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.

Access platforms shall be provided at minimum one (1) level above bunker supporting level for inspection and testing of bunker and hopper connections. Minimum (1) Nos. of man hole/ access window shall be provided for maintenance of silo.

The bottom level of base plates of columns shall be 1.20 m below the finished paving level in the Boiler Area. The columns of Mill-Bunker building shall consist of built up structural steel I-sections. Rolled sections with additional cover plates on column flange shall not be acceptable for column sections.

The cylindrical coal bunker and conical hopper shall be made of structural steel. The inside surface of hopper shall be lined with stainless steel plates the details of which are mentioned hereafter in this specification.

Structural steel brackets with PTFE bearings shall be provided at the end columns to support the external gallery of the Tripper Conveyor

The Mill-Bunker building roof shall be provided with Pre-fabricated insulated metal sandwich panels. Composition of Insulated Metal Sandwich Panels shall be as described in Clause 9.08.00, Part-B (Civil) of Technical Specification. Adequate slope shall be provided for quick drainage of rain water.

The RCC floor supporting the Tripper Conveyor shall be fully covered up to the Roof level with single skin metal sheet (& structural steel runners).

ii. Design Concept

The Mill Bunker Building shall be conceptualized as moment resisting frames in transverse direction and braced in longitudinal direction. In the transverse direction the bracings may be provided, wherever feasible, in order to meet the deflection requirement specified elsewhere in this section. Bracing member shall be connected to column flange plate through gusset plate (minimum 12mm thick).

Minimum thickness of structural steel Bunker plates shall be 12mm inclusive of 4mm corrosion allowance. Minimum wall thickness of Hopper shall be 8mm. Minimum thickness of stainless steel liners on the entire inner surface of hopper wall shall be 4mm conforming to ASTM A240 S304 (Type 304) with Mill finish 2B cold rolled, annealed, descaled (pickled) and skin passed. To ensure smooth flow of coal, the hopper surface shall be provided with minimum angle of 73^{o} with the horizontal plane.

The top of the cylindrical bunker shall bear no load/ reaction from the tripper floor and accordingly neoprene bellow strap shall be provided at the interface between the two structures to allow free deflection of the tripper floor. Neoprene bellow strap shall be provided all-round the bunker to effectively seal the gap between top of bunker and sealing plate below bunker.

For all other design methodology, refer to Design Criteria specified hereafter in this specification.

iii. Architectural Features

The Mill & Bunker Building shall be a structural steel framed structure having RCC floors and prefabricated insulated metal sandwiched panel sloped roof. The tripper floor side cladding shall be Single skin Metal cladding with steel louvered windows and fixed windows with poly carbonate sheet glazing. Area of windows shall be minimum 10 % of floor area. Rainwater down comer shall be of galvanized MS pipes and shall be located at every column location.

5.02.02 **DELETED**

5.02.03 **Machine Foundations in Main Plant Area**

A. SG Area

i. Salient Features

The scope of work of the Bidder shall be design and construction of all Civil & Structural Works of Machine Foundations including supply of all materials.

PA/ FD/ID Fan and Mill foundations:

PA/ FD/ ID Fan and Mill foundations shall be RCC block foundation directly resting on virgin soil/ pile below Ground level. The vertical faces of this block foundation shall be isolated from adjacent footings by providing minimum 100mm thick polystyrene board of type-1 conforming to IS: 4671 with density 20 Kg/cum sandwiched between the vertical face of block foundation and 230 thick brick wall all round.

ii. Design Concept:

a) For the foundations of Fans (ID, FD and PA), Mills, etc. detailed static and dynamic analysis shall be done.

b) Wherever block foundation is adopted by the bidder, suitable provisions to be ensured by the bidder in their General Arrangement and design to prevent transmission of vibration from these machine foundations to other nearby structures / foundations.

c) The bidder or his consultant should have adequate prior experience in design of machine foundations and the machines should be in successful operation for at least one year prior to the date of submission of bid.

