stipulation given elsewhere in the specification for structural steel work. All the joints of liners shall be butt welded joints. The circular deformation of liner shall be less than 1% of diameter of liner while handling, transportation, erection & construction. If required, temporary bracings may be provided, during handling, transportation & concreting to reduce the deformation.

The completed duct shall be tested for water tightness, for the pressure equal to twice the working pressure or 1.5 times the design pressure whichever is higher and shall be generally water tight to Engineer's satisfaction. The testing pressure shall be held for minimum period of 30 minutes without any signs of leakage or failure of weld. Any in flow / leakage of water from the duct shall be sealed / repaired at Contractor's cost. However, tests in part of length of duct may be permitted with prior approval only.

Wherever required anchor / thrust blocks shall be provided with RCC M25 grade concrete. Suitable RCC chambers shall be provided with precast covers to install flow measurement devices and valves in the duct.

Manholes of minimum 1000mm clear opening shall be provided in each CW duct at a spacing of 200M (approx.) to facilitate maintenance / dewatering of CW ducts. At least one manhole shall be provided at the deepest point for both intake & discharge duct.

Following shall be considered for design of C.W. ducts:

a. Maximum design water pressure

b. Surge or water hammer pressure of 5.0 Kg / Sq.cm.

c. Expected vacuum conditions as arrived from transient analysis

d. Soil overburden

e. Surcharge Pressure of 2T/Sq.m

f. The effect of concrete encasement shall not be considered in the design of CW duct

Painting as per Cl. 6.04.03 shall be carried out on machined faces, flanges and external exposed surfaces of CW ducts. For external surfaces of CW ducts encased in concrete, painting shall be as specified in Cl. 6.04.02(a).

5.18.01.06 **CW Channel**

The channel shall be of RCC section with vertical wall projecting minimum 300mm above finished ground level. Hand rails with 32 NB (medium) pipe shall be provided on both walls of the channel where height of channel wall is less than 1200 mm above finished ground level.

The channel shall be designed to carry the required discharge with minimum water level in cooling tower basin and considering minimum value of rugosity coefficient (n) of 0.018 for concrete surface. However, the maximum velocity in CW channel shall be restricted to 1.8m/sec.

The channel shall be designed by working stress method with crack width limited to 0.2 mm on water face and as cracked section on outer face as per IS: 456 considering (i) no water inside the channel, with earth pressure of soil upto FGL, ground water table upto FGL and surcharge load of 2.0 ton / Sq.m from outside, and (ii) with water inside the channel upto maximum level in the forebay / channel and no earth pressure, ground water pressure and surcharge load from outside. Right from construction to operating stage, minimum factor of safety against uplift due to ground water shall be 1.2.The channel shall be checked against uplift due to 50% of the total water head considering ground water table upto FGL. In addition pressure relief valves with under drainage arrangement in the channel shall be provided to prevent uplift of the channel as per relevant IS Codes. Minimum wall thickness shall be 250 mm.

Forebay Structure

Forebay consists of retaining wall and forebay slab. The walls shall be analysed as a retaining wall for stability against overturning and sliding, similar to end piers of the pump house. Pressure relief valves and under drainage arrangements shall be provided below the forebay slab to prevent uplift of the forebay slab. Size and spacing of pressure relief valves shall be designed by the Bidder to take care of the uplift due to ground water table. However, centre to centre spacing of PRV shall not exceed 5000mm.The forebay slab shall be designed against uplift due to 50% of the total water head considering ground water table upto FGL.The forebay slab shall be minimum 250 mm thick. The forebay slab shall be structurally separated from the retaining walls and water stops shall be provided at the junction of slab and retaining wall. Minimum thickness of retaining wall at top shall be 250 mm. Hand rails with 32NB (medium) pipe shall be provided on both walls of the forebay.

MUWPH Inlet Channel

The channel shall be designed by working stress method with crack width limited to 0.2 mm on water face and as cracked section on outer face as per IS: 456 considering (i) no water inside the channel, with earth pressure of soil up to FGL, ground water table up to FGL and surcharge load of 2.0 ton / sq.m from outside, and (ii) with water inside the channel up to maximum level in the forebay / channel and no earth pressure, ground water pressure and surcharge load from outside. The channel shall be checked against uplift due to 50% of the total water head considering ground water table upto FGL. In addition pressure relief valves with under drainage arrangement in the channel shall be provided to prevent uplift of the channel as per relevant IS Codes. Minimum wall thickness shall be 250 mm.

5.18.01.07	**Deleted**.
5.18.01.08	**Stop-logs and Trash Racks for CWPH, RWPH and MUWPH**
5.18.01.08.01	**Stop-log gates**
	Clear size of the stop logs shall be equal to the clear opening size of water inlet opening below breast wall. Number of segments of the stop log shall be decided to match the capacity of the electrically operated monorail hoist provided to handle it. Structural design of stop log shall conform to IS: 5620 and IS: 4622. Maximum water level for designing the stop logs shall be taken as maximum water level of the forebay. Top and bottom unit of stop log gates shall be designed for their respective water head, whereas the remaining interchangeable units shall be designed for the water head corresponding to the lower most interchangeable unit. The stop logs shall be operated under balanced water head and they are not to be designed for operating under flowing water. Filling valves shall be provided in the stop logs to balance the water pressure before lifting the stop log. These stop logs are used only during maintenance / inspection of pumps. The stop logs shall be operated by means of an electrically operated hoist. Suitable lifting beam shall be provided to operate the stop logs.
5.18.01.08.02	**Trash Racks**
	Bar screen trash rack is to be provided at inlet of the sump of the pump house in order to prevent ingress of timber & other floating particles which could damage the Pumps.
	Each bay of pump sump shall be provided with Type - 1 trash rack (removable section rack), conforming to IS: 11388. Centre to centre spacing of trash rack bars shall be 100mm (max). The trash racks shall be provided with number of interchangeable segments, to facilitate easier handling by means of a lifting beam and electrically operated hoist. Trash rack bars shall be designed for a differential water head of 2.0m. and other structural members shall be designed for a differential water head of 1.0m. Minimum thickness of trash rack bars shall be 10mm. Suitable size of horizontal members and end members shall be provided as per design requirements, for efficient operation of trash rack.
	All trash racks should be capable of being lowered in the associated stop log groove to enable drawal of clean water while a particular trash rack is raised for cleaning purpose.
	Suitable arrangement for storing all the stop logs and stand by trash rack shall be provided by the Bidder, to keep them in good working condition.
5.18.01.08.03	**Lifting Beams**
	Separate lifting beams (automatic) shall be designed & fabricated with guide shoes, hooks, links and counter weights etc. complete for automatic operation to engage and disengage the stop logs and trash racks in the required position.
5.18.01.08.04	**Leakage Tests of Stop logs**
	Leakage tests shall be carried out with the stop logs lowered onto the sill. Before observation for leakage, the stop log shall be raised and lowered about one meter several times in order to dislodge any debris that might have lodged in the side and bottom seals, The leakage shall then be measured and it should not be more than 5 litres / minute / meter of length of seal under maximum head.
5.18.01.08.05	**Material Specifications of Stop logs & Trash racks**
	All material used in the fabrication of stop log or trash rack shall be of high grade, free from defects and imperfections and shall be of the highest standard commercial quality suitable for the intended use. Radiographic examination or magnetic particle testing or other comparable tests shall be carried out for determining the soundness of steel castings and shall be conducted by the Bidder, if asked for by the Employer.
5.18.01.08.06	**Materials for the various components of Stop logs**

Sl. No.	Component Parts	Recommended materials	Reference
1.	Stop log Leaf	Structural steel	IS 2062
2.	Stop log Frames, 1st stage embedded parts and structural steel members	Structural steel	IS 2062
3.	2nd stage embedment	Stainless steel	SS316L or IS:1570 (part-5)
4.	Wheels (the hardness of wheel track surface shall be kept 50 points higher than that of wheel tread)	Cast steel	IS : 1030
5.	Wheel axles, wheel track	Corrosion resistant steel.	IS 1570
6.	Seals	Rubber	IS 11855
7.	Bearings	SKF or equivalent	04Cr19Ni
8.	Seal seats	Stainless steel	SS316L or IS 1570 (part-5)
9.	Lifting pin	Stainless steel	SS316L or IS 1570 (part-5)
10.	Guide	Corrosion resistant steel	IS 6603
11.	Guide shoe	Structural steel	IS 2062

5.18.01.08.07 Materials for various components of Trash Rack:

Sl. No.	Component Parts	Recommended	Reference Materials
1.	Trash rack and 1st stage embedded parts	Structural steel	IS 2062
2.	2nd stage embedment	Stainless steel	SS 316L or IS 1570 (Part–5)
3.	Slide Block	Structural steel with bronze padding	IS 2062 & IS 305
4.	Track base	Stainless steel	SS 316L or IS 1570 (Part–5)
5.	Track	Stainless steel	SS 316L or IS 1570 (Part–5)
6.	Guides	Corrosion resistant steel.	IS 6603

5.18.01.08.08 **Painting Specification for Structural Steel parts for Stoplog Gates and Trash Racks**

(i) All structural steel surfaces shall be cleaned by shot blasting.

(ii) All MS structural parts shall be galvanised to minimum coating of Sealed Zinc spray (250 Micron) as per BS 5493.

(iii) Over zinc coating one coat of zinc Phosphate Epoxy primer having minimum 30 micron DFT and three coats of coal tar Epoxy paint having minimum 75 micron DFT / coat shall be provided. Total DFT of epoxy paint including primer shall be minimum 250 microns.

5.18.01.09 **CONSTRUCTION REQUIREMENT AND ACCESS TO WORK AREAS**

Contractor shall notify to the Engineer before start of work well in advance about the method of construction for crossing road, pipeline, cable, railway, canals, utility lines and other existing obstacles.

Contractor shall not commence work on such crossings before having obtained approval from the authorities and land owners concerned to the satisfaction of the Engineer. The work at crossings shall meet at all times requirements and conditions of the permit issued by the authorities concerned. In the absence of any specific requirements by authorities, Bidder shall comply with Engineers' instructions.

Where the work areas come within the area of influence of high voltage electrical installations, contractor shall propose and provide adequate safety measures for all personnel working. He shall obtain necessary permission/permit from the concern authority. No work is allowed in such areas without Engineer's prior approval.

5.18.01.10 **Switch Gear / Control Room/ Remote IO room for CWPH, RWPH and MUWPH**

It shall be single storied building, framed RCC structure with beams, columns, floor and roof. It shall have non-load bearing brick wall cladding. It shall house the switch gear and MCC of respective Pump house & associated cable trenches. The architectural features shall be as specified elsewhere in the specification.

Bio Toilet shall be opted for make up water facility area outside the plant boundary. Specifications of same shall be as mentioned elsewhere in technical specifications.

5.18.02.00 MUWPH Piping Works

5.18.02.01 This section of the specification covers the technical requirements of design, preparation of general arrangement drawing and working drawings, supply of materials and construction of all civil and structural work associated with water piping works.

5.18.02.01.01 The work to be performed under this specification consists of providing all labour, materials, plant, equipments, temporary works, constructional plant, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the proper completion of the work, all in strict accordance with the specifications and including revisions and amendments thereto as may be required during the execution of the work.

5.18.02.01.02 Land for pipe corridor

The contractor is required to perform his construction activity within the width of acquired land set aside for erection of pipeline or within the Right-of-way area as decided by the Owner. The pipe line shall be buried either in the embankment or shall be buried in the natural ground or to be supported over pedestals or to be supported over steel structure/ bridge.

5.18.02.02 Scope of Work

5.18.02.02.01 The scope of civil, structural works shall include design, preparation of drawings and getting the same approved from the Owner and construction of all civil/structural works associated with the laying of complete water pipe lines to various system and facilities. The nature of work shall

	generally include clearing, grading, stripping/marking, excavation, backfilling, disposal, dewatering, road & drain cutting, rectification of damaged structure due to excavation, laying of RCC Hume pipe or culvert under road, railway track, canal / drains etc. as the case may be. Crossings may be made by open cut excavation. However, steel-cased boring, if permitted, shall be made below existing canals, rail crossing and for highway over bridge wherever required. Bidder shall restore original ground profile and include all concreting reinforcement, formwork, erection of miscellaneous steel (i.e. steel inserts, bolts etc.) if required, to erect the pipe, all crossings and bends, pockets and all other incidental items though not mentioned specifically but required to complete the work including the requirement of right of way and access thereto, restoration of work areas etc.
5.18.02.02.02	The tender drawing provides a general idea about the work to be performed under the scope of this contract. These are preliminary drawings for bidding purposes only and are by no means the final drawing or show the full range of the work under the scope. Work has to be executed according to the drawings prepared by the Bidder and approved by Engineer.
5.18.02.02.03	The work under this specification shall consist of but not limited to items mentioned below: Clearing and grading of work area including requirement of work areas and access there to and stacking of reference markers. Trenching for Laying of pipe. Top of pipe shall be minimum 1.5 M below Finished Ground level (FGL) / Natural Ground Level (NGL) as the case may be. Backfilling shall be done with the excavated material. Supplying and installation of permanent pipeline concrete markers at every 0.5 km and at change of direction including grouting of marker.
5.18.02.02.04	Clean up and restoration of work areas/embankment. Bidder shall restore the embankment & road work, and all sites used for construction of pipelines, water crossings and other structures in accordance with Engineer's instruction and deliver them to the satisfaction of Owner.
5.18.02.02.05	Rail & Road Crossings (a) Route the water pipe through casing pipe of adequate strength to cater to overburden & other traffic loads including live loads. Ends of the casing pies shall be sealed with coal tar enamel soaked fiber glass as per relevant IS Codes. (b) Route water pipe through NP-3/ NP-4 hume pipe culvert of internal diameter greater than 300mm of external diameter of water pipe by open-cut excavation and seal both ends of pipe with provision of vent pipes at cart road/ drain, local water body crossings and restore/ rectify cut roads, drain, Nalla, etc. End of hume pipes shall be sealed with coal tar enamel soaked fibre glass coating as per relevant IS Codes.
5.18.02.03	Ground Water Table For design of pipe line & for design of all structures, the water table shall be considered at finished ground level or actual water Table level, whichever is higher.
5.18.02.04	**Foundation System** Buried Pipe

Pipes shall be laid on firm soil. The backfilling shall be done by excavated soil. Entire backfilling shall be compacted to 90% of standard proctor density or more. Minimum soil cover on the top of buried pipe shall be 1.5 M unless specified otherwise.

Thrust Blocks/ Anchor blocks

Thrust Block/ Anchor block shall be provided at location of all change in direction, if required. The grade of concrete block shall be minimum M25. The concreting shall meet the requirements given elsewhere in the technical specification.

The minimum depth of foundation shall be 1.5M below NGL.

5.18.02.05 **Loading**

Thrust Block/ Anchor Block

The thrust block shall be designed for hydraulic thrust in pipe as applicable.

Pit and Pipes

The pit and pipes shall be designed for earth pressure with a surcharge of 2.0 T/m2. The earth pressure shall be estimated based on relevant provisions of IS Codes.

Entire length of buried pipe line shall be checked against buoyancy & provided with suitable saddles, counter weights to overcome buoyancy effect, if applicable.

For all other load and load combination IS:875 (Part I to V) shall be followed.

5.18.02.06 **Design Criteria And Drawings**

The pipe shall be designed based on appropriate IS Codes. In case of non-availability of IS Codes, relevant Internationals codes & manufacturers recommendations shall be followed subject to Owner's approval.

Whenever floating of the pipeline is to be reckoned with, anti-buoyancy measures shall be provided by Bidder using one or a combination of the following methods as specified.

a) extra weight by applying a continuous concrete encasement around the pipe;

b) extra weight by installing saddle weights;

The above provisions shall be in accordance with the relevant specifications and/or job standards/drawings.

5.18.02.06 **Construction Requirement And Access To Work Areas.**

Contractor shall notify to the Engineer well in advance during work progress, the method of construction for crossing road, pipeline, cable, railway, river, canals and other existing obstacles.

Contractor shall not commence work on such crossings before having obtained approval from the authorities and land owners concerned to the satisfaction of the Engineer. The work at crossings shall meet at all times requirements and conditions of the permit issued by the authorities concerned. In the absence of any specific requirements by authorities. Bidder shall comply with Engineers' instructions.

Where the work areas comes within the area of influence of high voltage electrical installations, contractor shall propose and provide adequate safety measures for all personnel working. No work is allowed in such areas without Engineer's prior approval.

5.18.02.07 **Work Areas - Reference Marker**

Contractor shall also establish all required lines and grades necessary to complete the work and shall be responsible for the accuracy of such lines and grades.

Prior to clearing operations contractor shall :

a) Install Bench Marks, Intersection Points and other required survey pillars.

b) Markers in the centerline of the pipeline at distances of maximum 100 metres for straight line sections and maximum 10 metres for horizontal bends.

c) Set out a reference line with respect to pipeline centerline at a convenient location. Markers on reference line shall be at a distance of maximum 100 metres for straight line sections and maximum 10 m for horizontals bends.

5.18.02.08 **Clearing And Grading**

Any obstacle which may hinder the construction and laying of the pipeline along the pipeline route shall be removed.

All stumps if met with shall be removed for a continuous strip, with a width equal to trench top with plus two metres on either side, centered on the pipeline centerline.

All stumps, timber, bush, undergrowth and roots cut removed from the work area shall be disposed of in a manner and method satisfactory to Engineer, and Government Authorities having jurisdiction. In no case shall it be left to interfere with the grading and laying operations. Whenever stumps are removed and a hole is left in the ground, contractor shall back-fill the hole and compact it to prevent water from gathering in it and making a big hole.

Bidder shall grade the pipeline work area as required for proper installation of the pipeline, for providing access to the pipeline during construction, and for ensuring that the pipeline is constructed in accordance with the latest engineering and construction practices.

Contractor shall grade sharp points, to allow the pipe to be bent and laid within the limits set forth in these specifications, and shall drill, or excavate any rock or other material which cannot be graded off with ordinary grading equipment in order to make an adequate working space along the pipeline.

No temporary / permanent deposit or of any kind of material resulting from clearing and grading shall be permitted in the approach to roads, railways, streams, ditches, drainage ditches and any other position which may hinder the passage and/or the natural water drainage.

In the case of natural or artificial deposits of loose soil, sand, heaps of earth, or other fill materials, these shall be removed till stable natural ground level is reached so as to ensure the construction of the pipeline trench in stable ground.

Wherever the pipeline work area runs across, through or alongside farmyards, built-up areas, groups of trees, groves, horticultural spreads, gardens, grass-fields, river, nallahs, ditches, dykes, roads, paths, railways or any other area with restrictions of some kind, Bidder shall work with all caution necessary for digging the pipeline trench and constructing the pipeline. In the said places Bidder shall carry out the works in such a way that damage resulting from the pipeline construction is kept to a minimum.

5.18.02.09 **Provision of Detours**

Contractor shall make all necessary arrangements to permit the passage of its men and equipment. It is understood that the bidder has recognised restrictive features of the work area

and shall provide the necessary detours and execute the works without any extra cost of owner. Public travel shall not be inconvenienced nor shall it be wholly obstructed at any point.

Contractor at his own cost shall furnish and maintain watchman, detours, lanterns, traffic lights, barricades, signs, wherever necessary to fully protect the public.

Contractor shall be responsible for moving its equipment and men across or around watercourses. This may require the construction of temporary bridges or culverts. Temporary bridging or access if required for crossing water courses shall be constructed. Contractor shall ensure that such temporary works shall not interfere with normal water flow, avoid overflows, keep the existing morphology unchanged and shall not unduly damage the banks of water courses. No public ditches or drains or canals shall be filled or bridged for passage of equipment until contractor has secured written approval of the authorities having jurisdiction over the same. The contractor shall furnish a copy of such approval.

5.18.02.10 **Work Area Damages**

Contractor shall confine all its operations within limits of the Work Area. Any damage to property within and outside the work area shall be restored or settled at the Contractor expenses.

Contractor shall promptly settle all damage claims. Should contractor fail to do so, Owner shall give written notice to the bidder and if contractor does not settle such claims within seven days after such notice, Owner shall have the authority to settle claims from the account of contractor.

5.18.02.11 **Pipe Line Trench**

Location

Contractor shall excavate and maintain the pipeline trench on the Centre-line of the pipeline taking into account the curves of the pipeline.

The free working space shall conform to IS:5822. Generally it shall not be less than 150 mm on either side or one third of diameter of the pipe flange whichever is greater. Irrespective of the diameter of pipes for all trenches deeper than 90 cm, the minimum width shall be 75 cm. The trench shall be excavated so as to provide minimum cover of 1500 mm between the top of the pipe and finished grade, or as shown in approved drawings.

In steep slope areas before commencing the works, proper barriers or other protection shall be provided to prevent the removed materials from rolling down slope.

On slopes-wherever there is danger of landside, the pipeline trench shall maintained open only for the time strictly necessary.

In certain slope sections, before the trench cuts through the water tables, proper drainage shall be ensured both near and trench and the work area in order to guarantee soil stability.

All sewers drain, ditches and other natural waterways involved in the execution of the works shall be maintained open and functional. The same applies to canals, irrigation canals, pipelines and buried facilities crossed by the trench for which temporary pipelines shall be laid, if required, and proper temporary installations provided.

Bidder to note that for restricted width of pipe line corridor (8m available at some points as shown in tender drawing) , he has to plan activities like movement of vehicle, storage of pipe, equipments and excavated materials etc. accordingly.

Extra Depth and Clearance

At points where the contour of the earth may require extra depth to fit the minimum radius of the bend as specified or to eliminate unnecessary bending of the pipe according to customary good pipelines practice, or where a deep trench is required at the approaches to crossings of roadways, rails, rivers, streams, drainage ditches, and the like, contractor shall excavate such additional depth as may be necessary.

Contractor shall excavate to additional depth where the pipeline approaches and crosses other pipelines, sewers, drain pipes, water mains, telephone conduits, and other underground structures, so that the pipeline may be laid with atleast 500 millimeters free clearance from the obstacle or as specified in the drawings, or such greater minimum clear distances as may be required by authorities having jurisdiction.

Where the pipeline crosses areas, which specifically require greater than normal depths of cover, the trench shall be excavated to extra depth in accordance with the Right-of-Way Agreements or as required.

Additional excavation should be made at each coupling /joint to ensure that the pipe will have continuous support. The pipe shall not rest on the coupling for support. However, it shall be assured that the coupling area is properly bedded and backfilled after the joint assembly is completed

Grades, Bends and Finish of Trench

The trench is to be cut to a grade that will provide a firm, uniform and continuous support for the pipe. Bends shall be made in the pipe at significant changes in grade of the trench. The owner reserves the right to set the grade of the trench and locate the bends if so desired, in which case contractor shall excavate, at no extra cost, the trench and bend the pipe to such a grade. Number of field bends to lay the pipe to conform to the general contour of the ground and maintain a normal cover shall be kept to a minimum. This can be accomplished by cutting the trench slightly deeper at the crest of ridges and by gradually deepening the trench in approaches to crossings.

Encroachments and working near other utilities

In locations, where pipelines has to be laid in the body of a road, canal, dyke, etc. or other locations under jurisdiction of Government/Public Bodies, the bidder shall perform such work without extra compensation, according to the requirement of concerned Authorities. When it becomes necessary that contractor has to resort to hand digging, well point dewatering, sheet piling or any other special construction method in these areas, no extra compensation shall be paid. Contractor shall contact the Authorities concerned in order to become familiar with their requirements.

In locations, where the pipeline has to be laid more or less parallel to existing pipeline, cable and/or other utilities in the Work Areas, contractor shall perform the work to the satisfaction of the Owner/Authority of the existing pipeline cable/utility. In such locations contractor shall perform work in such a way that even under the weather and flooding conditions, the existing pipeline/utilities shall remain stable and shall neither become undermined nor have the tendency to slide towards the trench.

Contractor shall be liable for any damage occurring to other pipelines, underground structures/utilities.

Protection of Trench

Contractor shall keep the trench in good condition until pipe is laid, and no claim is to be made to the Owner for reasons of its caving either before or after pipe is laid.

All timber, sheet-piling jacks or other materials, that may be necessary to shore the trench, in order to prevent caving are to be furnished and removed by contractor after completion of laying.

Contractor shall dewater if necessary, using well point system or other suitable systems, shore or do as required to excavate the trench, install the pipe in it and backfill the trench in accordance with these specifications at no extra cost to Owner.

Protection of underground utilities and special methods.

Contractor shall obtain plans and full details of all existing and underground services from the relevant Local Authorities & Owner and shall follow these plans closely at all times during the performance of work. Contractor shall be responsible for location and protection of all underground lines and structures.

Temporary under-pinning or any other type of supports and protective devices necessary to keep the interfering structure intact shall be provided by the contractor at his own cost and shall be of such design as to ensure against their possible failure.

Despite all precautions, should any damage to any structure/utility etc. occur, the Owner/Authority concerned shall be contacted by the Contractor and repair shall forthwith be carried out by contractor at his expense under the direction and to the satisfaction of Engineer, the concerned Owner/Authority. If contractor fails to repair in reasonable time, Owner reserves the right to have the repair executed at the cost of the contractor.

5.18.02.12 **Exacavation**

Excavation in Soil

Generally any strata, such as soil, sand, gravel, loam, clay, mud, black cotton, moorum, shingle, river or nallah bed boulders, siding of roads, paths etc. and hard core, macadam surface of any description (water bound, grouted tarmac etc.), lime concrete, mud concrete and their mixtures which for excavation yields to application of picks, showels, jumper, sacrifiers, ripper and other manual digging implements

Excavation in Rock

For the work of excavation in rock, the excavation shall be carried out by mechanical means and or controlled blasting. Contractor shall engage specialised agency having experience of excavation in rock by mechanical means and or controlled blasting.

Blasting shall be resorted to only with the written permission of the Engineer. All the statutory laws, (Explosives Act etc.) rules, regulations, Indian Standards etc. pertaining to the acquisition, transport, storage, handling and use of explosives etc. shall be strictly followed.

The contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives as per Explosives Act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive materials.

Excavation below ground water table

The Contractor shall dewater and maintain dry working conditions by maintaining the water table at least 0.5m below the bottom of the excavation level by suitable dewatering system.

Contractor shall continue dewatering i.e. maintain dry working condition till excavation, pipe laying, jointing, testing, back filling / filling and all other operations included in the scope of work, which require dry condition in the area, are completed.

Excavation below Water other than Ground water (i.e. Surface water)

The Contractor shall control the ground in the vicinity of all excavations so that the surface of the ground will be properly sloped or dyked to prevent surface water from running into the excavated areas during construction. The Contractor shall have to constantly pump out any water collected in excavated pits and other areas due to rain water, springs, drain, nala, reservoir etc. and maintain dry working conditions at all times until the excavation, concreting and backfilling is completed. The Contractor shall remove all slush / muck from the excavated areas to keep the work area dry. Sludge pumps, if required, shall be employed by the Contractor for this purpose.

5.18.02.13 Backfilling

Backfill Material for Mild Steel/ Ductile Iron Pipes

Prior to lowering and laying pipe in any excavated trench, the bottom of the trench may require to be back filled and compacted (or as the case may be) so as to be proved an acceptable bed for placing the pipe. Bed preparation in general shall be as per IS: 5822 & IS 3114 for MS and IS: 12288 for DI pipes respectively.
Bed preparation and back filling of excavated trenches for buried pipes depend on type of soil. Soil types are classified into following 3 categories:

I. Rocky Soil

II. Sandy/ Silty soil (including non-expansive clay)

III. Expansive soil (including water logged/ marshy soil)

The bidder shall note that the piping may travel underground through all types of soils and combination of soils described above. The type of trench preparation/ bedding and back filling for each are specified below.

In case of agricultural land, it is suggested that the soil may be classified as fertile (top strata) and non fertile (sub strata). During the excavation for laying the pipelineboth these layers may be heaped separately so that while back-filling the non-fertilesoil is filled first followed by the fertile strata, thus restoring the fertility of the soil in the excavated area our right of way.

(a) Rocky Soil

(1) Trench shall be excavated to a depth of 100mm below pipe invert.

(2) A bed of 100mm shall be laid with granular material (passable through 12.5mm aperture sieve - IS-2405 part-2) which shall be well rammed to form a fair and clean bed for pipe.

(3) Back filling shall be done with the excavated material/ borrow earth after ensuring that it is free of cinders, ashes, slag, refuse, lumpy/ frozen material, rocks etc. to the satisfaction of the Project Manager. The back fill from pipe invert upto 300mm above pipe crown shall be done with material passable through 20mm aperture

sieve (as per IS2405 part-2 1980). Total mass of loam and clay shall not be more than 10%. Back fill above this zone upto trench top shall be with similar material but may contain stones with 200mm as their maximum dimension

(4) Back filling upto 300mm above pipe crown shall be done by hand without moving or injuring the pipe. Above this zone upto trench top back fill may be by hand/ approved mechanical method.

(5) Any extra/ additional back-filling resulting from unintended rock blasting even while carrying out controlled blasting shall be done by the Contractor without any extra cost to the Employer

(b) Sandy/ Silty Soil

(1) Trench shall be excavated to the exact gradient required by the pipe invert so that no bedding is required. The trench bottom shall be made free of refuse and stones etc. so as to provide a smooth, uniform and continuous bearing surface

(2) Back filling shall be done with the excavated material after ensuring that it is free of cinders, ashes, slag, refuse, lumpy/ frozen material, rocks etc. to the satisfaction of the Project Manager.

Back filling upto 300mm above pipe crown shall be done by hand without moving or injuring the pipe. Above this zone upto trench top back fill may be by hand/ approved mechanical method

(c) Expansive/ Poor Support Soil

(1) Laying of pipes in such soil shall be avoided as far as possible. One possible method is to increase trench depth in case the expansive soil occurs at the surface. The method can then be one of the above (a or b) depending on soil encountered below the layer of expansive soil. The expansive soil shall not however, be used for back filling thetrench bottom to 300mm above the pipe crown. This shall however, be studied techno-economically (i.e., the aspect of increasing the trench depth to encounter non-expansive soil and follow a or b abovefor bed preparation and back filling).

(2) Where expansive soil occurs at a great depth the trench & bed shall be prepared as at a (1) & (2) above.

(3) Back filling around pipe upto 300mm above top of pipe crown shall then be done with sand/ gravel conforming to clause 8.2.1/ 8.2.2 of IS-3114 or with borrow earth. However, expansion soils having medium degree of expansion or having marginal degree of severity, as per IS:1498, may be used for backfilling around pipes with approval of Engineer.

(4) In case of marshy/ water logged soil, the pipes shall be laid on underground concrete pedestal (M25) installed at a spacing to ensure that the pipe is adequately supported. Prior to construction, design of the pedestal shall be got approved from Enginer-in-Charge.

During backfilling, it shall be made certain that the granular material flows completely under the pipe to provide full support. Proper backfilling shall be done in 150mm to 300 mm lifts, depending on backfill material and compaction method. Between each lift, the proper compaction shall be attained to ensure that the pipe will have adequate side support.

Backfilling shall not be done until the pipe and appurtenances have the proper fit andthe pipe is following the trench profile at the required depth. Backfilling of trench in water courses shall be carried out as per the relevant specifications.

Backfilling shall be carried out immediately after the pipeline has been laid in the trench, inspected and approved by the Engineer, so as to provide a nature anchorage for the pipeline, thus avoiding long exposure of coating to high temperature, damaging actions of adverse weather conditions, sliding down of trench sides and pipe movement in the trench. In generals the trench shall be dry during backfilling. The surplus material shall be neatly crowned directly over the trench and the adjacent excavated areas on both sides of the trench to such a heightwhich will, in the opinion of the Engineer, provide adequately for future settlement ofthe trench backfill during the maintenance period and thereafter. Surplus material, left from this operation shall be disposed off to the satisfaction of Engineer-in-Chargebeyond the Work Area to a place suitably identified by the contractor himself at no extra cost to the Owner.

At the end of each day's work, backfilling shall not be more than 500 meters behind the head end of lowered-in pipe, which has been padded and approved for backfill. The backfill shall be maintained against washouts etc., until the completion and final acceptance of the work by engineer.

When backfilling the trenches the sloping terrains or steep areas, where in the opinion of the Engineer the backfill may be washed out of the trench, sheet piling orother effective water breakers across the trench shall be provided. This is to divert the flow of water away from the trench into normal drainage followed before laying ofthe pipe line. In no case, the water is to be drained via the trench or via channels other than those followed before the line was laid.

Contractor shall leave the pipe uncovered at certain locations to allow the engineer to survey the centre line of the pipe and the level of the pipeline in the backfilled trench.

Temporary markers shall be installed during backfilling to locate the pipeline axis.These markers shall then the replaced with permanent pipeline markers

5.18.02.14 **Anchor Blocks/ Encasement**

RCC thrust blocks should be provided at bends and at places of reduction in cross section to take care of thrust forces as per approved designs/ drawings. Thrust blocks are to be installed at all locations where movement of pipe is envisaged.

If higher water table is encountered, uplift to shall be checked for pipe empty condition and if there is any uplift, pipe shall be encased with reinforced cement concrete (M25) of minimum 250 mm thick around the pipe.

5.18.02.15 **Permanent Markers**

Permanent pipe line markers made of concrete (of grade M25) shall be installed at every 500m and at every bend/turning point. The markers shall be 500 mm wide and75 mm thick and shall project 1200 mm above ground level. The marker shall be grouted in M-10 cement concrete mixture to correct line, level and direction all-alongthe pipe line. The work also includes necessary excavation for grouting of marker, cleaning, painting etc. The bidder shall furnish drawing of marker to Engineer for hisapproval before installation of the same. The mark shall show name of Owner, Chainage of pipe line, Ground elevation, invert level of pipe, direction of flow, etc.

5.18.03 **Clean-Up And Restoration Of Work Areas**

5.18.03.01 Bidder shall restore the Work Areas and all sites used for the construction pipelines, water crossings and other structures in accordance with the instructions of the engineer.

5.18.03.02 Disposal

All surplus and defective materials supplied/ excavated by contractor and all trash, refuse and spoiled materials shall be collected and disposed off to the satisfaction of Engineer-in-Charge beyond the Work Area to a place suitably identified by the contractor himself at no extra cost to the Owner.

The Work Areas shall be cleared of all rubbish, broken skids, empty cans, card board, sacks, stumps, trash, and leftover construction material. All burnable matter shall be burned, but only after obtaining appropriate permits for such burning. If burning is not allowed, bidder shall haul the clean-up material to an approved dumping area. All scrap metal and unburnable material shall be disposed off, in an appropriate manner, but never be buried in the Work Areas.

Surplus soil can only be removed from the work area after authorisation by Engineer.

All dumping fees connected with the disposal of materials shall be to the account of contractor.

All loose stones and rock exposed by the construction operations and scattered over the Work areas or adjacent ground shall be removed and transported to a location considered suitable by land-owner and/or tenant, or by authorities having jurisdiction, for satisfactory disposal. For gravel or other hard material which may be buried in the trench, the provisions of the specifications shall apply with the understanding that the use of the land by the land-owner and/or tenant will not be interfered with.

5.18.03.03 Temporary Structures

All auxiliary structure such as bridges, culverts, sheet piling, posts, signs, etc., whichwere erected or installed by bidder as temporary measure, shall be removed.

5.18.03.04 Repair of Damages

Damages to roads, bridges, private property shall be repaired by contractor. All fences and other structures which are damaged during construction shall be restored to original condition.

Slopes, water course sides or banks which have been partially or totally demolished during the execution of the works shall be properly consolidated and restored without waiting for their naturals consolidation and settling.

All boundary stones which have been moved or removed during the work must bereset in their original location to the specification of the land-owner concerned.

On completion of clean-up, the work areas shall be restored to such stable and usable condition as may be reasonably consistent with the condition of the Work Areas prior to laying the pipeline. The Owner shall be completely indemnified and held harmless by contractor from any and against all claims, demands, losses, expense etc. that may arise on this behalf. The Engineer may require from the contractor signed Releases from land owners regarding satisfactory indemnificationand restoration of their lands.

5.18.04 Cutting And Removal Of Paving/ Water Bound Macadam Road

5.18.04.01 Whenever it is permitted by Authorities and/or Owner to open cut a paved/WBM road crossing, or where the line is routed within the road pavement, bidder shall remove the paving in accordance with the restrictions and requirements of the authorities having jurisdiction there of or as directed by the Engineer. After laying the pipeline, backfilling shall be immediately performed and all the area connected with the works shall be restored.

5.18.04.02 Throughout the period of execution of such works, contractor shall provide and use warning signs, traffic lights or lanterns, barricades, fencing, watchman etc. asrequired by the local authorities having jurisdiction and/or owner.

5.18.04.03 For all roads, paths, walkways etc. which are open-cut, contractor shall provide temporary diversions properly constructed to allow the passage of normal traffic withthe minimum of inconvenience and interruptions. The paving/ WBM shall be restored to its original condition up to the satisfaction ofconcerned authorities/ Engineer after the pipeline is installed.

5.18.05 **Structural Steel Bridges For Make-Up Water Pipes Crossing At Irrigation Canal/Nallah/ Samal Barrage Reservoir Submergence Area**

General

Structural steel bridge shall be provided for make-up water pipes crossing at irrigation canal/nallah/ drain/samal barrage reservoir submergence area and any other water bodies/other submergence areas. The deck of bridge has been sized for two (2) make-up water pipes, etc. Tender drawing indicates minimum size of the approach bridge. The deck shall be of structural steel. Handrail for the structure shall be provided. The deck shall be supported on longitudinal beams and cross beams. Bottom of girder including deck shall be above the MWL of canal/nallah or HFL of Samal Barrage reservoir with adequate clearance as per relevant IRC codes. The entire deck shall be supported on piers. The piers shall be supported on piles and pile cap. Under water piling shall be carried out in reservoir submergence area in accordance to IRC standards. Necessary precautions like sheet piling, etc., shall be taken while executing piling works in the canal bund area to protect the canal structure.

The deck slab shall be designed for the live loads and pipe loads over the approach. Apart from the specified loads, any other equipment or possible overloading during construction/ erection/ installation of pipe line/ equipment and maintenance shall also be considered in the design.

The critical deflection shall be limited such that it shall not produce difficulties in serviceability conditions nor shall it cause damage to the structures and pipelines supported on the bridge, and its components etc. The horizontal deflection shall be checked for wind/ earthquake and current loading and the maximum value shall be limited to L/350, where 'L' is the average distance between bridge support points.

The bridge shall be designed to accommodate transverse and longitudinal differential movement between supports. Predicted maximum relative deflection shall be calculated based on "Worst case" situation, i.e., the sum of the maximum absolute deflections of the adjacent segments/ platforms. One end of the bridge shall be designed as hinged support and the other end as a sliding support. The sliding support shall provide guide restraints in the vertical and lateral support. The sliding support shall provide guide restraints in the vertical and lateral deflections. The sliding support shall be a self-lubricating bearing element.

150% of the total predicted translation shall be allowed for the end connection and bridge design. The hinged connection shall be designed to withstand 150% of the expected axial thrust.

Bridge support shall be capable of accommodating a tolerance in all directions for final support location. The tolerance shall be determined based on the accuracy of construction of support.

In certain stretches of the pipeline corridor along the irrigation canal, pipes will have to be laid along the slope of the embankment due to space constraints. In such cases, suitable retaining wall shall be provided on the downstream side of canal embankment to retain the pipelines as well as overburden fill above pipelines. In no case, pipelines shall be laid by excavation/cutting the embankment slope.

5.23.12 Staircases

All floors of transfer houses/crusher houses and roof/floors of all multistoried MCC/Control room buildings shall be accessible through staircase and mumty of staircase of mcc/control room shall be accessible through cage ladder. Cage ladders (min. 450mm wide) shall be provided for access to roof of penthouses & MCC/control room (with only ground floor).

All stairs of over ground portion of transfer houses & crusher house shall be of steel (minimum 1200 mm wide) and maximum rise should not be more than180 mm and minimum tread width 250 mm. Stringers shall be of rolled steel channel (minimum ISMC 250) and tread shall be of electro forgedsteel gratings. Stairs shall be provided with 32 mm dia nominal bore medium duty M. S. pipe hand rail.

Handrails (for staircases, around openings, in walkways etc.) shall be of standard weight steel pipe of flush welded constructions, ground smooth using 32 mm nominal bore medium class pipe provided with double rail, top rail about 1.0 metre, minimum above platform level (upto height of 12m the height handrail shall be 1.0 m and above 12m height the height of handrail on staircase landing and around cutouts and openings shall be 1.2 m) and pipe posts spaced not more than 1.5 metres apart. Angle handrail post may be provided when specifically called for in drawings approved by Engineering. Toe guard of size 100mm x 6mm shall be provided along the railing for all steel platforms/landings and RCC staircases.
Smooth uniform curves and bends shall be provided at stair returns and also where so ever required. Posts connected to curb plates shall have a neat closure at the bottom and a 6 mm thick plate neatly welded to posts for attachment to curb plate. All necessary fittings including inner dowels at splices, brackets, belts, bends, flanges and chains, where required shall be plugged and welded. A minimum radius of 3 times the pipe diameter shall be provided at all points of direction changes in the handrail.

Treads and landing shall be suitable for the prescribed loading. The maximum width of openings in gratings shall not exceed 40 mm. The minimum size of main bars shall be 25 x 6 mm and cross bar shall be 6mm. The usual span of grating will not generally exceed 1.5 meters. Stair case gratings shall be galvanized to grade 610g/m^2. All gratings shall be electro forged types.

Outside stairs to transfer points shall be open type. However, sheeting shall be provided at the top.

Stairs of MCC/control room, wagon tipplers/track hopper and underground TP's shall be of RCC construction. The minimum width of stairs for MCC/Control room, wagon tippler, reclaim hopper/underground TP's shall be 1200 mm. Maximum rise should not be more than 180 mm and minimum tread with 250 mm. Minimum 50 x 50 x 6 mm size angles with lugs shall be provided as edge protection for treads of stairs in wagon tippler/underground TP's.

Numbers and arrangement (including enclosures etc.) of stair cases shall be such as to meet the fire safety requirement as per guide lines of statutory regulatory bodies. External fire escape staircase along with internal staircase shall be provided for crusher house and multi-storied MCC cum control room building. Minimum headroom in all staircases and all levels shall be 2200mm from floor finish level.

5.23.13 Trenches

All trenches for cables or any other underground facility as detailed out elsewhere shall be of RCC Cable trenches shall be provided with pre - cast RCC covers / chequered plate cover. Cable trenches as well as pre - cast covers shall be provided with edge protection angles. Lifting hooks shall be provided for all pre - cast RCC covers. All embedments / block outs as required and specified elsewhere in these specifications shall be provided. Trench pre - cast cover weight shall not be more than 65 Kgs. At road crossings & entry locations, RCC trench covers designed for 10 T wheel load at centre shall be provided. Pre - cast covers shall be designed for central point load of 75 Kgs. RCC cable trenches shall be filled with sand after erection of cables, up to top level and covered with pre - cast RCC covers. For cable trenches outside buildings, top level shall be 200 mm above G.L and sand filling shall be overlaid with 50 thk. PCC.

Minimum 50 x 50 x 6 mm size angles with lugs shall be provided as edge protection all around cut outs / openings in floor slabs, edges of drains supporting grating/precast RCC covers, edges of RCC trenches supporting pre - cast covers, supported edges of pre - cast cover.

5.23.14 **Cable gallery/trestles**

Cable galleries/trestles shall be made of structural steel. The contractor can use either rolled sections or tubular steel sections. The tubular steel section shall be of circular/rectangular/square shape. The circular steel tube shall conform to IS:1161 and rectangular/square steel sections shall confirm to IS:4923. The steel structures using tubular sections shall be designed and fabricated as per IS:806 – "Code of Practice for use of steel tubes in general building construction." and EN 1993-1-8. Glavanised gratings shall be provided for walkways as per approved electrical drawings. Ladders shall be provided for access from ground to cable galleries at maximum 100m intervals.

5.23.15 **Structural shed over stock pile area**

Space frame Structure for stockpile area shall cover the complete stockpile area. The structure shall have suitable arrangement for fixing of solar panel over its surface. Walkway at the regular interval and staircases (at every 100 m interval along the length of the shed and on both side) shall be provided for the maintenance of solar panels. Maintenance walkway shall also be provided inside the stockpile area. The complete structure shall be covered with cladding as mentioned elsewhere in specifications. However, on the both sides, till 2.1 m for NGL, structure may be left open. Polycarbonate sheet of 2 mm thick for 5% of the total area shall be provided for skylight in the matching profile.

Structural steel pipes/tubes to be used shall be electric resistance or induction butt welded (ERW) as per IS 1161/1239/3589/4923. Bolts shall be high tensile bolts as per IS 1363/1364 of minimum 10.9 grade. Pipes shall be designated by their normal bore. These shall be light, medium or heavy as specified depending upon the wall thickness. Pipes shall be clean finished and reasonably free from scale. They shall be free from cracks, surface flaws, lamination and other defects. The ends shall be cut clean and square with axis of the pipe unless otherwise required per design/drawing. Minimum thickness for tubular section shall be 4 mm. Minimum section thickness for Purlin shall be 2.5 mm. The tubular section shall be effectively send at the end to avoid any corrosion.

SOLID NODES: Only full solid spherical nodes as per design should be used throughout the work. The node shall be made of EN9 equivalent material or higher grade.

5.23.16 **Limestone Storage Silo**

The supporting structure for silo shall be of structural steel. Enclosure with side metal cladding is to be provided above Limestone Storage Silos for limestone handling equipment. Side metal cladding is also to be provided for outgoing conveyors below limestone storage silos.

Stored Limestone load shall be treated as dead load for analysis and design of silo supporting structure.

5.23.17 **Drainage & Water Supply Works**

5.23.17.01 Drainage System:-

The drainage arrangements shall be so planned so as to ensure quick disposal of drainage water without stagnation and / or overflow. It is envisaged to clean the conveyor galleries, transfer points, crusher building, penthouse etc. with water periodically.

Minimum 4 nos. down comers shall be provided in each transfer house / crusher house. In case of conveyor galleries, the down comer shall be provided at every trestle location.

Drainage of the complete coal stock pile, area around stacker reclaimer rails etc. shall be discharged into the owner's coal slurry settling pond.

For all coal Conveyors, each down comer shall lead the water / coal slurry to RCC pit (of 2 Cu.M capacity) to allow settling of coal. The water from the pit shall overflow into contractor's R.C.C drain, which will lead the discharge finally into coal slurry settling pond.

For Crusher House, pent house, transfer house each down comer shall lead the water / coal slurry into the peripheral drains (Brick drains with steel gratings provided around the building) which will lead the water / coal slurry to water / coal slurry to RCC pit (of 2 Cu.M capacity) to allow settling of coal. The water from the pit shall overflow into contractor's R.C.C drain, which will lead the discharge finally to the coal slurry settling pond.

For Wagon Tippler & transfer houses peripheral drains (Brick drains with steel gratings provided around the building) shall lead the water / coal slurry to a local RCC pit (of 2 Cu. M. capacity) near each facility to allow settling of coal. The water from the pit shall overflow into contractor's R.C.C drain, which will lead the discharge to a coal slurry settling pit.

In case of Control rooms and MCC buildings, Pump houses, etc water / coal slurry coming from down comers shall discharge into peripheral drains (Brick drains with steel gratings provided around the building) which will lead the water / coal slurry into contractor's RCC drain, which will lead the discharge finally into coal slurry settling pond.

Suitable kick plates/Curb beams shall be provided around the floor openings, stair case landings, in the transfer points, crusher house and other buildings.

Contractor's scope shall also include construction of necessary culverts under the rail lines / roads as per railway / IRC standards and approval of Railway culverts from concern Railway authorities.

5.23.18 **Internal and external water supply, drainage etc.:-**

The scope for potable water supply includes all distribution systems, tanks, pipes, fittings etc. as required and as described here or elsewhere in these specifications.

The scope for service water supply and dust control water supply shall be as described elsewhere in these specifications.

For water supply, medium class galvanized mild steel pipes conforming to IS: 1239 shall be used.

The scope for drainage of surface water shall include design, layout and construction of drains for and from buildings and drains required for coal stockyard area, drainage up to main coal slurry settling tank including connection with the tank. Drainage system shall be designed for maximum intensity of rainfall as 75 mm/hr and 60 % runoff coefficient. Moreover, the drainage system shall also comply to detail mentioned in project information chapter. All buildings (including transfer houses, crusher house, MCC rooms, pump house etc.) shall be provided with open surface brick drains of minimum size of 300 mm width and 300 mm depth with removable steel gratings all around the periphery. All drains excepting the peripheral drains around the transfer points, crusher house, control / MCC. buildings, pumps house etc., shall be of RCC construction. All open RCC drains shall have removable steel gratings designed for loads as specified under loading clause. Minimum size of main bar of steel grating (Galvanised to 610 gm/m^2) shall be 25 mm x 5mm and cross bars 6mm. At all entry or road/rail crossing point's RCC box/pipe culvert shall be provided. The opening size of grating shall not be more than 90 mm x 35 mm. All drains as well as pre - cast covers shall be provided with edge protection angles and lifting hooks.

However, drains in coal stockyard area shall have pre cast RCC covers. RCC pre - cast cover weight shall not be more than 65 Kgs. RCC pre-cast covers near entry or at road crossings shall be designed for 10 T wheel load at centre. RCC pre - cast covers shall be designed for central point load of 75 Kgs.

The scope for foul water from toilets shall include layout and laying of sewers for sewerage system together with all fittings and fixtures and inclusive of ancillary works such as connections, manholes and inspection chambers within the building and from the building to the terminal point.

For rain water down comer and those to be used for conveying water / coal slurry generated from cleaning of walkways/floors, Galvanized MS pipes conforming to IS: 1239 (for 150 mm NB Medium grade pipes) with welded joints shall be provided for MCC buildings, penthouse, control rooms and Galvanized steel ERW pipes (273mm OD, 4mm thk) of steel grade Fe330 conforming to IS: 3589 with welded joints shall be provided for all TP's, Crusher house, and Conveyor galleries.

Galvanizing shall be as per IS: 4736. The minimum mass of zinc coating shall not be less than **360** gms/sq.m. as per IS:6745. The zinc coating shall be smooth and shall be subjected to testing as per IS: 2633, for uniformity of coating. The zinc coating shall be free from all defects as per IS: 2629.

All rain water down comers shall be provided with roof drain heads and complete with shoes bends, junctions, sockets, adapters, brackets and finished with anti-corrosive painting over a coat or primer.

For design of building drainage system IS: 1742 shall be followed.

For sanitary / sewerage pipes above ground, sand cast iron pipes conforming to IS : 1729 with leak proof lead joints.

For underground drain pipes, minimum class NP - 2 pipes conforming to IS: 458. At road crossings, concrete pipes of class NP 3 conforming to IS: 458 and at rail crossing RCC box culvert to be provided.

For sewerage below ground stoneware pipes conforming to IS: 651 with concrete bedding and haunch.

5.23.19 Roof Details

Roof slabs for CHP, LHP and GHP buildings shall be minimum 150 mm thick(in case of metal decking thickness shall be measured from crest top) and shall have minimum 10 dia HYSD reinforcement bars placed at 200 mm center both ways at top and bottom.

1000 mm high and minimum 100 mm thick RCC parapet wall shall be provided over roofs of all buildings. However, for mumty, 600mm high parapet wall shall be provided. Parapet wall shall have suitable coping. External face of parapet wall of the buildings provided with metal cladding shall also be finished with metal cladding of design and colour as per approved architectural drawings.

Junction of roof and parapet shall be provided with 150 x 150 mm size concrete fillet.

Drain level shall be provided with 45 x 45 cm size khurras having minimum thickness of 30 mm of M-15 concrete over PVC sheet of 1 m x 1m x 400 micron and finished with 12 mm 1 : 3 cement : sand plaster.

Roofs of all M. C. C./control rooms, crusher house and TP(if applicable), penthouse etc., shall have roof water proofing treatment. Roof water proofing treatment shall be as mentioned else where in specification.

Roof of pump house shall be provided with single skin troughed profile permanently colour coated sheet with slope of 1 in 5 for quick drainage of rain water.

5.23.20 Floors and Grade level details

5.23.20.1 DELETED

5.23.20.2 The floor slabs shall be minimum 150 mm thick(in case of metal decking thickness shall be measured from creast top) and shall have minimum 10 dia HYSD reinforcement bars placed at 200 mm center both ways at top and bottom. The RCC slab shall be designed without considering any composite action effect of metal deck sheet (ie the structural strength of metal deck sheet shall not be considered for RCC slab design).

Floors of transfer points shall have cross slope of not flatter than 1: 80, towards the floor washing drainage outlets, for efficient drainage. For ground conveyor & crusher house slope shall be 1:100.

Chequered plates (used for floors, walkways etc.) shall be minimum 6 mm thick o/p or as indicated on drawings. The chequered plate pattern shall be approved by Employer / Engineer. Mild steel flats/angles of suitable size shall be welded to the bottom portion of chequered plates at a designed spacing to stiffen chequered plates to restrict deflection within span/200. Chequered plates shall be fixed by staggered welding of suitable size.

Toe guard of size 100 x 6 mm shall be provided at various openings provided in floors e.g.

around stair case openings, chute openings and other similar cutouts. For conveyor walkways, angle runner to act as toe guard shall be provided.

All along the periphery of RCC floors (where no brick masonry walls are provided) 100 mm thick 300 mm high RCC wall and 900 mm high steel hand rails all around over this RCC wall shall be provided.
The grade slab shall consists of 230 mm thick rubble soling (63 mm downgraded hard stone aggregate as per IRC specification, watering and compaction to minimum of 90% Standard Proctor density, including filling the interstices of stone aggregates with sand), over well compacted earth, overlaid by 75 mm thick P. C. C. M-7.5 and 100 mm thick RCC of grade M-20 with minimum 8 mm dia bars placed at 200 mm C / C in either direction respectively. There will be minimum 50 mm thick metallic hardener finish over the RCC slab.

All buildings (including Wagon Tippler and machinery hatches, truck hopper, penthouse, MCC rooms, pump houses, transfer houses and crusher house) and ground conveyors shall be provided with 750 mm wide plinth protection all around. It consists of 50 mm thick P.C.C. M-20 grade with 12 mm maximum size aggregate over 200 mm thick stone soling using 40 mm nominal size rammed, consolidated and grouted with fine sand.

An area of 5 m width all round the water tanks near pump house, transfer houses and crusher house, Gypsum storage shed, truck tippler area, lime storage silo shall be paved. This paving will be in addition to plinth protection. The paving construction shall be as per specifications for the grade slab at ground level. However, 50 mm thick metallic hardener finish is not required to be provided in paved area. Paving shall also be provided in HGTU and VGTU area.

Heavy duty paving shall be provided inside the building(Gypsum storage shed) if any vehichular movement is envisaged.

Finished Floor level of all buildings shall be kept at least 500 mm above the finished grade / formation level.

5.23.21 Brickwork and allied masonry works

Brickwork cladding for various structures shall be so provided that there is a clear gap of 40 mm between inside face of external brick wall and outside face of column flange. Structural steel wall beams supporting brickwork shall be provided at a maximum spacing of 3m and suitably encased with plaster or 1:2: 4 concrete as the case may be. In case of box type steel beam, encasement shall be done with cement sand plaster in specified thickness and proportions over G. I. wire netting of 0.9 mm thickness.

50 mm thick Damp proof course shall be provided at plinth level for all brick wall.

5.23.22 CONCRETE

Refer General Specification.

5.23.23 De-watering of Deep Excavations

For deep underground structures like track hopper, tunnels and underground transfer houses, requiring open excavation with extensive de - watering, completely dry working conditions during excavation, shuttering, placement of reinforcement, concreting, water proofing of structures, backfilling and any other operation shall be maintained by suitable de - watering method of suitable capacity.

5.23.24 Galvanising

All burrs and irregular edges of the structural steel members to be galvanised shall be ground smooth before galvanising.

Purity of Zinc to be used for galvanising shall be 99.5 % as per IS : 209 (latest edition).

The weight of the zinc coating shall be at least 610 Gms. / m^2 unless noted otherwise.

5.23.25 CHEMICAL INJECTION GROUTING

Minimum, 12 mm dia (NB) threaded nozzle of suitable length, shall be provided over the surface and along the construction joint line in a grid pattern at a spacing not exceeding 1.5 m c / c before concreting operation. Adequate precaution shall be taken to keep the nozzles plugged at both ends to prevent them from getting closed by concrete.

For fixing of any nozzle in set concrete suitable size hole shall be drilled, preferably by using repercussive hammer drill electrically operated, in grid pattern and grouting nozzle shall be fixed in these holes.

After the nozzles are fully set, neat cement slurry admixed with water soluble non - shrink polymer / monomer based chemical shall be injected through the net - work of nozzles with low pressure grout pumps at a pressure of about 2.0 Kgs. / cm^2. Cement slurry shall be prepared by mixing cement with non-shrink polymer/monomer @ 500 gm/50 kg bag of cement and water, ensuring that Water: Cement ratio does not exceed 2 (by weight). Wetter the structure, lesser should be the water cement ratio. The property of the polymer/monomer should be such that when it is mixed with water @0.5% by weight of water, the viscosity of the resultant solution (water and polymer/monomer) should not be more than 1.2 centipoises. Plasticizing agent shall be added wherever required. The grouting shall be started at very low pressure and increased gradually to a required pressure. The grouting shall continue, till the hole refuses to take any further grout, even at an increased pressure. Applied pressure shall not be more than the designed strength of the concrete. After completion of grouting operation, the nozzles shall be sealed properly to the satisfaction of the Engineer.

5.23.26 POLYMER MODIFIED CEMENTITIOUS COATING

5.23.26.1 Materials

Modified liquid polymer blend shall be a dispersion containing 100 % acrylic based polymer solids. Polymer shall be mixed in the ratio of 1 cement: 0.5 polymer (for minimum solid content of polymer 30%).

Portland cement based dry powder.

Clean, fine specially prepared quartz sand approximately 0.6 mm size.

5.23.26.2 Mixing

The liquid polymer shall be stirred well and cement based powder shall then be added slowly to make a Slurry Mix. For preparation of Brush Topping Mix, quartz sand shall be added slowly and mixed well till a homogeneous mixture is obtained. The mix shall be used within half an

hour of the preparation. Addition of quartz sand may not be necessary, in case dry power contains the same.

5.23.26.3 Properties of Polymer Modified Cementitious Coating

It must adhere to wet surface.

It should develop adequate bond strength, with the concrete surface, not less than 2 N / Sq. mm.

Co - efficient of permeability shall be about $5x10^{-10}$ Cm / Sec.

Water absorption after continuous soaking shall not be more than 1 %.

The materials shall be permeable under water vapour.

The material shall be resistant to acids and alkalies present in the soil and underground water with normal pH value between 4 and 14.

The co - efficient of thermal expansion of the material shall be close to that of concrete.

5.23.26.4 Application

The concrete surface shall be cleaned and made free from grease, oils or loosely adhered particles. The surface shall be damp without any free water. For exterior underground part, application (b) pertaining to Brush topping Mix shall be followed.

(a) For Slurry Mix

A minimum of 2 coats shall be applied on the surface. The first coat being applied, when the surface is still damp and left to harden for 4 to 6 hours. After 4 to 6 hours of the application of second coat, it shall be finished by rubbing down with a soft dry sponge. The coverage shall not be less than 1 : 1 Kgs. / m^2 in the 2 coats. A lap of 75 mm shall be provided at the joints.

The coating shall be air dried for 4 to 6 hours and, thereafter, cured for 7 days after the application of last coat.

(b) For Brush Topping Mix

This shall be applied in two coats. A primary coat of slurry mix can also be first applied on the surface as first coat. After the coating has dried up, a coat of Brush Topping Mix shall be applied over it with a push broom or any other similar brush. It shall be left in broom finished condition. The nominal thickness shall be 1.5 mm and minimum thickness shall be 1.0 mm. A lap of 75 mm shall be provided at the joints. It shall be ensured that no pinhole exists and rebrushing shall be done to cover the pinholes, if any.

The Coating shall be air dried for 4 to 6 hours and thereafter cured for 7 days after the application of last coat.

Rate of application of coating shall be established to achieve the required thickness.

5.23.27 **Miscellaneous**

5.23.27.1 Ordinary form work shall be used in roofs and floor slabs in transfer houses, footings, pedestals, cable trenches, pits etc., Plywood form work shall be used for all over ground exposed work like columns, beams, floors and ceilings in control room and M. C. C. buildings.

5.23.27.1 Monorail girders and fixtures shall be provided for monorails at the locations as required and as described elsewhere in these specifications or drawings. Monorail openings in the walls shall be provided with steel frame doors preferably sliding type or otherwise open able inside, access platforms and ladders.

5.23.27.1 Steel frame around openings in roof and on external walls for mounting of exhaust fans shall be provided.

Ready mix non - shrink cementitious grout of reputed manufacturer as approved by the Employer shall be used for grouting of block outs and foundation bolts, underpinning of base plates and machine bases. Crushing strength of grout shall be one grade higher than the foundation concrete. Minimum crushing strength shall be 30 N / mm^2 unless higher strength requirement is specified by the equipment supplier or the grout manufacturers.

The bottom of steel in case of cable / pipe galleries and trestles shall be generally 3m above the ground except for rail / road crossing where it shall be 8m above the rail top / road crest/ground. Further in bunker areas it shall be 8 m above the ground.

Polysulphide Sealing Compound shall be two-part polysulphide sealant and shall be from approved manufacturer, conforming to IS : 12118. Materials shall consist of polysulphide polymer and a curing agent. Gun grade material shall be used unless otherwise specified. The application of the sealant shall be strictly followed as per manufacturer's guidelines.

5.23.28 **SHOTCRETING**

General Requirements

Generally, shotcreting shall be done in accordance with IS : 9012.

Reinforcement for shotcreting shall be as detailed below, unless specified otherwise.

(a.) Reinforcement in one direction consisting of 6 mm M. S. bars at 750 mm c / c shall be connected to the lugs for fastening of the wire fabric. This shall be used in case of 50 mm or above thick shotcreting.

(b.) Wire fabric conforming to IS : 1566 shall be used as reinforcement and shall consist of wire, 3 mm diameter, spaced 50 mm both ways and shall be electrically cross welded. Wire fabric shall be securely tied to 6 mm bars for 50 mm thickness. Adjacent sheet of wire fabric shall be lapped at least 100 mm and tied.

(c.) Clear cover to reinforcement mesh shall not be less than 15 mm.

Minimum thickness of shotcreting shall be 50 mm for abrasion resistant work and 25 mm for ordinary surface protection work.

Material

Generally, the materials shall be in accordance with aggregates specification given here under.

Fine aggregate shall consist of natural sand or crushed stone from a known source and shall be strong, hard, coarse, sharp, chemically inert, clean and free from any coating. It shall be free from clay, coal or coal residue, organic or any other impurities that may impair the strength or durability of the concrete and shall conform to IS : 383.

Fine aggregate (Sand) shall be well graded and particles shall range in size within the following limits. The Engineer, may approved the use of any other grading as per requirement or as per IS : 9012.

The fineness modulus shall be preferably between 2.5 and 3.3. Any other value can be used, with prior approval of the Engineer.

Application

After the placement of reinforcement and / or welded mesh and not more than six hours prior to the application of shotcrete, the surface shall be thoroughly cleaned of all loose materials and dirt. The Contractor shall properly prepare the surfaces, reinforcement and / or welded mesh to receive the shotcrete. Cleaned surfaces shall be wetted not more than hour prior to shotcreting.

The mix as placed on surface shall be one part cement to three parts approved sand by mass. Cement and sand shall be dry mixed; not water shall be added after mixing and before using in the gun. The quantity of water when added shall be only that which is sufficient to hydrate the cement. For average atmospheric conditions, the water cement ratio for shotcrete in place shall be between 0.35 and 0.5 by mass. Suitable admixture shall be used wherever required.

A uniform pressure of not less than 3 kg/cm2 at the nozzle shall be maintained. Necessary adjustments shall be made to ensure this pressure, taking into account the length of hose and height of the place to be shotcreted, above location of the machine.

The application shall proceed in an upward direction. Beams, stiffeners and intermediate walls, if any, shall be wrapped with wire fabric and completely covered with shotcreting. All rebound shall be removed from the area of application as the work progresses and such rebound material shall not be reused.

As soon as the freshly shotcreted surface shows the first dry patches, a fine spray of water shall be applied to keep too moist. After the surface has hardened, it shall be kept continuously moist for minimum seven days. If there is extreme heat, especially when accompanied by hot winds, the shotcreted surface, immediately upon completion, shall be covered with burlap or similar covering, which must be kept continuously moist for 14 days after shotcreting. The temperature of the lining shall not be permitted to exceed 38^{o}C during placing and curing.

5.23.29 **VIBRATION ISOLATION SYSTEM**

These specifications are meant for the design, supply and erection of vibration isolation system for supporting coal/limestone crushers.

Supporting Arrangement

minimum 12 mm thick plywood backing, one number stainless towel rail 600 x 20 mm, one number liquid soap dispenser

Bio toilet/Bio digester shall be comprised of four compartments and a soak pit. The size of the tank shall be as per the number of users. This four-compartment tank shall be constructed underground and shall be made of FRP with required strength as stipulated by DRDO norms. The bio-toilet constructed shall have S-trap and ball valve for ease of operation and maintenance. It shall have all necessary arrangement and fixture for future operation and maintenance as per manufacturer guidelines.

5.35.00 WORKER'S ACCOMODATION BUILDINGS

Worker's Accommodation shall be provided as per NBC requirement and Local factory act. The Building design shall be as per Tender Drawing. It shall have Brick wall around the Kitchen, Toilet, bathroom and washing area. It shall have Aerated Concrete panel wall with steel structure having sandwich panel roof sheeting.

5.36.00 OTHER BUILDINGS

For all other buildings mentioned in the scope of work but requirement not furnished in this chapter, the Bidder shall develop the details of such buildings based on the functional and statutory requirements.

D-1-6 **DESIGN CRITERIA**

6.01.01 **General**

The design criteria given herein is applicable for all sub-structure, super-structure works/ buildings/ facilities and various other works included in the scope of the Bidder.

6.01.02 Structures shall be designed for the most critical combinations of dead loads, imposed loads, equipment loads, crane loads, piping loads (static, friction and dynamic), earth pressure & surcharge loads, hydrostatic & hydrodynamic loads, wind loads, seismic loads and temperature loads. In addition, Erection loads, loads and forces developed due to differential settlement shall also be considered.

6.01.03

i) All the buildings shall have framed super structure. If the superstructure of building is a steel structure, the framed superstructure shall be moment resisting sway frame in the lateral direction and axially braced in the orthogonal direction. For columns having depth of 1000mm & above, the longitudinal bracings shall comprise a pair of members (spaced) with spacing equal to the column depth. Columns having depth less than 1000mm may have bracing in single plane and at the centerline of column. In both the cases (single bracing or pair of bracing) detailing shall be adequate to restrain the entire column cross-section including both the flanges. Only where axial bracing to one vertical plane is to be waived due to functional requirement, columns in that vertical plane may be allowed to undergo biaxial bending. Beam column joints shall be detailed as per seismic resistant joint with adequate ductility.

All 2-legged structural steel trestles shall be completely braced in the vertical plane. All 4-legged structural steel trestles shall be completely braced in all four vertical planes. In addition, specified horizontal planes shall be completely braced to provide stiffness against torsional sway.

If the superstructure is RCC structure, the superstructure shall be moment resisting sway frame in both orthogonal direction and all the members shall be designed for biaxial bending. Design of RCC structures shall be done as per IS 456. Detailing for ductility shall be followed as per guidelines of IS13920 to be effective against seismic load. Design of liquid retaining structures shall be done as per IS 3370.

ii) The Bunker building, transfer towers, conveyor galleries and trestles, crusher house, boiler, ESP Control Building, ESP supporting structures, including inlet and exhaust duct support structures, Compressor House, Pipe cable Gallery shall have structural steel framed super structure.

iii) All other buildings may have either RCC or structural steel framework.

iv) All buildings having RCC framing shall have masonry cladding of minimum one masonry unit thickness (not less than 225 mm.) on exterior face.

6.02.00 **Loading**

For consideration of loads on structures IS : 875 - 'Code of practice for structural safety of buildings' shall be followed. In addition to the dead load, live load, equipment load (including impact / vibration), Temperature loads etc. various loading conditions arising due to operation and maintenance of equipment shall be considered in the design.

6.02.01 **Dead loads**

Dead loads shall include the weight of structure complete with finishes, fixtures and partitions and shall be taken as per IS: 875 (Part-I)

6.02.02 **Imposed loads**

Imposed loads in different areas shall include live loads, erection, operation and maintenance loads. Equipment loads (which constitute all loads of equipment to be supported on the building frame) are not included in the imposed loads furnished below and shall be considered in

addition to imposed loads.

For consideration of imposed loads on structures, IS:875 (Part-2) "Code of practice for design loads (other than earthquake) for buildings and structures" shall be followed. The following minimum imposed loads as indicated for some of the important areas shall however be considered for the design. If actual expected load is more than the specified minimum load, then actual load is to be considered.

Sl.No.	Location	Imposed Loads (T/Sq.m.)
A)	Mill and Bunker Bay	
i)	Ground floor	2.5
ii)	Feeder floor	0.50
iii)	Tripper floor	0.50
iv)	Roof	0.15 (Where no equipment are located) 0.50 (Where equipment are located) 0.075 (For Inaccessible roof)
B)	Turbine Building	
i)	Ground floor (general)	2.50
ii)	Ground floor (heavy equipment storage area)	5.00
iii)	Mezzanine floor	1.00
iv)	Operating floor	
	a) Rotor Removal area	5.00
	b) Equipment lay-down area	3.50
	c) Other areas (corridors, etc.)	1.50
v)	Gratings, chequered floors, walkways, platforms, stairs, etc.,	0.50
vi)	Roof (Where no equipment is located)	0.15
C)	Deaerator and Heater Bay	
i)	H.P/L.P. heater floor	1.00
ii)	Deaerator floor	1.00
iii)	Cable gallery (In addition to this, actual cable load	0.50

shall be considered)

iv)	MCC, switchgear and Control building floors	1.00
v)	Roof (Where no equipment are located)	0.15
	(Where equipment are located)	0.5
vi)	A.H.U Room, Battery Room, Air Washer Room	1.0

D) Coal, Gypsum,Limestone handling structures

i)	Roofs	150 kg. / Sq. M. for accessible roofs and 75 kg. / Sq. M. for non - accessible roofs. In addition to this coal dust load (Dead load) of 150 Kg. / sq. m. on flat roofs & 25 kg. / sq. m. on inclined roofs shall also be considered.
ii)	Conveyor galleries	In addition to the live loads, loads due to cable trays, fire fighting / service water pipes shall also be considered @ 125 kg. / m (minimum) on each of the longitudinal girder. Roof-truss members are to be checked for supporting fire fighting pipes/ Service water pipes. Tentative locations and diameter for pipes are shown in Tender Drawing. In addition to this coal dust load (Dead load) of 50 kg. / sq. m. on walkway way shall also be considered.
iii)	Covers for trenches / channels/ drain	Covers for channels & trenches, shall be designed for a live load of 0.4T Sq. M. and loading as mentioned under clause in trenches, whichever is critical.
iv)	Sumps and tanks and other underground basement type structures/ drain	In addition to earth pressure with a surcharge of 2T / Sq. M. (or surcharge due to Railway loading whichever is critical for Railway load bearing structures etc.) and sub - soil water pressure etc. These are also to be designed for the following conditions : i) Water / liquid inside and no earth outside (applicable only to such structures which are liable to be filled up with water or any liquid). ii) Earth with surcharge outside and no water / liquid inside iii) For underground (basement) structures protection against buoyancy during execution and after execution shall

be ensured without superimposed loadings with minimum factor of safety of 1.2 against buoyancy.

v) Unit weight of bulk materials

a) For structural design
i) Lime stone 1700 kg. / Cu. M.
ii) Gypsum 1250 kg. / Cu. M.
iii) Coal 1100 kg. / Cu. M.

For sizing calculation
iv) Lime stone 1400 kg. / Cu. M.
v) Gypsum 1100 kg. / Cu. M.
vi) Coal 800 kg. / Cu. M.

E) Boiler/ ESP Support Structures

i. Operating Floors	1.00
ii. Separator Floor	1.00
iii. Elevator Machine Room	1.00
iv. Maintenance Platforms	1.00
v. Equipment Laydown Loads	As per Equipment supplier or 1.00 whichever is more.
vi. Lift Structure	As per Equipment supplier with 100% impact factor

F) Pump Houses
Operating floor 1.50

G) Underground Structures such as Channels, Sumps, Underground Pump House, Tanks, Trenches, Reservoirs, C.W. ducts etc.

In addition to earth pressure and ground water pressure, the surcharge load of 2T/sq.m. shall also be considered for design of all underground structures.

H) Road Culverts/Bridges and its allied structures including RCC Pipe Crossings and Road Crossing of Trenches.

Design for class 'AA' loading (wheeled and tracked both) and checked for class 'A' loading as per IRC Standard.

I) Covers for Channels/trenches	0.40 (General) or central point load of 75 kg whichever is higher As per IRC Standard (at road crossings for vehicular traffic)
H) Railway Supporting Structures, Rail Culverts	As per Railway 'Bridge Rules'

	I)	Conveyor Galleries		In addition to the live loads, loads due to cable trays, firefighting / service water pipes shall also be considered @125kg/m (minimum) on each of the longitudinal girder. Roof-truss members are to be checked for supporting firefighting pipes/ Service water pipes.
	J)	General (Unless Specified Otherwise)		
		i)	Stairs, Landings and Balconies	0.50
		ii)	Toilets	0.20
		iii)	Chequered plates, grating floors, etc.	0.50
		iv)	RCC floors (General)	0.50
		v)	a) Flat Roofs (where no equipment are located)	0.15
			b) Flat Roofs (where equipment are located)	0.50
			c) Inaccessible roof	0.075
		vi)	Inclined Roofs	As per IS : 875 (Part-II)
		vii)	Dust load on roof	0.050
		viii)	Walkways (General)	0.50
		ix)	Walkways of conveyor galleries, DM & PT	0.30
		x)	Floor of control room of switchyard control building	1.00
		xi)	Cable and pipe trestles	0.40 for walkway and in addition, friction loads as applicable
		xii)	Grating covers/ Precast RCC covers for drain, trench, sump pit in Ground floor/ paving of BTG area	2.50 As per IRC standard (at road crossings for vehicular traffic)

Notes:

a) If erection load is higher than the specified imposed loads on any floor or part thereof, then the erection loads are to be considered for the design.

b) Additional load for cable, piping/ducting, shall be considered as applicable. For any other structures, the loads specified for those structures elsewhere in the specification shall be followed.

6.02.03 **Equipment, piping and associated loads**

Equipment loads shall be considered over and above the imposed loads. Equipment loads

shall be considered as given by equipment supplier.

6.02.04 **Crane load**

For crane loads, an impact factor of 25% and lateral crane surge of 10% (of lifted weight + trolley weight) shall be considered in the analysis of frame according to the provisions of IS:875. The longitudinal crane surge shall be 5% of the static wheel load. Longitudinal surge and lateral surge shall not be considered to act simultaneously.

6.02.05 **Seismic load**

For design of all structures, the site specific seismic design criteria as attached in Annexure-E shall be followed.

6.02.06 **Wind load**

For design of all structures, the wind loads shall be taken as per the site specific wind data specified in Annexure–D of this specification.

6.02.07 **Temperature Load**

For temperature loading, the total temperature variation shall be considered as 2/3 of the average maximum annual variation in temperature. The average maximum annual variation in temperature for this purpose shall be taken as the difference between the mean of the daily minimum ambient temperature during the coldest month of the year and mean of daily maximum ambient temperature during the hottest month of the year. The structure shall be designed to withstand stresses due to 50% of the total temperature variation.

Suitable expansion joints shall be provided in the longitudinal direction wherever necessary with provision of twin columns. The maximum distance of the expansion joint shall be as per the provisions of IS 800 and IS 456 for steel and concrete structures respectively.

6.02.08 **Differential Settlement Loads**

Structures shall be designed considering an additional load on account of differential settlement of 1 in 1000 between any two adjacent columns, subject to a maximum differential settlement of 8 mm in case of foundations resting on soils & 4mm in case of foundations resting on rock/ pile.

These differential settlement loads shall be taken into consideration for design of footings & structures of Boiler & Mill Bunker, ESP supporting structure and Main Power House building.

Further, in the analysis of differential settlement loads, adjacent columns interconnected with bracings are preferably to be provided with combined footing. In such cases, where rigid combined foundations are provided below braced columns, differential settlement between those columns needs not be considered.

Moreover, when rigid raft is provided, the differential settlement amongst the columns supported on the rigid raft need not be considered. However, the differential settlement between the raft and the adjacent column footing of the same structure are to be considered.

In the structural analysis for differential loads, following approach may be considered: All the alternate columns in structure shall be applied downward displacement as described above and analyzed at a time. The resultant forces/ reactions shall be considered with reversible effects for design of structures and footings.

6.02.09 **Additional Loads**

Following Minimum additional Loads shall be considered in the design of Steam generator structures, Mill & bunker buildings, Coal handling Transfer points and Trestles (in BTG island) and ESP structure.

(a) Cantilever Loads of not less than 2000 kg/m at a distance of 1200 mm from the external face of the columns, on both sides of the ESP, for Cable trays and Walkways.

(b) Cantilever Loads of not less than 500 kg / M at a distance of 1200 mm from the external face of the columns, on both sides of the Steam Generator, for Cable trays and Walkways.

(c) Cantilever Loads of not less than 2000 kg / M at a distance of 2500 mm from the external face of the Mill & Bunker Building columns, CHP transfer point columns/ VGTU columns & conveyor gallery trestles (on one side) for Cable trays and Walkways.

(d) Dry Fly Ash Piping Loads.

(e) Ash Water Piping Loads.

(f) Supply Air and Instrument Air Piping.

(g) Service Water Piping

(h) Loads associated with Coal Handling Plant equipment

6.03.00 **Civil Design Concepts**

6.03.01 Individual members of the frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion, etc.,

6.03.02 The different load combinations shall be taken as per IS: 875 (Part-5) and other relevant IS Codes.

a) Wind and seismic forces shall not be considered to act simultaneously.

b) For the design of main plant structures during seismic condition, the deaerator feed water tank shall be considered full upto operating level. However, for other load combinations, deaerator feed water tank in flooded condition shall be considered.

c) 'Lifted load' of crane shall not be considered during seismic condition.

d) In case two cranes are provided and tandem operation is not envisaged, the load shall be taken as one crane fully loaded and second crane without lifted load but standing idle adjacent to first crane all through the building length (lifted load near to A/B Row).

e) In case two cranes are provided and tandem operation is envisaged then the crane wheel loads shall be taken as both the cranes fully loaded to capacity and travelling side by side al through the building length.

f) Permissible stresses for different load combinations shall be taken as per relevant IS and IRS codes.

g) For the design of pipe/cable supporting structure, the soil weight shall be considered as backfilled up to grade level for the condition of pipe running full/cables in position.

h) Frictional forces between the pipes and supporting structure in longitudinal direction need not be considered along with seismic or wind forces.

i) Paving in crane corridor shall be designed for the maximum load due to movement of crane.

j) In TG bay at crane rail level, chequered plate walkway with handrails shall be provided for entire column sectional depth for full length of the building. Walkway width clearance from the face of the column to the edge of the crane shall be as specified elsewhere in the specification.

k) For checking against uplift / tension case, 90% of Dead Loads with no Imposed Loads shall be considered along with other Loads.

l) The Structures shall be Designed for most unfavorable Combination of Dead Loads, Imposed Loads, Equipment Loads, Piping / Cables / Ducts Loads, Wind / Seismic Loads, Temperature Loads, Ash Loads, and other applicable Loads without exceeding the Permissible Stresses.

No reduction in equipment loads, piping loads, ash loads and loads due to other

permanent facilities shall be considered for calculation of seismic weight of the building/structure and for load combinations thereof.

m) In all Loading Combinations, the Loads that have reduction effect on design condition shall not be taken into account in the Combination concerned.

n) Where wind load is the main load acting on structure, no increase in stresses is to be considered for design of Structure and Foundation bolts. This includes structures like Transfer Points and Conveyor Trestles.

o) In all Load Combinations, differential settlement loads (with reversible effects) are to be considered.

6.03.03 Design of steel structures shall be done by the working stress method. Design shall be as per provisions of IS:800:1984 and other relevant IS standards. For design of coal bins and loading hopper IS:9178 (part I to III) shall be followed.

6.03.04 Shop connections will be welded type and all field connections will be bolted. Field permanent bolts wherever provided will be high tensile bolts of property class 8.8(min) as per 1367 for all major connections. However, nominal connections in the field like purlins, stairs, wall beams will be done by means of M.S. black bolts of grade 4.6 conforming to IS-1367. The bolted joints will be designed for friction grip or bearing type. For friction grip type connections, bolts will be tightened to develop the required pretension during their installation.

For bolted Connection, IS 4000, IS: 3757, IS: 6623 and IS: 6649 shall be followed. IS 814, IS 816, IS: 1024, IS 4353 and IS: 9595 shall be followed for welding of structures.

6.03.05 All structures close to railway line shall have clearances conforming to Railway norms.

6.03.06 For calculation of coal load on moving conveyor, a multiplication factor of 1.6 shall be used to take care of inertia force, casual over burden and impact factor, etc. Thus coal load per unit length of each moving conveyor shall be

$$\frac{1.6 \times (\text{rated capacity of conveyor system})}{\text{Conveyor speed}} \times \frac{1100}{800}$$

6.03.07 a) Conveyor gallery structure and trestles shall be designed considering both conveyors operating simultaneously

b) Dynamic analysis of conveyor galleries and conveyor supporting system shall be carried out for spans greater than 25 m.

c) All structures close to railway line shall have clearances conforming to Railway norms.

6.03.08 **Coal, Limestone and Gypsum handling structures:**

The loads for all railway load bearing structures e. g. wagon tippler, tunnel, culverts and under ground transfer houses etc. and the analysis and the design of these structures shall be made strictly in accordance with the provisions of Indian Railway Bridge rules (latest edition), and Indian Railway Codes of practice (latest edition) with all amendments up to the date of opening of bids. The axle load for analysis and design shall be considered as “DFC loading (32.5t axle load)” of Heavy mineral loading as per Indian railway standard. Coal heap of 1.2m height shall be considered above hopper top for design of hopper and supporting elements of wagon tippler. The analysis, design and detailed drawing for tunnel, under ground transfer houses, culverts etc. coming directly below the railway track shall be got approved by the contractor from the concerned railway authorities before taking up construction. All necessary payment for the above work shall be made by the bidder to the railway authority.

The steel structures shall be designed and fabricated as per ‘code of practice for use of structural steel in general building construction’, IS : 800 and other relevant IS Standards.

	For foundations of transfer points, crusher house & trestles, pedestals of isolated footings/pile caps shall necessarily be tied with RCC beams. For all RCC buildings, tie beams shall be provided at lintel level. Design of masonry walls shall be made as per IS : 1905. For metal roofing and side cladding, the spacing of purlins/runners shall be such that the deflection of metal sheet used is limited to span/250 under adverse loading condition. Minimum reinforcement (0.12% of total coss sectional area in each direction) shall be provided at the top face of the footing, even if, no reinforcements are required as per design
6.03.08.01	All liquid retaining structures shall be designed for following load conditions. Underground structures: a. Water filled inside up to design level and no earth outside. b. Earth pressure with surcharge of 2.0 T/m2 and ground water table up to FGL outside and no water inside. c. Stability against uplift shall be checked for completed structure and under construction stage with no water inside and ground water table up to FGL, with a minimum factor of safety of 1.20 against uplift. Installation of pressure relief valves shall not be permitted in the base slab of any liquid retaining / conveying structure. d. The structure shall also be checked for normal working condition with water filled inside up to design level and earth pressure outside with no effect of surcharge and ground water table. For design of over - ground liquid retaining structures appropriate load cases shall be considered.
6.03.08.02	All liquid retaining structures shall be designed by working stress method as given in clause 4.5 of IS 3370(Part2).
6.03.08.03	In the wall of liquid retaining structures with cylindrical shape such as clarifiers, vertical reinforcement shall be checked assuming the walls were fully fixed at the base, and the horizontal reinforcement shall be provided to resist horizontal (hoop) tension assuming hinged condition at the junction of the base slab & wall.
6.03.08.04	Wherever sandwich slabs are provided in liquid retaining structures to take care of stability against uplift, only well graded sand of approved quality shall be used as fill material. The sand compaction shall be done with plate / disc compactors in such a manner that the bottom slab is not structurally damaged.
6.03.08.05	Clear free board of at least 300 mm above design (total) water level shall be provided in all liquid retaining / conveying structures.
6.03.08.06	Coefficient of active earth pressure shall be considered for design of free standing retaining walls and coefficient of earth pressure at rest shall be considered for design of top propped retaining walls.
6.03.08.07	The minimum concrete clear cover to reinforcement bars in all RCC structures shall be as per IS:456 and IS:3370(Part II) for water retaining structures. Durability of concrete shall conform to moderate exposure conditions as per Table-3 of IS 456 except noted specifically otherwise.
6.03.08.08	Factor of safety against overturning and sliding The structure shall be checked for minimum factor of safety of 1.5 against overturning conditions (ratio of stabilizing moment to overturning moment) and 1.4 against sliding conditions as per IS: 456.
6.03.08.09	For detailing of Reinforcement IS 5525, IS 13920, IS 4326 and SP 34 shall be followed.

6.03.08.10 Two layers of reinforcement (on both faces) shall be provided for RCC sections having thickness of 150 mm and above.

6.03.08.11 Minimum diameter of main and distribution Reinforcement bars in different structural elements shall be as follows:

Sl. No.	Structural Element	Main Reinforcement	Distribution Reinforcement / Stirrups/ ties/ Anchor Bars
a)	Foundation	12 mm	12 mm
b)	Beams	12 mm	8 mm
c)	Columns	12 mm	8mm

6.03.08.12 Spacing of reinforcement bars in walls and slabs of liquid retaining / conveying structures shall not be more than 200 mm.

6.03.08.13 Buildings shall also comply to IS 4326 requirement.

6.03.08.14 Minimum Reinforcement in all elements of liquid retaining / conveying structures shall be 0.24 % of cross sectional area.

6.03.08.15 The sizing of foundation, design criteria & clear cover shall conform to IS:1904, IS:456 and other relevant Indian codes. However, minimum 0.12% of reinforcement shall be provided on the top face of the foundation concrete on either direction and minimum percentage of reinforcement at bottom face of foundation shall be same as that stipulated for beam as per IS:456.