B. STG Area

i. Salient Features

The scope of work of the Bidder shall be design and construction of all Civil & Structural Works of Machine Foundations including supply of all materials, springs & viscous dampers.

Turbo-Generator (TG) foundation:

Alternative-1

The TG foundation shall comprise of RCC top deck supported on steel helical springs & viscous dampers (called herein as the Vibration Isolation System – VIS) and shall be located in the Turbine bay of Main Power House. The springs-cum-viscous dampers shall be placed on a group of RCC/ Structural Steel columns. These TG columns can be interconnected to the Main Power House Building frame either rigidly or connected through PTFE bearings on corbels/ brackets of the TG Columns. The general arrangement & details of springs/ viscous dampers and supporting group of columns and beams shall be based on TG Equipment detail of the Bidder.

Alternative-2

The TG foundation shall be conventional machine foundations comprising of RCC top deck directly supported on substructure comprising of columns and beams without any steel helical springs and viscous dampers. The columns shall be rigidly connected to the RCC deck at top and shall rest on open / pile supported foundation at bottom. The entire foundation system (including deck, columns and raft) shall be isolated from the main plant building structural system and no connection between the main plant structure and TG foundation is permitted.

Bidder has the option to choose either Alternative -1 or Alternative-2 based on his design philosophy and practice. However in case Alternative-2 is adopted by bidder, then the bidder has to furnish extended warranty of five years for satisfactory static and dynamic performance of the foundation system.

TDBFP & MDBFP foundations:

Alternative-1

TDBFP&MDBFP foundations shall consist of RCC top deck supported on steel helical springs & viscous dampers inside Main Power House. In case the top deck is located at operating floor/mezzanine floor level, the springs/ viscous dampers shall be supported on a group of structural steel columns-beam grid which shall be rigidly integrated with the Main Power House Structural frame.

Alternative-2

TDBFP&MDBFP foundations shall consist of RCC top deck directly supported on RCC/ structural beams and columns without any steel helical springs & viscous dampers inside Main Power House. The structural columns and beams supporting the TDBFP / MDBFP shall be independent of the Main Power House Structural frame and shall also have independent foundation without any connection to other nearby foundations. Further each TDBFP / MDBFP shall have independent supporting structural arrangement without any interconnection among themselves.

Bidder has the option to choose either Alternative-1 or Alternative-2 based on his design philosophy and practice. However in case Alternative-2 is adopted by bidder, then the bidder has to furnish extended warranty of five years for satisfactory static and dynamic performance of the foundation system.

BFPs in ground floor

In case the MDBFP/TDBFP foundation is envisaged to be located at ground floor of Main Power House, then these shall be designed as block foundations directly resting on soil / pile. Vertical facing of this block foundation shall be isolated from adjacent footings by providing minimum 100mm thick polystyrene board of type-1 conforming to IS: 4671 with density 20 Kg/Cum sandwiched between the vertical face of block foundation and 230 thick brick wall all round.

ii. Design Concept:

a) For the foundations of Turbo-generator, Boiler feed pumps, etc. detailed static and dynamic analysis shall be done.

b) The vibration isolation system (where ever applicable) supplied shall be of proven make and shall be in successful operation supporting machines like steam turbo-generators, BFPs, etc.,

c) Wherever alternative-2 is adopted by the bidder for TG or BFPs, suitable provisions to be ensured by the bidder in their General Arrangement and design to prevent transmission of vibration from these machine foundations to other nearby structures / foundations.

d) The bidder or his consultant should have adequate prior experience in design of machine foundations for the respective alternative to be adopted by the bidder and the machines should be in successful operation for at least one year prior to the date of submission of bid.

For detailed specification of steel helical springs and viscous dampers refer General Specification Chapter.

5.02.04 **Boiler Structure**

i. Salient Features

The Boiler supporting structure shall be structural steel framed superstructure adequately braced in vertical planes in both the orthogonal directions. The general arrangement & details of structural steel columns, beams, bracings, ceiling girders etc shall be as per the Bidders Boiler Structure design and detailed engineering scheme.