6.03.08.16 Minimum thickness of foundation slab / raft and base slab of all liquid retaining tanks / pits shall not be less than 250 mm.

6.03.08.17 Minimum thickness of all elements of RCC liquid retaining / conveying structures (except effluent drains & launders) shall be 200mm. Effluent drains (depth more than 500mm) and launders shall have minimum element thickness of 150mm.

6.03.08.18 All Insert plates (except edge protection angles) provided in liquid retaining structures shall be 12 mm thick GI with lugs not less than 12 mm diameter. Edge protection angles shall be provided as specified elsewhere.

6.03.08.19 All water retaining structures shall be tested for water tightness as per provisions of IS: 3370 and IS: 6494.

6.03.08.20 2.0m wide walkway with concrete paving shall be provided connecting all structures, buildings and facilities. The top of walkway shall be minimum 200mm above FGL.

6.03.08.21 **Design Requirements for Crusher Foundation**

6.03.08.21.2 **Dynamic Analysis**

Detailed dynamic analysis shall be done for the top deck together with springs and dampers and the natural frequencies and amplitudes of vibration shall be determined. A mathematical model of the top deck shall be formulated with three - dimensional beam / plate finite elements for the purpose of analysis with the spring idealised with vertical and horizontal stiffnesses. The mass of the machine together with that of the top deck shall be considered for the analysis.

Natural frequencies upto at least 10 % above the operating speed shall be determined and

6.04.00 **CORROSION PROTECTION**

6.04.01 **General**

(a) All Steel structures shall be provided with painting as given in the specification. Further, painting system shall also meet the requirements of Corrosivity category (as mentioned in Part A IID Civil Works for the project as per ISO 12944).

Painting system for steel surfaces embedded in Concrete is given separately.

(b) All Painting shall be done as per Technical Specification Painting scheme shall submitted by the Bidder.

(c) All steel structures shall be designed by following basic design criteria in ISO 12944 Part 3. Minimum thickness of metal for any structural steel elements shall be not less than 6 mm where steel is fully accessible for cleaning and repainting and where it is feasible to folllow design criteria given in ISO 12944 part 3. However, where steel surfaces are inaccessible for cleaning and repainting or where it is not feasible to follow design criteria given in ISO 12944 part 3, corrosion allowance of 1.5 mm shall be kept in thickness (over the design thickness or 6mm, whichever is more).

Minimum thickness of tubular/ hollow steel sections conforming to IS 4923 shall be 4.0 mm, provided the ends of such steel sections are effectively sealed unless higher thickness is specified elsewhere for specific structure.

6.04.02 **Painting of Steel Surfaces Embedded In Concrete**

a) For the portion of Steel surfaces embedded in Concrete, the surface shall be prepared by Manual Cleaning and provided with Primer Coat of Chlorinated Rubber based Zinc Phosphate Primer of Minimum 50 Micron Dry Film Thickness (DFT).

b) All threaded and other surfaces of foundation bolts and its materials, insulation pins, Anchor channels, sleeves, etc. shall be coated with temporary rust preventive fluid and during execution of civil works, the dried film of coating shall be removed using organic solvents.

6.04.03 **Painting of Steel Surfaces (Other Than Those Embedded In Concrete)**

CORROSSIVITY CATEGORY	PRIMER COAT	INERMEDIATE COAT	FINAL COAT
C3	All steel surfaces shall be provided with two component moisture curing zinc (ethyl) silicate primer coat (having minimum 80% of metallic Zinc content in dry film, solid by volume minimum 60% ±2%) of minimum 70 micron DFT to be applied over blast cleaned surface conforming to Sa 2 ½ finish of ISO 8501-1 with surface	Primer coat shall be followed with the application of Intermediate coat of two component polyamide cured epoxy with MIO Content (containing lamellar MIO minimum 30% on pigment, solid by volume minimum 80% ±2%) of minimum 100 micron DFT. This coat shall be applied in shop after an interval of minimum 24 hours	Intermediate coat shall be followed with the application of finish coat of two-pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% ±2%) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour

	profile 40-60 Micron. The primer coat shall be applied in shop immediately after blast cleaning by airless spray technique. Zinc dust composition and properties shall be Type-II as per ASTM D520-00.	(from the application of primer coat) by airless spray technique.	change less than 2.0 ΔE) and minimum 70 micron DFT. This coat shall be applied shop after an interval of minimum 10 hours and within six (6) months (from the completion of Intermediate coat), Colour and shade of the coat shall be as approved by the Employer.
C5	All steel surfaces shall be provided with two component moisture curing zinc (ethyl) silicate primer coat (having minimum 80% of metallic Zinc content in dry film, solid by volume minimum 60% ±2%) of minimum 70 micron DFT to be applied over blast cleaned surface conforming to Sa 2 ½ finish of ISO 8501-1 with surface profile 40-60 Micron. The primer coat shall be applied in shop immediately after blast cleaning by airless spray technique. Zinc dust composition and properties shall be Type-II as per ASTM D520-00.	Primer coat shall be followed with the application of Intermediate coat of two component polyamide cured epoxy with MIO Content (containing lamellar MIO minimum 30% on pigment, solid by volume minimum 80% ±2%) of minimum 180 micron DFT. This coat shall be applied in shop after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.	Intermediate coat shall be followed with the application of finish coat of two-pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% ±2%) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 70 micron DFT. This coat shall be applied shop after an interval of minimum 10 hours and within six (6) months (from the completion of Intermediate coat), Colour and shade of the coat shall be as approved by the Employer.

Notes:

1. For Primer, high quality surface preparation is necessary and good amount of moisture is required for proper curing. Below 70 % relative humidity, curing time may go up to 7 days or more. In such a case additional water sprinkling may be ensured for completion of curing. Additionally Inorganic zinc silicate cannot be recoated; even with itself. Typically it should be used when coating bare steel surface for first time.
2. The most frequent problem associated when top coating Primer is bubbling/pinholing especially with non-weathered zinc silicate coatings. To a great extent, this bubbling of finish paint can be eliminated by applying a mist coat of intermediate/topcoat as the first pass of the product, allow the bubbles to subside and then apply a full coat, as required.
3. In case top coating of zinc silicate with epoxy/polyurethane coatings, is expected to be delayed, it is advisable to use a suitable tie coat to avoid formation of white rust. However, if white rust forms then clean the surface with high pressure water, dry and apply the subsequent coats as required.
4. Touch up paintings on damaged areas: Surface preparation by manual tools, wire brush/ emery paper etc. Minimum 6 inches peripheral area, adjoining to damaged area to be covered. If metal surface is exposed, it is to be painted with Zinc rich epoxy (70 micron) or suitable primer with existing paint scheme. If primer is intact, intermediate & top coat to be done with specified DFT in scheme.

6.04.04 **Coating for Mild Steel parts in contact with Water**.

a) All mild Steel parts coming in contact with water or water vapour shall be hot dip galvanised. The Minimum Coating of Zinc shall be 610 g/ Sq.m. for galvanised Structures and shall comply with IS: 4759 and other relevant Codes. Galvanising shall be checked and tested in accordance with IS: 2629.

b) The galvanising shall be followed by the application of an etching Primer and dipping in black bitumen in accordance with BS: 3416, unless otherwise specified.

6.04.05 **Gratings**

All gratings shall be blast cleaned to Sa 2 ½ finish or cleaned by acid pickling as per ISO 8501-1 and shall be hot dip galvanized at the rate of 610 gm/sqm.

6.04.06 **Hand Railings and Ladders**

All Mild steel (MS) handrails and ladders in outdoor locations and in pump valve pits shall be galvanised at the rate of 610 gm/sqm as per IS 4736. All other MS handrails shall be painted as specified in clause 6.04.03 above. However, Stainless steel handrails shall be provided as specified in General Architectural Specification clause 9.00.00.

6.04.07 **Sea Worthiness**

All Steel Sections and fabricated Structures, which are required to be transported on sea, shall be provided with anti-corrosive Paint before shipment to take care of sea worthiness.

6.04.08 DELETED

6.04.09 **For reinforced concrete work.**

i) The protection for concrete sub-structure shall be provided based on aggressiveness of the soil, chemical analysis of soil/sub-soil water and presence of harmful chemicals/salts.

ii) The protection to super structure shall depend on exposure condition and degree of atmospheric corrosion.
This shall require use of dense and durable concrete, control of water cement ratio, increase in clear cover, use of special type of cement and reinforcement, etc., coating of concrete surface, etc.,

Bidder shall furnish the details of corrosion protection measures.

D-1-7 **FOUNDATION SYSTEM AND GEOTECHNICAL DATA**

7.01.00 **Soil Data**

Owner has carried out preliminary geotechnical investigation at the project site. Available borelogs in vicinity along with laboratory test results and ERT, are enclosed at Annexure-C for Bidder's reference. The geotechnical investigation report for nearby areas will be made available for the Bidder's study at the Owner's office, if required.

Onus of correct assessment/ interpretation and understanding of the existing subsoil condition / data is on the Bidder. **Bidder may refer enclosed topographical survey drawing and general layout plan along with borelogs for variation in existing/ natural ground level (NGL) and finished ground level (FGL).** As per borelog data, near proposed Admin building, fire station, permanent store, Workshop building and gate complex area, carried out by owner ash/coal deposit is found. Wherever ash/coal deposit/brick-bats etc. is found the same shall be treated as filled up soil. Further, as per available borelog data of the above mentioned area, NGL is varying from RL(+) 64.9 m to RL(+) 67.0m and FGL is RL(+) 69.0 i.e. there may be filled up layer up to 2.0m to 4.1m of ash/coal deposit.

As per borelog data, water table is varying from 0.4m to 4.5m at the time of field investigation and may fluctuate with season.

7.00.01 Contractor shall carryout detailed geotechnical investigation for the facilities under this package. The scheme for geotechnical investigation shall be as given at Clause 7.10.00 and shall be approved by Owner before execution. Geotechnical investigation work may be got executed by the contractor through the suggested agencies as mentioned in Clause No. 7.09.03 or any other agency having adequate experience for carrying out such works and approved by engineering department of the owner. The geotechnical investigation report shall be prepared with detailed recommendations regarding type of foundation and allowable bearing pressure for various structures/ facilities and other soil parameters. The report shall be submitted for Owner's approval prior to commencement of design of foundation.

7.00.02 The furnished borelog details are specific to the co-ordinates where the boreholes have been carried out and are provided for bidder's information only. Soil profile in the proposed area may vary with respect to the borelogs enclosed for bidder's information. Bidder has to consider all such variations in his estimation, over the extent of the work to be carried out. The Bidder should note that nothing extra whatsoever on account of variation between soil data collected by Owner and that found by the Bidder during geotechnical investigation by him or during execution of works, shall be Payable.

7.00.03 Tank Foundations

a) The tanks shall rest on flexible tank pad foundation, resting on sand with concrete ring wall to retain sand. Base of the concrete ring wall shall not rest on the expansive soil, if any.

b) Entire loose/ soft soil inside the concrete ring wall shall be removed and shall be filled with sand. Sand for filling shall be clean and well graded conforming to IS 383 with grading Zone I to III.

c) Sand shall be spread in layers not exceeding 30cm compacted thickness over the area. Each layer shall be uniformly compacted by mechanical means like plate vibrators, small vibratory rollers, etc to achieve a relative density of not less than 80%.

d) Other requirements of tank foundations shall be as per IS 803 and as specified elsewhere in the specifications.

7.02.00 **Foundation System**

The requirements for the foundation system to be adopted are as given in subsequent clauses. Depending upon the depth of competent strata/stratum, type of structures, functional requirement of facility, extent of cutting / filling, suitable open or pile shall be adopted with

approval of owner.

7.02.01 **General Requirements**

a) All structures/equipment shall be supported on suitable open foundations (isolated, combined, raft) or pile foundations depending on type of structures/facilities, sub-strata, topography etc.

b) The roads, ground floor slabs, trenches, pipe pedestals (except thrust blocks), channels/drains and staircase foundation with foundation loading intensity less than 4 T / M2 may be supported on open / shallow foundations resting on virgin / controlled compacted filled up soil.

c) No other foundation (other than as mentioned in (b) above and (g) below) shall rest on the filled up ground / soil.

d) All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian Standards.

e) The water table for design purpose shall be considered at Finished Ground Level.

f) A combination of open and pile foundations shall not be permitted under the same equipment / structure / building.

g) Foundation for equipments on ground floor

For equipments of static weight upto 1.5 T, the equipment may be supported on the ground floor slab by locally thickening the slab. Thickening of the ground floor slab shall be done upto an extent of about 0.6 m beyond the plan area of the equipment on all the sides. Further, the load intensity below the equipment shall be limited to 4T/m2. Other requirements of floor slab and compaction below the floor slab shall be adhered, as specified elsewhere in the specifications.

For equipment's of static weight between 1.5 T and 20 T, the equipment may be supported on compacted sand filling from Natural Ground Level (NGL) or excavation level of nearby footing whichever is deeper with the load intensity below the equipment limited to 4T/m2. The minimum depth of foundation is 1.0m below FFL. Other requirements of sand compaction below the foundation shall be adhered, as specified elsewhere in the specifications.

For equipment of static weight more than 20 T, the equipment foundation shall be taken to the founding level or shall be built up with PCC from the level as mentioned in the Table 1. The pedestal of equipment foundation or the foundation Block shall be isolated from the adjoining floor slab by providing bitumen impregnated fiber board of minimum 50 mm thick, conforming to IS: 1838 all around the equipment pedestal for the full depth of the floor slab.

7.02.02 **Open Foundations**

In case open foundations are adopted, following shall be adhered to.

a) The minimum width of foundation shall be 1.0 m.

b) Minimum depth of foundation shall be 1.0m below Ground Level.

c) It shall be ensured that all foundations of a particular structure/ buildings/ facility shall rest on one bearing stratum.

d) Wherever the intended bearing sub-strata is virgin soil stratum but the actual stratum encountered during foundation excavation consists of filled up soil at founding level, under such cases either the foundation shall be lowered completely into the virgin stratum or the filled up soil upto the virgin layers shall be removed and built up through PCC (1:4:8) up to designed foundation level.

e) Wherever the intended bearing stratum is weathered rock, but the actual strata encountered during excavation consists of both overburden soil and weathered rock at founding level, under such cases, the overburden upto the weathered rock level

including 0.5 m into the weathered rock shall be removed and built up through PCC (1:3:6) upto the designed founding level. Thus, maintaining the same founding level for all the footings of a structure.

f) The last layer of about 300 mm before reaching the founding level shall be excavated carefully by such equipment so that soil / rock at the required level will be left in its natural condition.

g) Wherever the new facilities (excluding roads, ground floor slabs, trenches, pipe pedestals, channels/drains and staircase foundation) are to be constructed after dismantling existing facilities; it is to be ensured that the new foundations shall be taken at least 1m below the existing founding depth of the dismantled structures in case of soil and 0.6m below the existing founding depth of dismantled structures in case of rock.

h) During design the Allowable Bearing Pressure shall be adopted after approval of geotechnical investigation report. However, the maximum allowable bearing pressure shall be lower of the two values i.e. as per approved geotechnical report and as per the values furnished in Table-1.

Table-1

Founding Depth/ Stratum	Net Allowable Bearing Pressure T/m2		
	Isolated and combined footings including raft for 25mm permissible settlement in case of soil and 12mm in case of rocky strata	Isolated and combined footings for 40mm permissible settlement in case of soil and 12mm in case of rocky strata	Rafts (width > 6m) for 75mm permissible settlement in case of soil and 12mm in case of rocky strata
	Width upto 6.0m		
In case of foundation stratum is soil			
1.0m below NGL	-	5	7
2.0m below NGL	-	8	12
3.0m below NGL	10	15	18
4.0m and below NGL	14	20	24
In case of founding stratum is rock			
0.6m embedment into rock	35.0	35.0	35.0
1.0m embedment into rock	40.0	40.0	40.0
2.0m embedment into rock	50.0	50.0	50.0

For FGL refer GLP (General layout plan)

For NGL of the proposed area GLP along with enclosed topographical survey drawing and borelog data may be referred. In case any loose/soft pockets is encountered at founding level, the same shall be removed completely upto the hard strata and filled up with PCC (1:4:8).

For the new facilities to be constructed after dismantling existing facilities; founding level of new facilities shall be taken at least 1.0m below the existing founding depth of the dismantled structures in case of soil and 0.6m below the existing founding depth of the dismantled structures in case of rock.

For open foundations, the total permissible settlement shall be governed by IS: 1904 / IS: 13063 and from functional requirements whichever is more stringent. However, total settlement shall be restricted to the following:

Isolated & Raft (Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	25 mm
Isolated & Strip (other than Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	40 mm
Raft (other than Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	75 mm
Foundations in Weathered rock / rock	12 mm

7.03.00 **PILE FOUNDATIONS – In case piles are adopted, following shall be adhered to:**

i) The pile foundation shall be of RCC, Cast-in-situ bored piles as per IS:2911. Pile boring shall be done using Self erecting Crawler mounted Rotary Hydraulic Rigs. However, conventional tripod rig may be allowed in inaccessible areas subject to site specific conditions. Two stage flushing of pile bore shall be ensured by airlift technique duly approved by the Employer.

The piling work in river/water body shall be carried out with temporary or permanent MS liner and approved construction methodology. If piles are extending, above bed level of river/water body, in water, permanent MS liner of minimum 8mm thickness shall be provided.

In submergence area at Samal Barrage, under water piling shall be adopted. Further, Cl. No. 7.08.00, shall be referred for special requirement for piling work for river side/ submergence facilities.

ii) The minimum diameter of pile shall be 600 mm and in case of piles in water body/river, minimum diameter of piles for bridge/approach bridge shall be 1200mm. The allowable load capacity of the pile in different modes (vertical compression, lateral and pullout) shall be least of the three values i.e. as per approved geotechnical report, as per the values furnished in following table and pile capacity achieved in pile load tests:

Pile	Dia. (mm)	Vertical compression capacity (T)
Bored cast-in-situ pile	600	140
	760	250
	1000	350
	1200	450

Pile shall be socketed into weathered rock. A socketing length of **Five meter** into rock **shall be ensured.**

The uplift and lateral load capacity shall be respectively restricted to 35% and 5% of the allowable load capacity in vertical compression.

However, the pile capacities to be adopted shall be the least of the estimated design values and that obtained from the initial pile load tests.

iii) Only straight shaft piles shall be used. Minimum cast length of pile above cutoff level shall be 1.0 m.

iv) The 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, reinforcement for job as well as test piles, pile load test arrangement, locations of initial test piles etc.) for Engineer's approval.

v) 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 Contractor for Engineer's approval.

vi) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be subject to minimum as under.

Vertical

Lateral Minimum of 2 Nos. in each mode.

Uplift

vii) The initial pile load test shall be conducted with test load three times the estimated pile capacity. In case of vertical compression test (initial test) the method of loading shall be cyclic as per IS:2911 (relevant part).

viii) Load test shall be conducted at pile cut of level (COL). If the water table is above the COL the test pit shall be kept dry through out the test period by suitable de-watering methods. Alternatively, the vertical load test may be conducted at a level higher than COL. In such a case, an annular space shall be created to remove the effect of skin friction above COL by providing an outer casing of suitable diameter larger than the pile diameter.

ix) Number of routine pile load tests to be performed for each diameter/allowable capacity of pile shall be as under:

i) Vertical : 0.5% of the total number of piles provided.

ii) Lateral : 0.5% of the total number of piles provided.

x) The routine tests on piles shall be conducted upto test load of one and half times the allowable pile capacity. Piles for routine load tests shall be approved by the Employer.

xi) 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 Contractor shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required.

xii) Testing of piles and interpretation of pile load test results shall be carried out as per IS:2911 (Part-4). Contractor shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory / institute prior to their use. Settlement / movement of the pile top shall be made by Linear Variable Differential Transducers (LVDT) having a least count of 0.01mm.

xiii) The test load on initial test piles shall be applied by means of reaction from anchor piles / rock anchors alone or combination of anchor piles / rock anchors and kentledge with concrete blocks.

xiv) Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the routine load test and not intended to replace the use of static load test. This test is limited to assess the imperfection of the pile shaft and shall be undertaken by an independent specialist agency to be approved by Engineering department of Owner. The test equipment shall be of TNO or PDI make or equivalent. The process shall confirm to ASTM.

xv) High Strain Dynamic Load Test may be carried out for routine vertical load test of working piles. However, at least three numbers of static routine vertical load tests shall be carried out on pile on which high strain dynamic load test has already been carried out for establishing the correlation between the two tests. In case of discrepancy if any between dynamic and static vertical load tests, then additional static routine vertical load tests shall be conducted as decided by the Engineer and the results of static routine vertical load shall prevail. Number of routine vertical pile load tests as per clause 7.03.00 (ix) shall be total of static routine vertical load test and high strain dynamic load tests.

The procedure to carry out the test shall be submitted to the Engineer. The test and equipment shall conform to ASTM D4945-00. The test shall be conducted by an experienced independent test agency approved by the owner. Field data shall be submitted to the site engineer and shall include force velocity curves, pile capacity, simulated static load test curve, net and total pile displacement, pile integrity. A (Case pile wave analysis) CAPWAP or equivalent software analysis shall be conducted on the field data for correct capacity estimation and to evaluate end bearing and skin friction components of the pile.

xvi) From load considerations, single pile may be used under a column/tower. In that case, pile shall be connected with tie beams at pile cut off level in both directions.

xvii) Contribution of frictional resistance of filled up soil if any, shall not be considered for computation of frictional resistance of piles.

xviii) Reinforcement for job piles shall be designed as following:

(a) Compression + bending piles: For these piles, the allowable safe pile capacities in compression and bending shall be considered.

(b) Tension + bending piles: For these piles, the actual pile forces to be considered. However, maximum 3 types of combinations for varying percentage of tension capacity + bending case may be designed & adopted by contractor for the entire scope of work under this package.

7.04.00 Special Requirements

7.04.01 Details of treatment for foundations / underground structures required to counteract soil / water chemical environment shall be as per detailed geotechnical investigation to be carried out by contractor. Contractor shall carry out chemical analysis during detailed geotechnical investigation and required treatment shall be provided accordingly.

7.05.00 Excavation, Filling and Dewatering

7.05.01	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.
7.05.02	Excavation for shallow foundations shall be covered with PCC immediately after reaching the founding level. In case of any local loosening of soil or any loose pockets are encountered at founding level during excavation the same shall be removed and compensated by PCC M7.5. 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.
7.05.03	**Backfilling in Power House & Boiler Area** Backfilling around foundations, trenches, sumps, pits, plinths, etc. shall be carried out with sand in layers not exceeding 300 mm compacted thickness and each layer shall be compacted to minimum 80% of relative density. **Backfilling in other area** 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 upto 500mm with heavy mechanical compacting equipment) and each layer shall be compacted to 90% of standard proctor density for cohesive soils and to 80% of relative density for non cohesive soils. Rock pieces having size less than 150 mm and interstices filled with soil may be used for backfilling around foundation, plinths etc. and shall be compacted to minimum of 85% of original stack of material after filling the interstices.
7.05.04	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.
7.05.05	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.
7.05.06	The contractor shall take all necessary measures during excavation to prevent the hazards of falling or sliding of material or article from any bank or side of such excavation which is more than one and a half meter above the footing by providing adequate piling, shoring, bracing etc. against such bank or sides. Adequate and suitable warning signs shall be put up at conspicuous places at the excavation work to prevent any persons or vehicles falling into the excavation trench. No worker should be allowed to work where he may be stuck or endangered by excavation machinery or collapse of excavations or trenches.
7.06.00	**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.
7.06.01	Controlled blasting shall be done by a specialised agency duly approved by Engineer. All controlled blasting shall be done by using time delay detonators (i.e. excel type).
7.06.02	a) Contractor shall engage an agency expert in blasting such as, NIRM (National Institute of Rock Mechanics), CMPDIL, Central Institute of Mining and Fuel Research Dhanbad, Dept. of Mining of Govt. Institutions etc. to design detailed blasting scheme and get the same approved from Engineer before carrying out the blasting operation. All blasting shall be done as per the approved blasting scheme & initial blasting operations shall be done under the supervision & guidance of the representative of the blasting expert. b) All the statutory laws, (Explosives Act etc.) rules, regulations, Indian Standards, etc. pertaining to the acquisition, transport, storage, handling and use of explosives, etc. shall be strictly followed.

c) The Contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives as per explosives act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive Materials.

d) The Contractor shall be responsible and liable for any accident and injury / damage which may occur to any person or property of the project or public on account of any operations connected with the storage, transportation, handling or use of explosive and blasting operations.

7.07.00 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, drainage, etc. shall be provided and installed by the Contractor, to the satisfaction of the Engineer.

7.08.00 SPECIAL REQUIREMENTS FOR RIVER SIDE/SUBMERGENCE FACILITIES

Bidder may provide suitable foundations as per IRC. The design of river/water body side foundations shall account for local scour around foundations, which shall be assessed by Contractor. Scour depth calculation shall be as per IRC.
During design the Allowable Bearing Pressure/pile capacity shall be adopted after approval of geotechnical investigation report.

A) Bridges/ Approach bridge piles (Incase pile foundations are to be adopted)

i) The design of river/water body side piles shall account for local scour around pile, which shall be assessed by Contractor. Scour depth calculation shall be as per IRC.

ii) Contribution of frictional resistance from bed level upto maximum scour depth shall not be considered for computation of frictional resistance of river/water body side piles.

iii) All piles shall be located using Total Station Laser Operated Instrument.

iv) Initial pile load test under vertical (compression) & lateral loads shall be conducted on initial test piles installed river/water body side as per relevant IRC/IS code. If it is not feasible, initial load tests in simulated conditions (removal of skin friction from pile cut of level to the river bed level) may be conducted on river/water body bank with the approval of the Engineer.

v) All the river/water body work safety norms shall be adhered to.

vi) Diameter of piles for bridge/ approach bridges shall be 1200mm. The vertical capacity, uplift & lateral load carrying capacity shall be as per the geotechnical investigation report duly approved by the Owner.

7.09.00 Geotechnical Investigation

The Contractor shall carry out detailed geotechnical investigation in the areas under his scope for establishing the sub-surface conditions and to decide type of foundations for the structures envisaged, construction methods, any special requirements/treatment called for remedial measures for sub-soil/ foundations etc. in view of soft sub-soils, aggressive sub-soils and water, expansive/swelling soils etc. prior to commencement of detailed design/drawings. The Contractor shall obtain the approval for the field testing scheme proposed by him from the Owner before undertaking the geotechnical investigation work.

7.09.01.00 **Scheme of geotechnical Investigation**

7.09.02.01 Field test shall include but not be limited to the following:

Boreholes, Standard Penetration Test (SPT), Dynamic Cone Penetration Test (DCPT), collection of disturbed samples (DS) and undisturbed soil samples (UDS), Trial Pits (TP), Plate Load Tests (PLT),Cyclic Plate Load Test(CPLT), Electrical Resistivity Test (ERT), Cross Hole

	Test, Pressure Meter Test (PMT), In situ field permeability tests, collection of water samples, etc.
7.09.02.02	The diameter of borehole shall be minimum 150 mm in soil and 76 mm in rock. The diameter of UDS sampler shall be 100 mm minimum. Core drilling in rock shall be done by using hydraulically feed rotary drill & double tube core barrel with diamond bit.
7.09.02.03	The minimum tests are indicated in relevant clause**.** Adequate number of tests shall be conducted up to sufficient depth for complete determination of subsoil conditions. The depth of boreholes shall be as specified in relevant clause. SPT shall be carried out in all types of soil deposits and in all rock formations with core recovery up to 20%, met within a borehole. This test shall be conducted at every 3.0 m interval or at change of strata, up to the final depth. SPT 'N' of 100 and above shall be referred as refusal. UDS shall be collected at every 3.0 m interval or at change of strata up to depth of borehole. UDS may be replaced by additional SPT, if SPT'N' value in the strata is above 50.
7.09.02.04	Laboratory tests shall be done as per relevant IS codes. The laboratory tests, not be limited to the following shall be conducted on disturbed and undisturbed soil samples, rock samples & water samples collected during field investigations in sufficient numbers. **Laboratory Tests on Soil Samples** Laboratory tests shall be carried out on disturbed and undisturbed soil samples for Grain Size Analysis, Hydrometer Analysis, Atterberg Limits, Triaxial Shear Tests (UU), Natural Moisture Content, Specific Gravity and Bulk Unit Weight, Consolidation Tests, Unconfined Compression Test, Free swell Index, Shrinkage Limit, Swell Pressure Test, Chemical Analysis test on soil and water samples to determine the carbonates, sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel. **Laboratory Tests on Rock Samples** Moisture content, porosity & density, Specific Gravity, Hardness, Soundness, Slake durability index, Unconfined compression test (Both at saturated and in-situ water content), Point load strength index and deformability test (Both at saturated and in-situ water content) shall be carried out on rock samples.
7.09.02.05	Geotechnical investigation (field & laboratory) shall be carried out in accordance with the provisions of relevant Indian Standards. On completion of all field & laboratory work, geotechnical investigation report shall be submitted for Owner's review/approval. The Geotechnical investigation report shall contain geological information of the region, procedure adopted for investigation, field & laboratory observations/ data/ records, analysis of results & recommendations on type of foundation for different type of structures envisaged for all areas of work with supporting calculations. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, recommendation along with slope stability calculation for deep excavation, etc.
7.09.03.00	**Geotechnical investigation work may be got executed by the Contractor through the following suggested agencies** **1. C.E.TESTING COMPANY Pvt. Ltd, Kolkata** **2. Cengrs Geotechnica Pvt. Ltd, New Delhi** **3. KCT Consultancy Services, Ahemdabad** **4. M.K. Soil Testing Laboratory, Ahemdabad** **or any other agency having adequate experience for carrying out such works**

and approved by engineering department of the owner.

7.10.00 **Geotechnical Investigation Scheme**

a) **Boreholes (Minimum)**

S.N	Structure	Spacing/Number of borehole	Depth of borehole	Remarks
1	Main power house, Turbo-Generator (TG)	30 to 45 m along the rows of main power house columns. Minimum 2 boreholes under each TG	20 to 25m.	Depth of boreholes shall be as mentioned in column "Depth of Borehole" or 5m continuous in rock with RQD > 50% whichever is earlier.
2	Main Plant structures (Boiler, ESP, Chimney, Mills, Fans etc)	Minimum 4 boreholes under each Boiler, Mill & Bunker, ESP structure and 4 boreholes under Chimney, Minimum 2 boreholes under each ESP Control Room, TPs, Fans and Duct Support.	20 to 25m.	
3	Service Building	Minimum 2 no of boreholes	20 to 25 m	
4	CPU Building	Minimum 2 no of boreholes	15 to 20m	
5	Flue Gas Ducting and Absorber Area (FGD)	Minimum 15 boreholes	20 to 25m	
6	Ash Handling Structures	Minimum 8 boreholes	20 to 25 m	
7	Corridors for Ash pipe routes	1 borehole @ 500 m c/c along the identified corridor and one ERT shall be conducted near each borehole	8-12 m	
8	Crossings along the pipeline corridor like road, river, nallah/ canal, Approach bridge	2 no. of boreholes at each crossing (one on each side) and 2 nos (min) of boreholes inside the river/ nallah of width more than 10.0m	15 to 20m	
9	Cooling Tower Area, CW system Area	4 boreholes and one ERT in each CT. 4 boreholes and two ERT in CW system Area	15 to 20m	
10	Switchyard	Minimum 10 No of Boreholes	10 to 15 m	
11	Coal, Limestone and Gypsum Handling System	Minimum one borehole under each TP and one under each crusher and one borehole under	20 to 30 m	

		each structure. Minimum 6 no of under each stockpile area, 12 nos in Limestone and Gypsum handling area, 8 nos in Track & Truck Hopper area and 8 Nos of ERT		
12	Transformer yard	Minimum 8 boreholes and 3 Nos ERT	10 to 15 m	
13	Water treatment plant Area	Minimum 8 boreholes and 4 Nos of ERT	15 to 20 m	
14	Raw water system Area	Minimum 4 boreholes	15 to 20 m	
15	Miscellaneous buildings	1 borehole under each buildings	15 to 20 m	
16	Reservoir	20 Nos	10 to 15m	
17	Make-up Water pump house, Control room building	Minimum 10 Nos. 4 Nos ERT	25 to 30 m	
19	Other Structure/Facility	Minimum 2 Nos. boreholes under each area / facility	10 to 15 m	

b) Other Field Tests (Minimum)

1	Plate Load Test (PLT)	2 no in Power House, 3 Nos. in boiler area, 1 No. in CPU, 1 no each in each ESP and 3 Nos. in Ash Handling Structure area in Plant Area, 6 No in Balance of Plant area	Test Depth from 2 to 4 m	
2	Cyclic Plate Load Test (CPLT)	1 no in each TG, 1 no in each Mill, 1 no in ID fan, 1 no in each FGD	Test Depth from 2.5 to 4 m	
3	Trial Pit (TP)	About 35 Nos.	Depth 3- 4 m	
4	In Situ Permeability Test In Boreholes	In minimum 35 Nos. of boreholes	Tests shall be conducted at depths of 1.0m, 3.0m, 5.0m, 8.0m and 10.0m in other than Track & Truck hopper area. In Track & Truck hopper area test shall be	

			conducted at depths of 1.0m, 4.0m,7.0m, 10.0m, 13.0m,16.0m and 20.0m	
5	ERT	6 Nos. in TG/Power House area, 1 No. in CPU Building, 2 Nos. each in Boiler, Chimney, ESP Control Room, 4 Nos. in Ash Handling Structures area in Plant area, 4 Nos in FGD, 8 Nos in switchyard, 1No near each Pump House other than mentioned above		
6	CROSS-HOLE TEST	1No. in each TG, 1No. in each Mill & bunker and 2 Nos in ID Fan, 1 no in each FGD	Depths covering from 1.0 m to 15.0 m	
7	PMT	80 no of tests in power house area, SG area & Balance of Plant area	Depths covering from 1.0 m to 20.0 m	

- Depth and location of Boreholes and other field tests (PLT, ERT, field permeability tests etc.) shall be approved by Owner before execution of geotechnical investigation work.
- Investigation in any other building / structure / facilities / trestles which are not mentioned above shall also be carried out, if required, by the bidder for the facilities under his scope.

D-1-8 GENERAL SPECIFICATION

8.01.00 **GENERAL REQUIREMENTS**

8.01.01 **JOINTS IN CONCRETE STRUCTURES**

Construction Joints

All horizontal construction joints shall be provided with a groove (shear key) for transfer of shear force.

For construction joint in concrete wall, the maximum height of any lift should not exceed 2 meters. However, the time interval between the successive lifts should be as small as possible and the wall should be built to its full height in the least possible time.

Expansion joints for all underground structures shall be made watertight by using ribbed PVC water stops with central bulb or of kicker type. The thickness and width of PVC water stops shall be as per the requirement of design. However, the minimum thickness and width shall be 6mm and 225mm respectively.

Expansions Joints

In case of expansion joints, preformed bitumen impregnated fibre board conforming to IS 1838 shall be used as joint filler. The joints shall be sealed with bitumen sealing compound conforming to IS 1834, however in case of liquid retaining/carrying structures, two parts polysulphide sealant conforming to IS 12118 or silicon sealing compound shall be used.

IS 3414 shall be followed for details of joints in buildings. 3 mm thick stainless steel strip in matt or buff finish shall be provided over building expansion joints.

8.01.02 **Miscellaneous General Requirements**

8.01.02.1 All steel sections and fabricated structures, which are required to be transported on sea, shall be provided with anti-corrosive paint before shipment to take care of sea worthiness.

8.01.02.2 Monorails, monorail girders and fixtures shall be provided, wherever required to facilitate erection / maintenance of equipment.

8.01.02.3 Wherever possible all floor openings shall be provided with 100 mm thick 150 mm high RCC kerb all around.

8.01.02.4 Angles 75 x 75 x 6 mm (minimum) with 8mm diameter and 150mm long MS lugs @ 150 c/c shall be provided for edge protection all around cut outs/openings in floor slabs. Angles 50 x 50 x 6mm with effective anchor lugs shall be provided for edges of concrete drains supporting grating/covers, edges of RCC cable / pipe trenches supporting covers/chequered plates/ grating, edges of manholes supporting covers, supporting edges of precast RCC covers and any other place where breakage of corners of concrete is expected.

8.01.02.5 Floor of switchgear room shall be provided with embedded M.S. channel suitable for easy movement of breaker panels.

8.01.02.6 Anti-termite constructional measures and chemical treatment measures shall be given to all vulnerable areas susceptible to termite including column pits, wall trenches, foundations of buildings, filling below the floors, etc., as per IS 6313 and other relevant Indian Standards.

8.01.02.7 All cable & pipe routing shall be done as per system requirement and as stipulated elsewhere in the specification and shall run above ground on elevated trestles or other supporting structures except in some localized area (as approved by Employer) where the same can run in trenches. In case, pipes are to be routed on RCC pedestals, the height should not be less than 500mm above formation level/paving level. All trenches shall be of RCC with removable RCC covers.

	All cable trenches located inside buildings shall have minimum 6mm thick (o/p) chequered plate covers.
	Cable trenches, where allowed, located outside the buildings shall project at least 200mm above the finished formation level unless noted otherwise elsewhere in this specification so that no storm water shall enter the trench. The bottom of the trench shall be provided with a longitudinal slope of 1:500.The downstream end of trenches shall be connected through pipe drains to the nearby RCC manholes (to convey water from trenches) of storm water drainage system, but avoiding back flow of storm water. In general, the precast covers shall not be more than 300 mm in width and shall not weigh more than 65 kg. Lifting hooks shall be provided in the precast covers.
	All cable trenches, wherever required, shall be provided with suitable insert plates for fixing support angles of cable trays.
	In Main plant area wherever fire water pipe trenches are envisaged, these trenches shall be of RCC and provided with precast RCC cover flush with finished level of paving in that area.
	R. C. C. cable slits shall be filled with sand after erection of cables, up to top level and covered with 75mm thick PCC cover of minimum M15 grade.
8.01.02.8	All steel platforms above grade shall be provided with 100 x 6 thick kick plates at edge of platform.
8.01.02.9	Duct banks consisting of PVC conduits conforming to IS 4985 for cables shall be provided with proper sealing arrangement consisting of fire retardant sealing compound.
8.01.02.10	Independent network of lines for sewerage and drainage shall be provided. Plant effluent shall not be mixed with either storm water or sewage.
8.01.02.11	The sub-grade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor density at Optimum moisture content (OMC.)
8.01.02.12	Detailed scheme for dewatering shall be prepared, wherever required, before starting of deep excavation work. IS 9758 shall be followed as general guidance for dewatering.
8.01.02.13	Structural steel column base plates and bolts, gussets, etc., shall not project above the floor level unless and noted otherwise. These shall be encased by concrete cover up to floor level with concrete grade M 25.
8.01.02.14	Non-shrink flow able grout shall be used for under-pinning work below base plate of columns. Nominal thickness of grout shall be 50 mm. Non-shrink cum plasticizer admixture shall be added in the grout. Crushing strength of the grout shall generally be one grade higher than that of the base concrete. Minimum grade of grout shall be M-30.
	Grouting of all pockets, blockouts, sleeves and the openings around the embedment, inserts, bolts etc. and under pinning below the base / sole plate shall be with non - shrink flow able grout. Grade of grout shall be one grade higher than concrete. However minimum grade of grout shall be M - 30.
	However, for equipment foundations, high strength (minimum characteristic compressive strength of 60 N/sq.mm at 28 days) ready mixed non-shrink, chloride free, cement based, free flowing, non-metallic grout as recommended by equipment manufacturer shall be used.
8.01.02.15	All the buildings and site development including landscaping shall be designed to take care of rain water harvesting & ground water recharging. Development of rain water harvesting scheme for the buildings, structures, facilities in Bidder's scope and obtaining approval of the scheme from Central Ground Water board is in Bidder's scope.
8.01.02.16	As required suitable steel frames shall be provided around openings in the roof and external walls for mounting exhaust fans.

8.01.02.17	750mm wide x 100 mm thick plinth protection in PCC (M-15) shall be provided around all buildings, pits / sumps, clarifiers, tanks, etc.
8.01.02.18	All masonry walls shall be provided with Damp Proof Course at plinth level.
8.01.02.19	All monorail openings in the walls shall be provided with double plate flush steel door shutters with suitable access platform and ladder as required.
8.01.02.20	Hand rail (of minimum 1m height), size and material to be adopted shall be as per general architectural specification.
8.01.02.21	In all buildings, suitable arrangement for draining out water collected from equipment blow downs, leakages, floor washings, firefighting etc. shall be provided for each floor with suitable floor drains.
8.01.02.22	Unless specified all sand filling shall be compacted to minimum 80% of the relative density and backfilled earth shall be compacted to minimum 90% of the Standard proctor density at OMC.
8.01.02.23	All buildings shall be provided with peripheral drains by the side of plinth protection for catering to the rain water from roofs and storm water from adjacent area. Plinth protection drains shall be provided all around the building and to be connected with nearest storm water drain. Minimum size of plinth protection drain will be 300mmx300mm.
8.01.02.24	Minimum 2.0m wide walkway with plain cement concrete (nominal mix M15 grade) paving 150 mm thick laid over 75 mm thick bed of dry aggregate shall be provided connecting all buildings and facilities. The top of walkway shall be minimum 200mm above FGL, unless specified otherwise.
8.01.02.25	For all buildings, finished floor level (FFL) shall be minimum 500mm above finished ground level (FGL).
8.01.02.26	40mm Diameter MS rods as earthing mat, placed at a distance of 1.0m away and at depths between 0.60m and 1.00m shall be supplied and laid all around the periphery of buildings, structures, and outdoor equipment, as per approved drawings. Riser of 40mm Dia. MS rods and connecting to the above Earthing mat shall also be supplied and laid in position by the Contractor, as per the approved drawings. Raiser shall be laid up to a height of 300 mm above the local Ground level, at each of the columns of the buildings on the outside of the buildings, and minimum 2 (two) numbers for each structures and equipment. The contractor shall also supply and lay necessary number of 3.0 m deep 40 mm diameter MS rods Earthing electrodes and connect electrodes to the Earthing mat, as per the approved drawings and supplying and laying of 40 mm Dia. MS rods for connecting the Contractor's earthing mat with the Employer's earthing mat separately.
8.01.02.27	Hume pipes of required class shall be as per IS: 458. Hume pipe made of Geopolymer concrete may also be used. Details of ingredients for Geopolymer concrete is as per details specified elsewhere.
8.01.02.28	Coefficient of active earth pressure shall be considered for design of free standing retaining walls and coefficient of earth pressure at rest shall be considered for design of top propped retaining walls.
8.01.02.29	Interlocking concrete block , kerb blocks or concrete block specified for various uses shall be precast blocks made of alkali-activated concrete /Geopolymer concrete as per IS:17452-2020.
8.01.02.30	Rail-track from transformer yard to unloading bay of Main Power House shall be provided with rigid type RCC foundation. Rail weighing 52 kg/m(minimum) shall be used.
8.01.03	**Acid/ Alkali Resistant Lining**
	All structures receiving acid / alkali resistant lining shall be tested for water tightness and made leak proof before lining work.
	The acid / alkali resistant lining shall be provided broadly in the areas identified. The Bidder

shall give a guarantee for satisfactory functioning of the lining for a period of 36 months from the date of completion of the work or date of handing over the site to the Engineer, whichever is later. The Bidder shall replace / rectify defects is any, observed in the lining to the satisfaction of the Engineer without any extra cost during this period.

The material for Acid/ Alkali Resistant Lining shall conform to the following:

i) Bitumen primer shall conform to IS: 158.

ii) Bitumastic compound shall conform to IS: 9510. Where the height of bitumastic layer on vertical surface is more than 2.0 m, the bitumastic layer shall be reinforced with diamond pattern expanded metal steel sheets conforming to IS: 412.

iii) A.R. Bricks/ Tiles shall conform to class II of IS: 4860 & IS: 4457 respectively.

iv) Mortar: Potassium silicate & resin type mortars shall conform to IS: 4832 Part-I&II respectively.

8.02.00 **CONCRETE**

8.02.01 **GENERAL**

a) Concrete work shall be of grade as per IS 456. Mix design concrete shall be used for all areas other than lean concrete work and plain cement concrete where nominal/volume mix can be permitted. Design mix shall be carried out as per IS10262. Specific approval of the Engineer shall be obtained regarding degree of quality control to be adopted for design mix.

b) Minimum grade of reinforced cement concrete for all foundations shall be M25 unless noted otherwise. Minimum grade of concrete for other structures/areas (other than machine foundations) shall be M25 for all superstructure and substructure unless noted otherwise elsewhere in this specification.

c) The minimum grades of concrete for different machine foundations and some of other important structural members shall be as follows:

Sl No	Description	Minimum grade of concrete
i)	ID, FD, PA fan & Mill foundations (block foundations)	M-30
ii)	TG top Deck	M50
iii)	TG Raft/ Substructure	M35
iv)	Complete wagon trippler/track hopper, Stacker and Reclaimer foundations, Crusher Deck foundation and other railway load bearing structures.	M35
v)	BFP foundations (in case of springs supported) / (in case of block foundation)	M35 / M30
vi)	Rail load Bearing Structures	M35

Concrete design mix of M50 grade concrete for TG top deck and substructure shall be carried out as per IS 10262 satisfying following conditions /Specification:

i) OPC 43 grade cement shall be used to design M50 grade of concrete mix. However, in case the mix design using OPC 43 grade cement fails to achieve the target strength of M50 grade concrete, OPC 53 grade cement may be used provided adequate precautions for higher heat of hydration and quality assurance measures are in place.

ii) The concrete slump shall be in the range of 150-180mm at pouring point.

iii) Maximum cement content (OPC) shall be limited as stipulated in IS 456.

iv) Free water-cement ratio shall be as per clause 5.1 of IS 10262.

v) PCE type superplasticizers shall be used as high range water reducing admixtures (Type F as per ASTM C494 or equivalent) in the concrete mix. Dosage & mixing methodology of this chemical admixture shall be as per manufacturer's recommendation.

vi) Fly ash conforming to IS 3812 part 1 shall be used as pozzolana (mineral admixture) considering approx 15%-30% (mass) replacement of total cementitious materials.

d) Higher grade of concrete than specified above may be used at the discretion of the Bidder.

e) Unless otherwise specified, 20mm and down aggregates shall be used for all structural concrete works. However, 40mm and down aggregates may also be used under special conditions for mass concreting in foundation.

f) For thin concrete sections such as roof slab over profiled metal deck sheets, 12mm and down coarse aggregates shall be used for coarse aggregates.

g) Minimum 75mm thick lean concrete M-7.5 shall be provided below all other underground structures, foundations, trenches, etc., to provide a base for construction.

h) All structural(reinforced) concrete production shall be done at automated batching plant of suitable capacity, conforming to IS:4925., situated within the area allocated to the contractor. Batching plant shall also have provision to mix fly ash (by weight). The batching plant shall have facility of digitised recording of the materials added along with quantity of concrete produced in each batch and printout of the same. Batch-wise report for each shift shall be submitted to the Engineer.

8.02.02 **Reinforcement Couplers**

Reinforcement couplers (mechanical splicing systems with upset parallel threaded couplers) may be used in reinforced concrete works, subject to following conditions:

a. Couplers shall meet the performance requirements of IS 16172 for class H.
   i. It shall have minimum tensile strength corresponding to Fe550D which is 600 N/mm2 and failure shall take place outside the length of splice as per clause no 9.2.1 of IS 16172.
   ii. Percentage elongation at maximum force in the reinforcing bar outside the length of mechanical splice shall be minimum 3 % before the failure of test piece as per clause no. 9.2.2 of IS:16172.
   iii. Slip test value shall not exceed 0.10 mm. as per clause no 9.3 of IS 16172.
   iv. Cyclic tensile test corresponding to Fe550D reinforcement bar as per clause no 9.4 of IS 16172.
   v. Low cycle fatigue test as per clause no 9.5.1 of IS 16172.
   vi. High Cycle Fatigue test as per clause no 9.5.2 of IS 16172.

b. The manufacturer shall mark the coupler in such a way that all finished reinforcement couplers can be traced to the original cast from which they were made along with date of manufacture.

c. Sampling and other requirements of IS 16172 shall be complied with.

d. Each lot shall be supplied with manufacturer's test certificate (MTC) indicating values of tests in line with IS 16172.

e. The minimum clear cover requirements are to be ensured for reinforcement couplers also.

f. The couplers shall be used only at the locations where joint is required as per standard lapping purpose and couplers shall not be used for joining of several cut pieces of reinforcement in a single bar. As a general guideline, the length of the bars in which coupler is to be provided should not be less than 4m.

Vendors for the reinforcement couplers shall be subject to the approval of Engineer-In-Charge

8.02.03 Special requirements for concreting of major equipment foundations shall be as given below.

a) **Temperature Control of Concrete**

All the machine foundations such as Mills & Fans, top decks of TG & BFPs, the temperature of fresh concrete shall not exceed 25 deg C when placed. For maintaining the temperature of 25 deg C, crushed ice shall be used in mixing water.

b) **Admixture**

Plasticizer /super plasticizer admixture shall generally be added to the concrete for promoting workability. In addition, plasticizer/super plasticizer-cum-retarder shall be added to retard the setting time for mass concreting work as required. In case of pumping, suitable pumping additive shall also be added to avoid segregation and increase flowability. The slump shall generally be in the range given below:

Top decks of TG & BFP	-	150 mm to 180 mm
Block foundations	-	100 mm to 150 mm
TG Column	-	100 mm to 150 mm

c) **Form work**

Plywood with film face form work shall be used for the top decks of all machine foundations

d) **Placing of Concrete**

Base Raft and top deck of machine foundations shall be cast in a single pour.

e) **Scheme for Concreting**

Weigh Batching Plants, transit mixer, concrete pump shall be mobilized. Arrangements for standby Plant and Equipment shall also be made.

f) **Ultrasonic Testing**

Ultrasonic pulse velocity test shall be carried out for TG top deck including TG Columns & BFP top decks (in case of Block type, UPV testing is not required) to ascertain the homogeneity and integrity of concrete. In general, grid spacing of 1.0m to 1.5m may be adopted for carrying out the UPV testing. In addition, additional cubes (at the rate of one cube per 150 Cum of concrete subject to a minimum of six cubes) shall be taken to carry out Ultrasonic Pulse velocity (UPV) testing on the cubes, to

serve as reference UPV values. Testing shall be done as per IS13311 (Part-1). In case of any defect, the Bidder shall rectify the defects suitably using cement/epoxy grout, etc.

Wherever block type foundations are provided for machine foundations such as BFPs, UPV testing of foundation concrete is not required.

8.02.04 **Anchor Fasteners**

Anchor Fasteners for use in concrete shall conform to the following:

a. The safe tensile load carrying capacity of the anchors shall be arrived by providing the minimum factor of safety of 2.5 on the characteristic load of the anchor. Minimum size of the anchors shall be M8.

b. All anchors shall be from established and approved makes/ manufacturers.

c. Anchors shall be fixed in position as recommended by the manufacturer and as approved by the engineer.

d. Anchor fastener can be of mechanical type based on working principles such as keying, friction, combined friction- keying or chemical bonding type.

1) Mechanical type: The anchors shall be cold formed stud type torque controlled mechanical expansion fasteners having 3-way expansion sleeve of SS 316 grade with nut and washer and galvanized to minimum 5 microns. For coastal/ corrosive environments, the anchors shall be of Stainless Steel (min grade SS 304) or HCR (High Corrosion Resistance). The anchors shall conform to a minimum grade of 5.8 as per IS: 1367.

2) Chemical type: The anchor shall be adhesive type consisting of slow curing chemical adhesive with a proportion of resin and hardener as per manufacturer's recommendation in a soft foil pack, threaded rod of carbon steel conforming to a minimum grade of 5.8 as per IS: 1367 and minimum galvanization of 5 microns with associated nut and washer. The chemical shall be dispensed through mechanical dispenser and shall be self-curing type.

e. Capacity of the anchors shall be established after considering the effect of concrete grade, embedded depth, concrete thickness, anchor spacing and edge distance from the concrete.

f. The selection for particular type of the anchors shall be made after considering the concrete grade, available embedment depth, load to be transferred, space available for installing anchors.

8.03.00 **FORMWORK**

Formwork for building RCC Slabs/ Beams & Columns shall be of 2 different types.

Type 1 Formwork: (For RCC slab of Structural Steel Framed Buildings Only)

Troughed colour coated metal deck sheets shall be used as permanent shuttering having minimum thickness of 0.80mm. These profiled metal deck sheets shall be fixed to the structural

steel secondary beams/ Purlins using Headed shear anchor studs. The detailed material property requirement of metal deck sheet is specified elsewhere in this specification.

The shear anchor studs for fixing metal deck sheet to floor structural beams shall conform to Type-B studs specified in AWS D1.1/D1.1M or equivalent as shear connector of 19mm diameter and 100mm length manufactured from cold drawn round steel bars conforming to the requirement of ASTM A 29, of grade designation 1010 through 1020, of standard quality with either semi-killed or killed, welded by Drawn Arc Stud Welding through metal deck sheet.

The shear anchor studs for fixing metal deck sheet to roof structural purlins shall conform to Type-B studs specified in AWS D1.1/D1.1M or equivalent as shear connector of 16mm diameter and 65mm length manufactured from cold drawn round steel bars conforming to the requirement of ASTM A 29, of grade designation 1010 through 1020, of standard quality with either semi-killed or killed, welded by Drawn Arc Stud Welding through metal deck sheet.

Type 2 Formwork: (For RCC Buildings)

Plywood with film face formwork shall be used for floor & roof slabs, Columns & Beams of all RCC buildings.

8.04.00 **CULVERTS /RACKS ACROSS RAIL TRACKS**

Design of bridges/ culverts or any other structure crossing the Railway tracks shall be as per Railways/ RDSO guidelines/specifications for Dedicated Freight Corridor (DFC) 32.5 T loads. The Bidder shall obtain necessary approvals from Railways before start of construction work. Construction of these structures is to be done as per Railways guidelines. Any statutory and codal charges payable to Railways/ RDSO for approval & execution of the above crossings shall be borne by the Bidder. Engagement of approved Railway Consultant for the above work by the bidder would be at his own cost.

The levels/clearances of the above crossings are to be finalized by the bidder as per Railway standards and shall be subject to approval of Owner/Owner's Consultant.

However, for design of the above crossings above rail track, the following minimum clearance from Rail track shall be maintained:

A. Horizontal clearance: A minimum clearance of 3.5m shall be maintained between centre line of the Railway track to face of the crossing structure.

B. Vertical clearance: A min vertical clearance of 8.5m shall be maintained between Rail top level and bottom of structure.

Bidder has to submit to the Owner two sets of railway approved drawings and two sets of (hard & soft copies) as built drawings.

The construction of rail network inside the plant for transportation of coal, fly ash & POL is in the scope of Owner. The bidder should plan to complete the construction work of all roads/ drainage/ pipe line/ cable crossings etc which are crossing below the rail track well in advance to facilitate owner to undertake the construction work of siding.

8.05.00 **FENCING AND GATE**

8.05.01 **FENCING**

Fencing with gate shall be provided around fuel oil area, and other areas wherever necessary due to security, safety, and statutory requirements as per following specifications. However for isolation between existing station/township and the project, the total height of fence may be reduced to 2.4m with 450mm barbed wire on top, while other details being same as given below.

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.

The PVC coated chain link will 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 will 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 will 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 will 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 will have two stay posts and every tenth post will 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 50 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 paint (Sandtax Matt or equivalent) of approved colour and shade. Toe wall shall be provided with weep holes at appropriate spacing.

8.05.02 **Gate along Fencing**

All gates shall be of structural steel of minimum 3.75 metre width for single lane access road and 8.00 m width for double lane access roads. The height of gate shall be same as that of the fence unless noted otherwise. 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 aldrops with locking arrangement, tempered steel pivot, guide track of MS tee, bronze aluminium ball bearing arrangement, castor wheel, etc.

8.06.00 **GRATING**

All gratings shall be electroforged types. Minimum thickness of the grating shall be 40 mm for indoor installation and 32 mm for outdoor installation. The opening size shall not be more than 30mmx100mm. The minimum thickness of the main bearing bar shall be 5 mm or as per design requirement whichever is higher. All gratings shall be hot dip galvanised at the rate of 610 g. per sq.m. after surface preparation by means of shot blasting or cleaned by acid pickling.

8.07.00 **FABRICATION & ERECTION OF STEEL STRUCTURES**

The fabrication shall be done as per fabrication drawing which would clearly indicate various details of joints to be welded, type of weld, length and size of weld.

All steel structures shall be fabricated in factory, transported and erected at site. All factory fabricated structures shall have bolted field connections.

Coal bunkers with hoppers and chimney flue liners can either be fabricated at factory in segments, transported and welded at site before erection or fabricated at site. For coal bunkers, hoppers and chimney flue liners, to prevent coal dust/flue gas leakages, the applicable field joints shall necessarily be welded.

Note: Steel structures shall mean Plant and Non-Plant building structures, boiler & ESP support structures, CHP structures (boiler area), AHP structures, chimney flue liners support platforms & stairs, pipe and cable support structures.

Site welding can be permitted in special cases where final inputs are not available before release of fabrication drawings.

Before dispatching the fabricated structural members to site, it shall be ensured that all parts in the assembly fit accurately together by carrying out pre-assembly of fabricated structural members having bolted field joints, in the factory.

All steelwork before and after manufacturing shall be smooth, straight and free of deformations, cracks, twists and burrs. All steelwork shall be cut and fabricated to a tolerance of ± 1.5 mm in its length and location of matching bolt holes for field connections.

8.07.01 **Welding**

a) Welding of Structural steel shall be done by an electric arc process and shall conform generally to relevant acceptable standards viz. IS:816, IS:9595, IS:814, IS:2014, IS:4354 and Indian Standard Hand Book for metal arc welding, and other standards, codes of practice internationally accepted. For welding of any particular type of joint, Bidder shall give appropriate tests as described in any of the Indian Standards - IS: 817, IS: 7307 and international standards as relevant.

b) Submerged arc-welding shall be used for welding longitudinal fillet welds (connecting flange with web) and longitudinal / transverse butt joints for fabrication of columns, framing beams and crane girders and all other built-up members, unless manual arc welding is specifically approved by the Engineer. Necessary jigs and fixtures and rotation of structures shall be so arranged that vertically down-hand position of welding becomes possible. 'Open-Arc-Welding' process employing coated electrodes shall be employed for fabrication of other welded connections and field welding.

c) Wherever welding is done for assembling the components of structures, the job shall so positioned that down hand welding is possible.

d) Any structural joint shall be welded only by those welders who are qualified for all welding procedures and positions in such type of joint that is welded.

e) All records for entire welding operations such as welders identification marks, the joints welded by the each welder, the welding procedures adopted, welding machine employed, pre and post heating done and any non-destructive test done and stress relieving /heat treatment performed on such joints shall be accessible to the Engineer for scrutiny.

f) In a fabrication of plated columns/beams and built up members all shop splices in each component part shall be done before such component part is welded to other parts of the member. Wherever weld reinforcement interferes with proper fitting between components to be assembled by welding, these welds shall be ground flush prior to assembly.

g) The members to be joined by fillet welding shall be brought and held as close together as possible and in no event shall be separated locally by more than 3mm. If the local

separation is 1.5mm or greater, the fillet weld size shall be increased by the amount of separation.

Edge preparation for welding as per weld joint detail shall be prepared either by machines or by automatic gas cutting. All edges cut by flame shall be ground before they are welded.

8.07.01.1 **Electrodes**

a) The electrodes used for welding shall be of suitable type and size depending upon specification of the parent materials, the method of welding, the position of welding and quality of welds desired e.g. normal penetration welds or deep penetration welds. However, only low Hydrogen electrodes shall be used for plate thickness above 20 mm.

b) All low hydrogen electrodes shall be baked and stored before use as per manufacturer recommendation. The electrodes shall be rebaked at 250°C - 300°C for one hour and later on cooled in the same oven to 100°C. It shall be transferred to a holding oven maintained at 60°C - 70°C. The electrodes shall be drawn from this oven for use.

c) Where coated electrodes are used they shall meet the requirements of IS: 814 and relevant ASME-Sec. Covering shall be heavy to withstand normal conditions of handling and storage.

d) Only those electrodes which give radiographic quality welds shall be used for welds which are subjected to radiographic testing

e) Where bare electrodes are used, these shall correspond to specification of the parent material. The type of flux-wire combination for submerged arc welding shall conform to the requirements of F-60 Class of AWSA-5-17-69 and IS: 3613. The electrodes shall be stored properly and the flux shall be baked before use in an oven in accordance with the manufacturer's requirements as stipulated.

f) 308L and 309L electrodes / fillers shall be used for welding of stainless steel to stainless steel and stainless steel to mild steel respectively.

g) Specific approval of the Engineer shall be taken by Bidder for the various electrodes proposed to be used on the work before any welding is started.

8.07.01.2 **Preheating inter-pass Temperature and Post Weld Heat Treatment**.

a) Mild steel plates conforming to IS: 2062 and thicker than 20mm, may require preheating of the parent plate prior to welding as mentioned in Table-I.

However, higher preheat and inter-pass temperatures required due to joint restraint etc. and will be followed as per approved welding procedure. In welding materials of unequal thickness, the thicker part shall be taken for this purpose.

b) Base metal shall be preheated, notwithstanding provisions of IS: 9595, to the temperature given in Table-1 prior to welding or tack welding. Preheating shall bring the surface of the base metal to the specified preheat temperature and this temperature shall be maintained as minimum temperature while welding is in progress.

TABLE – 1

MINIMUM PREHEAT and INTER PASS TEMPERATURE FOR WELDING

Thickness of thicker part at point of Welding	**Welding using Low hydrogen electrodes or Submerged arc welding**

	Upto and including 20mm	None
	Over 20mm and upto and including 40m	20°C
	Over 40mm and upto and including 63mm	66°C
	Over 63mm	110°C

c) Preheating may be applied by external flame which is non-carbonising like LPG, by electric resistance or electric induction process such that uniform heating of the surface extending up to a distance of four times the thickness of the plate on either side of the welding joint is obtained.

d) Thermo-chalk, thermo-couple or other approved methods, shall be used for measuring the plate temperature.

e) All butt welds with plates thicker than 50mm and all site butts weld of main framing beam shall require post weld heat treatment as per procedure given in AWS D-1.1. Post heating shall be done up to 600°C and rate of application shall be 200°C per hour. The post heat temperature shall be maintained for 60 minutes per 2.5cm thickness. For maintaining slow and uniform cooling, asbestos free pads shall be used for covering the heated areas.

8.07.01.3 **Sequence of Welding**

a) The sequence of welding shall be carefully chosen to ensure that the components assembled by welding are free from distortion and large residual stresses are not developed. The distortion should be effectively controlled either by a counter effect or by a counter distortion. The direction of welding should be away from the point of restraint and towards the point of maximum freedom.

b) Each case shall be carefully studied before finally following a particular sequence of welding.

c) Butt weld in flange plates and/or web plates shall be completed before the flanges and webs are welded together.

d) The beam and column stiffeners shall preferably be welded to the webs before the web and flanges are assembled unless the web and flanges to the beam or column are assembled by automatic welding process.

e) All welds shall be finished full and made with correct number of runs, the weld being kept free from slag and other inclusions, all adhering slag being removed.

f) Current shall be appropriate for the type of electrode used. To ensure complete fusion, the weaving procedure should go proper and rate of arc advancement should not be so rapid as to leave the edges unmelted.

g) Pudding shall be sufficient to enable the gases to escape from the molten metal before it solidifies.

h) Non-uniform heating and cooling should be avoided to ensure that excessive stresses are not locked up resulting ultimately in cracks.

i) The ends of butt welds shall have full throat thickness. This shall be obtained on all main butt welds by the use of run off and run on pieces adequately secured on either side of main plates. The width of these pieces shall not be less than the thickness of the thicker part joined. Additional metal remaining after the removal of extension

pieces shall be removed by grinding or by other approval means and the ends and surface of the welds shall be smoothly finished. Where the abutting parts are thinner than 20mm the extension pieces may be omitted but the end be welded to provide the ends with the required reinforcement.

j) The fusion faces shall be carefully aligned. Angle shrinkage shall be controlled by presetting. Correct gap and alignment shall be maintained during the welding operation.

k) All main butt welds shall have complete penetration and back surface of the weld being gouged out clean before first run of the weld is given from the back. However, partial penetration butt weld shall be permitted, when specifically shown in the design drawings.

l) Intermittent welds shall be permitted only when shown in the design drawings.

m) The welding shrinkage shall be minimised by adopting the correct welding procedure and method. In long and slender member extra length should be provided at the time of fabrication for shrinkage.

8.07.01.4 **Testing of Welders**

All the welders to be employed for the job shall have to qualify the appropriate tests laid down in IS: 817 and IS: 1181 and ASME IX/AWS D1.1. All the necessary arrangements required for the testing of welders are to be provided by the Bidder.

8.07.01.5 **Inspection of Welds**

a) **Visual Inspection**

100 percent of the welds shall be inspected visually for external defects. Dimensions of welds shall be checked. The lengths and size of weld shall be as per fabrication drawings. It may be slightly oversized but should not be undersized. The profile of weld is affected by the position of the joint but it should be uniform. The welds should have regular height and width of beads. The height and spacing of ripples shall be uniform. The joints in the welds run shall as far as possible be smooth and should not show any humps or craters in the weld surface. Welds shall be free from unfilled craters on the surface, under-cuts, stages on the surface and visible cracks.

Such inspection shall be done after cleaning the weld surface with steel wire brushes and chisel to remove the spatter metal, scales, slag, etc., If external defects mentioned above are noticed, there is every possibility of internal defects and further radiographic/ultrasonic examination shall be undertaken.

b) **Production Test Plate**

Test plates shall be incorporated on either side of at least one main butt welds of each flange plate and web plate of every main frame columns and crane girder. The weld shall be continuous over the test plate. The test plate extensions of the main plates and shall be fixed so that metal lies in the same direction as that of the main plate. Test plates shall be prepared and tested in accordance with the accepted Standards, in the presence of the Engineer or his authorised representative. Should any of these tests fail, further radiographic examination of the welds shall be done. These tests for test plates and radiographic examination are additional to those contemplated under inspection and testing.

c) **Non-destructive and special testing**

Radiographic / ultrasonic or other non-destructive examination shall be carried out. All tests of welds shall be carried out by the Bidder at his own cost. The cordoning of radiation zone, while Radiography testing is going on, shall be done.

In case of failure of any of the tests, re-testing of the joints shall also be carried out after rectification is done.

d) **Rectification of defective welding work**

Wherever defects like improper penetration, extensive presence of blow holes, undercuts, cracking, slag inclusion, etc., are noticed by visual inspection/other tests, the welds, in such location shall be removed by gouging process. The joints shall be prepared again by cleaning the burrs and residual matters with wire brushes and grinding, if necessary, and rewelded. The gouging shall as far as possible be done using gouging electrodes.

8.07.01.6 **Inspection and Testing**

a) **Fillet Welds**

Refer clause 11.1.5 of Part B Sub Section E-41 of Technical Specification

b) **Butt Welds**

Refer clause 11.1.5 of Part B Sub Section E-41 of Technical Specification

c) **Dimensional Tolerance and Acceptance Criteria of Welds**

Refer clause 11.1.5 of Part B Sub Section E-41 of Technical Specification

8.07.01.7 **Correction of Defective Welds**

Correction of defective welds shall be carried out without damaging the parent metal. When a crack in the weld is removed magnetic particles inspection or any other equally positive means shall be used to ensure that the whole of the crack and material up to 25mm beyond each end of the crack has been removed.

8.07.02 **Painting**

a) Surface treatment and painting before and after delivery to site shall be in accordance with Clause no. 6.4.0 above. All steel structures shall be designed by following basic design criteria in ISO 12944 Part 3. However, where it is not feasible to follow the design criteria given in ISO 12944 Part 3 where the steel surface are inaccessible for application of protective coating, corrosion allowance in thickness(over the design thickness) of structural steel members shall be kept.

b) For parts to be bolted, the surfaces in contact shall be provided with ethyl Zinc silicate primer as specified in clause 6.4.3 (a) and shall be free of oil, dirt, loose rust, burrs and other defects, which would prevent proper seating of the parts. For design of friction type bolted joints slip factor for surfaces with ethyl zinc silicate primer as given in IS 4000 shall be considered.

c) Surfaces inaccessible after shop assembly shall receive the full-specified protective treatment before assembly. However, interior surfaces of Box-sections, which are effectively sealed from all ends, need not be painted.

8.07.03 **Bolting**

The threaded portion of each bolt shall project through the nut by at least one thread. High strength friction grip bolts, preferably the type with indicated load, shall be used where specified and shall be tightened strictly in accordance with the manufacturer's instructions and the relevant regulations.

When connections are made using high strength friction grip bolts the relevant standards shall be observed.

8.07.04 **Erection of Structures**

All erection work shall be done with the help of cranes, use of derrick is not envisaged.

Erection Marks

a) Erection marks in accordance with fabrication drawing shall be clearly painted on the fabricated steelwork. Each piece shall be marked in at least on two places. Each piece shall also have its weight marked thereon.

c) The centre lines of all columns, elevations and girder bearings shall be marked on the sections to ensure proper alignment and assembly of the pieces at site.

Erection Scheme

a) The Erection Scheme for the erection of all major structures shall be furnished. The erectability of the structure shall be checked by the Bidder before commencement of fabrication work to avoid future modification. The erection scheme shall indicate the approximate weight of the structural members, position of lifting hook, crane boom length, crane capacity at different boom length and at different boom inclination, etc.,

b) The erection scheme shall also give details of the method of handling, transport, hoisting, including false work/staging, temporary, bracing, guying, temporary strengthening, etc., It will also give the complete details of the number and capacity of the various erection equipment that will be used such as cranes, winches, etc., along with disposition at the time of erection of columns, trusses, etc.

c) The erection of columns, trusses, trestles, portals, etc., shall be carried out in one single piece as far as practicable. No column shall be fabricated and erected in more than 3 pieces. Galleries shall generally be erected as box i.e. the bottom chord and bracings, top chord and bracings, side vertical posts and bracings, end portals and roof-trusses shall be completely welded prior to erection and if required temporary strengthening during erection shall be made. The inside sheeting runners and roof sheeting purlins may be erected individually. When erection joints are provided in columns, their location shall generally be just above a floor level.

8.08.00 STEEL HELICAL SPRINGS AND VISCOUS DAMPERS UNITS

8.08.01 General Requirement

This part of the specification covers the requirement for the manufacturing, testing, supply, transport to site, pre-stressing erection, supervision of erection by the vendor, release of pre-stress, alignment, commissioning, etc. of Steel helical springs and viscous dampers units.

The Steel helical springs and viscous dampers units supplied should be of proven make.

8.08.02 Codes and Standards

Some of the relevant applicable Indian standards and codes, etc, applicable to this section of the specification are listed below:

DIN : 4024 Machine foundations; Flexible supporting structures for machine with rotating masses.

DIN : EN 13906-1 Cylindrical helical springs made from round wire and bar: calculation & design.

DIN : 2096 Helical compression springs out of round wire and rod; quality requirements for hot formed compression springs.

ISO : 10816 /IS:14817 Criteria for assessing mechanical vibrations of machine.

ISO : 1940/IS: 11723 Criteria for assessing the state of balance of rotating rigid bodies.

8.08.03 Design & Supply of Material

Information on Geopolymer Concrete-

A) Ingredients: Geo-Polymer Concrete is a special type of concrete where no cement is used unlike conventional cement concrete.

Major ingredients of Geo-polymer concrete are as below:

a) Fly Ash (to be collected from location within existing operating plant/from existing fly ash silos near plant boundary)
b) Ground Granulated Blast Furnace slag
c) Aggregates (Coarse and fine)
d) Sodium Silicate
e) Sodium Hydroxide
f) Chemical admixtures like super-plasticiser, retarder, shrink-reducing compound, evaporation reducer etc.

Fly ash produced by coal-based power stations of NTPC, if available, will be issued free of cost for the production of Geo-polymer concrete on 'as is where is' basis.

B) Batching & Mixing: Geopolymer concrete of minimum required grades of M10 and M35 shall be prepared for Dry Lean Concrete (DLC) and Pavement Quality Concrete (PQC), respectively. The solid constituents of geo-polymer concrete mix such as coarse aggregate, fine aggregate, fly ash and slag are to be mixed dry for 2-3 minutes, then Geo-activator solution, consisting of sodium silicate and sodium hydroxide pre-mixed in tanks at site, is added to the dry mix in batching plant mixer.The whole mixture is mixed until a homogeneous cohesive mix is obtained. Pumping devices shall be used for transferring activator solution from tank to the mixer. Proportion of different ingredients and mixing process are to be finalized/established during mix design finalization and trial mix at site. However, if any constraint is observed related to initial setting time of the geopolymer concrete and time required for transporting the geopolymer concrete mix from batching plant to the point of application then suitable alternative option such as mixing of geoactivator solution may have to be mixed in transit mixer instead of batching plant.
Bidder shall make available concrete batching plant suitably customized for handling/feeding/dosing/weighing etc of ingredients and capable of production of Geo-Polymer Concrete of suitable grade.

C) Geo-activator: This solution shall be prepared using Sodium Hydroxide & Sodium silicate with water in a certain ratio. The ratio of Sodium Silicate and Sodium Hydroxide in activator solution shall be decided during finalization of Design mix. Separate tanks having adequate capacity are to be constructed close to batching plant with fencing and a lockable gate for preparation of Sodium Hydroxide and Sodium Silicate solution. These tanks shall be provided with acid-alkali resistant lining and covered with GI sheet. Each tank shall be fitted with a chemical resistant pump of suitable capacity and dual valve in the discharge line for recirculation (to enable mixing) and also for transferring the Geo-Activator solution to mixer. This connection pipe from Pump discharge to batching plant mixer shall be HDPE of suitable Diameter.

Preparation of Geo-activator solution is a critical process and extra care needs to be taken during the preparation in respect of safety of personnel handling the chemicals. Worker handling the chemicals shall be provided with proper PPE's. A dedicated shower with water tank shall be available close to chemical handling area/tank on permanent basis for washing of affected person, in case of emergency. Bottles filled with distilled water in cupboard / Boxes near work place shall also be kept for emergency eye wash by worker exposed to such hazardous chemicals.

D) Placing: Laying /placing of Geopolymer concrete DLC and PQC manually with hand-guided means or by semi-mechanized methods may be permitted provided acceptance criteria as per MORT&H specification is achieved.

D-1-9 **Architectural Concepts and Design**

9.01.00 For Architectural Concepts and Design refer to 5.01.00 in this specification.

9.02.00 **General Architectural Specifications**

9.02.01 **General**

a) Minimum 1000 mm high (from floor/ roof level) hand railing shall be provided around all floor/roof openings, projections/balconies, walkways, platforms, steel stairs, etc., wherever the height of the building is more than 12m, railing height shall be 1.2m. All handrails and ladder pipes (except at operating floors) shall be 32 mm nominal bore MS pipes (medium class) conforming to IS: 1161 and shall be galvanised as per IS: 4736 and finished with suitable paint. All rungs and ladders shall also be galvanised. Minimum weight of galvanising shall be 610 g/sqm. The spacing of vertical posts shall be maximum 1500mm. Two number of horizontal rails shall be provided including the top member. In addition, toe guard/ kick plate of min size 100x6th shall be provided above the floor level.

For handrailing at operating floors of Main Power House including RCC stairs (for one flight above and below operating floor level), passages, around all floor openings shall be Stainless Steel (SS) pipes shall be used. All floors of Service Building, Administration Building, Gate Complex, Canteen shall also be provided with SS handrailing. Height of the handrail shall be 1000 mm /1200mm in accordance with the preceding para. For SS handrail 32NB/50NB/60NB (polished) stainless steel pipe shall be provided. The spacing of vertical posts shall not be more than 1500mm. Two number of horizontal rails shall be provided including the top member. SS Toe guard and kick plate shall be provided above the floor level.

b) All stairs shall have a maximum riser height of 180mm and a minimum tread width of 275 mm. Minimum clear width of stair shall be 1200 mm unless specified otherwise.

c) All buildings having metal cladding shall be provided with 1M high brick wall at ground floor level. All buildings having metal cladding shall be provided with a 150 mm high RCC toe kerb (on upper floor) at the edge of the floor along the metal cladding. 1000 mm high hand railing shall be provided on this RCC kerb, wherever required from the safety point of view.

d) In all buildings, structures, suitable arrangement for draining out water collected from equipment blowdowns, leakages, floor washings, fire fighting, etc., shall be provided for each floor. All the drains shall be suitably covered with grating or precast RCC panels.

e) RCC staircase shall be provided for main entrance of all RCC construction buildings.

f) Parapet, Chajjas 450mm over window and 600mm door heads, 900mm over rolling shutters, architectural facia, projections, etc., shall be provided with drip course in cement sand mortar 1:3.

g) All fire exits shall be painted with fire resistant paint P.O red/signal red colour shade which shall not be used anywhere except to indicate emergency or safety measure. Fire safety norms shall be followed as per National Building Codes and fire safety requirements for providing fire exits, escape stairs and fire fighting equipment. In detailing of all buildings, fire safety requirements conforming to IS: 1641 and IS:1642 shall be followed.

h) Ramps & Lifts for physically challenged persons shall be provided for barrier free access to the Service buildings.

9.03.00 **Water Supply and Sanitation**

9.03.01 Roof water tanks of adequate capacities depending on the number of users and 8 hours requirement shall be provided for each building and pump house. Polyethylene water storage

j) In addition, adequate number of portable toilet units with adequate plumbing and sanitary arrangement, shall be provided during construction stage for workers.

k) Adequate number of toilet units with adequate plumbing and sanitary arrangement, shall be provided for workers (O&M workers).

9.04.00 **Flooring**

Floor finishes of approved shade and colour (non - premium colours), over under bed of cement mortar / concrete, at all levels and for all kind of works, elevations, on horizontal and vertical surfaces for all types of work (like flooring, skirting, dado, wall lining & facing, tread and risers etc.), including topping, spreading white cement slurry at an average rate of 2.5 kg/Sq. M., (unless noted otherwise), jointing and joint filling with white cement (unless noted otherwise) slurry mixed with colour pigment, to match the shade of the finishing material, laying to plumb and water level in desired pattern, line and flush butt square jointing, curing, rubbing, grinding, polishing, edge moulding, finishing and cleaning, testing, providing opening of required size and shape, casting in panels wherever specified.

9.04.01 The nominal total thickness of floor finish shall be 50 mm i.e. underbed and topping. The floor shall be laid on an already laid and matured concrete base. The underbed for floors and similar horizontal surfaces shall consist of cement concrete M20 grade. Stone chips shall be 12.5 mm down well graded & proper filling shall be done with brick bats/cinders. Flooring like Tiles/ Stones shall be laid with 1:4 cement sand mortar and Tile/ Stone Cladding on wall shall be laid with 1:3 cement sand mortar.

9.04.02 All toilets shall have sunken slab to accommodate sanitary pipes and the finish level of floor shall match with general floor finish level. Sunken slabs shall be made watertight by suitable water proofing treatment.

9.04.03 Metallic hardener topping -with ordinary grey cement shall be- 12 mm thick (insitu) or finishing the concrete / mortar surfaces topping shall be furnished with neat cement slurry (with ordinary grey cement)

9.04.04 Heavy duty cement concrete tiles 300 mm x 300 mm shall be in using white cement with pigment, with hard and abrasion resistant carborundum / quartz chips for wearing course as per IS:1237. Laying of tiles shall be as per IS: 1443.

9.04.05 Digitally glazed ceramic tiles shall be as per IS: 15622. Designer digitally glazed ceramic floor and wall tiles

a) 300x300mm in white colour of Kajaria/ Nitco/ Somany/ Orient/ Johnson or equivalent

b) 300x450mm in DIGITAL series of Kajaria/ Nitco/ Somany/ Orient/ Johnson or equivalent

c) 300x600mm in DIGITAL series of Kajaria/ Nitco/ Somany/ Orient/ Johnson or equivalent

9.04.06 12mm/20mm / 38mm / 75 mm/ 115mm thick acid resistant tile on horizontal and vertical surfaces, at all levels for all type of works shall include one coat of bitumen primer followed by 12 mm thick bituminastic layer, 20mm / 38mm/ 75 mm / 115mm thick A.R. tiles, 6 mm thick under-bed by potassium silicate mortar conforming to IS:4832 (Part-I), pointing of joints of tiles with acid/alkali resistant epoxy/furane mortar conforming to IS:4832 (Part-I), up to a depth of 20 mm and bituminastic end sealing.

Battery Room in all buildings shall be provided with acid/ alkali resistant tiles on flooring & dado 1200mm high.

9.04.07 (i) Mirror polished Digitally glazed vitrified & Matt Finish Digitally glazed Vitrified ceramic tiles (minimum 9.0mm thick) with 3mm groove joints as per approved pattern pointed neatly with 3x4mm stainless epoxy grout mix of 0.70kg of organic coated filter of desired shade (0.10kg of hardener and 0.20kg of resin per kg) with sizes of the tiles shall be as under:

	a) Size of tile 600x600/605x605 of Premium Series Kajaria/ Royale Series Somany/ OMA00025 Series Johnson or equivalent b) Size of tile 800x800 of Polished and Lapatto Series Kajaria/Diamond Series Somany/ Polished and Lapatto Series Johnson or equivalent ii) Anti-Skid Full Body Vitrified Tiles Antiskid, full body Vitrified Tiles of size 600X600X20 mm thick as specified below of approved make, shade, colour and pattern, over under bed of cement mortar / PCC shall be provided in TG Hall flooring at operating level. Full body Vitrified Tiles shall be laid on properly laid leveled floor, with joints 3 to5 mm wide & 8 to10 mm deep & shall be filled with approved Epoxy Grout mix of 0.70 kg of organic coated filler of desired shade (0.10 kg of hardner and 0.20 kg of resin per kg). Full body Vitrified Tiles shall have water absorption less than 0.5%, Modulus of Rupture more than 38N/mm2, Breaking strength more than 7500 N, Mohs scale more than 6, Abrasion resistance less than 144 mm3 and coefficient of friction more than 0.4. Vitrified Tiles shall generally conform to IS: 15622
9.04.08	For pathway, chequered and designed concrete tiles minimum 22 mm thick, 200x200 mm size conforming to IS: 13801 of approved shade and colour shall be used. 1000 wide pathways shall be provided for maintenance on rooftops of all buildings.
9.04.09	**Epoxy Flooring** Epoxy Flooring shall be provided with surface preparation of concrete substrate with Captive Shot Blasting Machine OR Light Grinding to form the required anchor profile on the floor substrate followed by application of epoxy resin based moisture barrier underlay of 2 mm thickness including filling of saw cut joints with epoxy cementitious resin based moisture barrier underlay as per manufacturer specification. Application of self smoothing epoxy floor topping of epoxy based resin of 2 mm thickness over epoxy resin based moisture barrier underlay including application of solvent free epoxy resin based two component primer. It shall include application of PU Sealant at Expansion and Isolation Joint respectively including surface preparation of the joint, fixing of backup strip and application of sealant.
9.04.10	Wherever required, carpet flooring shall be provided over cement concrete floor. The carpet shall be of tile/roll form, machine/handmade tupled un-cut loop pile and lay with under lay of 10mm thick and shall be laid as per manufacturer's recommendations, in matching grains. It shall be treated with anti fungus and anti-termite before laying.
9.04.11	Mirror polished (6 layers of polish) Granite stone (slab) - 18 mm thick (minimum) / Flame finish/ (making top surface rough by burning)/ honed finish granite stone (slab) - 18 mm thick (minimum) shall be provided.
9.04.12	Decorative/designer prepolished, plain and pigmented, high wearing resistance concrete tiles of 20mm thickness (minimum) in various non-standard interlocking patterns.
9.04.13	Skirting in general shall be 150 mm high. Dado in toilets & pantries, shall be upto false ceiling level from finished floor level. Skirting and Dado shall match with the floor finish.
9.04.14	Interlocking concrete blocks shall be of various sizes and thickness having M35 grade of concrete and pigmented to specified colours, in different pattern (in different textures chequered or other patterns in indentation for guiding band/s for visually impaired persons) including the preparation of sub base with 20mm thick sand and filling of joints with sand.
9.04.15	Matt finish (with grooves) Porcelain tiles (for guiding band/s for visually impaired persons in service building) shall be with 3mm groove joints as per approved pattern pointed neatly with

	3x4mm stainless epoxy grout SP- 100 of Laticrete or approved equivalent in approved colour to match colour of tile. 24 mm x 24 mm x 3.8 mm thick (minimum) glass mosaic tiles in decorative murals and pattern. Laminated wooden flooring (11mm thick) shall be provided in VIP area, conference rooms.
9.04.16	**Rubber Flooring** Rubber flooring shall conform to IS 809. The minimum thickness shall be 4 mm with sheet size of 602mm x 602mm. Rubber flooring shall consist of 100% virgin elastomer reinforcing agents, resins, curing agents, anti-oxidants and pigments. It shall have excellent abrasion resistance and shall have class-I fire rating. It shall be acid & alkali resistant and shall be of anti static grade. In general, BS code shall apply for their technical characteristics.
9.05.00	**Epoxy Resin Floor Finish** Self-smoothing, seamless epoxy resin floor finish shall be provided on horizontal and vertical surfaces including preparation of surface, application of epoxy based primer coat, of approved colour, quality and make to give minimum thickness of 300 micron (in two coats)
9.06.00	**Roof**
9.06.01	Except for the roofs subjected to heavy loads, roof of all buildings having structural steel frame work shall consist of permanently colour coated (on exposed face) troughed metal sheet decking of approved profile as specified in clause 9.08.00. Silicon modified polyester paint having DFT of minimum 20 microns shall be used for permanent coating. The sheeting shall be fixed by means of concealed fixing system or any other compatible method approved by the Engineer. RCC slab of minimum 40 mm clear thickness in excess of trough depth shall be provided over the metal decking. Water proofing cum plasticiser compound shall be added to concrete over the metal decking. Bidder shall demonstrate that the roof is leak proof by carrying out the water-retaining test by maintaining the minimum water depth of 50mm over the roof surface for a period of 48 hours. Water Proofing Treatment as given below for RCC roof slabs shall be provided to ensure that the roof is watertight.
9.06.02	DELETED
9.06.03	For efficient disposal of rainwater, the run off gradient for the roof shall not be less than 1:100 and the roof shall be provided with RCC water gutter, wherever required. Gutter shall be made water tight using suitable watertight treatment. This gradient can be provided either in structure or subsequently by screed concrete 1:2:4 (using 12.5 mm coarse aggregate) and/or cement mortar (1:4). However, minimum 25 mm thick cement mortar (1:4) shall be provided on top to achieve smooth surface.
9.06.04	Medium class galvanised mild steel pipes conforming to IS 1239/IS 3589 with welded joints shall be provided to drain off rain water from the roof. These shall be suitably concealed with masonry work, cement concrete / or sheeting work to match with the exterior finish. The number and size of down comers shall be governed by IS 1742 and IS 2527. Roof drain level of all RCC framed buildings having cast-in-situ RCC roof shall be provided with Rain water gutter and/or 45 x 45 cm size Khurras having minimum thickness of 30 mm with 1:2:4 concrete over PVC sheet of 1 m x 1 m x 400 micron and finished with 12 mm thick cement sand plaster 1:3. All the pipes shall be provided with suitable fittings and fixtures.
9.06.05	**Roof Water Proofing** Roof water proofing treatment shall be as follows: a) For roofs having structural slope: Top surface of sloped R.C.C. slab shall be finished with 15mm thick cement plaster (1:4). Over the finished surface elastomeric membrane shall be laid. The elastomeric shall comprise of high solid content liquid applied urethane laid over reinforcing layer of polyscrim cloth or non woven geo-textile. The top of the elastomeric membrane

	shall be finished with 20 mm thick cement: sand (1:4) mortar with chicken wire mesh and pressed precast concrete tiles of 20 mm thickness where applicable shall be laid over mortar at green stage. 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.
	b) For roofs having no structural slope: Screed concrete mix (1:2:4) grading having minimum 25mm thickness at the lowest point of the slope shall be laid over R.C.C. slab and shall be laid as per the slope specified elsewhere in the specification. Top surface of grading underbed shall be finished with 15mm thick cement plaster (1:4). Over the finished surface elastomeric membrane shall be laid and top of the elastomeric membrane shall be finished with 20 mm thick cement: sand (1:4) mortar with chicken wire mesh and pressed precast concrete tiles of 20 mm thickness where applicable shall be laid over mortar at green stage. 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
9.06.06	Roof of all buildings shall be provided with access/approach through staircase or ladder. Roof where equipment are mounted shall be provided with access through staircase.
9.06.07	RCC parapet wall of minimum 1000 mm height (above top of slab) for all accessible roofs and 600 mm height for all non-accessible roofs shall be provided. Alternatively, parapet wall comprising structural steel post, runner and sheeting may be provided for buildings with metal sheet cladding.
9.06.08	Fillets at junction of roof and vertical walls shall be provided with cast-in-situ cement concrete (1:1.5:3) nominal mix followed by 12mm thick 1:4 cement sand plaster.
9.06.09	Pathways for handling of materials and movement of personals shall be provided with 22mm thick chequered cement concrete tiles as per IS:13801 for a width of 1000mm.
9.07.00	**Walls**
9.07.01	All walls shall be non-load bearing infill panel walls.
9.07.02	For initial height up to 1 metre in buildings one brick thick masonry wall shall be provided wherever metal cladding is specified.
9.07.03	All internal walls shall be with one brick thick in cement mortar (1:6). However, internal partition walls for toilets shall be with half brick masonry thick with cement mortar (1:4).
9.07.04	For ESP Control Room Building, wall shall be of Autoclaved Aerated Concrete Block. Autoclaved Aerated Concrete (AAC) block masonry shall be with blocks having dimensions of 625 mm x 250 mm. thickness ranging from 100 mm to 300 mm conforming to I.S. :2185(part-III).The jointing cement sand mortar in the composition of 1: 6 (Cement: sand) shall be used with suitable plasticizer(optional). Sand having modulus of fineness 1.1 shall be used. The horizontal and vertical joint thickness shall be approximately 10 mm. In case of partition walls (100 mm /125 mm thk.) the joint reinforcement i.e. 1 number of 6-8 mm diameter bars shall be placed at every alternate course to be anchored properly with the main structure. All other structural requirements like stiffening of masonry, joint reinforcement etc. in the AAC masonry work strictly be carried out as per instructions laid down in IS 6041 – 1985, IS - 1905.
9.07.05	Toilet Block in ESP Control Room Building shall be of Brick Masonry
9.07.06	50 mm thick DPC in Cement concrete (1:1.5:3) with water proofing compound followed by two layers of bitumen coating 85/25 grade as per IS: 702 @ 1.7 kg./sq.m. shall be provided at plinth level before starting the masonry work.