The bottom base plates of Boiler structure columns shall be 1.20m below the finished paving level in the Boiler area. The RCC pedestals supporting the column base plates shall be extended in order to provide RCC encasement to the structural steel columns up to at least 350mm above the top of the paving RCC slab. Steam Generator roof (pent house)/canopy/side cladding shall have single skin troughed profile permanent colour coated sheet. Cladding for Boiler elevator enclosure except its machine room shall be with single skin troughed profile permanently colour coated sheet.

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

Waterless Bio Urinals with enclosure are to be provided by the contractor on each floor elevation of each boiler. Maintenance of toilet in hygienic condition till COD of the unit shall be the responsibility of the bidder.

ii. Design Concept

Boiler supporting structure shall be designed by the Bidder based on provisions of IS 800 for structural steel and IS: 456 for RCC works.

Boiler Elevator Machine Room

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.

5.02.05 **Compressor House**

i. Salient Features:

The compressor house shall be a structural steel framed superstructure with a overhead crane as per requirements specified in Part-A Sub Section IIA-19 and Part-B Sub Section A-25 of Technical Specification. The gantry girder for the crane shall have walkway with chequered plate on both rows and cage ladder access.

The roof shall comprise minimum 40mm thick RCC slab (with additional water proofing) supported on profiled metal deck sheet and purlins. The ground floor slab shall comprise of all RCC block foundations, cable trenches and pipe trenches. The building shall be completely covered with vertical cladding and roof.

Design Concept:

The Design of Compressor House steel structure shall be based on provisions of IS 800 & IS 456 for RCC works. The structural frame shall be moment resisting sway frame in the lateral direction and longitudinally braced in the longitudinal direction. Design shall also be based on the Design Criteria specified elsewhere in this specification.

ii. Architectural Features

This building shall be steel framed structure with brick wall up to window sill height & Single Skin Metal Panel cladding above it. The roof system shall be as per the detail furnished in the salient features of this building

Cut-outs and opening shall be provided in floors and walls as per requirements.

Metal Panel cladding shall be composed of different colour shades to match with the existing surroundings. External finish shall be of Premium Acrylic Smooth Paint with Silicone additives

The size, height, door/window/rolling shutter details and building size shall be as per the approved equipment layout plan of the bidder.

5.02.06 **ESP Structure**

i. Salient Features

The ESP structure shall be a structural steel superstructure with vertical bracings in the required vertical planes in both longitudinal and transverse directions, the details of which shall be as per the approved ESP equipment GA & details of the bidder.

The bottom of base plate for ESP structure columns shall be 300mm above the finished paving level in ESP area. The RCC pedestals supporting the column base plates shall be extended accordingly above the top of the paving RCC slab. Further, the gusset plate / base plate shall be encased in concrete up to the top of bolts. ESP roof (pent house)/canopy/side cladding shall be single skin troughed profile permanently colour coated sheet.

ii. Design Concept

Design of ESP structure shall be based on provisions of IS 800 for structural steel and IS 456 for RCC works. It shall be an axially braced structure in both orthogonal directions. The ESP supporting columns shall be suitably strengthened about the minor axis for sliding movement of the base plate of ESP due to thermal movement.

5.02.07 **ESP Control Building**

i. Salient Features

ESP Control Building can either be structural steel superstructure or RCC framed structure with RCC floors at ground floor level and upper levels. The RCC floors at upper levels shall support the Switchgears, cable galleries and Control Room. The RCC floors at upper levels shall be cast in situ RCC slabs.

For steel framed building the RCC floors shall be supported on profiled metal deck sheet and structural steel beams and roof of the building shall comprise of minimum 40mm thick RCC slab supported on profiled metal deck sheet and structural steel beams.

The rainwater down comers shall be as per specification and shall be suitably concealed.

The external Transformer Yard of the building shall comprise the transformer foundations and cable slit below ground level.

The building shall have Lift structure with lift pit below ground level and staircase at each gable end of the building.

ii. Design Concept

The Design of ESP Control Building shall be based on provisions of IS 800 for Structural Steel & IS 456 for RCC works.

iii. **Architectural Features**

This building shall be completely covered with Light Weight Autoclaved aerated concrete blocks on all four sides except for the portion in front of the external Transformer Yard and toilet and pantry block. Provision for glazed/ fire proof doors & windows shall be included. Minimum 345mm thick brick wall shall be provided for the external brick wall facing the adjacent transformer yard and the brick wall height shall be 600mm above the highest point of the transformer. Inside the building, AHU rooms, UAF Room& Battery rooms shall have brick masonry of one brick thickness. The internal walls of air-conditioned area shall be finished with 2 hour fire rated Aluminum Composite Panel Cladding.

Entire transformer yard, which shall be adjacent to the building, shall be provided with metal fencing with gates.

The building shall accommodate cable vault, toilet, staircase, switchgear rooms, control rooms and AHU room. An auxiliary transformer yard with fencing and gate shall be provided adjoining to the building. Control room and VFD room shall be air-conditioned and shall have false ceiling. Windows& Ventilators all shall be provided with Aluminium sections. All doors, windows in air conditioned area shall be provided with hermetically sealed toughened glass glazing in Aluminium frame work Steel doors and Fire proof doors shall be provided as per requirements. Internal columns in Control Room shall be encased with Aluminium Composite Panel cladding.

Minimum 2 Nos. of stairs and 2 Nos. of Toilets shall be provided as per requirement. Cut-outs and opening shall be provided in floors and walls as per requirements.

External finish shall be of Aluminum Composite Panel Cladding except Transformer area where premium smooth Acrylic Paint shall be provided.

5.02.08 **Pipe & Cable Galleries**

i. Salient Features

The Pipe- Cable Gallery shall be Structural Steel Superstructure with Steel Truss (Lattice Girder) having a general span of 15.0m/20.0m. The steel truss shall be supported on 2 legged/ 4 legged trestles the arrangement of which shall be developed by the Bidder. Trestles for pipe and cable galleries shall also be of structural steel.

The width of the Gallery shall vary depending on the functional requirement. A walkway of minimum width 600mm shall be provided along the Cable Trays supporting floor of the gallery. The walkway shall comprise 40mm thick MS grating and 1.0m high handrail made of 32NB MS pipes. For pipe cable galleries carrying ash pipes, galvanized MS grating shall be provided over entire width of the gallery.

Plan bracings shall be provided at all chord levels of the cable gallery truss. Minimum gusset plate thickness shall be 8mm for all connections.

The level of the bottom chord (bottom of steel) of the gallery shall be at least 3.0m above the finished paving level in general. However, at all road/rail crossings, the level of bottom of steel of the gallery shall be at least 8.0m from the top of road surface and 8.5 m from top of rail track. Before and after the road/rail crossings, a barrier of suitable height shall be constructed so as to prevent the approach of cranes (having height more than 8 m) up to the pipe/cable racks/trestles.

The Caged structural steel ladder shall be provided at an interval of 200m for access to the Pipe-Cable Gallery Walkway.

At the inter-connection of Pipe/Cable gallery with Plant buildings, Pipe/Cable gallery shall be terminated at a maximum distance of 1.50m from the building. The foundation of the Pipe/Cable Trestle shall be constructed at a distance of 4.0M from center line of the plant building. Cantilever of 2.50m shall be taken from pipe-cable gallery/ trestle structure.

The foundation for Pipe-Cable gallery trestles shall be open foundation or pile foundation depending upon bearing capacity requirements. For specification regarding open and pile foundations, clause. 7.00.00 is to be referred. The grade of concrete for RCC footing/pilecaps & pedestals shall be M25. The structural trestles shall not be supported on paving RCC slab.

ii. Design Concept

The pipe-cable structure shall be designed as a 3-dimensional space frame for all the relevant load cases mentioned in the design criteria chapter.