9.07.07 Enclosure of the elevator shall have 2hours fire rating and it shall be sealed from outside to ensure dust free environment.

9.08.00 **COLOUR COATED AND OTHER SHEETING WORK**

9.08.01 Material

a) Wall Cladding & Roofing Material

Troughed permanently colour coated sheet of approved shade and colour shall be

i) either of steel with minimum 0.6mm bare metal thickness (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G250 as per AS1397 / grade SS255 as per ASTM A653M / grade S250GD as per EN 10326 with zinc coating to class Z275 / aluminium-zinc alloy coating to class AZ150

ii) or of minimum 0.5mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G350 as per AS1397 / grade SS340 class 4 as per ASTM A792M / grade S350GD as per EN 10326 with zinc coating to class Z275 / aluminium-zinc alloy coating to class AZ150.

iii) or of steel of minimum 0.4mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G550 as per AS1397 / grade SS550 as per ASTM A792M / grade S550GD as per EN 10326 with zinc coating to class Z275 / aluminium-zinc alloy coating to class AZ150
Alternatively aluminium feed material of minimum bare metal thickness of 0.7 mm of aluminium alloy of Series 31000 and above as per IS 737 and IS: 1254.

Bidder to ensure that same profile is to be used throughout the package for all facilities to maintain uniformity.

b) Metal Deck Roof Material

Troughed permanently colour coated metal decking sheets shall be

i) either of steel with minimum 0.8mm bare metal thickness (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G250 as per AS1397 / grade SS255 as per ASTM A653M / grade S250GD as per EN 10326 with zinc coating to class Z275.

ii) or of minimum 0.6mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G350 as per AS1397 / grade SS340 class 4 as per ASTM A792M / grade S350GD as per EN 10326 with zinc coating to class Z275.

iii) or of steel of minimum 0.6mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G550 as per AS1397 / grade SS550 as per ASTM A792M / grade S550GD as per EN 10326 with zinc coating to class Z275.

Alternatively aluminium feed material of minimum bare metal thickness of 0.9 mm of aluminium alloy of Series 31000 and above as per IS 737 and IS 1254 can also be used for metal decking.

Thickness tolerance of (+/-) 0.04mm is permissible. However, all design calculations shall be carried out on the basis of lowest value of sheet thickness provided.

Bidder to ensure that same profile is to be used throughout the package for all facilities to maintain uniformity. In addition, the depth of the profile shall be restricted to 60 mm (maximum) to reduce the overall thickness of floor slab and thus minimizing the dead load of the floor slab. If the bidder proposes to use two different metal deck sheets

(same profile but different grades or thicknesses), the unexposed (concrete) side of the metal deck sheets shall be painted with clearly distinct colours to facilitate identification.

Bidder to ensure that both cladding sheet and decking sheet supplied at site to be provided with transparent organic film of thickness of 40 microns on each face. Also they should be stored in a covered place on wooden sleepers till erection.

9.08.02 Colour Coating

Steel shall be colour coated with total coating thickness of at least 40 microns (nominal) comprising of silicon modified polyester (SMP with silicon content of 30% to 50%) paint or Super Polyester paint, of minimum 20 microns (nominal) dry film thickness (DFT) on external face over primer coat of minimum 5 microns (nominal) and minimum 10 microns (nominal) SMP or super polyester paint over primer coat of minimum 5 microns (nominal) on internal face. SMP and Super polyester paint systems shall be of industrial finish of product type 4 of AS/NZ2728.

9.08.03 Design Criteria

For wall cladding insulated / uninsulated and conveyor gallery sides and roof, permanently colour coated sheet of troughed profile shall be used. However alternative profile meeting the strength, deflection and other functional requirements such as section modulus and moment of inertia shall be provided.

Sheet shall be of profile, sectional properties, colour and shade as per specifications.

For profiled metal decking sheets (to be used for RCC floor slab or roof slab) the sectional modulus and moment of inertia of troughed profile per meter width shall be so as to limit the deflection of sheets to span/250 under total super imposed loading (DL +LL) comprising the self-weight of metal deck sheet, dead weight of green concrete and an additional construction load 100kg per sq.m for two span condition. The section modulus and moment of inertia of troughed profile shall be computed as per the provisions of IS 801 for satisfying the deflection and strength requirements.

For metal deck sheets used for roofing (with or without RCC) and side cladding, the sectional modulus and moment of inertia of troughed profile per metre width shall be such that the deflection of sheets is limited to span/250 under design wind pressure for two span condition. The sectional modulus and moment of inertia of troughed profile shall be computed as per the provisions of IS 801 for satisfying the deflection and strength requirements. No increase in allowable stress is permissible under wind load condition.

9.08.04 Fasteners

Side cladding/roofing/decking sheets shall be fixed to the runner/purlins using self-drilling special coated fasteners confirming to corrosion resistant class 3 of AS3566 and tested for 1000 hours salt spray test. Spacing of Self-drilling fasteners in transverse direction (along runners/purlin) shall be equal to the pitch of trough or 250(+/-100) mm, whichever is lesser and in longitudinal direction at every runner/purlin location.

Shear anchor studs shall also be provided through metal deck, which are to be used as permanent shuttering, at regular interval on all top flange / flange plate of structural beams as specified in Clause no. 8.03.00.

Alternatively, J/U type hooks shall be used in roofing which shall be provided in transverse direction (along runners/purlin) at a spacing equal to the pitch of trough or 250(+/-100) mm, whichever is lesser and in longitudinal direction at every runner/purlin location.

9.08.05 Miscellaneous Details

To minimize the number of joints, the length of the sheet shall preferably be not less than 4.5m, cut pieces shall not be used, unless specifically approved by the Engineer. However, the actual length shall be such so as to suit the purlin / runner spacing.

Lap between the sheets shall be at least 150mm in the longitudinal direction and at least one crest wide in the transverse direction which shall be properly anchored / fixed with fasteners.

Z spacers if required shall be made of at least 2 mm thick galvanised steel sheet of grade 350 as per IS 277

Sealant used for cladding shall be butyl based, two parts poly sulphide or equivalent approved, non stainless material and be flexible enough not to interface with fit of the sheets

.

Filler blocks as a trough filler shall be used to seal cavities formed between the profiled sheet and the support or flashing. The filler blocks shall be manufactured from black synthetic rubber or any other material approved by the Engineer.

For insulation of cladding and other areas, mineral wool conforming to IS 8183 shall be used. The density shall be 32 or 48 kg. /cu.m for glass or rock wool respectively. The nominal thickness of insulation shall be 50mm.

All flashings, trim closures, caps etc. required for the metal cladding system shall be made out of plain sheets having same material and any weather/moisture sealants with appropriate material and coating specification as mentioned above for the outer face of the metal cladding. Overlap shall be min. 150 mm or as specified by manufacturer.

The contractor shall prepare working drawings of sheeting system including end and side laps, flashing, fixing details etc. before starting sheeting work at site.

9.08.06 **Pre-Fabricated Insulated Metal Sandwich Panels**

For buildings where Pre-Fabricated (Factory made) Insulated Metal Sandwich Panels shall be used for Roofing, the sandwich panels shall comprise top sheet as troughed permanently colour coated sheet & bottom sheet as plain permanently colour coated with 50mm thick insulation sandwiched between the two sheets. Each sheet shall be

i) either of steel with minimum 0.6mm bare metal thickness (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G250 as per AS1397 / grade SS255 as per ASTM A653M / grade S250GD as per EN 10326 with zinc coating to class Z275 / aluminium-zinc alloy coating to class AZ150

ii) or of minimum 0.5mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G350 as per AS1397 / grade SS340 class 4 as per ASTM A792M / grade S350GD as per EN 10326 with zinc coating to class Z275 / aluminium-zinc alloy coating to class AZ150

iii) or of steel of minimum 0.4mm BMT (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade G550 as per AS1397 / grade SS550 as per ASTM A792M / grade S550GD as per EN 10326 with zinc coating to class Z275 / aluminium-zinc alloy coating to class AZ150.

Alternatively aluminium feed material of minimum bare metal thickness of 0.7 mm of aluminium alloy of Series 31000 and above as per IS 737 and IS 1254.

Metal sheets (steel or aluminium) shall be colour coated with total coating thickness of at least 40 microns (nominal) dry film thickness (DFT) comprising of Silicon Modified Polyester (SMP with silicon content of 30% to 50%) paint or Polyester paint, of minimum 20 microns (nominal) SMP or polyester paint on one side (exposed face), over minimum 5 micron (nominal) primer coat and minimum 10 micron (nominal) SMP or Polyester paint over minimum 5 micron (nominal) primer coat on other side. SMP and Super Polyester paint shall conform to product type 4 of AS/NZS 2728. Troughed sheet shall be of approved profile, sectional properties, (suitable for the specified loading / deflection and purlins / runners spacing), colour and shade.

Special coated fastener conforming to corrosion resistant Class 3 of AS3566 and tested for 1000 hours salt spray test shall be used for fixing Pre-Fabricated Insulated Metal Sandwich Panels with the structural members below.

	The contractor shall prepare working drawings of sheeting system including end and side laps, fixing details etc. before starting sheeting work at site.
9.08.07	**Polycarbonate Sheets**
	The polycarbonate sheet to be used for cladding and glazing purpose in conveyor galleries, Transfer points & pump houses shall have toughed profile to match with the metal cladding profile. Minimum 3.0mm thick fire retardant and UV resistant polycarbonate clean sheet of approved make shall be used. The polycarbonate sheet shall be installed along with the metal cladding so as to have a watertight lapping arrangement. Suitable detailing shall be made to cater for the thermal expansion. IS 14434 to be referred for other details.
9.09.00	**Plastering**
9.09.01	Outer face (i.e. rough side) of all brick walls shall have 18 mm thick and inner face (i.e. smooth side) of all walls shall have 12 mm thick cement sand plaster 1:6.
9.09.02	Acrylic wall putty in two coats shall be applied over cement plastered surfaces in interior of building. The finish surface shall be smooth and shall be of 2 mm nominal thickness.
9.09.03	All R.C.C. walls shall have minimum 12mm thick cement sand plaster 1:6.
9.09.04	All RCC ceilings (except areas provided with false ceiling, cable vault ceiling and metal decking) shall be provided with 6mm thick cement sand plaster 1:4.
9.09.05	Groove of uniform size 12 x 12 mm up to 20 x 15 mm in plastered surface as per approved pattern, shall be provided as per approved drawing.
9.09.06	All plastering work shall conform to IS: 1661.
9.10.00	**Painting, Aluminium Composite Panel, Glass Reinforced Concrete Tile and GRC Customized Screens and Dome**
9.10.01	All painting on masonry or concrete surface shall preferably be applied by roller. If applied by brush then same shall be finished off with roller.
9.10.02	All paints shall be of approved make including chemical resistant paint.
9.10.03	Minimum 2 finishing coats of paint shall be applied over a coat of primer.
	Stone work for wall lining etc. (Veneer work) over 20 mm thick bed of cement mortar 1:3 (1 cement: 3 coarse sand) and jointed with grey cement slurry @3.3kg/sq.m, including rubbing and polishing in complete. (Black polished granite stone slab, 18 mm thick / polished Sadarhally grey granite slab 18 mm thick).
	The final, finished coating shall be fungus resistant, UV resistant, water repellant, alkali resistant, and extremely durable with colour fastness.
9.10.04	Acrylic emulsion paint shall be as per IS: 15489. Acrylic distemper shall be as per IS: 428. Cement paint shall conform to IS: 5410, white wash/colour wash shall conform to IS: 627.
9.10.05	All fire exits shall be painted in post office red/signal red colour shade, which shall not be used anywhere else except to indicate emergency or safety measure.
9.10.06	For painting on concrete, masonry and plastered surface IS: 2395 shall be followed. For painting on wood work IS: 2338 shall be followed.
9.10.07	For painting on steel work and ferrous metals, BS: 5493 and IS: 1477 shall be followed. The type of surface preparation, thickness and type of primer, intermediate and finishing paint shall be according to the painting system adopted.
9.10.08	Bitumen primer used in acid/alkali resistant treatment shall conform to IS: 158.
9.10.09	All internal paints shall be of low VOC (Less than 50 g /L) content conforming to GRIHA rating for reduction of VOC content.

member and shade. The Screens should be made from '53 grade' White Portland Cement manufactured by 'JK Cement' or 'Birla white', White Quartz fine graded sieved Silica Sand, Alkali Resistant Glass Fibre manufactured by 'NEG Japan, Owen Corning 'Saint Gobain' or equivalent, Super Plasticizers manufactured by 'Karochem' or equivalent, Polymers manufactured by 'Nova Polychem' or equivalent and U.V resistant Synthetic inorganic pigments shall be used for pigmentation manufactured by 'Phenochem industries or equivalent. The Screens casting shall take place with layering methodology using- Direct Power Spray machines. The GRC Screens flexural strength average L.O.P shall be above or equivalent to 6 N/mm2 & M.O.R shall be above or equivalent to 12 N/mm2 for tests done on 28 days cured samples.

The fixing of Screens shall be done using 'Dry fixing' method onto structural support members i.e. R.C.C, Brick work, MS Framework. SS / MS Galvanized CLAMPS & PINS also if required fasteners to be used of Wurth, Hilti & Fischer or equivalent. ALL CAST IN SOCKET TO BE EPOXY PRIMER COATED. ELECTRODES to be used of ADVANI, MANGALAM, ESAB or Victor brand or equivalent.

9.10.13 **Exterior Painting on Wall (Premium Acrylic Smooth Exterior Paint with Silicone Additives)**

The paint shall be (premium acrylic smooth exterior paint with silicone additives) of approved brand and manufacture. This paint shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty containers shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

Preparation of Surface

For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Engineer in charge after inspection before painting is commenced.

Application of Base Coat
Base coat shall be of water proofing cement paint.
Preparation of Mix for Base Coat

Cement Paint shall be mixed in such quantities as can be used up within an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish. Cement Paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of cement Paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the cement Paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. In all cases the manufacturer's instructions shall be followed meticulously.

The lids of cement Paint drums shall be kept tightly closed when not in use, as by exposure to atmosphere the cement Paint rapidly becomes air set due to its hygroscopic qualities. In case of cement Paint brought in gunny bags, once the bag is opened, the contents should be consumed in full on the day of its opening. If the same is not likely to be consumed in full, the balance quantity should be transferred and preserved in an airtight container to avoid its exposure to atmosphere.

Application of Base Coat

The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so that the direct heat of the sun on the surface is avoided. The method of application of cement Paint shall be as per manufacturer's specification. The completed surface shall be watered after the day's work. The second coat shall be applied after the first coat has been set for at least 24 hours. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted.

For new work, the surface shall be treated with three or more coats of water proof cement Paint as found necessary to get a uniform shade.

Precaution
Water proof cement Paint shall not be applied on surfaces already treated with white wash, colour wash, distemper dry or oil bound, varnishes, Paints etc. It shall not be applied on gypsums, wood and metal surfaces. If water proofing cement is required to be applied on existing surface, previously treated with white wash, colour wash etc., the surface shall be thoroughly cleaned by scrapping off all the white wash, colour wash etc. completely. Thereafter, a coat of cement primer shall be applied followed by two or more coat of water proof cement.

Application of exterior paint
Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of paint with potable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer's instructions & directions of the Engineer-in-charge shall be followed meticulously.

The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust. Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks.

9.11.00 **Doors & Windows**

9.11.01 Doors, windows and ventilators of air-conditioned areas, entrance lobby of all buildings (where ever provided), and all windows and ventilators of all buildings (unless otherwise mentioned) shall have aluminium framework with glazing. The aluminium section shall have minimum 2 mm thickness. The aluminium frame shall be electro colour dyed (anodised with 15 micron coating thickness) when used on outer side of the building and it shall be powder coated(50 microns coating thickness) when used in interior of the building. All doors of toilet areas shall be of steel framed solid core flush shutter. For Mill Bunker Building, transfer points, crusher house, conveyor gallery, steel louvered windows shall be provided.

9.11.02 Control Rooms of all buildings shall be provided with Aluminium Glazed door.

9.11.03 Single glazed panels with aluminium framework shall be provided as partition between two air-conditioned areas wherever clear view is necessary.

9.11.04 a) The doors frames shall be fabricated from 1.6 mm thick MS sheets and shall meet the general requirements of IS: 4351.

b) All steel doors shall consist of double plate flush door shutters. The door shutter shall be 35 mm (min.) thick with two outer sheets of 1.2 mm rigidly connected with

	continuous vertical 1.0 mm stiffeners at the rate of 150 mm centre to centre. Side, top and bottom edges of shutters shall be reinforced by continuous pressed steel channel with minimum 1.2 mm. The door shall be sound deadened by filling the inside void with mineral wool. Doors shall be complete with all hardware and fixtures like door closer, tower bolts, handles, stoppers, aldrops, locks etc.
9.11.05	Steel windows and ventilators shall be as per IS: 1361 and IS: 1038.
9.11.06	Wherever functionally required Rolling shutter (fully closed/partly grilled) with suitable operating arrangement (manual/Electric) shall be provided to facilitate smooth operations. Rolling shutters shall conform to IS: 6248. M.S sliding doors with suitable mechanical and electrical operations fixtures as per requirement for bigger openings shall be used.
9.11.07	All windows and ventilators on ground floor of all buildings shall be provided with suitable Aluminium grill.
9.11.08	Fire-Proof doors with panic devices shall be provided at all fire exit points as per requirements. These doors shall generally be as per IS 3614 (Part 2). Fire rating of the doors shall be of minimum 2 hours. These doors shall be double cover plated type with mineral wool insulation.
9.11.09	Hollow extruded section of minimum 2 mm wall thickness as per IS: 1285 (**Grade of Alluminum shall be Alloy 63400)** shall be used for all aluminium doors, windows and ventilators.
9.11.10	Minimum size of door provided shall be 2.1 m high and 1.2 m wide. However for toilets minimum width shall be 0.75 m and office areas minimum width shall be 1.20m.
9.11.11	Electrically operated, self operable/closing, aluminium framed with tinted glass, sliding doors shall be provided at the entrance of all common control rooms, entrance lobby of facility building.
9.11.12	Minimum area of windows in building on each floor level shall be 10% of floor area.
9.12.00	**Glazing**
9.12.01	All windows and ventilators (not specified elsewhere) shall be provided with minimum 6 mm thick toughened glass conforming to IS: 5437.
9.12.02	For single glazed aluminium partitions and doors, 8mm thick clear toughened glass shall be used.
9.12.03	Toughened tinted glass of 6 mm thickness shall be used for all windows and ventilators in toilets.
9.12.04	All glazing work shall conform to IS: 1083 and IS: 3548.
9.12.05	For glazings of Air Conditioned Buildings Composite double glazing shall be 24mm thick consisting of 6mm thick clear float glass on inner side and 6mm thick reflective toughened glass on outer side. The two glasses shall be separated by 12mm air-gap and hermetically sealed by beading of anodized aluminium with outer edge sealed with silicon sealant. Outer glass of 6mm thickness shall have following technical characteristics: Solar factor 25% or less, Maximum U-value 3.3 W/ SQMK, VLT min 30%: Light reflection internal 10 to 15%, light reflection external 10 to 20 %, shading coefficient (0.25- 0.28) The glass to be used should be from the manufacturers of glass like Saint Gobain (India) or Asahi (India) or equivalent. The glass should be free from distortion and thermal stress
9.12.06	For internal glazed partition, 8mm thick clear toughened glass shall be provided.
9.13.00	**False ceiling**
9.13.01	False ceiling of 12.5 mm thick tapered/square edge glass fibre reinforced gypsum board conforming to IS : 2095 having fine texture finish, including providing and fixing of frame work at all levels, for all kind of work, consisting of light weight galvanised steel member (minimum

	0.8 mm thick and galvanised as per IS: 277) having maximum grid size of 1200 mm x 600 mm for supporting panels of specified size, suspended from RCC structural steel or catwalkway grid above, with 4 mm (minimum) galvanised wires (rods), with special height adjustment clips, providing angle section of minimum 25 mm width along the perimeter of ceiling, supporting grid system (minimum 0.8 mm thick and galvanised as per IS: 277), expansion fasteners for suspension arrangement from RCC, providing openings for AC ducts, return air grills, light fixtures, etc., all complete. (concealed grid and finished flat seamless and curve shape (dome etc.), finished smooth(seamless) along with the galvanised light gauge steel supporting system laid in profile to suit the profile of dome).
9.13.03	False ceiling of 12 mm thk calcium silicate board of 'HILUX' or equivalent with suspension system as per manufacturers details including supporting grid system, expansion fasteners for suspension arrangement from RCC, providing openings for AC ducts, return air grills, light fixtures, etc., all complete. (With concealed grid and finished flat seamless).
9.13.05	ALUMINIUM FALSE CEILING : Aluminium false ceiling shall be in 600 mm x 600 mm tile or plank type of 0.6 mm thickness (minimum) with perforation of 2.5 mm dia in combination with built in nonwoven tissue for providing good acoustic properties. False ceiling shall have coil coating of thickness 25micron (minimum)and it shall be installed with T-Grid (of profile 24 mm) in same or contrasting colours or with 6 mm recess joints. The whole system shall be level adjusting arrangement and shall be suspended as per manufacturer guidelines.
9.13.08	Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures, A.C. ducts etc.
9.13.09	Suitable M.S. channel (Minimum MC75 with maximum spacing of 1.2 m C/C both ways) grid shall be provided above the false ceiling level for movement of personnel and to facilitate maintenance of lighting fixtures, AC ducts etc.
9.13.10	Underdeck insulation shall be provided on the ceiling (underside of roof slab) and underside of floor slab of air-conditioned area depending upon the functional requirements. This underdeck insulation shall consist of 50mm thick mineral wool insulation with 0.05 mm thick aluminium foil & 0.6 mm x 25mm mesh wire netting and shall be fixed to the ceiling with 2 mm wire ties.
9.13.11	Suitable cut-outs shall be provided in false ceiling to facilitate fixing of lighting fixtures, AC grills, smoke detectors, etc.
9.14.00	**Elevator Machine Room** Elevator machine room shall be as per NBC requirements in either way. a) Floor of the elevator machine room shall be of RCC and wall shall be of one brick thick masonry wall. It shall be provided with fire door and other requirements as per NBC and elevator norms. b) Floor of Machine Room shall be provided with profiled metal decking sheet. Trough shall be filled with Insulating Material (glass wool or rock wool) and thereafter finished with Minimum 50 mm thick wooden flooring, consisting of 37 mm thick hardwood planks, finished with 11mm thick laminated wooden flooring (of 'pergo' or equivalent) with plank size 193x1195mm (material class shall be 34 as per EN13329), over 2 mm expanded polystyrene foam and polythene sheet under laying. Roof and Side enclosure of Machine Room shall be provided with Prefabricated Insulated Metal Sandwich panels. Composition of Insulated Metal Sandwich Panels shall be as described in Clause 9.08.00 of Part-B (Civil) of Technical Specification. Doors of Machine Room shall be Double Plate Steel flush doors of thickness 45 mm with steel sheets of 18 gauge with necessary stiffeners. Space between two sheets shall be filled with mineral wool insulation. Frame of doors shall be pressed steel sheets of 16 gauge. All necessary fittings for the doors shall be provided by the Bidder. Rubber sealing, for making the Doors airtight shall also be provided.

Windows/ventilators shall be of standard extruded anodised Aluminium Sections of minimum 2 mm thickness with 24 mm hermitically sealed double glazing consisting of two 6 mm thick toughened glass separated by 12 mm. gap.

Technical requirements of prefabricated insulated metal sandwich panels/decking sheets shall be same as given elsewhere in this specification.

9.15.00 **Interior Design**

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. All the design aspects such as flooring, false ceiling, furniture, colour scheme equipment design & layout, illumination, fire fighting, acoustics and ergonomics requirements shall be detailed out so as to present an overall unified aesthetic spatial appearance.

The areas to be undertaken for this interior design process shall be control room complex including common control room, computer room, conference rooms and office areas in the buildings and the following aspects shall be reviewed and evaluated for design. Furniture to be supplied by Bidder for the control room complex and other control rooms shall be as specified under C&I specification.

a) Layout, keeping in view the man-machine interface and suitable ergonomic practices.

b) Integration of civil engineering with architecture and interior design.

c) Illumination levels, noise levels, electromagnetic interference levels, taking into account the equipment and furniture.

d) Comfort and safety requirements such as air conditioning, fire fighting, fire escapes, etc.

e) Microprocessors based control system to control the functional requirements.

The above design philosophy put into practice shall be detailed out through presentation drawings, perspective views, scale models, detail drawings, etc.

9.16.00 **Stainless Steel Hand railing**

Providing and fixing knockdown railing system comprising of SS 304 Grade Stainless Railing of 50mm diameter handrail fixed on 50 mm SS round baluster placed at maximum 1000 c/c along with five numbers 19 mm diameter midrail connected at side of baluster by special brackets, both the end of mid rail should be bush inserted for jointing and to give extra strength (joints should not be welded and invisible). The balustrade should be fixed onto floor with casted plate of minimum 6mm thickness. Base plate shall be concealed with suitable SS 304 cover cap so that the mounting height fasteners are not visible after installation. Only high strength anchor fasteners would be used for fixing of baluster, as giving extra strength, rust proof and more durable. Onsite welding is strictly not allowed. Wherever welding is required, it should be Tig welding process with same grade 304/316 at factory only so that floor stone and other things would not be damaged and for safety purpose also. Baluster and handrail connector should be screwed tightened and not to be welded on site. Wall thickness of all pipes shall be taken as 2 mm. Along with all visible components developed in high grade SS and whenever required, joints to be filled with bushings for extra strength. Railing Height to be taken @ 1000/ 1200 mm from floor level.

9.17.00 **Finishing Schedule**

Interior and Exterior Finishes shall be as given in Tables-A & B respectively attached at the end of these specification.

D-1-10

MATERIAL SPECIFICATION

10.01.00

Cement

Fly ash based portland pozzolana cement conforming to IS: 1489 (Part-1) shall be used for all areas other than for the critical structures identified below. Other properties shall be as per IS code.

Ordinary Portland Cement (OPC) shall necessarily be used for the following structures.

a) Ordinary Portland Cement (OPC) shall necessarily be used for RCC for Chimney shell.

b) TG foundation top deck/ Substructure

c) Spring supported decks of all machine foundations such as TDBFP/MDBFP

The grade of cement shall be Grade 43 for OPC conforming to IS: 269.

In place of fly ash based portland pozzolana cement, OPC mixed with Fly Ash can be used. Batching plant shall have facility for mixing fly ash. Fly ash shall conform to IS: 3812(Part I). Percentage of fly ash to be mixed in concrete shall be based on trial mix. Mix design shall be done with varying percentage of fly ash mix with cement

10.02.00

Aggregates

a) **Coarse Aggregate**

Coarse aggregate for concrete shall be crushed stones chemically inert, hard, strong, durable against weathering of limited porosity and free from deleterious materials. It shall be properly graded. It shall meet the requirements of IS: 383.

However, use of aggregate manufactured from other than natural sources (Listed in Annexure-A of IS 383) and Bottom Ash from Thermal Power Plants shall be permitted only in Lean Concrete of Grade M7.5 and M10 (for % of utilization refer Table-1 of IS 383).

b) **Fine Aggregate**

Fine aggregate shall be hard, durable, clean and free from adherent coatings of organic matter and clay balls or pellets. Fine aggregate in concrete shall conform to IS: 383. Bidder can use either natural sand or crushed sand, confirming to IS:383, based on availability.

For plaster, it shall conform to IS: 1542 and for masonry work to IS: 2116.

However, use of aggregate manufactured from other than natural sources (as Listed in Annexure-A of IS 383) and Bottom Ash from Thermal Power Plants conforming to IS:383 shall be permitted only in Lean Concrete of Grade M7.5 and M10 (for % of utilization refer Table-1 of IS 383).

c) Petrographic examination of aggregate shall be carried out by the contractor at National Council for Cement and Building Materials (NCB), Ballabgarh, or any other approved laboratory to ascertain the structure and rock type including presence of strained quartz and other reactive minerals for machine foundations, etc. In case, the coarse aggregate sample is of composite nature, the proportions (by weight) of different rock types in the composite sample and petrographic evaluation of each rock should also be ascertained. While determining the rock type, special emphasis should be given on identification of known reactive rocks like chalcedony, opal etc. The procedure laid down in IS 2430 for sampling of aggregates may be followed.

The laboratory shall determine potential reactivity of the aggregate, which may lead to reaction of silica in aggregate with the alkalis of cement and / or potential of some aggregates like limestone to cause residual expansion due to repeated temperature cycle. If the same is established, the contractor shall further carry out alkali aggregates

reactivity test as per IS 2386 (Pt.VII) and / or repeated temperature cycle test to establish the suitability of the aggregates for the concrete work. The test results, with the final recommendations of the laboratory, as to a suitability of the aggregate, for use in the concrete work for various structures and suggested measures, in case of results are not satisfactory, shall be submitted to the Engineer for his review, in a report form.

In case in the report, it is established, that the aggregates contain reactive silica, which would react with alkalis of the cement, the contractor shall change the source of supply of the aggregate or use low alkali cement as per recommendation or take measures as recommended in the report as instructed by Engineer. In case aggregates indicate residual expansion, under repeated temperature cycle test (from 10o Celsius to 65o Celsius and for 60 temperature cycles) the material shall not be used for concreting of TGs', BFPs' and other equipment foundations which are likely to be subjected to repeated temperature cycle. The contractor shall use aggregates free from residual expansion under repeated temperatures cycle test.

10.03.00 **Reinforcement Steel**

Reinforcement steel shall be of high strength deformed TMT steel bars of grade Fe-415/Fe-500/Fe 500D and shall conform to IS 1786 and IS 13920. However, minimum elongation shall be 14.5%.

Relevant clause of IS 13920 are quoted below for clarity:

Quote

5.3.1 Steel reinforcement shall comply with all of the following:
a) Elongation shall be at least 14.5 percent,
b) Ratio of ultimate stress to 0.2 percent proof stress shall not exceed 1.25,
c) Ratio of ultimate stress to 0.2 percent proof stress shall be at least 1.15, and
d) Steel shall be only of strength grades with minimum 0.2 percent proof stress of 415 MPa, 500 MPa or 550 MPa, in addition to other requirements of IS 1786.'

5.3.2 The actual 0.2 percent proof stress of steel bars based on tensile test must not exceed their characteristic 0.2 percent proof stress by more than 20 percent

Unquote

Mild steel and medium tensile steel bars shall conform to Grade A of IS:432-Part 1 and hard drawn steel wire shall confirm to IS:432-Part II. Welded wire fabric shall conform to IS 1566.

10.04.00 **Structural Steel**

Structural Steel (including embedded Steel) shall be straight, sound, free from twists, cracks, flaw, laminations and all other defects. Structural steel shall comprise of mild steel, medium strength steel and high tensile steel as specified below.

10.04.01 **Mild Steel**

a) Rolled sections shall be of grade designation E250, Quality A/BR, Semi-killed/ killed conforming to IS 2062. All steel plates shall be of Grade designation E250, Quality BR (fully killed), conforming to IS 2062 and shall be tested for impact resistance at room temperature. Plates beyond 12mm thickness and up to 40mm thickness shall be normalized rolled. Plates beyond 40mm thickness shall be vacuum degassed & furnace normalised and shall also be 100% ultrasonically tested as per ASTM –A578 level B-S2.

b) Pipes shall conform to IS: 1161.

c) Hollow (square and rectangular) steel sections shall be hot formed conforming to IS: 4923 and shall be of minimum Grade Yst 240 and minimum thickness shall be 4 mm..

d) Chequered plate shall conform to IS 3502 and shall be minimum 6 mm thick excluding projection. Steel for chequered plate shall conform to grade E250A semi killed of IS: 2062 or equivalent grade conforming to ASTM & BS standards only.

10.04.02 **Medium and High Tensile Steel**

Rolled Sections and plates shall be of grade designation E350 or higher, Quality B0 (Fully killed), conforming to IS: 2062. Plates beyond 12mm thickness and up to 40mm thickness shall be normalized rolled. Plates beyond 40mm thickness shall be vacuum degassed & furnace normalised and shall also be 100% ultrasonically tested as per ASTM –A578 level B-S2.

10.05.00 **Bricks**

Only fly ash bricks shall be used in all construction, except for elevator shafts, which can be either of burnt clay bricks or RCC construction as per functional / codal provisions. Bricks shall be table moulded/ machine made of uniform size, shape and sharp edges and shall have minimum compressive strength of 75kg/cm2. Burnt clay fly ash bricks and fly ash lime bricks shall conform to IS: 13757 and IS: 12894 respectively. Minimum fly ash content in fly ash based bricks shall be 25%.

10.06.00 **Foundation Bolts**

Material and details of foundation bolts shall conform to IS: 5624. Mild steel bars used for the fabrication of bolt assembly shall conform to grade 1of IS: 432 and/ or grade A of IS: 2062. Hexagonal nuts and lock nuts shall conform to IS: 1363 & IS: 1364 upto M36 diameter and IS: 5624 for M42 to M150 diameter.

10.07.00 **Stainless steel**

The material specification for stainless steel plates are mentioned in the design concept area of Mill Bunker building.

10.08.00 **Water**

Water used for cement concrete, mortar, plaster, grout, curing, washing of coarse aggregate, soaking of bricks, etc. shall be clean and free from oil, acids, alkalis, organic matters or other harmful substances in such amounts that may impair the strength or durability of the structure. Potable water shall generally be considered satisfactory for all masonry and concrete works, including curing. When water from the proposed source is used for making the concrete, the maximum permissible impurities, development of strength and initial setting time of concrete shall meet the requirements of IS: 456.

All materials brought for incorporation in works shall be of best quality as per IS unless specified otherwise.

10.09.00 PTFE (Poly Tetra Fluoroethylene) Bearing

The bearing shall be of reputed make and manufacturer as approved by the Engineer, for required vertical load and end displacement/rotation. PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg/sq.cm. In order to prevent cold flow in PTFE surface it shall be rigidly bonded by a special high temperature resistance adhesive to the stainless steel substrata. The stainless steel surface that slides against the PTFE is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of stainless steel plate shall be between 1.0 mm to 1.5 mm.

10.10.00 **Statutory Requirements**

Bidder shall comply with all the applicable statutory rules pertaining to Factories Act, Fire Safety Rules at Tariff Advisory Committee. Water Act for pollution control, Explosives Act, etc.

Provisions of safety, health and welfare according to Factories Act shall be complied with.

These shall include provision of continuous walkways along the crane - girder level on both sides of building, comfortable approach to EOT crane cabin, railing, fire escape, locker room for workmen, pantry, toilets, rest room etc.

Provisions for fire proof doors, number of staircases, fire separation wall, lath plastering/encasing the structural members (in fire prone areas), type of glazing etc. shall be made according to the recommendations of Tarrif Advisory Committee.

Statutory clearances and norms of State Pollution Control Board shall be followed.

Bidder shall obtain approval of Civil/Architectural drawings from concerned authorities before taking up the construction work.

D-1-11 **Inspection, Testing and Quality Control**

11.01.00 Sampling and testing of major items of civil works viz. earthwork, concreting, structural steel work (including welding,sheeting, etc. shall be carried out in accordance with the requirements of this specification. Wherever nothing is specified relevant Indian Standards shall be followed. In absence of Indian Standard equivalent International Standards may be used.

The Bidder shall submit and finalise a detailed field Quality Assurance Programme before starting of the construction work according to the requirement of this specification. This shall include frequency of sampling and testing, nature/type of test, method of test, setting of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of format for record, Field Quality Plan, etc. Tests shall be done in the field and/or at a laboratory approved by the Engineer. The Bidder shall furnish the test certificate from the manufacturer's of various materials to be used in the construction.

11.02.00 Workmanship and dimensional tolerances shall be checked as stipulated else where in the specification

D-1-12(D)

Annexure- (D)

CRITERIA FOR WIND RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT

All structures shall be designed for wind forces in accordance with IS:875 (Part-3) and as specified in this document. See Annexure – I for site specific information.

Along wind forces shall generally be computed by the Peak (i.e. 3 second gust) Wind Speed method as defined in the standard.

Along wind forces on slender and wind sensitive structures and structural elements shall also be computed, for dynamic effects, using the Gust Factor or Gust Effectiveness Factor Method as defined in the standard. The structures shall be designed for the higher of the forces obtained from Gust Factor method and the Peak Wind Speed method.

Analysis for dynamic effects of wind must be undertaken for any structure which has a height to minimum lateral dimension ratio greater than “5” and/or if the fundamental frequency of the structure is less than 1 Hz.

Susceptibility of structures to across-wind forces, galloping, flutter, ovalling etc. should be examined and designed/detailed accordingly following the recommendations of IS:875(Part-3) and other relevant Indian standards.

It should be estimated if size and relative position of other structures are likely to enhance the wind loading on the structure under consideration. Enhancement factor, if necessary, shall suitably be estimated and applied to the wind loading to account for the interference effects.

Damping in Structures

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

a) Welded steel structures : 1.0%

b) Bolted steel structures/ RCC structures : 2.0%

c) Prestressed concrete structures : 1.6%

d) Steel stacks : As per IS: 6533 & CICIND Model Code whichever is more critical.

ANNEXURE-I

SITE SPECIFIC DESIGN PARAMETERS

The various design parameters, as defined in IS: 875 (Part-3), to be adopted for the project site shall be as follows:

a) The basic wind speed "V_b" at ten metres above the mean ground level : 50 metres/second

b) The risk coefficient "K_1" : 1.08

c) Category of terrain : Category-2

D-1-12(E)

Annexure-(E)

CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT

All structures and equipment shall be designed for seismic forces adopting the site specific seismic information provided in this document and using the other provisions in accordance with IS:1893 (Part 1 to Part 4). Pending finalization of Part 5 of IS:1893, provisions of part 1 shall be read along with the relevant clauses of IS:1893:1984, for embankments.

A site specific seismic study has been conducted for the project site. The peak ground horizontal acceleration for the project site, the site specific acceleration spectral coefficients (in units of gravity acceleration 'g') in the horizontal direction for the various damping values and the multiplying factor (to be used over the spectral coefficients) for evaluating the design acceleration spectra are as given at Appendix-I.

Vertical acceleration spectral values shall be taken as 2/3rd of the corresponding horizontal values.

The site specific design acceleration spectra shall be used in place of the response acceleration spectra, given at figure-2 in IS:1893 (Part 1) and Annex B of IS:1893 (Part 4). The site specific acceleration spectra along with multiplying factors specified in Appendix-I includes the effect of the seismic environment of the site, the importance factor related to the structures and the response reduction factor. Hence, the design spectra do not require any further consideration of the zone factor (Z), the importance factor (I) and response reduction factor (R) as used in the IS:1893 (Part 1 to Part 4).