The gallery being an unclad building, wind load shall be evaluated based on the projected frontal area of the structural members and cable tray depth.

The end portals shall be designed as rigid frames hinged (pinned support) at the base plate level (on top of the trestle column). Deflection of end portal due to wind shall be evaluated at the portal column-rafter joint. The gallery vertical truss shall be designed as simply supported girders on trestles and detailing of end portals shall be done accordingly.

Suitable expansion gap shall be provided in the gallery structure by providing twin two-legged trestles at the expansion gap. The expansion gap shall be provided at an interval of 100 to 120m. Expansion gap shall also be provided at location where changes in plan dimensions (gallery width) take place abruptly.

5.02.09 **Main Power House**

(i) Salient Features:

Main Power House shall consist of the Turbine bay, adjacent Deaerator Bay, electrical bay & common control room building (CCR Building) (as stipulated elsewhere in this specification). The turbo – generator (TG) foundation, boiler feed pumps foundations and shall be located inside the power house and their foundation system shall be as per design concept of machine foundation. All other equipment foundations (including Heaters & Deaerators) shall be supported on RCC floors with structural steel beams. The RCC floors shall comprise RCC slab over profiled metal deck sheets (to be used as permanent shuttering but not to be considered for design of RCC slab as composite slab). Shear anchor studs shall be provided through metal deck at regular interval on all top flange / flange plate of structural beams. However, steel gratings, chequered plate flooring as well as precast RCC covers shall be provided as per the functional requirements. All RCC pits & trenches below ground floor slab (including Condensate Extraction Pump (CEP) pit) shall be covered with minimum 40 mm thick MS grating supported on structural steel beams. The RCC pits shall also be provided with a sump at the corner for dewatering with submersible pumps. Staircases & ladders shall be provided for access to these pits. Electrically Operated Travelling (EOT) cranes shall be placed in the turbine bay with the gantry girders (supporting crane wheel loads) supported on structural steel brackets on A & B row columns). Walkway with chequered plate shall be provided at crane girder level at both 'A' row & 'B' row side with caged ladder access from the operating floor.

All main columns & beams of Main Power House shall be of structural steel girder (open web or solid web) with base plate level of columns 1.20m below ground floor slab level in

general except for other pit areas where structural steel column shall be extended below upto a depth lower than the pit top surface such that the column base plate & stiffeners are concealed below the pit raft level are concealed below the pit raft level. Auxiliary columns in main power house shall be either of structural steel construction.

The roof system in turbine bay shall comprise a structural steel girder (open web or solid web) for the entire bay width. The roof slab shall consist of 40mm thick (min. above the crest of metal deck sheet) RCC slab supported on profiled metal deck sheet. The metal deck sheet shall be supported on structural steel purlins. The purlins shall be in turn be supported on turbine bay roof girder top chord at regular interval. Additional waterproofing shall be provided above the roof RCC slab as per details mentioned elsewhere in this specification. 1 in 100 slope shall be provided for the turbine bay roof sloping downwards towards the A-row (towards transformer yard). Minimum 150mm dia. galvanized mild steel pipes shall be used at A-row & C-row as Rainwater Down comers. Staircases in main power house shall be of structural steel. Treads of each staircase shall be 40mmthick MS grating and handrail/ hand post shall be 32mmNB circular hollow sections unless specified otherwise in architectural section of the specification. All staircases in turbine Bay and Deaerator Bay shall be enclosed with minimum 230 thick brick masonry wall with fireproof doors at all floor landing levels. The parapet wall shall be of minimum 1m height and shall be provided all the around roof of main plant building.

All edges of openings shall have edge protection angles (minimum ISA 75x75x6) and handrails with hand posts (Hand post spacing 1m maximum).

ii. Design Concept:

Main Power House shall be designed as moment resisting sway frame in the transverse direction and braced in the longitudinal direction. However, due to functional requirement, vertical bracings to the column in CCR Building not to be provided at (& above) the operating floor level and CCR Building frames shall be designed as moment resisting frames in both transverse and longitudinal directions.

All beam column moment connections shall be designed for adequate ductility. The building shall have connectivity with walkways from Boiler & Service Building through sliding bearing only. The connectivity with cable gallery shall be as specified in Pipe &cable gallery section of this chapter. Floor level acceleration spectra shall be generated during seismic analysis for design of pipe supports / equipment located at the elevated floors. Adequate number of thermal expansion gap (minimum 2.00m) between adjacent structural frames at expansion joint and minimum 50mm between RCC slabs at expansion joint) shall be provided between the units and Common Control Building.

In the RCC floor/ roof slabs, the spacing of shear anchor studs on structural beams shall be minimum of the spacing required for

i) Restraining the compression flanges of beams and

ii) Transfer of the horizontal shear at floor/roof to the supporting beams.

The roof girder in Turbine Bay shall be provided with a camber to take care of deflection due to dead weight.

The Main columns in A, B &C rows of Main Power House Building shall be built-up I sections. Rolled sections/ I sections with additional flange plates shall not be acceptable for main columns & auxiliary columns. The roof girder (open web or solid web) to column connection shall be bolted connection using high strength bolts (grade 8.8/ IS 1367). The roof girder of Turbine Hall shall be adequately braced in plan using Tie level and rafter level bracings. The longitudinal bracing shall comprise a pair of members connected to the column flanges and detailing shall be adequate to restrain the entire column cross-section. Minimum gusset plate thickness for bracings shall be 12mm.

Common Control Room at operating floor shall have minimum 60% free space for

movement, control room to be free of any auxiliary/stub columns other than the C-row central column with minimum depth as possible

For all other design methodology, refer to Design Criteria specified elsewhere in this specification.

iii. Architectural Features

This building shall be of Structural Steel Framed structure and shall be completely covered with external cladding and RCC roof. The external vertical face (herein stated as 'A' row) of main power house facing (& adjacent to) the transformer yard and also the two gable ends shall be completely covered with vertical cladding comprising 3.0m high brick wall (on ground floor slab) and single skin profiled vertical metal sheet for the remaining height except for the vertical segment between operating floor &gantry girder bracket level where double skin vertical metal sheet shall be provided.

In case of routing of bus-duct is done outside the A-row (part/full), there shall be a continuous cladding of metal sheeting covering steel structure supporting the bus duct to match the entire A-row elevation. The metal cladding shall be designed to suit the aesthetics of the entire main plant building.

In front of the power transformers, RCC fire barrier wall shall be provided as per functional requirement in lieu of brick wall at A-row. The above mentioned RCC wall shall be attached with single skin metal sheet on external face.

The 'A' row & Gable End columns projecting inside the turbine hall shall be concealed with single skin profiled metal sheet from operating floor level to crane girder bracket top level.

The external vertical face (herein stated as 'C' row) facing (& adjacent to) the Boiler area shall be completely covered upto the Deaerator floor level with vertical cladding comprising 3.0m high brick wall on ground floor followed by either single skin metal sheeting with runners or brick wall sandwiched with single skin metal sheeting on external face (for all floors requiring 2 hours of fire rating e.g. cable spreader room, ventilation/ air washer room, AHU Rooms and air conditioned areas)

The internal vertical interface plane between Turbine bay & Deaerator bay (herein stated as 'B' row shall have brick masonry Wall from RCC roof slab level of turbine bay (AB bay) upto specified floor level below such that Turbine bay & Part of Deaerator bay below the Deaerator supporting floor level is completely covered on all sides.

Glazing for A Row & gable end shall be reflective 6mm thick clear toughened glass with Aluminium frame. Hermetically sealed double glazing shall be provided between air conditioned & non air conditioned areas. Internal glazed partition inside CCR/CER/Offsite Control Room and B-Row at operating floor level shall be of fire resistant glass having 2 (Two) hour fire rating and with suitable frame. Light weight aerated concrete panels with Single Skin Metal Panel cladding shall be provided in exterior of UPS Battery room area and Control Equipment Room area. All internal side of Aerated concrete panel and columns in air-conditioned areas other than CCR in MPH shall be encased with Aluminium Composite panel cladding from inside.