Damping in Structures

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

a)	Steel structures	:	2%
b)	Reinforced Concrete structures	:	5%
c)	Reinforced Concrete Stacks	:	3%
d)	Steel stacks	:	2%

Method of Analysis

Since most structures in a power plant are irregular in shape and have irregular distribution of mass and stiffness, dynamic analysis for obtaining the design seismic forces shall be carried out using the response spectrum method. The number of vibration modes used in the analysis should be such that the sum total of modal masses of all modes considered is at least 90 percent of the total seismic mass and shall also meet requirements of IS:1893 (Part 1). Modal combination of the peak response quantities shall be performed as per Complete Quadratic Combination (CQC) method or by an acceptable alternative as per IS:1893 (Part 1).

In general, seismic analysis shall be performed for the three orthogonal (two principal horizontal and one vertical) components of earthquake motion. The seismic response from the three components shall be combined as specified in IS:1893.

The spectral acceleration coefficient shall get restricted to the peak spectral value if the fundamental natural period of the structure falls to the left of the peak in the spectral acceleration curve.

For buildings, if the design base shear (V_B) obtained from modal combination is less than the base shear ($\bar{V}_B$) computed using the approximate fundamental period (T_a) given in IS:1893:Part 1 and using site specific acceleration spectra with appropriate multiplying factor, the response quantities (e.g. member forces, displacements, storey forces, storey shears and base reactions) shall be enhanced in the ratio of $\bar{V}_B / V_B$. However, no reduction is permitted if $\bar{V}_B$ is less than V_B.

Design/Detailing for Ductility for Structures

The site specific design acceleration spectra is a reduced spectra and has an in-built allowance for ductility. Structures shall be engineered and detailed in accordance with relevant Indian/International standards to achieve ductility.

APPENDIX-I

SITE SPECIFIC SEISMIC PARAMETERS FOR DESIGN OF STRUCTURES AND EQUIPMENT

The various site specific seismic parameters for the project site shall be as follows:

1) Peak ground horizontal acceleration (MCE) : 0.16 g

2) Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') to obtain the design acceleration spectra

   a) for special moment resisting steel frames designed and detailed as per IS:800 : 0.04

   b) for special concentrically braced steel frames designed and detailed as per IS:800 : 0.03

   c) For special moment resisting RC frames designed and detailed as per IS:456 and IS:13920 : 0.024

   d) for RCC chimney, RCC Natural Draft Cooling Tower : 0.08

   e) for liquid retaining tanks : 0.048

   f) for Steel chimney, Absorber tower, Vessels : 0.06

   g) for design of structures not covered under 2 (a) to 2 (f) above and under 3 below, in general (excluding special structure/configuration/ materials) : 0.04

3) Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') for design of equipment and structures where inelastic action is not relevant or not permitted : 0.08

Note: g = acceleration due to gravity

The horizontal seismic acceleration spectral coefficients are furnished as **Annexure – S** in subsequent pages.

ANNEXURE - S

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS for Talcher TPP
(In units of 'g')

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
0	1	1	1
0.03	1	1	1
0.04	1.388	1.338	1.261
0.05	1.790	1.676	1.509
0.06	2.204	2.015	1.748
0.07	2.627	2.355	1.980
0.08	3.059	2.696	2.205
0.09	3.499	3.036	2.424
0.097	3.810	3.275	2.575
0.098	3.810	3.310	2.596
0.1	3.810	3.310	2.640
0.11	3.810	3.310	2.640
0.108	3.810	3.310	2.640
0.11	3.810	3.310	2.640
0.115	3.810	3.310	2.640
0.12	3.810	3.310	2.640
0.125	3.810	3.310	2.640
0.13	3.810	3.310	2.640
0.135	3.810	3.310	2.640
0.14	3.810	3.310	2.640
0.145	3.810	3.310	2.640
0.15	3.810	3.310	2.640
0.2	3.810	3.310	2.640
0.25	3.810	3.310	2.640
0.3	3.810	3.310	2.640
0.35	3.810	3.310	2.640
0.37	3.810	3.310	2.640
0.38	3.810	3.310	2.640
0.39	3.713	3.310	2.640
0.4	3.620	3.310	2.640
0.43	3.367	3.079	2.456
0.45	3.218	2.942	2.347
0.52	2.785	2.546	2.031

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
0.555	2.609	2.386	1.903
0.56	2.586	2.364	1.886
0.565	2.563	2.343	1.869
0.57	2.540	2.323	1.853
0.575	2.518	2.303	1.837
0.58	2.497	2.283	1.821
0.585	2.475	2.263	1.805
0.59	2.454	2.244	1.790
0.595	2.434	2.225	1.775
0.6	2.413	2.207	1.760
0.65	2.228	2.037	1.625
0.7	2.069	1.891	1.509
0.75	1.931	1.765	1.408
0.8	1.810	1.655	1.320
0.85	1.704	1.558	1.242
0.9	1.609	1.471	1.173
0.95	1.524	1.394	1.112
1	1.448	1.324	1.056
1.05	1.379	1.261	1.006
1.1	1.316	1.204	0.960
1.15	1.259	1.151	0.918
1.2	1.207	1.103	0.880
1.25	1.158	1.059	0.845
1.3	1.114	1.018	0.812
1.35	1.073	0.981	0.782
1.4	1.034	0.946	0.754
1.45	0.999	0.913	0.728
1.5	0.965	0.883	0.704
1.55	0.934	0.854	0.681
1.6	0.905	0.828	0.660
1.65	0.878	0.802	0.640
1.7	0.852	0.779	0.621
1.75	0.827	0.757	0.603
1.8	0.804	0.736	0.587
1.85	0.783	0.716	0.571
1.9	0.762	0.697	0.556
1.95	0.743	0.679	0.542
2	0.724	0.662	0.528
2.05	0.706	0.646	0.515
2.1	0.690	0.630	0.503

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
2.15	0.673	0.616	0.491
2.2	0.658	0.602	0.480
2.25	0.644	0.588	0.469
2.3	0.630	0.576	0.459
2.35	0.616	0.563	0.449
2.4	0.603	0.552	0.440
2.45	0.591	0.540	0.431
2.5	0.579	0.530	0.422
2.55	0.568	0.519	0.414
2.6	0.557	0.509	0.406
2.65	0.546	0.500	0.398
2.7	0.536	0.490	0.391
2.75	0.527	0.481	0.384
2.8	0.517	0.473	0.377
2.85	0.508	0.465	0.371
2.9	0.499	0.457	0.364
2.95	0.491	0.449	0.358
3	0.483	0.441	0.352
3.05	0.467	0.434	0.346
3.1	0.452	0.427	0.341
3.15	0.438	0.427	0.335
3.2	0.424	0.414	0.330
3.25	0.411	0.401	0.320
3.3	0.399	0.389	0.310
3.35	0.387	0.378	0.301
3.4	0.376	0.367	0.292
3.45	0.365	0.356	0.284
3.5	0.355	0.346	0.276

D-1-12(F)

Annexure-(F)

QA REQUIREMENT

All Civil, Structural and Architectural construction work at the project shall be executed strictly in accordance with the Quality Assurance guidelines specified in separate part of the Specification.

h. Roads over the toe drain if any shall be provided with suitable cross drainage arrangement to avoid blockage of toe drain

i. At locations where heavy equipments are to be placed and are to be used as fabrication yards, heavy duty paving/ hard crusting shall be carried out.

j. It should be ensured that there is no vehicular movement in any part of dyke embankment except on the new roads that shall be constructed connecting laydown area in the dyke lagoon. No vehicular movement should be there along dyke embankment top.

1.3.0 CONTRACTOR'S OBLIGATIONS

The EPC vendor shall be deemed to have full knowledge of the site and site limitations, whether he visits site or not and no extra charges consequent on any misunderstanding or otherwise shall be allowed. EPC Contractor is advised to visit site and its surroundings to assess and satisfy themselves about the local conditions such as access roads to the site, water and power supply, application / details of taxes, duties, royalties and levies, nature of ground and subsoil conditions, general topography of the site, availability of construction materials, environmental and safety laws, acts and regulations and any other relevant information, as required by them. The EPC Contractor may obtain all necessary information as to risk, contingencies and other circumstances, which may influence or affect their tender. EPC Contractor shall be deemed to have considered local conditions and information and to have satisfied himself in all respects. before quoting terms and no claim whatsoever in this regard shall be entertained by the Owner at a later date.

1.4.0 SOIL DATA

Not Available. Vendor to carry out the same.

1.5.0 ACCESS TO WORK SITE

1.5.1 The Contractor shall make his own arrangement for access to the work site and for movement of men, machinery, other equipments, etc. required for carrying out the work included under this contract.

1.5.2 Roads over the toe drain if any shall be provided with suitable cross drainage arrangement to avoid blockage of toe drain.

1.6.0 Rainfall run-off

As part of the work may have to be carried out in wet season. The Contractor shall supply, install and operate his own temporary pumping installation along with DG set that may be required for dewatering. Proper drainage arrangement in the area shall be developed.

1.7.0 CONSTRUCTION POWER AND CONSTRUCTION WATER

In order to meet Construction Power requirement for this area and construction water, the EPC Contractor shall make its own arrangement.

1.8.0	**GENERAL ENVIRONMENTAL REQUIREMENTS**
1.8.1	The contractor shall be solely responsible and liable for all damage caused by any pollution that may take place during the execution of the works, and he shall make arrangements, as the Engineer may approve, for preventing pollution but, not withstanding such approval, the entire responsibility for any pollution shall rest with the contractor.
1.8.2	**Measures for sprinkling of water to suppress the fugitive dust emission in the area like construction, haulage roads during transportation, filling areas etc. shall be done by the contractor.**
1.9.0	**BORROW PITS/ QUARRY AREA**
1.9.1	For carrying filling work in the abandoned dyke area borrow pits/quarry area shall be identified in consultation with Engineer-in-charge. The Contractor shall formulate a detailed proposal for working in borrow pits identified outside ash lagoon areas as per the requirements. The proposal shall be submitted to the Engineer for his approval. Obtaining Engineer's prior approval is mandatory to start any work in borrow areas/Quarry areas.
1.9.2	Borrow area/quarry material is to be arranged by the contractor at his cost. The contractor shall conduct test to check the suitability of the fill material. The Contractor shall not incorporate in the works, material which has not been passed as satisfactory by the Engineer in charge.
1.9.3	Contractor's Borrow areas shall not be within the land boundary of ash dyke area and shall also be outside the NTPC property line. For materials to be borrowed & supplied by the contractor from pits / quarries, it shall be the Contractor's responsibility for identification and arranging of such quarry areas, obtaining approval for their use from concerned authorities, the Contractor shall pay any levies, royalties, etc., that may have to be paid for utilisation of borrow areas as per the provisions of SCC & GCC.
2.0.0	**GENERAL TECHNICAL REQUIREMENT**
	Specification of various works covered in the scope of work has been mentioned in the section. The content mentioned herein shall be read in conjugation with other relevant portions of the technical specification. For details not mentioned in this section relevant clauses in Part A and Part B of Technical specification may be referred.
2.1.0	**AREA FILLING, BACKFILLING, PAVING & HARD CRUSTING**
	Any existing area which falls in the working area shall be made suitable for the purpose of being used as a laydown area by carrying out filling using suitable material. Hard crusting of Laydown area, fabrication, and pre-assembly yard area has to be carried out as per specifications mentioned below. At locations where hard crusting is not present, Soil cover of minimum 500 mm shall be maintained on top of the abandoned dyke. Soil of approved type shall be obtained from identified borrow area. Specification for area filling & compaction shall be in accordance with Stipulations under relevant clause of Site Levelling and Slope Protection Works, Subsection D-01 Part B of Technical specification, Section VI.

Specification for backfilling shall be in accordance with Stipulations under relevant clause of Area Paving, Subsection D-01 Part B of Technical specification, Section VI.

Hard crusting shall be of minimum 200mm thickness comprising of compacted filling using 63 mm and down aggregate having interstices filled with well graded selected moorum/ non-expansive soil on compacted and dressed sub - grade.

2.2.0 ROAD WORKS

Construction of flexible pavement (WBM roads with bituminous top) wherever constructed shall be in accordance with the IRC, MORTH and IS specifications. The road shall have 300mm thk subbase course 225mm thk base course, 75 thk bituminous macadam surface and 25 mm thk premix bituminous carpet. The roads shall be double lane.

Drains shall be designed as per local conditions. However, drains shall be of minimum 1m width x 1.5m depth.

2.3.0 TURFING

2.3.1 Scope

This section of the specification covers turfing on selected locations of the laydown area which are not hard crusted.

2.3.2 General Requirements

The Contractor shall furnish all labour, equipment and materials required for the complete performance of the work in accordance with the drawings, Schedule of Quantities and as described here in.

2.3.3 Material

50 mm thick grass turf sods of locally available variety shall be used in this work. Direct planting of grass on the dyke slope shall not be permitted.

2.3.4 Placing

Selected locations of the laydown area, which are not hard crusted, shall be turf sodded. Area to be turf sodded shall be slightly roughened and covered with a layer of turf sod consisting of blocks of dense lining grass growth of locally available species. The sod shall include a mat of roots and earth at least 5 cm. thick. Sod containing an excessive amount of obnoxious weed growth shall be excluded. Sod shall be carefully handled in transportation and placing so that a minimum amount of earth will be lost from the root mass. The blocks of sod shall be laid in close contact and then tamped firmly in place so as to fill and close the joints between blocks. Immediately after placing, the sodded area shall be thoroughly wetted and then kept moist for 3 months or till such time the grass establishes itself uniformly on the surface whichever is later. The watering shall be done so as to avoid erosion and prevent damage to sodded areas by water tanker, etc. The growth of weeds on the turfing shall be prevented by removing them and disposing off.

D-1-12(M)

ANNEXURE – M

Specification For High Performance Moisture Compatible Corrosion Resistant Coating System

a) Providing & applying **High Performance Moisture Compatible Corrosion Resistant Coating System** manufactured as per technical specifications of Central Electrochemical Research Institute, Karaikudi, (C.S.I.R. affiliate Institute), Tamil Nadu, Pin - 630 006.

b) The coating system shall be water compatible, compatible for applying in wet conditions also and shall be tolerant to under-prepared surfaces and existing residual tar / paint. The system shall also be quick curing so as to be suitable for application during shut downs.

The coating material shall be stored in the manner as per recommendations of the manufacturer until ready for use. The coating material shall be used within the manufacturer's written recommended shelf life.

c) The coating system shall conform to the following :

PROPERTIES OF PAINT

Base	High Performance Moisture Compatible Corrosion Resistant Coating System CECRI know-how system
Volume Solids	70%
Specific Gravity (ASTM-D-1475)	1.25 ± 0.1
Dry Film Thickness (ASTM-D-1186)	160 ± 10 µm per coat
Coverage	4 - 4.5 sq.m/ ltr
Touch Dry	2 Hours
Recoating	24 Hours

PROPERTIES OF COATING

Salt Spray (ASTM-B 117)	2000 Hours
Resistance to sea water (Carried out upto 6 months)	Passes
Coating Resistance (Carried out upto 6 months)	10^9 Ω. cm^2
Adhesion (ASTM-D 4541)	4.5 N/mm Sq
Flexibility (ASTM-D-522) Elongation	1/8" passes 33%
Impact (ASTM G 14–04)	45 cm passes

d) Paint material & its application method shall be obtained from any manufacturer who has been granted License by CECRI, Karaikudi for technical know how for **High Performance Moisture Compatible Corrosion Resistant Coating System**. The application method of coating shall be got duly approved from CECRI, Karaikudi.

NTPC Ltd

TALCHER SUPER THERMAL POWER STATION

KANIHA

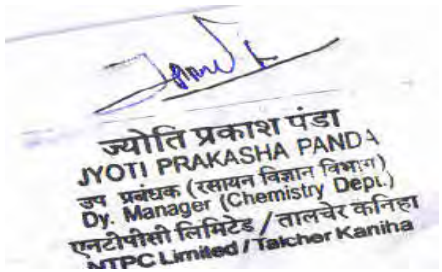
CHEMISTRY LABORATORY

Name of sample: Quarry-4 of Jagannath mine void area water sample

Sample Date – 01/04/22

Collected by: EMG Dept., TTPS

Sample name:	pH	TSS (ppm)	Turbidity (NTU)
Drinking water stg-1	7.56	11.2	20



D1-11	Section-VI/Part-B	D-1-5	107 OF 120	5.23.20.2	The grade slab shall consists of 230 mm thick rubble soling (63 mm downgraded hard stone aggregate as per IRC specification, watering and compaction to minimum of 90% Standard Proctor density, including filling the interstices of stone aggregates with sand), over well compacted earth, overlaid by 75 mm thick P. C. C. M-7.5 and 100 mm thick RCC of grade M-20 with minimum 8 mm dia bars placed at 200 mm C / C in either direction respectively. There will be minimum 50 mm thick metallic hardener finish over the RCC slab. All buildings (including **Wagon Tippler** and machinery hatches, truck hopper, penthouse, MCC rooms, pump houses, transfer houses and crusher house) and ground conveyors shall be provided with 750 mm wide plinth protection all around. It consists of 50 mm thick P.C.C. M-20 grade with 12 mm maximum size aggregate over 200 mm thick stone soling using 40 mm nominal size rammed, consolidated and grouted with fine sand. An area of 5 m width all round the water tanks near pump house, transfer houses and crusher house, Gypsum storage shed, truck tippler area, lime storage silo shall be paved. This paving will be in addition to plinth protection. The paving construction shall be as per specifications for the grade slab at ground level. **However, 50 mm thick metallic hardener finish is not required to be provided in paved area.** Paving shall also be provided in HGTU and VGTU	The grade slab shall consists of 230 mm thick rubble soling (63 mm downgraded hard stone aggregate as per IRC specification, watering and compaction to minimum of 90% Standard Proctor density, including filling the interstices of stone aggregates with sand), over well compacted earth, overlaid by 75 mm thick P. C. C. M-7.5 and 100 mm thick RCC of grade **M-25** with minimum 8 mm dia bars placed at 200 mm C / C in either direction respectively. There will be minimum 50 mm thick metallic hardener finish over the RCC slab. All buildings (including **Track Hopper** and machinery hatches, truck hopper, penthouse, MCC rooms, pump houses, transfer houses and crusher house) and ground conveyors shall be provided with 750 mm wide plinth protection all around. It consists of 50 mm thick P.C.C. **M-25** grade with 12 mm maximum size aggregate over 200 mm thick stone soling using 40 mm nominal size rammed, consolidated and grouted with fine sand. An area of 5 m width all round the water tanks near pump house, transfer houses and crusher house, Gypsum storage shed, truck tippler area, lime storage silo shall be paved. This paving will be in addition to plinth protection. The paving construction shall be as per specifications for the grade slab at ground level. Paving shall also be provided in HGTU and VGTU
D1-12	Section-VI/Part-B	D-1-6	8 OF 24 102 OF 120	6.03.08 5.23.12	The loads for all railway load bearing structures e. g. wagon tippler, tunnel, culverts and underground transfer houses etc. and the analysis and the design of these structures shall be made strictly in accordance with the provisions of Indian Railway Bridge rules (latest edition), and Indian Railway Codes of practice (latest edition) with all amendments up to the date of opening of bids. The axle load for analysis and design shall be considered as “DFC loading (32.5t axle load)” of Heavy mineral loading as per Indian railway standard. Coal heap of 1.2m height shall be considered above hopper top for design of hopper and supporting elements of wagon tippler.	The loads for all railway load bearing structures e. g. **Track hopper,** tunnel, culverts and underground transfer houses etc. and the analysis and the design of these structures shall be made strictly in accordance with the provisions of Indian Railway Bridge rules (latest edition), and Indian Railway Codes of practice (latest edition) with all amendments up to the date of opening of bids. The axle load for analysis and design shall be considered as “DFC loading (32.5t axle load)” of Heavy mineral loading as per Indian railway standard. Coal heap of 1.2m height shall be considered above hopper top for design of hopper and supporting elements of **Track hopper.**

D1-13	Section-VI/Part-B	D-1-6	9 OF 24 102 OF 120	6.03.08 5.23.12	For design of all underground structures / foundations, ground water table shall be assumed at the formation level (i. e. the adjoining ground level).For all underground structures like wagon tippler, tunnels and underground transfer points crack width shall be restricted to 0.2 mm.	For design of all underground structures / foundations, ground water table shall be assumed at the formation level (i. e. the adjoining ground level).For all underground structures like **Track hopper**, tunnels and underground transfer points crack width shall be restricted to 0.2 mm..
D1-14	VI/ Part-B				Service Building Architectural Features This building shall be **four storeyed (Ground + 3 stories above)** and shall be provided with floor area of 3700 sq.m with RCC framed structure. Autoclave Aerated Concrete Block masonry wall shall be provided for the full height of the building for both external and internal walls. **Floor-to-floor height shall be minimum 4.25m.**	Service Building Architectural Features This building shall be **five storeyed (Stilt + 4 stories above)** and shall be provided with floor area of 3700 sq.m with RCC framed structure. Autoclave Aerated Concrete Block masonry wall shall be provided for the full height of the building for both external and internal walls. **Floor-to-floor height above the stilt floor shall be minimum 4.25m. Height of stilt floor shall be 8 meters (clear)**
D1-15	VI/ Part-B	D-1-5	45 of 120	5.12.04	**Fuel Oil Unloading Pump House** Fuel Oil Unloading Pump house shall be a covered building with RCC columns and Structural Steel Roof truss (with rafter and tie level plan bracings), purlins and roof slab. The roof slab shall comprise minimum 40 mm thick (above the crest of metal deck sheet) RCC slab supported on profiled metal deck. **250mm thick** external brick wall shall be provided with provisions for fire proof door, windows & rolling shutters.	**Fuel Oil Unloading Pump House** Fuel Oil Unloading Pump house shall be a covered building with RCC columns and Structural Steel Roof truss (with rafter and tie level plan bracings), purlins and roof slab. The roof slab shall comprise minimum 40 mm thick (above the crest of metal deck sheet) RCC slab supported on profiled metal deck. **One Brick** thick external brick wall shall be provided with provisions for fire proof door, windows & rolling shutters.
D1-16	VI/ Part-B	D-1-5	47 of 120	5.14.00	**GATE COMPLEX** **.....** Gate Complex shall include Central Industrial Security Force (CISF) building. The CISF Building shall be a two (2) storied RCC super structure with office complex in ground floor & first floor. The building shall be constructed with **250mm thick** brick wall with provisions for doors, windows & ventilators.	GATE COMPLEX ..... Gate Complex shall include Central Industrial Security Force (CISF) building. The CISF Building shall be a two (2) storied RCC super structure with office complex in ground floor & first floor. The building shall be constructed with **One Brick** thick brick wall with provisions for doors, windows & ventilators.
D1-17	VI/ Part-B	D-1-5	102 of 120	5.23.12	**Staircases** **.....** All stairs of over ground portion of transfer houses & crusher house shall be of steel (minimum 1200 mm wide) and maximum rise should not be more than180 mm and minimum tread width **250 mm.**	GATE COMPLEX ..... All stairs of over ground portion of transfer houses & crusher house shall be of steel (minimum 1200 mm wide) and maximum rise should not be more than180 mm and minimum tread width **275 mm.**
D1-18	VI/ Part-B	D-1-5	1/2 of 31	9.03.01	**Water Supply and Sanitation** **.....** Roof water tanks of adequate capacities depending on the number of users and 8 hours requirement shall be provided for each building and pump house. Polyethylene water storage tanks conforming to IS:12701 shall be used. The tanks shall be complete with all fittings including lid, float valve, stop cock, vent pipe, etc. Service water tank shall be of RCC construction.	**Water Supply and Sanitation** ..... Roof water tanks of adequate capacities depending on the number of users and 8 hours requirement shall be provided for each building and pump house. Polyethylene water storage tanks conforming to IS:12701 shall be used. The tanks shall be complete with all fittings including lid, float valve, stop cock, vent pipe, etc. Service water tank shall be of RCC construction. **In Service Building, Administation Building, Canteen Building Roof water Tank shall be of RCC.**

D1-27	VI/B	D-1-5	40 of 120	5.07.00	SEWERAGE SYSTEM: Complete sewerage system including Sewage Treatment Plant for facilities within the plant is in bidder's scope. Bidder shall provide 'De-centralized Sewage Treatment' units. The capacity of the Decentralized Sewage Treatment' units should be as per the design requirements, subject to minimum combined capacity of 75 Cum/day. Design of Sewage treatment plant shall be as per CPHEEO manual. Primary, Secondary and Tertiary treatment to be provided. Cement concrete pipes of class NP-3 as per IS 458 shall be used below ground level for sewage disposal in all areas other than main plant area. However, for pressure pipes and in main plant areas, and under roads spun Cast Iron pipes conforming to IS 1536 of required class shall be used. RCC manholes with CI cover shall be provided at every 30m along the length, at connection points, and at every change of alignment, gradient or diameter of a sewer pipeline. This shall be as per IS 4111. Sewage pump stations shall be provided as per IS 4111. BIDDER SHALL HAVE TO PROVIDE COMPLETE ARRANGEMENT for sewage disposal up to the sewage treatment plant including pumping facilities.	SEWERAGE SYSTEM: Complete sewerage system including Sewage Treatment Plant for facilities within the plant is in bidder's scope. Bidder shall provide 'De-centralized Sewage Treatment' units. The capacity of the Decentralized Sewage Treatment' units should be as per the design requirements, subject to minimum combined capacity of 75 Cum/day. Design of Sewage treatment plant shall be as per CPHEEO manual. Primary, Secondary and Tertiary treatment to be provided. **Treated sewage water shall be used for horticulture purpose as per quality requirement of CPHEEO manual.** Cement concrete pipes of class NP-3 as per IS 458 shall be used below ground level for sewage disposal in all areas other than main plant area. However, for pressure pipes and in main plant areas, and under roads spun Cast Iron pipes conforming to IS 1536 of required class shall be used. RCC manholes with CI cover shall be provided at every 30m along the length, at connection points, and at every change of alignment, gradient or diameter of a sewer pipeline. This shall be as per IS 4111. Sewage pump stations shall be provided as per IS 4111. BIDDER SHALL HAVE TO PROVIDE COMPLETE ARRANGEMENT for sewage disposal up to the sewage treatment plant including pumping facilities.
D1-28	VI/A	IID	3 of 13	1.00.00	5. Construction of Raw Water Reservoir and dismantling, removal, disposal of waste material of existing reservoirs and levelling to FGL.	Construction of Raw Water Reservoir and dismantling, removal, disposal of waste material of existing reservoirs and levelling to FGL. The interconnection of Stage -III reservoir inlet pipe with existing MUW pipe line of Stage-II & I including booster pump, if required, shall be under Bidder's scope.
D1-29	VI/B	D-1-12(P)			Annexure-P	Annexure-P
D1-30	VI/E	Tender Drawings			4540-001-POC-A-006, Rev 0	4540-001-POC-A-006, Rev 1
D1-31	VI/B	D-1-6	11 of 24	6.03.08.18	All Insert plates (except edge protection angles) provided in liquid retaining structures shall be 12 mm thick GI with lugs not less than 12 mm diameter. Edge protection angles shall be provided as specified elsewhere	All Insert plates (except edge protection angles) provided in liquid retaining structures shall be 12 mm thick GI with lugs not less than 12 mm diameter **or 6mm flats**. Edge protection angles shall be provided as specified elsewhere
D1-32	VI/B	D-1-5	11 of 127	5.02.09	Windows on south side at accessible level at operating floor level shall have Building Integrated Photovoltaic Cell as Glazing. The glazing area shall be increased accordingly for proper lighting.	**Deleted**
	VI/B	D-1-5	13 of 127	5.02.10	Windows on south side shall have Building Integrated Photovoltaic Cell as Glazing. The glazing area shall be increased accordingly for proper lighting.	**Deleted**
	VI/B	D-1-5	114 of 127	5.30.00	Windows on south side shall have Building Integrated Photovoltaic Cell as Glazing. The glazing area shall be increased accordingly for proper lighting.	**Deleted**
D1-33	VI/B	D-1-5	83 OF 127	5.19.02.02.01	The tank foundation shall be as per IS:803 and as specified in Cl. No.7.01.04.	The tank foundation shall be as per IS:803 and as specified **in relevent clause of foundation chapter.**

D1-39	VI/B	D-1-5	64 of 120	5.17.05.03	Exterior surfaces of cooling tower shell and all surfaces of raker columns shall be given three coats of waterproof cement paint of approved make and colour. No painting is envisaged for internal surfaces of cooling tower shell and internal grillage columns and beams.	Exterior surfaces of cooling tower shell and all surfaces of raker columns shall be given three coats of waterproof cement paint of approved make and colour. All concrete surfaces below Eliminator level such as internal surface of CT shell, all surfaces of raker columns, beams & internal columns, platforms, walkways and any other RCC/PCC components shall receive high build heavy duty polyurethane coating having formulation of 100 % solids, solvent free after grit blasting of the concrete surface. Thickness of polyurethane coating shall be 2.0 mm. Suitable primer as per standard practice/manufacturers' recommendation shall be used. The detailed specification of the coating system on concrete surfaces is given in Annexure Q.

SL. NO.

ANNEXURE – Q

SPECIFICATIONS FOR 100% SOLIDS , HIGH BUILD, ELASTOMERIC POLYURETHANE COATING FOR CONCRETE IN SEAWATER APPLICATIONS

1.00.00 The coating shall meet minimum requirements for materials, equipment, application, inspection, repair and handling aspects associated with the coating of Concrete In Sea water Applications using 100% Solids (Solventless) Two Component, Fast Curing Elastomeric Polyurethane Coating classified under ASTM D -16, Type V.

1.01.00 The polyurethane on the external / internal surface of the Concrete shall provide a hard yet flexible, impermeable barrier with outstanding adhesion impact and abrasion resistance as well as crack spanning capability to protect the Concrete from corrosion and abrasion. It shall cover all variations associated with operating conditions of NDCT.

1.02.00 Supplier or his licensed applicator shall obtain prior written approval from the Owner for any deviations from the requirements of this specification and / or the standard referred herein.

1.03.00 The work shall conform to following documents (latest revision or as specified) and as referred in this specification.

a) SSPC-PS Guide 17.00, 1 Aug, 1991	Guide for Selecting Urethane Painting System
b) RP 0892-92	NACE International Linings Over Concrete For Immersion Service
c) RP 0187-96	NACE International Design Considerations For Corrosion Control of Reinforcing Steel In Concrete.
d) ASTM D 4541	Method for Pull Off Strength of Coatings Using Portable Adhesion Testers

2.00.00 **GENERAL REQUIREMENT**

2.01.00 The bidder shall perform all work in accordance with this specification and other requirements noted herein.

Bidder shall submit a detailed written description in the form of a manual covering coating equipment, procedure, materials, inspection, tests and repair etc, for Owner's approval.

2.02.00 The bidder shall also supply copies of test reports conducted by in internationally reputed test agencies evidencing that materials conform to minimum performance requirements. The bidder shall also supply certificates from coating manufacturer as under.

- That the materials (with batch numbers, dates of manufacture and shelf life) are free from all manufacturing defects.

- That the materials will meet performance criteria as given below when applied.

- That the bidder or his applicator possesses the necessary technical skills and equipment to apply these materials and is authorized by the manufacturer for this purpose.

100% Solids, Two Component Polyurethane are specialized coatings characterized by very short pot lives. The coating shall be applied either by the coating material manufacturer himself or by his authorized applicator. The authorized applicator should have been trained and certified by the coating manufacturer and shall possess the necessary specialized equipment, trained crew and experience in spraying fast setting plural component polyurethane coatings. Contractor shall provide, for the owner's approval, details of coating manufacturer's authorized applicator including details of equipment, experience in spraying fast setting 100% Solids Polyurethane Coatings and client references for verification. In no case shall coating application be undertaken by coating contractors without prior track record of applying these materials. In addition, contractor shall provide certificate from coating materials manufacturers that the applicator possesses the necessary technical skills and equipment to apply these materials and is authorized by the manufacturer for this purpose.

2.03.00 Applied coating will be tested for dry film thickness and adhesion and hardness.

All coating operations shall be performed under the supervision of, and performed by, personnel skilled in the application of the coating system.

2.04.00 The bidder shall provide access, during all phases of work, to the Owner and their representatives.

2.05.00 All cleaning, priming and coating machines shall be equipped with rubber or wheels overlaid with hard fiber to prevent damaging the concrete surface.

2.06.00 The materials shall be applied by Airless Spray System, as per the standards specified by the material manufacturer.

2.07.00 100% Solids Polyurethane systems are solvent free eliminating solvent health hazards and flammability concerns All safety precautions warranted by good industrial hygiene practices and regulated by local, state or central laws must be taken into consideration while applying these coatings.

3.00.00 MATERIAL SPECIFICATIONS

3.01.00 ELASTOMERIC POLYURETHANE COATING :

Spray applied, Impermeable, 100% Solids, Elastomeric Aromatic Polyurethane Coating (Non Tar Extended), as per ASTM D-16, Type V (Two Component, Chemical Cure). Shall meet following criteria. All tests at ambient (25 C) unless otherwise specified.

- NOMINAL THICKNESS — 2,000 Microns
- TENSILE STRENGTH ASTM D-638 — 17 N / mm^2
- ADHESION ASTM D-4541 (Elcometer Pull Off) — 2 N / mm^2
- RECOVERABLE ELONGATION ASTM D-638 — 50% Min.
- SURFACE HARDNESS ASTM D 2240 (Cured Film - Shore D) — 50 Min.
- WATER VAPOUR PERMEABILITY ASTM E - 96 / F-1249-90 — 0.3 gms. / 24 Hour / M2 Max.
- RESISTANCE TEMPERATURES — 0º C to 60ºC
- FLEXIBILITY 180° Bend -1.0 mm thick ASTM D 1737 — Pass over 12 mm Mandrel
- ACCELERATED WEATHERING ASTM G – 154 53 / BS 3800 2,000 Hours — Excellent. Some Discoloration.
- ABRASION RESISTANCE ASTM D 4060 /FTMS 141 Taber Abraser H - 10 Wheel 1,000 gms., 1,000 cycles — Weight Loss 0.05 gms. Max
- CHEMICAL RESISTANCE Immersion of 30 days in sea water followed by
  - (%) Weight Change — < 1.0 %
  - (%) Hardness (Shore D) Change — < 5.0 %
  - (%) Tensile Strength Change — < 5.0 %

3.02.00 **PRIMER**

Primer shall be used on new concrete surfaces before application of PU coating.

Damp tolerant, penetrating, sealing primer shall be applied at 100-125 Microns Wet Film Thickness in accordance with the recommendation of the Polyurethane Coating manufacturer.

4.00.00 **SURFACE PREPARATION**

4.01.00 The bidder shall be responsible for the structural integrity of the concrete.

The use of form release agents shall be compatible to the coating. Contractor shall take measures in concrete casting to provide a suitable surface finish that shall be compatible with subsequent application of coating. The measures shall include providing well compacted, dense concrete with minimal air entrainment and a relatively smooth surface finish. Pond floor shall be vacuum dewatered.

Remove any fins or protrusions using power grinding. These may also be required to be removed for applications requiring an even finish.

Residual bug – holes beneath the surface of the coating shall be opened by sweep blasting and flooded with Polyurethane coating during spray application. Any larger voids shall be filled with Elastomeric Polyurethane hand mix material or compatible grout. Active cracks shall be bridged by using Elastomeric Polyurethane over Industrial Nylon / Polyester Fabric. Any exposed steel surfaces shall be wire brush cleaned and primed before coating application.

4.02.00 Exterior waterproofing shall be applied to the structure below the finished ground level and upto atleast 300 mm above it. The structure shall be sealed from the exterior (soil side) to block capillary action of moisture through the concrete. Leaks from groundwater can permeate the entire concrete thickness. The exterior waterproofing system must be suitable for the expected exposure condition.

4.03.00 Before general surface preparation, surface contaminants (if any) shall be removed. Oil and Grease shall be removed by multiple detergent wash, preferably using steam. (Solvents shall not be used as they will cause the petroleum products to penetrate the concrete surface). Chemically contaminated concrete shall be neutralized prior to complete surface preparation. Acidic surfaces shall be neutralized using an alkaline cleaner and rinsed with fresh water and then cleaned with steam and detergent. After chemical cleaning, surface will be tested for residual chemicals. pH shall be tested using ASTM D - 4262 using pH test paper on rinse water . Concrete shall be dried thoroughly thereafter.

4.04.00 Sweep blast the concrete surface using expendable abrasive. The blast nozzle should be kept at sufficient distance to avoid over blast and exposing of aggregate. Following blasting remove dust using air jet (with the abrasive turned off) .

4.05.00 Any of the following methods of surface preparation may be used to achieve a near white blast cleaned surface :

a) Dry abrasive blasting using compressed air, blast nozzles and abrasive.
b) Dry abrasive blasting using a dosed cycle, re-circulating abrasive system, with compressed air, blast nozzle, and abrasive, with or without vacuum for dust and abrasive recovery.
c) Dry abrasive blasting using a dosed cycle, re-circulating abrasive system with centrifugal, wheels and abrasive (such as Wheelabrator).

4.06.00 Compressed air used for blast cleaning shall be dean, dry and free of moisture and oil. Moisture separators, oil separators, traps or other equipment may be necessary to achieve dean, dry air.

4.07.00 Blast cleaning operations shall be done in such a manner that no damage is done to partially or entirely completed portions of the work.

4.08.00 Dry blast cleaning shall not be concluded during times when the surface will become wet after blast cleaning.

4.09.00 Non-metallic disposable mineral abrasive such as silica sand shall be the chosen abrasive for open blasting operations Steel grit and shot are approved abrasive media for blast cleaning in closed cycle, recirculating abrasive systems (compressed air, vacuum and centrifugal wheel) . No other abrasive media shall be used without prior approval.

4.10.00 The cleanliness and size of recycled abrasive shall be maintained to ensure compliance with this standard.

4.11.00 The blast cleaning abrasive shall be dry and free of oil, grease and other contaminants. Applicator shall use abrasive media of size that will ensure the necessary roughness desired.

4.12.00 Dust and residues shall be removed from prepared surface by brushing, blowing off with dean , dry air or vacuum cleaning. Moisture separators, oil separators, traps or other equipment may be necessary to achieve clean, dry air.

4.13.00 Prior to the application of Elastomeric Urethane on new concrete surface, sufficient time must pass to allow the excess moisture to evaporate. This time will vary on conditions and is normally 14-28 days. After the curing period has elapsed, concrete must be checked for the presence of excess moisture on and beneath the surface using a Delmhorst BD-8 Moisture Detector. A reading of 2% and under indicates that the concrete is ready to be coated. The moisture content must not only be checked on the surface but beneath it by driving nails 6-12 mm into the concrete and placing the probes on the nail - heads. Alternatively the moisture may be tested by the Plastic Sheet Test ASTM D-4263 . The test involves taping a 450 mm X 450 mm , 0.1 mm thick dear plastic sheet to the surface of the concrete for a duration of 16 hours. Absence of any droplets of moisture underneath the plastic sheet indicates that the concrete is ready for coating.

In cases of continued ingress of moisture from localised areas of concrete, apply propane blow torch to ensure that the moisture content as specified above is achieved.

5.00.00 PRIMING

5.01.00 Before beginning priming and coating, measure the humidity using a sling psychrometer and calculate the dew point. The relative humidity must be lower than 85%. Temperature of concrete surface must be at least 3°C higher than the dew point. Under controlled conditions, it is possible to heat the concrete surface to eliminate condensation problems.

5.02.00 The type of primer used shall be as described in the coating specification 3.02.00.

5.03.00 Primer shall be sprayed onto the cleaned surface with a wet film thickness of 75-125 Microns. Since the primer penetrates into the concrete surface, no DFT measurements

will be taken and estimation shall be on volumetric basis. The primer on application shall be free from runs or drips or areas of excessive thickness.

5.04.00 The primed surface shall be protected so that it will not come into contact with rain, dust or other substances until completely hardened and coated with the Elastomeric Polyurethane Top Coat.

5.05.00 Primed surface should be over coated within the time recommended for the approved type of primer. In the event that the re-coat interval of primed surface is exceeded without top-coating with the Elastomeric Polyurethane, the surface must be re-primed.

6.00.00 **COATING**

6.01.00 Nominal thickness of the Elastomeric Polyurethane shall be 2,000 Microns, measured in accordance with 7.02.02. Being a thixotropic, high build, non-levelling coating, the Elastomeric Polyurethane coating shall take the contour / profile of the substrate.

Coating shall be done only at times when the substrates temperature is at least 3°C over the dew point. Hourly measurements of dew point and surface temperatures shall be made prior to and when coating is under progress. Surface temperature should be minimum 5°C and should not exceed 70°C.

6.02.00 Equipment for the spray application shall be in conformity with system specification, meeting minimum specified by the coating manufacturer. Equipment shall consist of Material Feed Pumps, Purge Pump, Proportioning Pump, Mix Manifold, Static Mixer, Interconnecting Hoses etc.

6.03.00 Partially used and unused material drums must be tightly sealed and contain a blanket of nitrogen to prevent moisture contamination when not in use.

6.04.00 Before application on the substrate apply a test patch for runs or drips and gel time as well as tack free time.

6.05.00 The proportioning pump shall be fitted with a numeric counter to keep track of the volume while spraying.

6.06.00 Entire thickness shall be built up in a single application (with a number of passes) . If the surface is large enough to require more than one day for the coating, the edges of the coated areas shall be feathered and roughened with a grinding too) prior to beginning priming and coating.

6.07.00 Areas not to be coated shall be masked with disposable plastic sheets, cardboard etc.

6.08.00 Visual inspection shall be made for film discontinuities such as air bubbles, blowholes, skips, shadows. Such defects will be marked and repaired with Elastomeric Polyurethane hand mix kit with slower pot life after roughening the edges.

7.00.00 **INSPECTION**

7.01.00 All work under this specification shall be subject to inspection by the owner or his representative. All parts of work shall be accessible. The applicator shall correct such work as is found defective and not as per the specifications.

7.02.00 The following tests shall be made :

During coating application the wet film thickness will be measured using Nordson wet Film Gauge as per ASTM D 4414.

7.02.01 Adhesion

Pull Off adhesion to Concrete measured using an portable adhesion tester such as Positest AT-CM Elcometer or equivalent as per ASTM D4541 on fully cured (7 days) concrete. Frequency shall be 3 readings per 1,000 Sq.M of coated area. The average of readings from three ~~five~~ randomly selected areas shall constitute the adhesion and shall be minimum 2 N/mm2 (see below). Test area to be flat (without curvature). The following method will be used to determine whether coating meets adhesion requirements

Elcometer Reading	Type of Failure		Result / Conclusion
> 2 N / mm^2	T1	90% or more of break at coating - concrete interface	Coating meets adhesion criteria. Take actual reading of bond strength.
	T2	90% of more of break within the concrete	Concrete Failure. Coating adhesion exceeds 2N/mm^2
< 2 N / mm^2	T1	90% or more of break at coating - concrete interface	Coating does not meet adhesion criteria. Take actual reading of bond strength achieved.
	T2	90% of more of break within the concrete	Concrete lacks sufficient strength to provide necessary adhesion figure. Coating adhesion accepted.

7.02.02 Film Thickness (DFT)

The film thickness shall be determined from the thickness of the coating detached along with the Elcometer dollies of the adhesion test and the readings shall be recorded. Frequency shall be identical to adhesion test. Average of 3 reading shall constitute the film thickness and shall be al least 2,000 Microns. Minimum spot reading shall be 1,800 Microns. Recommended spread rate by the manufacturer for the specified thickness of the PU coating shall be ascertained and adhered to during the coating process.