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.

Inside the main power house building, brick masonry wall (and fire proof doors) shall be provided for switchgear rooms, cable spreader rooms, MCC rooms, AHU rooms, Air Washer room & Oil rooms and all other rooms where fire protection is envisaged.

Cut-outs and opening shall be provided in floors and walls as per functional requirement.

All door, windows in air conditioned area and all windows glazing shall be provided with

Aluminium frame work Steel door and Fire Proof doors shall be provided as per requirements.

Stairs in BC Bay and on A-Row shall be provided as per functional requirement and as per National Building Code and Factories Act.

All stairs in BC Bay lift lobby Area shall be in RCC. Stainless steel railing shall be provided at TG floor level for all cut-outs/ openings, walkways, cut-outs at lower level that are visible from TG floor level and stairs near lift lobby. M.S. railing shall be provided for all other locations. All peripheral edges of floor cut-outs / openings at T.G floor level and covered with gratings/ chequered plates, expansion joints along T.G deck, structural expansion joints shall be covered with minimum 2mm thick stainless steel plate of grade SS 316.

For each unit minimum one no. gent's toilet with adequate facilities including drinking water space and janitor's space shall be provided at each level of power house building, in addition one no ladies toilet shall be provided in each unit at 0.00M and mezzanine floor level and CCR level. A separate ladies and gent’s toilet and pantry shall be provided for CCR approachable from CCR / CER / Offsite Control Rooms.

B Row portion in TG Hall fronting Control Room & CER and glazed partitions in CER/ CCR/Offsite Control room shall be of 25 mm thick Hermetically sealed double glass of Fire resistant of min 11mm thick clear, toughened, interlayered 120 minute fire rated for both integrity & radiation control and 6 mm thick toughened tinted glass with 8 mm gap and with suitable fire resistant frame of 1.6 mm thick powder coated steel sheet. The partitions shall be up to false ceiling level and wall above up to the soffit of floor slab above control room and shall be finished with Aluminum Composite panels cladding and shall also have FRP mural of theme matching to local art and Culture.

Glass partition between AC areas in CCR/CER and other areas in associated with CCR/ CER shall be single Fire Resistant glass in line with technical specs as per fire zoning requirement. It shall be single toughned glass minimum 10 mm thick if not within fire zone.

In CCR, EIC Room, Conference Room, Programmer’s Room and Visitors Gallery etc. a theme based coordinated false ceiling shall be provided with latest state of art design.

In CCR, EIC Room, Conference Room, Programmer’s Room and Visitor’s Gallery etc., vitrified flooring shall be designed with theme and color coordination in line with the designed false ceiling.

Mullion-less charged glass wall shall be provided in between the control room and the Visitor’s gallery.

The fire resistant glass partition in between CER/PADO room & control room (control room left hand side wall) and shift in-charge room/Conference room & control room (control room right hand side wall) shall have motorized blinds (with provision of remote control from Unit in-charge desk) with central metallic panel column having NTPC signature icon.

The rest of the walls including LVS wall shall have coordinated design keeping in mind the overall theme of the control room using metallic panels with calcium silicate boards.

The control room gates shall have biometric physical security feature with double layer of sliding doors.

Control room interiors shall be designed and executed by M/s EVANS / M/s Pyrotech or equivalent vendor who are specialized in control room interior design.

Control room/ Control Equipment Room / Offsite Control Rooms, entire area, False Ceiling shall have Cat Walk Way above for service/ maintenance.

Main power house building shall be provided with passenger lift in BC way as specified

elsewhere in technical specification.

Adequate partitioning as per functional requirement above false ceiling in control Room & CER shall be provided for Inert Gas zoning.

Internal steel columns in Air Conditioned Area of Main Power House Building (CER, UPS charger room, SWAS room, etc.) shall be encased with Aluminium Composite Paneling up to false ceiling.