7.02.03 Hardness (Durometer)

Cured films (7 days) shall be tested for hardness using Durometer (Shore D) as per ASTM D 2240.

SL. NO.	SPECIFICATION REFERENCE				EXISTING	READ AS
	SEC/ PART	SUB SEC.	PAGE NO.	CLAUSE NO.		
C-13	VI/A	IV	2 of 73	1.00.01 g)	PG test shall be performed by using process instruments envisaged for normal operation and control of unit. Any additional instrument/ item required for PG test shall also be supplied by the contractor. Instruments to be used for PG test shall be indicated in the respective P&IDs. Control system loop tuning required to limit the variation of parameters during performance guarantee testing shall be completed prior to PG Test / initial operation. Test result for PG test is envisaged to be computed in DDCMIS.	**Instruments for PG test and instruments for process control of similar applications shall be of same make and model having same accuracy level.** Instruments to be used for PG test shall be indicated in the respective P&IDs. **PG test equipment being supplied, installed and commissioned for each unit, shall be retained by employer after completion of PG test.** Control system loop tuning required to limit the variation of parameters during performance guarantee testing shall be completed prior to PG Test / initial operation. **All PG test process parameters shall be made available in DDCMIS.**
C-14	VI/A	IIC	17 of 18	21.00.00	2. Bidder is to provide……. The training models shall comprise of dismantling, overhauling, and re-assembling modules up to its last sub-component for major equipment's of Boiler, Turbine, Generator, AHP, CHP. The individual equipment models shall …… finalized during detail engineering.	2. Bidder is to provide……. The training models shall comprise of dismantling, overhauling, and re-assembling modules up to its last sub-component **for the following equipments: Boiler, Turbine, Generator. Crusher House , Dry ash evacuation system, MDBFP, TDBFP, CW pumps, ID fan, FD fan, PA fan**, P**ulverizer, Condenser and Dearato**r The individual equipment models shall …….. finalized during detail engineering.

Annexure (Q)

GPR Report

D-1-7 **FOUNDATION SYSTEM AND GEOTECHNICAL DATA**

7.00.00 Soil Data

Owner has carried out detailed geotechnical investigation at the project site. Bearing capacity for design of foundations and Bore logs data are given at Annexure - C of this specification. The geotechnical investigation report comprising of Boreholes, Laboratory tests, Chemical analysis, etc. in respect of the sub-strata prevailing at site will be made available for the Bidder's study at the Employer's office, if required. The onus of correct assessment / interpretation and understanding of the existing subsoil condition / data is on the Bidder. The geotechnical investigation report will be made available for the Bidder's study at the Owner's office, if required. **In case, bidder feels that the available data is inadequate, he may carry out his own geotechnical investigation**. **Further, if any change in layout or area not covered as per enclosed borelog data, Contractor shall carry out geotechnical investigation in the area at no cost to owner.** The scheme for geotechnical investigation shall be approved by owner before execution. Geotechnical investigation work may be got executed by the contractor through the suggested agencies as mentioned in Clause No. 7.08.00 or any other agency having adequate experience for carrying out such works and approved by engineering department of the owner. However, no time extension shall be given on account of soil investigation carried out by the Bidder. The geotechnical investigation report shall be prepared with detailed recommendations regarding type of foundation and allowable bearing pressure for various structures/ facilities and other soil parameters. The report shall be submitted for Owner's approval prior to commencement of design of foundation.

Bidder may refer enclosed topographical survey drawing and general layout plan along with borelogs for variation in existing/ natural ground level (NGL) and finished ground level (FGL). As per borelog data, near proposed Admin building, fire station, permanent store, Workshop building and gate complex area, carried out by owner ash/coal deposit is found. Wherever ash/coal deposit/brick-bats etc. is found the same shall be treated as filled up soil. Further, as per available borelog data of the above mentioned area, NGL is varying from RL(+) 64.9 m to RL(+) 67.0m and FGL is RL(+) 69.0 i.e. there may be filled up layer up to 2.0m to 4.1m of ash/coal deposit.
As per borelog data, water table is varying from 0.0m to 4.5m at the time of field investigation and may fluctuate with season.

7.00.01 **The furnished borelog details are specific to the co-ordinates where the boreholes have been carried out and are provided for bidder's information only. Soil profile in the proposed area may vary with respect to the borelogs enclosed for bidder's information. Bidder has to consider all such variations in his estimation, over the extent of the work to be carried out. The Bidder should note that nothing extra whatsoever on account of variation between soil data collected by Owner and that found by the Bidder during geotechnical investigation by him or during execution of works, shall be Payable.**

7.01.00 Tank Foundations

a) The tanks shall rest on flexible tank pad foundation, resting on sand with concrete ring wall to retain sand. Base of the concrete ring wall shall not rest on the expansive soil, if any.

b) Entire loose/ soft soil inside the concrete ring wall shall be removed and shall be filled with sand. Sand for filling shall be clean and well graded conforming to IS 383 with grading Zone I to III.

c) Sand shall be spread in layers not exceeding 30cm compacted thickness over the area. Each layer shall be uniformly compacted by mechanical means like plate vibrators, small vibratory rollers, etc to achieve a relative density of not less than 80%.

d) Other requirements of tank foundations shall be as per IS 803 and as specified elsewhere in the specifications.

7.02.00 Foundation System

The requirements for the foundation system to be adopted are as given in subsequent clauses. Depending upon the depth of competent strata/stratum, type of structures, functional requirement of facility, extent of cutting / filling, suitable open or pile shall be adopted with approval of owner.

7.02.01 General Requirements

a) All structures/equipment shall be supported on suitable open foundations (isolated, combined, raft) or pile foundations depending on type of structures/facilities, sub-strata, topography etc.

b) The roads, ground floor slabs, trenches, pipe pedestals (except thrust blocks), channels/drains and staircase foundation with foundation loading intensity less than 4 T / M2 may be supported on open / shallow foundations resting on virgin / controlled compacted filled up soil.

c) No other foundation (other than as mentioned in (b) above and (g) below) shall rest on the filled up ground / soil.

d) All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian Standards.

e) The water table for design purpose shall be considered at Finished Ground Level.

f) A combination of open and pile foundations shall not be permitted under the same equipment / structure / building.

g) Foundation for equipments on ground floor

For equipments of static weight upto 1.5 T, the equipment may be supported on the ground floor slab by locally thickening the slab. Thickening of the ground floor slab shall be done upto an extent of about 0.6 m beyond the plan area of the equipment on all the sides. Further, the load intensity below the equipment shall be limited to 4T/m2. Other requirements of floor slab and compaction below the floor slab shall be adhered, as specified elsewhere in the specifications.

For equipment's of static weight between 1.5 T and 20 T, the equipment may be supported on compacted sand filling from Natural Ground Level (NGL) or excavation level of nearby footing whichever is deeper with the load intensity below the equipment limited to 4T/m2. The minimum depth of foundation is 1.0m below FFL. Other requirements of sand compaction below the foundation shall be adhered, as specified elsewhere in the specifications.

For equipment of static weight more than 20 T, the equipment foundation shall be taken to the founding level or shall be built up with PCC from the level as mentioned in the Table 1. The pedestal of equipment foundation or the foundation Block shall be isolated from the adjoining floor slab by providing bitumen impregnated fiber board of minimum 50 mm thick, conforming to IS: 1838 all around the equipment pedestal for the full depth of the floor slab.

7.02.02 Open Foundations

In case open foundations are adopted, following shall be adhered to.

a) The minimum width of foundation shall be 1.0 m.

b) Minimum depth of foundation shall be 1.0m below Ground Level.

c) It shall be ensured that all foundations of a particular structure/ buildings/ facility shall rest on one bearing stratum.

d) Wherever the intended bearing sub-strata is virgin soil stratum but the actual stratum encountered during foundation excavation consists of filled up soil at founding level, under such cases either the foundation shall be lowered completely into the virgin stratum or the filled up soil upto the virgin layers shall be removed and built up through PCC (1:4:8) up to designed foundation level.

e) Wherever the intended bearing stratum is weathered rock, but the actual strata encountered during excavation consists of both overburden soil and weathered rock at founding level, under such cases, the overburden upto the weathered rock level including 0.5 m into the weathered rock shall be removed and built up through PCC (1:3:6) upto the designed founding level. Thus, maintaining the same founding level for all the footings of a structure.

f) The last layer of about 300 mm before reaching the founding level shall be excavated carefully by such equipment so that soil / rock at the required level will be left in its natural condition.

g) Wherever the new facilities (excluding roads, ground floor slabs, trenches, pipe pedestals, channels/drains and staircase foundation) are to be constructed after dismantling existing facilities; it is to be ensured that the new foundations shall be taken at least 1m below the existing founding depth of the dismantled structures in case of soil and 0.6m below the existing founding depth of dismantled structures in case of rock.

7.03.00 **PILE FOUNDATIONS – In case piles are adopted, following shall be adhered to:**

i) The pile foundation shall be of RCC, Cast-in-situ bored piles as per IS:2911. Pile boring shall be done using Self erecting Crawler mounted Rotary Hydraulic Rigs. However, conventional tripod rig may be allowed in inaccessible areas subject to site specific conditions. Two stage flushing of pile bore shall be ensured by airlift technique duly approved by the Employer.

If required, temporary or permanent MS liner may be provided for piling.

ii) The minimum diameter of pile shall be 600mm. The allowable load capacity of the pile in different modes (vertical compression, lateral and pullout) shall be least of the two values i.e. as per the values furnished in following table and pile capacity achieved in pile load tests:

Pile	Dia. (mm)	Vertical compression capacity (T)
Bored cast-in-situ pile	600	140
	760	250
	1000	350
	1200	450

Pile shall be socketed into weathered rock. A socketing length of **Five meter** into rock **shall be ensured.**

The uplift and lateral load capacity shall be respectively restricted to 35% and 5% of the allowable load capacity in vertical compression.

However, the pile capacities to be adopted shall be the least of the estimated design values and that obtained from the initial pile load tests.

iii) Only straight shaft piles shall be used. Minimum cast length of pile above cutoff level shall be 1.0 m.

iv) The 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, reinforcement for job as well as test piles, pile load test arrangement, locations of initial test piles etc.) for Engineer's approval.

v) 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 Contractor for Engineer's approval.

vi) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be subject to minimum as under.

Vertical

Lateral Minimum of 2 Nos. in each mode.

Uplift

vii) The initial pile load test shall be conducted with test load three times the estimated pile capacity. In case of vertical compression test (initial test) the method of loading shall be cyclic as per IS:2911 (relevant part).

viii) Load test shall be conducted at pile cut of level (COL). If the water table is above the COL the test pit shall be kept dry through out the test period by suitable de-watering methods. Alternatively, the vertical load test may be conducted at a level higher than COL. In such a case, an annular space shall be created to remove the effect of skin friction above COL by providing an outer casing of suitable diameter larger than the pile diameter.

ix) Number of routine pile load tests to be performed for each diameter/allowable capacity of pile shall be as under:

i) Vertical : 0.5% of the total number of piles provided.

ii) Lateral : 0.5% of the total number of piles provided.

x) The routine tests on piles shall be conducted upto test load of one and half times the allowable pile capacity. Piles for routine load tests shall be approved by the Employer.

xi) 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 Contractor shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required.

xii) Testing of piles and interpretation of pile load test results shall be carried out as per IS:2911 (Part-4). Contractor shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory / institute prior to their use. Settlement / movement of the pile top shall be made by Linear Variable Differential Transducers (LVDT) having a least count of 0.01mm.

xiii) The test load on initial and routine test piles shall be applied by means of reaction from anchor piles / rock anchors alone or kentledge with concrete blocks alone or combination of anchor piles / rock anchors and kentledge with concrete blocks.

xiv) Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the routine load test and not intended to replace the use of static load test. This test is limited to assess the imperfection of the pile shaft and shall be undertaken by an independent specialist agency to be approved by Engineering department of Owner. The test equipment shall be of TNO or PDI make or equivalent. The process shall confirm to ASTM.

xv) High Strain Dynamic Load Test may be carried out for routine vertical load test of working piles. However, at least three numbers of static routine vertical load tests shall be carried out on pile on which high strain dynamic load test has already been carried out for establishing the correlation between the two tests. In case of discrepancy if any between dynamic and static vertical load tests, then additional static routine vertical load tests shall be conducted as decided by the Engineer and the results of static routine vertical load shall prevail. Number of routine vertical pile load tests as per clause 7.03.00 (ix) shall be total of static routine vertical load test and high strain dynamic load tests.

The procedure to carry out the test shall be submitted to the Engineer. The test and equipment shall conform to ASTM D4945-00. The test shall be conducted by an experienced independent test agency approved by the owner. Field data shall be submitted to the site engineer and shall include force velocity curves, pile capacity, simulated static load test curve, net and total pile displacement, pile integrity. A (Case pile wave analysis) CAPWAP or equivalent software analysis shall be conducted on the field data for correct capacity estimation and to evaluate end bearing and skin friction components of the pile.

xvi) From load considerations, single pile may be used under a column/tower. In that case, pile shall be connected with tie beams at pile cut off level in both directions.

xvii) Contribution of frictional resistance of filled up soil if any, shall not be considered for computation of frictional resistance of piles.

xviii) Reinforcement for job piles shall be designed as following:

(a) Compression + bending piles: For these piles, the allowable safe pile capacities in compression and bending shall be considered.

(b) Tension + bending piles: For these piles, the actual pile forces to be considered. However, maximum 3 types of combinations for varying percentage of tension capacity + bending case may be designed & adopted by contractor for the entire scope of work under this package.

7.04.00 Special Requirements

7.04.01 Details of treatment for foundations / underground structures required to counteract soil / water chemical environment, cement type, grade of concrete, type of reinforcement, cover to

	reinforcement and protective coating to foundations, etc. shall be as mentioned in Annexure-1 of this specification
7.05.00	**Excavation, Filling and Dewatering**
7.05.01	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.
7.05.02	Excavation for shallow foundations shall be covered with PCC immediately after reaching the founding level. In case of any local loosening of soil or any loose pockets are encountered at founding level during excavation the same shall be removed and compensated by PCC M7.5. 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.
7.05.03	**Backfilling in Power House & Boiler Area** Backfilling around foundations, trenches, sumps, pits, plinths, etc. shall be carried out with sand in layers not exceeding 300 mm compacted thickness and each layer shall be compacted to minimum 80% of relative density. **Backfilling in other area** 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 upto 500mm with heavy mechanical compacting equipment) and each layer shall be compacted to 90% of standard proctor density for cohesive soils and to 80% of relative density for non cohesive soils. Rock pieces having size less than 150 mm and interstices filled with soil may be used for backfilling around foundation, plinths etc. and shall be compacted to minimum of 85% of original stack of material after filling the interstices.
7.05.04	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.
7.05.05	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.
7.05.06	The contractor shall take all necessary measures during excavation to prevent the hazards of falling or sliding of material or article from any bank or side of such excavation which is more than one and a half meter above the footing by providing adequate piling, shoring, bracing etc. against such bank or sides. Adequate and suitable warning signs shall be put up at conspicuous places at the excavation work to prevent any persons or vehicles falling into the excavation trench. No worker should be allowed to work where he may be stuck or endangered by excavation machinery or collapse of excavations or trenches.
7.06.00	**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.
7.06.01	Controlled blasting shall be done by a specialised agency duly approved by Engineer. All controlled blasting shall be done by using time delay detonators (i.e. excel type).
7.06.02	a) Contractor shall engage an agency expert in blasting such as, NIRM (National Institute of Rock Mechanics), CMPDIL, Central Institute of Mining and Fuel Research Dhanbad, Dept. of Mining of Govt. Institutions etc. to design detailed blasting scheme and get the same approved from Engineer before carrying out the blasting operation. All blasting shall be done as per the approved blasting scheme & initial

blasting operations shall be done under the supervision & guidance of the representative of the blasting expert.

b) All the statutory laws, (Explosives Act etc.) rules, regulations, Indian Standards, etc. pertaining to the acquisition, transport, storage, handling and use of explosives, etc. shall be strictly followed.

c) The Contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives as per explosives act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive Materials.

d) The Contractor shall be responsible and liable for any accident and injury / damage which may occur to any person or property of the project or public on account of any operations connected with the storage, transportation, handling or use of explosive and blasting operations.

7.07.00 **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, drainage, etc. shall be provided and installed by the Contractor, to the satisfaction of the Engineer.

7.08.00.00 **Geotechnical investigation work may be got executed by the Contractor through the following suggested agencies**

1. C.E.TESTING COMPANY Pvt. Ltd, Kolkata

2. Cengrs Geotechnica Pvt. Ltd, New Delhi

3. KCT Consultancy Services, Ahemdabad

4. M.K. Soil Testing Laboratory, Ahemdabad

or any other agency having adequate experience for carrying out such works and approved by engineering department of the owner.

Annexure-I

SOIL DATA AND FOUNDATION SYSTEM

Employer has carried out geotechnical investigation in the proposed area. Logs of boreholes of proposed area are enclosed with this Annexure.

a) The minimum founding level and the corresponding net allowable bearing pressure shall be as given in Table – 1 below.

Table-1

Founding Depth/ Stratum	Net Allowable Bearing Pressure T/m2

	Isolated and combined footings including raft for 25mm permissible settlement in case of soil and 12mm in case of rocky strata	Isolated and combined footings for 40mm permissible settlement in case of soil and 12mm in case of rocky strata	Rafts (width > 6m) for 75mm permissible settlement in case of soil and 12mm in case of rocky strata
	Width upto 6.0m		
In case of foundation stratum is soil			
1.0m below NGL	-	5	7
2.0m below NGL	-	8	12
3.0m below NGL	10	15	18
4.0m and below NGL	14	20	24
In case of founding stratum is rock			
0.6m embedment into rock	35.0	35.0	35.0
1.0m embedment into rock	40.0	40.0	40.0
2.0m embedment into rock	50.0	50.0	50.0
4.0m embedment into rock	55.0	55.0	55.0
5.0m and more embedment into rock	60.0	60.0	60.0

For FGL refer GLP (General layout plan)
For NGL of the proposed area GLP along with enclosed topographical survey drawing and borelog data may be referred. In case any loose/soft pockets is encountered at founding level, the same shall be removed completely upto the hard strata and filled up with PCC (1:4:8).
For the new facilities to be constructed after dismantling existing facilities; founding level of new facilities shall be taken at least 1.0m below the existing founding depth of the dismantled structures in case of soil and 0.6m below the existing founding depth of the dismantled structures in case of rock.

b) For open foundations, the total permissible settlement shall be governed by IS: 1904 / IS: 13063 and from functional requirements whichever is more stringent. However, total settlement shall be restricted to the following:

Isolated & Raft (Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	25 mm
Isolated & Strip (other than Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	40 mm
Raft (other than Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	75 mm
Foundations in Weathered rock / rock	12 mm

In case the total permissible settlement is to be restricted to less than as above specified from functional requirements, then the net allowable bearing pressure shall be reduced after review in consultation with Engineer.

c) Special Requirements:

i) Chemicals in ground water and subsoil, as observed during investigation are:

Chemical	Sulphates	Chlorides	pH
Ground Water	288-341mg/l	20-95 mg/l	7.2-8.5
Sub-soil	0.09-0.13 %	0.01-0.04 %	7.1-7.8

ii) The sulphate content of the soil is slightly more than the specified limit. Therefore, strata at the site may be treated in Class-II as described in IS: 456.

iii) In view of the above, the following shall be adopted.

Cement Type	As per IS 456 Table 4
Concrete Grade	As specified elsewhere in the specifications
Type of Reinforcement	As specified elsewhere in the specifications
Cover to Reinforcement	As specified elsewhere in the specifications

Sr. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Bid Specification Stipulation	Statement of Prebid Queries & Clarification	Owner's Reply (EPC)
513	SECTION-VI / PART-B /SUB-SECTION-D-1-5	5.19.01.21 6.03.08.18	88 of 120 11 of 24	All Insert plates (except edge protection angles) provided in liquid retaining structures shall be 12 mm thick GI with lugs not less than 12 mm diameter. Edge protection angles shall be provided as specified elsewhere	As specified in clause no.5.02.11.01.08, lugs used shall not be less than 12mm diameter rods or 6mm flats.	**Bidder to refer amendment no. D1-31**
514	SECTION VI / PART E/	4540-001-POC-A-002	11 of 35	Topographical Survey	Spot Levels of some areas like proposed CHP, Railway siding, Outfall area in south east direction etc. are not available in the tender topographical survey drawing. Bidder requests Owner to provide the aforesaid spot levels for estimation of area grading quantities.	The available spot level is provided in Topographical Survey.
515	SECTION VI / PART B/ SUB-SECTION D-1-5 SECTION VI / PART A/ SUB-SECTION III	5.01.00 (i) 4.03.00	1 0f 21 2 of 3	All the buildings and site development including **Landscaping** shall be designed to take care of rain water harvesting & ground water recharging. Development of rainwater harvesting scheme for the project and obtaining approval of the scheme from central Ground water board is in bidder scope. Exclusions: Landscaping	Bidder understands that landscaping is excluded from Bidder's scope of work. Please confirm,	Confirmed
516	SECTION VI / PART B/ SUB SECTION D-1-5	5.01.00.k	1 of 120	For Control Rooms, CER, UPS Charger Room area in MPH dry wall construction technology shall be incorporated. Control room shall be designed as designer control room with ACP Cladded wall panelling for housing LVS	Details of dry wall for Partition is not mentioned in the specification. Bidder shall consider gypsum partition wall for dry wall construction. Please confirm.	**Bidder to refer amendment no. D1- 25**
517	SECTION VI / PART B/ SUB-SECTION D-1-5	5.02.09 (iii)	12 of 120	Mullion-less charged glass wall shall be provided in between the control room and the visitor's gallery.	a) Bidder requests Owner to provide brief specification of charged glass as the same was never used in any past NTPC project. b)Also bidder understands that mullion-less glass wall is same as curtain wall. Please confirm.	**Bidder to refer amendment no. D1-20**
518	SECTION VI / PART B/ SUB-SECTION D-1-5	5.02.10 (i)	13 of 120	Architectural Features. This building shall be **four storied (Ground +3)** and shall be provided with floor area of 3700 sq. m with R.C.C. framed structure.	As per Tender drawing GLP (General Layout Plan), Service building is on stilts and therefore the building shall be five storied (Stilt + 4). Please confirm bidder's understanding and accordingly modify the tender clause.	**Bidder to refer amendment no. D1-14**
519	SECTION VI / PART B/ SUB-SECTION D-1-5	5.02.10 (i)	13 of 120	Floor - to - Floor height shall be minimum 4.25m.	In case Owner wants Stilt+4 building as per tender drawing then the clear height of Stilt floor shall be 8 m. Please confirm and accordingly modify specification.	**Bidder to refer amendment no. D1-14**

Sr. No.	Section / Part / Chapter / Volume	Sub Section	Page no.	Clause No.	Bid Specification Stipulation	Statement of Prebid Queries & Clarification	Owner's Reply
768	Section-VI/Part-B	D-1-5	106 OF 120 98 OF 120 99 OF 120	5.23.19 5.23.04/5.23.05	Roof slabs for CHP, LHP and GHP buildings shall be minimum 150 mm thick(in case of metal decking thickness shall be measured from crest top) and shall have minimum 10 dia HYSD reinforcement bars placed at 200 mm center both ways at top and bottom. The roof of crusher house/transfer house shall be provided with pre-fabricated insulated metal sandwich panels. Pre-Fabricated Insulated Metal Sandwich Panel for Roofing shall be laid to specified slope.	The said clauses are contradictory. Bidder shall consider pre-fabricated insulated metal sandwich panels laid on the roof for all CHP steel buildings including Crusher House & Junction Tower. Kindly confirm the same.	Clause 5.23.19 is generic and shall be followed unless noted otherwise for specific structure/buildings/facilities as mentioned in Cl 5.23.04/5.23.05 etc.
769	Section-VI/Part-B	D-1-6	4 OF 24	6.02.02 (G)	Underground Structures such as Channels, Sumps, Underground Pump House, Tanks, Trenches, Reservoirs, C.W. ducts etc. In addition to earth pressure and ground water pressure, the surcharge load of 2T/sq. m. shall also be considered for design of all underground structures.	Bidder understands that foundations of the buildings (isolated/strip/raft) are not considered as underground structures. Hence a surcharge load of 2T/sq. m. shall not be applicable for such foundations. Kindly confirm the same.	Bidder's understanding is not correct. Foundations are underground structures.
770	Section-VI/Part-B	D-1-6	8 OF 24 2 OF 6	D-1-6, 6.03.03 D-1-12(E)	Design of steel structures shall be done by the working stress method. Design shall be as per provisions of IS 800:1984 and other relevant IS standards. Design/Detailing for Ductility for Structures :- The site specific design acceleration spectra is a reduced spectra and has an in-built allowance for ductility. Structures shall be engineered and detailed in accordance with relevant Indian/International standards to achieve ductility.	As per D-1-12(E) we understand that since the site specific design acceleration spectra has an in-built allowance for ductility, the design of steel structure as per IS 1984 by working stress method will impart the said ductility to the relevant steel structure. Hence we do not need to engineer and detail those structure with any additional ductile check separately since the said code does not talk about ductile design of steel structure. Kindly confirm the same.	Bidder to follow technical specifications. Structures shall be engineered and detailed in accordance with relevant Indian/International standards to achieve ductility.
771	Section-VI/Part-B	D-1-5	41 OF 120	5.08.00	The inside drain dimension at any point should not be less than 0 .45m (height) x 0.75m(breadth).	Bidder proposes to adopt minimum 0.3 m (breadth) x 0.3 m (depth) drain and subsequent sizing as per hydraulic and discharge requirements. The same has been adopted in other NTPC projects. This is because it shall be very difficult to provide 750 mm wide drains due to space constraints and land utilisation.	**Bidder to comply the Specification Requirements**
772	Section-VI/Part-B	D-1-9	2 OF 31	9.03.00	All buildings shall have minimum one toilet block each. The facilities provided in the toilet block shall depend on the number of users.	Please mention the list of buildings in CHP area which requires toilet facilities. Kindly also share no of users building wise in CHP area (where toilet facilities needs to be provided) and the volume of waste generated (m3/day).	Bidder to follow technical specification
773	Section-VI/Part-B	D-1-6	10 OF 24	6.03.08.08	Factor of safety against overturning and sliding The structure shall be checked for minimum factor of safety of 1.5 against overturning conditions (ratio of stabilizing moment to overturning moment) and 1.4 against sliding conditions as per IS: 456.	As per IS 456 clause 20.1, Factor of safety against overturning is 1.2 due to characteristic DL and 1.4 due to characteristic LL which is at variance from the provisions of the said clause. Kindly clarify.	**Bidder to comply the Specification Requirements**
774	Section-VI/Part-B	D-1-6	11 OF 24	6.03.08.11	Minimum diameter of Distribution Reinforcement / Stirrups/ ties/ Anchor Bars is 12 mm for foundation.	Bidder proposes to use minimum 8mm diameter bar for shear links in foundation. Please confirm.	**Bidder to comply the Specification Requirements**

Sr. No.	Section / Part / Chapter / Volume	Sub Section	Page no.	Clause No.	Bid Specification Stipulation	Statement of Prebid Queries & Clarification	Owner's Reply
775	Section-VI/Part-B	D-1-6	9 OF24	6.03.08	Horizontal bracing system shall be provided at floor levels around the openings for plan area greater than 2 sqm.	Bidder understand that horizontal bracing system shall be provided at floor levels only around openings having plan area greater than 2 sqm. Beside these opening areas, the balance portion of RCC floor systems shall be considered as Rigid diaphragm. Structural floor beams supporting RCC slab in that portion shall be designed as laterally restrained. Kindly confirm the same.	Bidder shall adhere to Technical specifications. Please refer Cl 6.03.18 of SectionVI/Part-B Sub Section D-1-6
776	Section-VI/Part-B	D-1-5	104 OF 120	5.23.17.01	Drainage of the complete coal stock pile, area around stacker reclaimer rails etc. shall be discharged into the owner's coal slurry settling pond.	a)Kindly share drawings of Owner's coal slurry settling pond. Bidder needs the same to plan drainage of coal stock pile area and stacker reclaimer area (around rails). b)Also the location of the existing coal slurry settling	**Bidder to refer Amendment no. D1-10**
777	Section-VI/Part-B	D-1-6	9 OF 24	6.03.08	Minimum thickness for rolled/ built upsection shall be 6mm.	Bidder understand that minimum thickness of member means flange thickness irrespective of web thickness for a rolled / built up section. Please clarify.	Minimum thickness of web or flange which ever is lesser shall be 6mm.
778	Section-VI/Part-B	D-1-5 47 OF 120	107 OF 120 5.13.01	5.23.20.2	The grade slab shall consists of 230 mm thick rubble soling (63 mm downgraded hard stone..... overlaid by 75 mm thick P. C. C. M-7.5 and 100 mm thick RCC of grade M-20 with minimum 8 mm dia bars placed at 200 mm C / C in either direction respectively. There will be minimum 50 mm thick metallic hardener finish over the RCC slab. In all buildings including main plant building, the ground floor slab shall consist of minimum 150mm thick RCC M25 grade base slab over an under bed as specified below.	The said clauses are contradictory. For grade slab of all buildings bidder shall follow clause 5.23.20.2. Kindly confirm the same.	**Bidder to refer Amendment no. D1-11**
779	Section-VI/Part-B	D-1-5	107 OF 120 46 OF 120	5.23.20.2 5.13.00	The paving construction shall be as per specifications for the grade slab at ground level. However, 50 mm thick **metallic hardener finish is not required to be provided in paved area.** Paving areas **shall be provided with the metallic hardener floor** finish as specified elsewherein the specification.	The said clauses are contradictory. Bidder shall consider to proceed with clause 5.23.20.2 for all CHP structures. Please confirm.	**Bidder to refer Amendment no. D1-11**
780	Section-VI/Part-B	D-1-5	96 OF 120	5.23.02	Cross beams at floor level supporting conveyor stringer beams shall be made of single rolled steel beam or single channel section (ISMB or ISMC) or plate girder.	Bidder proposes that in addition to ISMB, ISMC or plate girder , Jindal sections(NPB or UB) can also be used for cross beams & end portals in conveyor galleries as well as floor beams and columns in steel buildings in coal handling plant area. Please confirm.	**Rolled steel sections confirming to relevent IS codes are already envisaged in the mentioned Clause.**
781	Section-VI/Part-E (TENDER DRAWINGS)		1 OF 8	Sl. No:1	Drawing no. 4540-999-POC-F-001 titled "General Layout Plan" - Structural shed over stock pile area.	It is difficult to support the structural shed by not providing any column foundation supports in the existing ETP facility area (as shown in the plot plan). Bidder proposes to dismantle existing ETP facilities (Refer the attached PDF)in order to support the shed. Request you to revisit the arrangement.	**Dismantling of existing ETP has been included in EPC vendor's scope. Bidder to refer Amendment no. D1-4**

Sr. No.	Section / Part / Chapter / Volume	Sub Section	Page no.	Clause No.	Bid Specification Stipulation	Statement of Prebid Queries & Clarification	Owner's Reply
786	Section-VI/Part-B	D-1-5	99 OF 120	5.23.06	Stacker Reclaimer Foundation: Stacker – Reclaimer (S/R) foundation shall be in RCC and shall ..... provided at a regular interval of approx. 3.0 m center. Conveyor short posts shall be supported on RCC beams at grade level..... RCC retaining wall on both sides of the S/R foundation shall be provided **as shown in the tender drawing**	Bidder could not find Stacker Reclaimer Foundation drawing along with the tender documents. Kindly share the relevant details of stacker reclaimer foundation along with retaining wall.	Refer tender drawing no. 4540-XXX-POC-A-0016. Detail engineering is in bidder's scope
787	Section-VI/Part-B	D-1-5 D-1-9	102 OF 120 1 OF 31	5.23.12 9.02.01	All stairs of over ground portion of transfer houses & crusher house shall be of steel (minimum 1200 mm wide) and maximum rise should not be more than180 mm and **minimum tread width 250 mm.** All stairs shall have a maximum riser height of 180mm and a **minimum tread width of 275 mm.**	The said clauses are contradictory. Bidder shall consider minimum tread width 250. Kindly confirm the same.	**Bidder to refer Amendment no. D1-17**
788	Section-VI/Part-B		6 of 101	4.1.7	Pavement of minimum **8 m width, all along the Ground conveyor** shall be provided. For single stream conveyor, **width of the pavement may be 4 m minimum.**	Bidder understands that - 1. For Double Stream conveyor **4m wide paving shall be provided on each side.** 2. For single stream conveyor **2m wide paving shall be provided on each side.** Kindly confirm bidder understanding.	Bidder's understanding is correct.
789	Section-VI/Part-B	D-1-9	6 OF 31 1 OF 31 98 OF 120	9.07.02 9.02.01 5.23.04	For initial height **up to 1 metre in buildings one brick thick masonry wall shall be provided** wherever metal cladding is specified. All buildings having **metal cladding shall be provided with 1M high brick wall** at ground floor level. **The lower portion of side cladding, at ground, for a minimum height of 0.9 m above the finished floor level** shall be one brick thick wall plastered on both side. .... Grade slab with brick cladding of 0.9 m height, plastered on both sides shall be provided for all transfer houses	The said clauses are contradictory. Bidder shall consider minimum height of 0.9 metre single brick thick masonry wall in buildings wherever metal cladding is specified. Kindly confirm the same.	Clause 5.23.04 is specific to CHP, LHP and GHP area
790	Section-VI/Part-B	D-1-5	97 OF 120 Page 1 of 15	5.23.02 1.01.02	At the location where the overhead conveyor gallery crosses road / rail line, **minimum clearance of 8.0m above the road crest / rail top** shall be provided. PLANT LAYOUT PHILOSOPHY :In case of rail track minimum 3m horizontal clearance between face of adjacent structure to center line of rail and **8.5m vertical clearance between bottom of structure to top of rail shall be maintained.**	The said clauses are contradictory. Bidder shall consider minimum clearance of 8.0m above the rail top. However 3m horizontal clearance between face of adjacent structure to centreline of rail will be maintained. Kindly confirm the same.	**Bidder to refer Ammendment no. D1-9**

Sr. No.	Section / Part / Chapter / Volume	Sub Section	Page no.	Clause No.	Bid Specification Stipulation	Statement of Prebid Queries & Clarification	Owner's Reply
791	Section-VI/Part-B	D-1-9	13 OF 31 97 OF 120 98 OF 120	9.11.01 5.23.02 5.23.04	For Mill Bunker Building, transfer points, crusher house, conveyor gallery, steel louvered windows shall be provided. Overhead / Ground Conveyor Galleries and Trestles : Windows shall be provided with wire mesh as specified elsewhere in this specification. Transfer Houses : Adequate steel doors and windows for proper natural lighting and ventilation shall be provided.	Bidder proposes the following - For mill building, Transfer points and crusher house steel louvered windows shall be provided. For conveyor galleries windows shall be provided with wire mesh. Kindly confirm the same.	Bidder to comply the Specification Requirements
792	Section-VI/Part-B	D-1-6	1 OF 24	6.01.03 5.23.04 5.23.05	All the buildings shall have framed super structure. If the superstructure of building is a steel structure, the framed superstructure shall be moment resisting sway frame in the lateral direction and axially braced in the orthogonal direction.	Bidder understands that vertical bracings shall be provided on four sides along the periphery in Transfer Points & Crusher House. Being a braced frame in both directions, moment resisting sway frame is not required. Kindly confirm bidder understanding.	Bidder's understanding is correct.
793	Section-VI/Part-B	D-1-6	11 OF 24	6.03.08.20	2.0m wide walkway with concrete paving shall be provided connecting all structures, buildings and facilities. The top of walkway shall be minimum 200mm above FGL.	All buildings/structures/facilities within the coal handling plant are interconnected with road network. To access each buildings/structures/facilities approach road will be provided from main road. In this connection separate 2.0m wide concrete paving will not be required. Kindly confirm.	Bidder's understanding is correct.
794	Section-VI/Part-B	D-1-5	106 OF 120 14 OF 24	5.23.20.2 6.03.11 (f)	Mild steel flats/angles of suitable size shall be welded to the bottom portion of **chequered plates** at a designed spacing to stiffen chequered plates to restrict deflection within span/200. Permissible deflection for all purlins, cladding runners, roofing/cladding sheets and grating / **chequered plates** shall be span/250.	The said clauses are contradictory. Bidder shall consider permissible deflection limit span/200 for chequered plates. Kindly confirm the same.	Cl 5.23.20.2 is specific to CHP, LHP and GHP.
795	Section-VI/Part-B	D-1-6	9 OF 24 102 OF 120	6.03.08 5.23.12	For all underground structures like **wagon tippler**, tunnels and underground transfer points crack width shall be restricted to 0.2 mm. Stairs of MCC/control room, wagon tipplers/track hopper and underground TP's shall be of RCC construction.	Bidder understands that Wagon Tippler is excluded from EPC scope of work. Bidder request Owner to delete Wagon Tippler structure from tender specification.	**Refer ammendment no. D1-12**

855	Section VI, Part A,	Sub Section IV, Performance Guarantees & Liquidated damages	1 of 73	1.00.01	The guaranteed performance parameters indicated in furnished by the bidder in his offer, shall be without any tolerance values whatsoever and all margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures.	Tolerance of 0.3 deg C in the cold water temperature shall be allowed to take care of instrument inaccuracies with reference to other NTPC executed projects like Tanda, Darlipalli and Lara projects. Please confirm acceptance.	Bidder's proposal is not acceptable. Bidder to comply technical specification requirements.
856	Section VI, Part B,	Sub Section A-01, Equipment sizing criteria SUB SECTION A-15 CW SYSTEM	56 of 101 10 OF 31	3.02.00 3.05.00	Quantity of water to be cooled by cooling tower of one unit shall be CW pumps flow/unit + 10 % margin The water distribution system, basin and cold-water discharge channel shall be designed in such a way that it can handle 120% of rated water flow without any overflow in basin	Please note that hydraulic design of the cooling tower is already provided with 20% margin as per cl.no. 3.05.00 of Sub-section 15. Hence no additional margin of 10% will be considered in the thermal design of cooling tower & accordingly cooling tower capacity will be same as per rated capacity of CW pump. Please confirm acceptance.	Bidder's proposal is not acceptable. Bidder to comply technical specification requirements.
857	Section VI, part B,	sub section D-1-5 Sub-Section – A-15 (Cooling Towers-Mechanical) SUB-SECTION-D-1-5 CIVIL WORKS	64 of 120 PAGE 11 OF 31	5.17.05.07 5.00.00 3.10.06 (d)	The tower shall be provided with two numbers external FRP Staircase,…. ……. Staircase is RCC. The design of staircase, pipe trestle foundation, and peripheral water drain shall be designed as per IS: 456 (2000).	Discrepency in both tender clauses for staircase. Bidder understands that RCC staircase to be considered as per clause 5.00.00 Constructional Features of Sub-Section – A-15 (Cooling Towers-Mechanical). Owner requested to confirm.	For Cl 5.17.05.07 Bidder to refer amendment no. D1-6 Stair case shall be RCC inline with clause no- 5.00.00 , Sub section-A-15, Part-B.
858	Section VI, part B,	sub section D-1-5	64 of 120	5.17.05.08	A FRP platform of 1500 mm clear width shall be provided around the tower periphery which will be a means of access to next walkways and all end valves…	Since generally peripheral platform is provided from tower shell it will be easier to provide it with RCC than the FRP. Please confirm.	**Bidder to refer amendment no. D1-7**
859	Section VI, Part A,	Sub Section IV, Performance Guarantees & Liquidated damages	1 of 73	1.00.01	If the cold water temperature is less than or equal to predicted cold water temperature as detailed above the tower is deemed to have met the guarantee.	Since the test will be conducted as per CTI ATC-105, the acceptance criteria shall be the tower capability calculated as given in CTI. If the tower capability is found to be equal to or more than 100% then the tower is acceptable. Please Confirm acceptance.	Bidder's proposal is not acceptable. Bidder to comply technical specification requirements.
860	General		-	-	Colour of Fill	The colour of fills shall be black as per bidders consideration. Kindly confirm.	Bidder query is not clear. Bidder to comply technical specification requirement.
861	Section VI, Part B,	Sub sec- A-15, CW system	Page 13 of 31	11.00.00	The maximum drift loss shall be limited to 0.001% of total water in circulation. Contractor shall demonstrate during performance test as per relevant test codes that drift loss is limited to 0.001%.	Kindly confirm whether certification of drift eliminator for drift loss by CTI approved laboratory/ fill supplier is acceptable. Owner requested to confirm.	Bidder's proposal is not acceptable. Bidder to comply technical specification requirements.
862	SECTION – VI, PART-A	SUB-SECTION-I	5 of 8	4.02.00	Regarding, coal & fuel oil, the Contractor shall quote the total maximum quantity of the coal and fuel oil as required upto the successful completion of "Initial Operation" (as defined in General Technical Requirements, Part-C, Section-VI of Technical Specification) for both the units which shall be issued to it free of charge by the employer for such operation during execution. These quantities for both coal and fuel oil shall be compared with the respective quantities as quoted by various bidders. The quantities over & above the base value (minimum among the quoted figures for coal & fuel oil) shall be used as a loading factor and corresponding computed price (total for coal & fuel oil) shall be added to the quoted bid price for deriving the total bid price. The cost of coal & fuel oil shall be used as Rs. 2108/Ton (Rupees Two Thousand One Hundred and Eight only per ton of coal) Rs. 40,000/KL (Rupees Forty Thousand per KL of fuel oil) for such purpose.	1) To bring fair competition among the Bidders, NTPC has fixed all the guarantees and no evaluation benefit is provided **except only for coal and LDO consumption**. 2)Coal consumption during commissioning is highly dependent on the factors like quality of coal, shutdown or backing down of unit due to reasons not attributable to EPC Contractor. The quantification of exact requirement of coal is highly uncertain. 3) Owner gets compensated for the "infirm power" supplied to grid after unit is synchronised. 4) As this requirement has asked by Client first-time, Bidder doesn't have any record of coal quantity used in past projects during commissioning stage. **In view of the above and to bring parity among the Bidders,NPTC is requested to remove the evaluation and provide coal for pre- commissioning/commissioning activities free of cost till completion of Initial Operation.**	Requirements as per Amendment No. G-03 to be complied with.

S. No.	Sec/Part	Sub Sec	Page No.	Clause No.	Specification Requirement	Bidder's Query	NTPC's Clarification
1304	VI/Part-B	Sub-sec-D-1-5	55 of 120	5.17.01.02.06	(b) The design of all structures other than liquid retaining/conveying structures of cooling tower above Cold Water basin slab such as Raker Columns, Shell structure, fill/drift eliminator support columns, beams, walkways, slabs, partition wall, precast beams etc. shall be carried out by limit state method as outlined in Clause 4.4 of IS: 3370 (Part 2). Further, for limiting the crack width, the stress for the reinforcement steel shall be limited to 130 MPa (on all faces) as per clause 4.4.3.1 of IS: 3370 (Part 2): 2009 using the partial safety factor for serviceability condition as per clause 4.4.1.3.	a) As per IS 3370(Part2):2021 , Cl.No. 4.3.1, "Structural elements that are not exposed to retained liquid shall be designed in accordance with IS 456 and IS 1343, as applicable." Hence, Structures of cooling tower above Cold Water basin slab such as Raker Columns, Shell structure, fill/drift eliminator support columns, beams, walkways, slabs, partition wall, precast beams etc. shall be designed by limit state method as per IS 456 and no stress limit in steel is required to control crack width. kindly confirm the design methodology. b) Raker columns design procedure in CL.No. 5.17.01.02.04 (in Sl.No. 3) & 5.17.01.02.06 (in Sl.No. 4) are contradictory. Kindly clarify which one to be adopted.	a).Bidder to follow provisions of Technical Specification b). There is no contradiction in Specification. Bidder is requested to refer Clause No. 5.17.01.02.06 for raker column design and CL.No. 5.17.01.02.04 for raker column pedestal design
1305	VI/Part-B	Sub-sec-D-1-5	113 or 120	5.29.00	Owner's Construction Office The floor area for Owner's Construction office shall be 1025 sqm. The building should be as per the tender drawing.	Tender drawing indicates floor area of 1400 sqm whereas 1025 sqm mentioned in tender specification. Owner to kindly clarify.	Floor area of Owner's Construction office shall be 1025 sqm.

S. No.	Sec/Part	Sub Sec	Page No.	Clause No.	Specification Requirement	Bidder's Query	NTPC's Clarification
8	SECTION-VI, PART-E	TENDER DRGS	4540-001-POC-A-012		In Make-up Water Pump House Plan and Section, TWS is shown at the suction of each make up water pumps.	Customer may please clarify whether TWS is to be envisaged at the suction of make-up water pumps or not. If it is to be envisaged, please provide the detailed technical specification, design criteria, MOC etc.	Bidder to refer Amendment No. D2
9	SECTION-VI, PART-E	TENDER DRGS	4540-001-POM-A-061		In Scheme of make-up water system, TWS is not shown at the suction of make-up water pumps.		
10	SECTION-VI, PART-B	D-1-7	3 of 12	7.02.02	Open Foundations h) During design the Allowable Bearing Pressure shall be adopted after approval of geotechnical investigation report. However, the maximum allowable bearing pressure shall be lower of the two values i.e. as per approved geotechnical report and as per the values furnished in Table-1.	**Allowable bearing pressure shall be adopted as per approved geotechnical investigation report during contract stage. Please confirm.**	Bidder to refer Amendment No. D2
11	SECTION-VI, PART-B	D-1-7	4 of 12	7.03.00 ii)	Pile shall be socketed into weathered rock. A socketing length of Five meter into rock shall be ensured.	As per the bore log details, type of rock is weathered sandstone. In case of pile foundation, socketing of 5m inside rock is technically not required. Socketing inside the rock shall be done as per design requirement during contract stage. Please confirm.	Bidder to refer Amendment No. D2
12	SECTION-VI, PART-B	D-1-7	4 of 12	7.03.00 ii)	The uplift and lateral load capacity shall be respectively restricted to 35% and 5% of the allowable load capacity in vertical compression.	In case of pile foundation, the uplift and lateral load capacity shall be adopted as per approved geotechnical investigation report during contract stage. Please confirm.	Bidder to refer Amendment No. D2
13					General	Geotechnical details for make-up water pipe line, pump house, forebay etc may please be furnished including following details: a) Bore logs b) Field and lab test results c) Chemical analysis soil/water d) ERT results	Bidder to refer Amendment No. D2

3.00.00	**GEO-TECHNICAL INVESTIGATION & FOUNDATION SYSTEM**
3.01.01	Owner (NTPC) had carried out detailed geo-technical investigation in the proposed cooling tower site. The sub-strata details encountered at various bore holes (BH-10, 11, 12, 14, 16,17,18, NBH-149,150,151,154,155,156 & 157) in the cooling tower area are enclosed as Annexure-1. The geotechnical data attached shall be solely for the purpose of guidance to the bidder. BHEL/owner does not take any responsibility about the accuracy and applicability of the geo-technical data furnished herewith. The onus of correct assessment/interpretation and understanding of the existing sub-strata conditions is on the bidder. Any variation in the data between the one furnished and to that found during execution of the work at site shall not constitute a valid reason in affecting the terms & conditions of this bid and the bidder shall note that nothing extra will be payable on this account. The bidder shall fully satisfy himself about the nature of sub-strata expected to be encountered including the type of foundation, ground water table and construction methodology to be adopted etc prior to the submission of the bid.
3.01.02	Detailed geo-technical Investigation report shall be made available to the successful bidder during contract engineering stage. If the bidder desires to carry out additional geo-technical investigation he/she may do so with prior information/permission of BHEL/owner at no extra cost to BHEL/owner. No extension in time schedule shall be permitted on this account. The bidder shall obtain approval on the agency for conducting geo-technical investigation work, field and laboratory testing schedule proposed by the bidder etc from BHEL/owner before undertaking the geo-technical investigation work. However, the Net Allowable Bearing Pressure of shallow foundation/ safe load carrying capacity of pile foundation to be adopted for the design of foundations during detailed engineering shall be limited to the values mentioned elsewhere in the specification and any value of Net Allowable Bearing Pressure/pile capacity higher than the one indicated shall not be accepted. However, bidder shall note that the Net Allowable Bearing Pressure and foundation depth/ safe load carrying capacity of pile to be adopted for design during detailed engineering stage shall be got approved by BHEL/owner.

3.02.00	**Foundation System**
3.02.01	General Requirements a. All equipments/structures shall be supported on suitable open foundation (isolated, combined, raft) depending on type of structures/facilities, sub strata from topography etc. as required along with any special requirements/remedial measures/treatment called for subsoil/foundations as approved by BHEL/owner. b. All foundations shall be designed in accordance with the provisions of relevant part of the latest revision of Indian Standards. c. No foundation shall rest on filled up soil/fly ash strata. d. No foundation shall rest on expansive soil. e. A combination of open and pile foundations shall not be permitted under the same structure. f. Foundations shall be designed to resist loading derived from environmental loads including loads due to wave, current, wind or seismic, gravity loads, construction loads, static and moving loads and any other loads as applicable and as specified elsewhere in the specification. g. Foundation shall be designed for worst combination of loads as described elsewhere in the specification. h. Ground water table shall be considered at finished ground level for design purposes unless specified elsewhere in the specification. i. Finished ground level (FGL) of NDCT area is RL (+) 71.000 M j. For NGL of the proposed area, GLP along with enclosed topographical survey drawing and bore log data may be referred. In case any loose/soft pockets are encountered at founding level, the same shall be removed completely up to the hard strata and filled up with PCC (1:4:8).

3.02.02 **Open foundations**

In case open foundations are adopted then the following shall be adhered to.

i. Minimum width of foundation shall be 1m.

ii. Minimum depth of foundation shall be 1.0m below natural ground level (NGL)

iii. Minimum founding level and the corresponding net allowable bearing pressure shall be as given in Table-1.

iv. Net Allowable Bearing Pressure of shallow/open foundations at different founding level shall be limited to the values as mentioned in the following Table-1 and any value of Net Allowable Bearing Pressure higher than the one indicated shall not be accepted. However, bidder shall note that the Net Allowable Bearing Pressure and depth of foundation to be adopted for design during detailed engineering stage shall be got approved by BHEL/owner.

Table-1
Net Allowable Bearing Pressure

Founding Depth/Stratum	Net Allowable Bearing Pressure T/m2		
	Isolated and combined footings including raft for 25mm permissible settlement in case of soil and 12mm in case of rocky strata	Isolated and combined footings for 40mm permissible settlement in case of soil and 12mm in case of rocky strata	Rafts (width > 6m) for 75mm permissible settlement in case of soil and 12mm in case of rocky strata
	Width up to 6m		
In case of foundation stratum is soil			
1m below NGL	-	5	7
2m below NGL	-	8	12
3m below NGL	10	15	18
4m or more, below NGL	14	20	24
In case of foundation stratum is rock			
0.6m embedment into rock	35	35	35
1m embedment into rock	40	40	40
2m embedment into rock	50	50	50
4m embedment into rock	55	55	55
5m and more embedment into rock	60	60	60

v. It shall be ensured that all foundations of a particular structure/building/equipment shall rest on one bearing stratum.

vi. The permissible total settlement and differential settlement of foundation resting on soil mass shall be governed by IS: 1904/IS: 13063 and from functional requirements whichever is more stringent. Unless otherwise mentioned, the total permissible settlement of cooling tower foundation resting on soil shall be 40mm in case of isolated foundation and 75mm in case of raft foundation.

vii. Total permissible settlement of cooling tower foundation resting on weathered rock/rock shall be 12mm

viii. Analysis and proportioning of footings to minimize differential settlements shall be carried out for all major foundations and the same shall be submitted for BHEL/owner's approval.

ix. Wherever the intended bearing sub-strata is virgin soil stratum but the actual stratum encountered during foundation excavation consists of filled up soil at founding level, under such cases either the foundation shall be lowered completely into the virgin stratum or the filled-up soil up to the virgin layers shall be removed and built up through PCC (1:4:8) up to designed foundation level.

x. Wherever the intended bearing stratum is weathered rock, but the actual strata encountered during excavation consists of both overburden soil and weathered rock at founding level, under such cases, the overburden upto the weathered rock level including 0.5 m into the weathered rock shall be removed and built up through PCC (1:3:6) upto the designed founding level. Thus, maintaining the same founding level for all the footings of a structure.

xi. Wherever the new facilities (excluding roads, ground floor slabs, trenches, pipe pedestals, channels/drains and staircase foundation) are to be constructed after dismantling existing facilities; it is to be ensured that the new foundations shall be taken at least 1m below the existing founding depth of the dismantled structures in case of soil and 0.6m below the existing founding depth of dismantled structures in case of rock.

3.02.03 Pile Foundations

In case pile foundations are adopted then the following shall be adhered to.

1. The pile foundation shall be of RCC, Cast-in-situ bored piles as per IS:2911. Pile boring shall be done using Self erecting Crawler mounted Rotary Hydraulic Rigs. However, conventional tripod rig may be allowed in inaccessible areas subject to site specific conditions. Two stage flushing of pile bore shall be ensured by airlift technique duly approved by the Employer. If required, temporary or permanent MS liner may be provided for piling.
2. The minimum diameter of pile shall be 600mm. The allowable load capacity of the pile in different modes (vertical compression, lateral and pullout) shall be least of the two values i.e. as per the values furnished in table-2 and pile capacity achieved in pile load tests:

Table-2

Pile	Dia. (mm)	Vertical compression capacity (T)
Bored cast-in-situ pile	600	140
	760	250
	1000	350
	1200	450

Pile shall be socketed into weathered rock. A socketing length of Five meter into rock shall be ensured. The uplift and lateral load capacity shall be respectively restricted to 35% and 5% of the allowable load capacity in vertical compression.
However, the pile capacities to be adopted shall be the least of the estimated design values and that obtained from the initial pile load tests.

3. The minimum grade of concrete for pile shall be M25 with minimum cement content of 400 Kg / cum.

4. Only straight shaft piles shall be used. Concrete shall be cast minimum 1m above cut off level.

5. Bidder shall furnish the 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, reinforcement for job piles and test piles etc), construction methodology/specification for construction of piles and scheme of initial pile load tests in vertical, lateral and uplift load carrying capacities for BHEL/owner's approval. The bidder shall submit the proposed location of initial test piles for BHEL/owner's review and approval prior to installation.

6. From load considerations, single pile may be used under a column/tower. In that case, pile shall be connected with tie beams at pile cut off level in both directions.

7. Regular quality assurance checks for density of circulation mud, contamination mud and samples from pile bore bottom, slump of concrete, pile concrete integrity etc shall be done by the bidder.

3.02.04 Pile Load Tests

Bidder shall install the piles for initial load test. Minimum number of initial load tests to be performed for each diameter and rated capacity of pile shall be as under.

i. Vertical (compression) 2

ii. Lateral (horizontal) 2

iii. Uplift (tension) 2

The initial pile load test shall be conducted up to a maximum test load of three times the estimated safe load carrying capacity of pile. In case of compression test, the method of loading shall be cyclic as per IS: 2911 ((relevant part).

Load test shall be conducted at pile cut of level (COL). If the water table is above the COL the test pit shall be kept dry throughout the test period by suitable dewatering methods. Alternatively, the vertical load test may be conducted at a level higher than COL. In such a case, an annular space shall be created to remove the effect of skin friction above COL by providing an outer casing of suitable diameter larger than the pile diameter.

The routine load test on piles shall be conducted up to a maximum test load of one and half times the allowable pile capacity as per relevant Indian Standards. Number of routine pile load tests to be performed for each diameter/allowable capacity of pile in vertical compression and lateral load shall be at least 0.5% of total number of job piles in each case. Piles for routine load test shall be approved by BHEL/owner.

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 Contractor shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required.

Testing of piles and interpretation of pile load test results shall be carried out as per IS: 2911 (Part-4). Contractor shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory / institute prior to their use. Settlement / movement of the pile top shall be made by Linear Variable Differential Transducers (LVDT) having a least count of 0.01mm.

Testing of piles and interpretation of pile load test results shall be carried out as per IS: 2911, Part-4. Bidder shall ensure that all equipments/ instruments are properly calibrated at a reputed laboratory/institution prior to their use

and the calibration test certificates shall be submitted to BHEL/owner.

The test load on initial test piles shall be applied by means of reaction from anchor piles / rock anchors alone or combination of anchor piles / rock anchors and kentledge with concrete blocks.

A report on the pile load tests shall be submitted for BHEL/owner's approval. In case, routine pile load test shows that the pile has not achieved the desired capacity or pile (s) have been rejected due to any other reason, then the bidder shall install additional pile(s) as required and accordingly pile cap design shall be reviewed and modified if required at no extra cost to BHEL/owner.

3.02.05 **Pile Integrity Test**

Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the routine load test and not intended to replace the use of static load test. This test is limited to assess the imperfection of the pile shaft and shall be undertaken by an independent specialist agency to be approved by Engineering department of Owner. The test equipment shall be of TNO or PDI make or equivalent. The process shall confirm to ASTM.

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BORE HOLE NO. 10

Co-ordinates E=1044 N=3785

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	3	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	3
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 20/07/17
Completion Date : 22/07/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 71.425 m.
Water Struck At :
Standing Water Level : 1.40 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Loose, yellowish grey, silty sand. Obs. kankars. (SM)		2 3 5 — 8	*UDS-1	0.50-0.95
			DS-1	1.25
			SPT-1	1.50-1.95
2.50m		100 — Refusal 6.0 cm Pentn.	*SPT-2	2.50-2.56
Very dense, yellowish grey, silty sand with kankars. Obs. decomposed rock dust. (SM)		100 — Refusal 3.0 cm Pentn.	*SPT-3	2.80-2.83
2.80m				2.80
Highly weathered, yellowish grey, medium grained, fractured sandstone.			R1	CR=37% RQD=21%
3.50m				3.50
			R2	CR=56% RQD=24%
				4.25
			R3	CR=52% RQD=NIL
Moderately weathered, yellowish grey, medium grained, fractured sandstone.		NX rotary drilling from 2.80m to 14.00m		5.00
			R4	CR=57% RQD=NIL
5.75m				5.75
			R5	CR=73% RQD=62%
				6.50
			R6	CR=81% RQD=NIL
				7.25
			R7	CR=83% RQD=34%
				8.00
			R8	CR=89% RQD=80%
				9.50
Slightly weathered / fresh, grey, fine to medium grained, slightly fractured sandstone.			R9	CR=92% RQD=84%
				11.00
			R10	CR=82% RQD=74%
				12.50
			R11	CR=84% RQD=80%
14.00m				14.00

N.B. - '*' means sample could not be recovered.

BH-10/Sheet-1

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BORE LOG DATA SHEET

BORE HOLE NO. 11

Co-ordinates E=1137 N=3769

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	3	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	3
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 17/07/17
Completion Date : 20/07/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 69.845 m.
Water Struck At :
Standing Water Level : 0.40 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Soft, brownish grey, silty clay / clayey silt with kankars & sand mixture. (Cl)		3 (1 1 2)	DS-1	0.50
			*UDS-1	1.00-1.45
			SPT-1	1.60-2.05
2.20m.		Refusal	*SPT-2	2.20-2.25
Very dense, yellowish grey, silty sand with decomposed rock. (SM) 2.40m.		100 5.0 cm Penth.	*SPT-3	2.40-2.44
		100 Refusal 4.0 cm Penth.		2.40
			R1	CR=70% RQD=58%
Moderately weathered, yellowish grey, medium grained, fractured sandstone.				3.00
			R2	CR=45% RQD=41%
				3.75
			R3	CR=52% RQD=17%
4.50m.		NX rotary drilling from 2.40m to 13.50m		4.50
			R4	CR=77% RQD=72%
				5.25
			R5	CR=75% RQD=19%
				6.00
			R6	CR=76% RQD=73%
				6.75
			R7	CR=80% RQD=58%
				7.50
			R8	CR=87% RQD=20%
				8.25
Slightly weathered / fresh, light grey, medium grained, fractured sandstone.			R9	CR=94% RQD=88%
				9.75
			R10	CR=86% RQD=23%
				10.50
			R11	CR=80% RQD=62%
				12.00
			R12	CR=85% RQD=76%
13.50m.				13.50

N.B. - '*' means sample could not be recovered.

BH-11/Sheet-1

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BORE LOG DATA SHEET

BORE HOLE NO. 12

Co-ordinates E=1155 N=3672

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 04/08/17
Completion Date : 07/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 69.812 m.
Water Struck At :
Standing Water Level : 2.20 m.

DESCRIPTION	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	Depth (m)
0.00m. Filled up soil consists of kankars, boulders. 0.40m.		DS-1	0.50
Stiff to very stiff, light grey, silty clay with traces of sand mixture. (Cl)	4 4 5 (9)	UDS-1	1.00-1.45
		SPT-1	1.45-1.90
		DS-2	2.50
	5 7 11 (18)	SPT-2	3.00-3.45
		UDS-2	4.00-4.45
4.50m. Very dense, yellowish brown, silty sand with decomposed rock. (SM)	28 32 40 (>100) 5.0 cm Pentn.	SPT-4	4.45-4.80
5.00m.	100 Refusal 3.0 cm Pentn.	*SPT-4	5.00-5.03
5.75m. Highly weathered, yellowish brown, medium to fine grained fractured sandstone.	NX rotary drilling from 5.00m to 20.00m	R1 CR=25% RQD=NIL	5.00
		R2 CR=56% RQD=NIL	5.75
		R3 CR=82% RQD=16%	6.50
		R4 CR=78% RQD=NIL	7.25
		R5 CR=89% RQD=24%	8.00
		R6 CR=68% RQD=24%	8.75
		R7 CR=84% RQD=22%	9.50
		R8 CR=76% RQD=33%	10.25
		R9 CR=90% RQD=18%	11.00
		R10 CR=77% RQD=52%	11.75
Slightly weathered / fresh, light grey, fine grained, fractured sandstone.		R11 CR=91% RQD=24%	12.50
		R12 CR=96% RQD=NIL	13.25
		R13 CR=83% RQD=38%	14.00
		R14 CR=89% RQD=18%	15.50
		R15 CR=88% RQD=61%	17.00
		R16 CR=99% RQD=95%	18.50
20.00m.			20.00

N.B. – '*' means sample could not be recovered.

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BORE HOLE NO. 14

Co-ordinates E=1143 N=3758

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date : 25/07/17
Completion Date : 26/07/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 68.122 m.
Water Struck At :
Standing Water Level : 1.30 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m Yellowish brown, silty clay with sand mixture. (Cl)			DS-1	0.50
			UDS-1	1.00-1.45
1.45m		2 2 4 (6)	SPT-1	1.45-1.90
Medium, yellowish grey, silty clay. (Cl)			DS-2	2.50
		3 4 4 (8)	SPT-2	3.00-3.45
4.00m			DS-3	4.00
Very dense, yellowish grey, silty sand with decomposed rock. (SM)		64 40 (>100) 5.0 cm Pentn.	SPT-3	4.50-4.70
5.00m		100 Refusal 3.0 cm Pentn.	*SPT-4	5.00-5.03
Moderately to slightly weathered, yellowish grey, medium grained, fractured sandstone.			R1	CR=57% RQD=17% 5.00-5.75
			R2	CR=80% RQD=16% 5.75-6.50
6.50m		NX rotary drilling from 5.00m to 13.00m	R3	CR=79% RQD=20% 6.50-7.25
			R4	CR=75% RQD=NIL 7.25-8.00
			R5	CR=89% RQD=24% 8.00-8.75
			R6	CR=87% RQD=21% 8.75-9.50
Slightly weathered / fresh, grey, medium grained, fractured sandstone.			R7	CR=85% RQD=16% 9.50-11.00
			R8	CR=83% RQD=38% 11.00-12.50
			R9	CR=90% RQD=76% 12.50-13.00
13.00m				

N.B. - '*' means sample could not be recovered.

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BORE HOLE NO. 16

Co-ordinates E=1064 N=3629

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	4
		Water Sample (WS)	0

Commencement Date : 22/07/17
Completion Date : 25/07/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 70.314 m.
Water Struck At :
Standing Water Level : 2.50 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Filled up soil consists of brownish grey, silty sand. 0.70m.			DS-1	0.50
Hard, deep grey, silty clay. Obs. calcareous nodules. (CI)		10 14 17 (31)	UDS-1	1.00-1.45
			SPT-1	1.45-1.90
			DS-2	2.50
		11 19 21 (40)	SPT-2	3.00-3.45
			DS-3	3.80
4.00m. Hard, yellowish grey, silty clay. Obs. sand mixture. (CI)		17 20 24 (44)	UDS-2	4.10-4.55
			SPT-3	4.55-5.00
		>100	DS-4	5.40
6.00m. Very dense, yellowish grey, silty sand with decomposed rock. (SM) 6.50m.		61 100	SPT-4	5.80-5.97
		100 2.0 cm Penetn. Refusal 3.0 cm Penetn.	*SPT-5	6.50-6.53
Moderately to slightly weathered, yellowish brown, medium grained, fractured sandstone.		NX rotary drilling from 6.50m to 20.00m	R1	CR=58%/RQD=NIL 6.50
			R2	CR=64% RQD=NIL 7.00
			R3	CR=68% RQD=21% 7.75
			R4	CR=72% RQD=20% 8.50
			R5	CR=76% RQD=32% 9.25
			R6	CR=72% RQD=16% 10.00
			R7	CR=70% RQD=NIL 10.75
			R8	CR=80% RQD=NIL 11.50
			R9	CR=76% RQD=NIL 12.25
13.00m.			R10	CR=72% RQD=NIL 13.00
Slightly weathered, grey, medium to fine grained, fractured sandstone.			R11	CR=80% RQD=32% 13.75
			R12	CR=78% RQD=28% 14.50
			R13	CR=72% RQD=16% 15.25
			R14	CR=80% RQD=NIL 16.00
			R15	CR=76% RQD=NIL 16.75
			R16	CR=72% RQD=NIL 17.50
			R17	CR=78% RQD=NIL 18.25
			R18	CR=76% RQD=NIL 19.00
20.00m.				20.00

N.B. - '*' means sample could not be recovered.

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BORE HOLE NO. 17

Co-ordinates E=1122 N=3606

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	7
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date : 26/07/17
Completion Date : 27/07/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 70.782 m.
Water Struck At :
Standing Water Level : 2.40 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
			DS-1	0.50
		20	UDS-1	1.00-1.45
		6 9 11	SPT-1	1.45-1.90
			DS-2	2.50
		19		
Very stiff, grey, silty clay. Obs. kankars. (Cl)		6 9 10	SPT-2	3.00-3.45
		26	UDS-2	4.00-4.45
		6 11 15	SPT-3	4.45-4.90
			DS-3	5.50
		28		
		8 12 16	SPT-4	6.00-6.45
6.80m		≥100		
		100 12.0 cm Pentn. Refusal	SPT-5	6.80-6.92
Very dense, brownish grey, silty fine sand with decomposed rock. (SM)		100 4.0 cm Pentn. Refusal	*SPT-6	7.20-7.24
7.40m		100 4.0 cm Pentn.	*SPT-7	7.40-7.44
		NX rotary drilling from 7.40m to 20.00m	R1	CR=56% RQD=18% 7.40 / 8.00
			R2	CR=57% RQD=NIL 8.75
			R3	CR=78% RQD=NIL 9.50
Moderately to slightly weathered, brownish grey to deep grey, fine to medium grained, highly fractured sandstone.			R4	CR=76% RQD=NIL 10.25
			R5	CR=79% RQD=NIL 11.00
			R6	CR=78% RQD=16% 11.75
			R7	CR=77% RQD=NIL 12.50
12.50m			R8	CR=80% RQD=16% 13.25
			R9	CR=85% RQD=16% 14.00
			R10	CR=81% RQD=29% 15.50
Slightly weathered / fresh, alternative deep grey to light grey, fine to medium grained, highly fractured sandstone.			R11	CR=80% RQD=19% 17.00
			R12	CR=81% RQD=NIL 18.50
			R13	CR=77% RQD=14%
N.B. - '*' means sample could not be recovered. 20.00m				20.00

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BORE HOLE NO. 18

Co-ordinates E=1086 N=3556

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	5
		Water Sample (WS)	0

Commencement Date : 17/07/17
Completion Date : 22/07/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 70.128 m.
Water Struck At :
Standing Water Level : 2.75 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	Ref. No	Depth (m)
0.00m.				
Filled up soil consists of light grey, fly ash. 0.50m.			DS-1	0.50
		27	UDS-1	1.00-1.45
		11 13 14	SPT-1	1.45-1.90
			DS-2	2.50
Very stiff to hard, yellowish grey, silty clay / clayey silt with sand mixture. Obs. calcareous nodules. (Cl)		36		
		12 17 19	SPT-2	3.00-3.45
			DS-3	3.80
		43	UDS-2	4.20-4.65
		11 19 24	SPT-3	4.65-5.10
5.20m.			DS-4	5.50
Hard, yellowish grey, silty clay. Obs. sand mixture. (Cl)		66		
		18 28 38	SPT-4	6.00-6.45
7.00m.		>100	DS-5	7.00
Very dense, yellowish grey, silty sand with decomposed rock. (SM)		100 10.0 cm Pentn.	SPT-5	7.20-7.30
7.50m.		100 Refusal 3.0 cm Pentn.	*SPT-6	7.50-7.53
			R1	CR=78% RQD=23% 7.50 - 8.25
			R2	CR=75% RQD=29% 8.25 - 9.00
Slightly weathered, yellowish grey, medium grained, fractured sandstone.			R3	CR=64% RQD=NIL 9.00 - 9.75
			R4	CR=68% RQD=24% 9.75 - 10.50
		NX rotary drilling from 7.50m to 16.50m	R5	CR=72% RQD=20% 10.50 - 11.25
11.50m.			R6	CR=76% RQD=16% 11.25 - 12.00
			R7	CR=72% RQD=58% 12.00 - 12.75
			R8	CR=74% RQD=22% 12.75 - 13.50
Slightly weathered / fresh, grey, medium to fine grained, fractured sandstone.			R9	CR=80% RQD=40% 13.50 - 14.25
			R10	CR=84% RQD=40% 14.25 - 15.00
			R11	CR=82% RQD=40% 15.00 - 16.50
16.50m.				

N.B. - '*' means sample could not be recovered.

BOREHOLE NO: BH-NBH149

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BOREHOLE NO : BH-NBH149	**SOIL BORING METHOD :** Rotary Drilling	**CASING DEPTH, m :** 3.50
LOCATION : Talcher, Odisha	**ROCK DRILLING METHOD :** Rotary Drilling	**GROUND ELEVATION, m :** RL 70.63
	BOREHOLE DIAMETER IN SOIL, mm : 150	**GROUND WATER DEPTH, m :** 1.40
COORDINATES : 1040 E, 3706 N	**BOREHOLE DIAMETER IN ROCK, mm :** NX	**TERMINATION DEPTH, m :** 8.5
DATE OF START : 08-Feb-2022	**DATE OF FINISH :** 09-Feb-2022	**LOGGED BY :** Mr. Vijay Tiwari

DEPTH (m)	FIELD N VALUES	GRAPHICAL LOG	LAYER DEPTH, m	MATERIAL DESCRIPTION	LAYER ELEVATION, m	SAMPLE NUMBER	SAMPLE DEPTH (m)	SERIAL NO. OF CORES	SAMPLE TYPE SYMBOL	RETURN WATER COLOR	RETURN WATER LOSS	BITS USED	PERCENTAGE RECOVERY	ROCK QUALITY DESIGNATION (RQD), %	ROCK MASS RATING (RMR)
0			0.50	Fill: Light grey clayey silt intermixed with fly ash	70.1	DS-1	0.00-0.50								
1						UDS-1	0.50-0.80								
2				Very stiff grey clayey silt (CI)											
3	15		3.50		67.1	SPT-1	2.50-2.95								
4	Ref*/ 3cm			Moderately strong, brown SANDSTONE, moderately weathered		SPT-2	3.50-3.53								
5						RK-1	3.51-5.00	1		Light Brown	Partial	Impregnated Bit	87	85	45
6						RK-2	5.00-6.50	2-9					100	80	45
7						RK-3	6.50-8.00	10-18					100	77	45
8			8.50		62.1	RK-4	8.00-8.50	19					100	97	48
				Termination at 8.50 meters Depth.											

Ground Water Table | DISTURBED SAMPLE (DS) | UNDISTURBED SAMPLE (UDS) | Standard Penetration Test (SPT) | Rock Core (RK)

BOREHOLE NO: BH-NBH150

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BOREHOLE NO : BH-NBH150	**SOIL BORING METHOD :** Rotary Drilling	**CASING DEPTH, m :** 4.00
LOCATION : Talcher, Odisha	**ROCK DRILLING METHOD :** Rotary Drilling	**GROUND ELEVATION, m :** RL 70.22
	BOREHOLE DIAMETER IN SOIL, mm : 150	**GROUND WATER DEPTH, m :** 0.40
COORDINATES : 1111 E, 3713 N	**BOREHOLE DIAMETER IN ROCK, mm :** NX	**TERMINATION DEPTH, m :** 10.5
DATE OF START : 08-Feb-2022	**DATE OF FINISH :** 09-Feb-2022	**LOGGED BY :** Mr. Vijay Tiwari

DEPTH (m)	FIELD N VALUES	GRAPHICAL LOG	LAYER DEPTH, m	MATERIAL DESCRIPTION	LAYER ELEVATION, m	SAMPLE NUMBER	SAMPLE DEPTH (m)	SERIAL NO. OF CORES	SAMPLE TYPE SYMBOL	RETURN WATER COLOR	RETURN WATER LOSS	BITS USED	PERCENTAGE RECOVERY	ROCK QUALITY DESIGNATION (RQD), %	ROCK MASS RATING (RMR)
0			0.50	Fill: Dark grey fly ash with gravel	69.7	DS-1	0.00-0.50								
1				Hard grey clayey silt (CI)		UDS-1	0.50-0.70								
2															
3	15					SPT-1	2.50-2.95								
4	Ref*/ 3cm		4.00		66.2	UDS-2	3.50-3.80								
5				Moderately strong, brown SANDSTONE, moderately weathered		SPT-2	4.00-4.03								
						RK-1	4.01-5.50	1-10		Light Brown	Partial	Impregnated Bit	74	38	35
6						RK-2	5.50-7.00	11-17					80	57	40
7															
8						RK-3	7.00-8.50	18-20					100	96	48
9						RK-4	8.50-10.00	21-23					100	94	48
10			10.50		59.7	RK-5	10.00-10.50	24					98	96	48
				Termination at 10.50 meters Depth.											

Ground Water Table | DISTURBED SAMPLE (DS) | UNDISTURBED SAMPLE (UDS) | Standard Penetration Test (SPT) | Rock Core (RK)

BOREHOLE NO: BH-NBH151

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BOREHOLE NO : BH-NBH151	**SOIL BORING METHOD :** Rotary Drilling	**CASING DEPTH, m :** 7.50
LOCATION : Talcher, Odisha	**ROCK DRILLING METHOD :** Rotary Drilling	**GROUND ELEVATION, m :** RL 70.66
	BOREHOLE DIAMETER IN SOIL, mm : 150	**GROUND WATER DEPTH, m :** 2.05
COORDINATES : 1098 E, 3659 N	**BOREHOLE DIAMETER IN ROCK, mm :** NX	**TERMINATION DEPTH, m :** 12.5
DATE OF START : 10-Feb-2022	**DATE OF FINISH :** 11-Feb-2022	**LOGGED BY :** Mr. Vijay Tiwari

DEPTH (m)	FIELD N VALUES	GRAPHICAL LOG	LAYER DEPTH, m	MATERIAL DESCRIPTION	LAYER ELEVATION, m	SAMPLE NUMBER	SAMPLE DEPTH (m)	SERIAL NO. OF CORES	SAMPLE TYPE SYMBOL	RETURN WATER COLOR	RETURN WATER LOSS	BITS USED	PERCENTAGE RECOVERY	ROCK QUALITY DESIGNATION (RQD), %	ROCK MASS RATING (RMR)
1	11		0.50	Fill: Dark grey fly ash with gravel	70.2	DS-1	0.00-0.50								
				Stiff to hard brown clayey silt (CI)		UDS-1	0.50-0.80								
2				- stiff, 0.5 to 4.0 m		SPT-1	1.00-1.45								
3															
4	25					UDS-2	3.50-3.80								
5				- very stiff, 4.0 to 7.0 m		SPT-2	4.00-4.45								
6															
7	32		7.50	- hard, 7.0 to 7.5 m	63.2	UDS-3	6.50-6.80								
						SPT-3	7.00-7.45								
8	Ref*/ 3m			Moderately strong brown SANDSTONE, moderately fractured, moderately weathered		SPT-4	7.50-7.53								
						RK-1	7.51-9.00	1-7		Light Brown	Partial	Impregnated Bit	80	66	38
9															
10						RK-2	9.00-10.50	8-13					96	80	45
11						RK-3	10.50-12.00	14-18					96	85	45
12			12.50		58.2	RK-4	12.00-12.50	19					100	97	48
				Termination at 12.50 meters Depth.											

Ground Water Table | DISTURBED SAMPLE (DS) | UNDISTURBED SAMPLE (UDS) | Standard Penetration Test (SPT) | Rock Core (RK)

BOREHOLE NO: BH-NBH154

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BOREHOLE NO : BH-NBH154	**SOIL BORING METHOD :** Rotary Drilling	**CASING DEPTH, m :** 4.50
LOCATION : Talcher, Odisha	**ROCK DRILLING METHOD :** Rotary Drilling	**GROUND ELEVATION, m :** RL 69.25
	BOREHOLE DIAMETER IN SOIL, mm : 150	**GROUND WATER DEPTH, m :** 0.77
COORDINATES : 1039 E, 3511 N	**BOREHOLE DIAMETER IN ROCK, mm :** NX	**TERMINATION DEPTH, m :** 8
DATE OF START : 08-Feb-2022	**DATE OF FINISH :** 09-Feb-2022	**LOGGED BY :** Mr. Kumar Gaurav

DEPTH (m)	FIELD N VALUES	GRAPHICAL LOG	LAYER DEPTH, m	MATERIAL DESCRIPTION	LAYER ELEVATION, m	SAMPLE NUMBER	SAMPLE DEPTH (m)	SERIAL NO. OF CORES	SAMPLE TYPE SYMBOL	RETURN WATER COLOR	RETURN WATER LOSS	BITS USED	PERCENTAGE RECOVERY	ROCK QUALITY DESIGNATION (RQD), %	ROCK MASS RATING (RMR)
1	8		0.50	Loose brown silty sand (SM)	68.7	DS-1	0.00-0.50								
				Stiff to very stiff brown clayey silt (CI)		UDS-1	0.50-0.85								
2				- stiff, 0.5 to 4.0 m		SPT-1	1.00-1.45								
3															
4						UDS-2	3.50-3.79								
	19		4.50	-very stiff, 4.0 to 4.5 m	64.7	SPT-2	4.00-4.45								
5	Ref*/ 2cm			Moderately strong brown SANDSTONE, moderately fractured, moderately weathered		SPT-3	4.50-4.52								
						RK-1	4.51-6.00	1		Light Brown	Partial	Impregnated Bit	46	45	35
6															
7						RK-2	6.00-7.50	2-4					57	54	35
8			8.00		61.2	RK-3	7.50-8.00	5-6					60	46	38

Termination at 8.00 meters Depth.

Ground Water Table | DISTURBED SAMPLE (DS) | UNDISTURBED SAMPLE (UDS) | Standard Penetration Test (SPT) | Rock Core (RK)

BOREHOLE NO: BH-NBH155

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BOREHOLE NO : BH-NBH155	**SOIL BORING METHOD :** Rotary Drilling	**CASING DEPTH, m :** 6.00
LOCATION : Talcher, Odisha	**ROCK DRILLING METHOD :** Rotary Drilling	**GROUND ELEVATION, m :** RL 69.66
	BOREHOLE DIAMETER IN SOIL, mm : 150	**GROUND WATER DEPTH, m :** 0.88
COORDINATES : 1102 E, 3514 N	**BOREHOLE DIAMETER IN ROCK, mm :** NX	**TERMINATION DEPTH, m :** 9
DATE OF START : 08-Feb-2022	**DATE OF FINISH :** 09-Feb-2022	**LOGGED BY :** Mr. Kumar Gaurav

DEPTH (m)	FIELD N VALUES	GRAPHICAL LOG	LAYER DEPTH, m	MATERIAL DESCRIPTION	LAYER ELEVATION, m	SAMPLE NUMBER	SAMPLE DEPTH (m)	SERIAL NO. OF CORES	SAMPLE TYPE SYMBOL	RETURN WATER COLOR	RETURN WATER LOSS	BITS USED	PERCENTAGE RECOVERY	ROCK QUALITY DESIGNATION (RQD), %	ROCK MASS RATING (RMR)
1			0.50	Medium dense brown silty sand (SM)	69.2	DS-1	0.00-0.50								
1				Hard brown clayey silt (CI)		UDS-1	0.50-0.80								
2															
3	11					SPT-1	2.50-2.95								
4						UDS-2	3.50-3.88								
5															
6	33		6.00		63.7	SPT-2	5.50-5.95								
7	Ref*/ 2cm			Weak, brown SANDSTONE, very intensely fractured, moderately weathered		SPT-3	6.00-6.02								
7						RK-1	6.01-7.50	1-10		Light Brown	Partial	Impregnated Bit	63	48	38
8						RK-2	7.50-9.00	11-12					55	53	38
9			9.00		60.7										
				Termination at 9.00 meters Depth.											

Ground Water Table | DISTURBED SAMPLE (DS) | UNDISTURBED SAMPLE (UDS) | Standard Penetration Test (SPT) | Rock Core (RK)

BOREHOLE NO: BH-NBH156

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BOREHOLE NO : BH-NBH156	**SOIL BORING METHOD :** Rotary Drilling	**CASING DEPTH, m :** 8.50
LOCATION : Talcher, Odisha	**ROCK DRILLING METHOD :** Rotary Drilling	**GROUND ELEVATION, m :** RL 70.46
	BOREHOLE DIAMETER IN SOIL, mm : 150	**GROUND WATER DEPTH, m :** 0.75
COORDINATES : 1151 E, 3516 N	**BOREHOLE DIAMETER IN ROCK, mm :** NX	**TERMINATION DEPTH, m :** 13
DATE OF START : 09-Feb-2022	**DATE OF FINISH :** 10-Feb-2022	**LOGGED BY :** Mr. Kumar Gaurav

DEPTH (m)	FIELD N VALUES	GRAPHICAL LOG	LAYER DEPTH, m	MATERIAL DESCRIPTION	LAYER ELEVATION, m	SAMPLE NUMBER	SAMPLE DEPTH (m)	SERIAL NO. OF CORES	SAMPLE TYPE SYMBOL	RETURN WATER COLOR	RETURN WATER LOSS	BITS USED	PERCENTAGE RECOVERY	ROCK QUALITY DESIGNATION (RQD), %	ROCK MASS RATING (RMR)
1	7		0.50	Loose brown silty sand (SM)	70.0	DS-1	0.00-0.50								
				Firm to hard brown clayey silt (CI)		UDS-1	0.50-0.78								
2				-firm, 0.5 to 4.0 m		SPT-1	1.00-1.45								
3															
4	31					UDS-2	3.50-3.81								
				- hard, 4.0 to 8.0 m		SPT-2	4.00-4.45								
5															
6															
7	18					UDS-3	6.50-6.86								
						SPT-3	7.00-7.45								
8			8.00		62.5										
	Ref*/ 2cm			Weak, brown SANDSTONE, very intensely fractured, moderately weathered		SPT-4	8.00-8.02								
9						RK-1	8.01-10.00	1-6		Light Brown	Partial	Impregnated Bit	18	0	20
10				Moderately strong brown SANDSTONE, moderately fractured, moderately weathered											
11						RK-2	10.00-11.50	7-13					50	35	35
12						RK-3	11.50-13.00	14-18					66	52	35
13			13.00		57.5										
				Termination at 13.00 meters Depth.											

Ground Water Table | DISTURBED SAMPLE (DS) | UNDISTURBED SAMPLE (UDS) | Standard Penetration Test (SPT) | Rock Core (RK)

BOREHOLE NO: BH-NBH157

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BOREHOLE NO : BH-NBH157	**SOIL BORING METHOD :** Rotary Drilling	**CASING DEPTH, m :** 6.00
LOCATION : Talcher, Odisha	**ROCK DRILLING METHOD :** Rotary Drilling	**GROUND ELEVATION, m :** RL 68.86
	BOREHOLE DIAMETER IN SOIL, mm : 150	**GROUND WATER DEPTH, m :** 0.56
COORDINATES : 1095 E, 3459 N	**BOREHOLE DIAMETER IN ROCK, mm :** NX	**TERMINATION DEPTH, m :** 9
DATE OF START : 09-Feb-2022	**DATE OF FINISH :** 10-Feb-2022	**LOGGED BY :** Mr. Kumar Gaurav

DEPTH (m)	FIELD N VALUES	GRAPHICAL LOG	LAYER DEPTH, m	MATERIAL DESCRIPTION	LAYER ELEVATION, m	SAMPLE NUMBER	SAMPLE DEPTH (m)	SERIAL NO. OF CORES	SAMPLE TYPE SYMBOL	RETURN WATER COLOR	RETURN WATER LOSS	BITS USED	PERCENTAGE RECOVERY	ROCK QUALITY DESIGNATION (RQD), %	ROCK MASS RATING (RMR)
0			0.50	Loose brown silty sand (SM)	68.4	DS-1	0.00-0.50								
1	7			Stiff to very stiff brown clayey silt (CI)		UDS-1	0.50-0.80								
2				- stiff, 0.5 to 4.0 m		SPT-1	1.00-1.45								
3															
4	20					UDS-2	3.50-3.76								
5				-very stiff, 4.0 to 6.0 m		SPT-2	4.00-4.45								
6			6.00		62.9										
7	Ref*/ 2m			Moderately strong brown SANDSTONE, moderately fractured, moderately weathered		SPT-3	6.00-6.02								
						RK-1	6.01-7.50	1		Light Brown	Partial	Impregnated Bit	46	45	35
8						RK-2	7.50-9.00	2-4					98	96	48
9			9.00		59.9										

Termination at 9.00 meters Depth.

Ground Water Table | DISTURBED SAMPLE (DS) | UNDISTURBED SAMPLE (UDS) | Standard Penetration Test (SPT) | Rock Core (RK)