Functionally the very heart of Power House Building is its Control Rooms. Special attention shall be given for conceptualization of interior design of the Control Rooms. Control rooms design shall be both functional and ergonomic for ensuring reliable and error free operation of the plant. Control room shall have metallic panels with calcium silicate boards cladded video wall housing large video screens and a separate visitor viewing gallery. A walk through view of the control rooms shall be submitted along with bill of quantity to illustrate the design scheme.

Metal Panel Cladding shall be composed of Different Colour shades to match with the surroundings. External finish of Masonry wall shall be premium acrylic smooth exterior paint with silicon additives finish.

5.02.10 **Service Building**

i. Salient Features

This building shall be an RCC structure having RCC frame with RCC floors and roof slab. For the building, floor-to-floor height shall be as per architectural features. A connecting corridor with MPH building shall be provided at operating floor level. The building walls shall comprise aerated concrete blocks from ground floor to roof level. The grade of concrete for RCC frame (including foundation) shall be M25. Plant road of approx. 12 m width shall pass through the building. Building up to minimum 8 m height shall have no floor in 12 m width for road opening.

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. A connecting corridor with Main Power House building shall be provided at operating floor level. The floor of the connecting corridor shall have vitrified ceramic tiles flooring, stainless steel hand rail & fixed structural gazing with reflective toughened glass. The connecting corridor shall have double skin Aluminium Composite Panel (ACP) cladding & insulated metal sheet sloped roof.

Hermetically sealed double glazing with toughened glass shall be provided for external glazing. Windows on south side shall have Building Integrated Photovoltaic Cell as Glazing. The glazing area shall be increased accordingly for proper lighting.

A minimum 70 mm margin for floor finish to be kept for providing of metallic raceway.

This building shall provide offices for Operation staff, Conference room for 50 persons, C&I Laboratory, Exhibition Hall, VIP Lounge etc. This will be fully air-conditioned building with adequate provision of toilets, pantry, cabins for senior executives and separate rooms for executives, supervisors etc. Lift structure with RCC lift pits shall be located inside the service building. Separate toilet facilities shall be provided for ladies and gents in each floor. One toilet shall be provided for persons with disabilities on each floor. Attached toilets shall be provided with cabin of senior executives cabin and conference rooms. 2 nos of staircases and 2 nos of lifts with adequate capacity shall be provided. One store room shall be provided.

Covered parking space for 10 nos. cars shall be provided. Covered parking shall be of RCC construction. Open parking space for 45 nos. cars & 75 nos. scooters shall be provided. Minimum 23 sq.m./car (including circulation area) and 5 sq.m./Scooter (including circulation area) shall be considered for working out parking space.

The service building shall be fully IT enabled. 300x40 mm GI Raceway with standard length 2500 mm single compartment trunking raceways made from 14 gauge (minimum) pre-galvanised sheet including fasteners, floor support, connectors, bends cross-way, earthing stud for fixing etc. complete as per requirement, drawings and instructions of EIC shall be laid under floors of service building for IT enablement. 350x350x50 mm Junction boxes of pre-galvanised sheet with cover plate for raceways shall also be provided. Solar PV panel of 17% efficiency shall be provided on roof of service building.

External finishing shall be of premium acrylic smooth exterior paint with silicone additives and Coloured Aluminium Composite panel combination.

ii. Design Concept

This building shall be analysed & designed as RCC framed structure considering loads & load combinations mentioned in clause 6.2.0. Loads due to Solar PV panels also to be considered on roof slab of the building. Use of shear walls can be made in the building, in case peripheral road of BTG block is to be routed through the building. The design of RCC structure, foundations & slabs shall be carried out as per provisions of IS 456.

5.02.11 CPU CIVIL WORKS

5.02.11.01 **Design Concepts for Buildings/ Shed**

i. All Buildings shall have RCC framed structure with cast-in-situ RCC roof slabs with brick cladding.

ii. Equipment/facilities with shed shall have structural steel superstructure with permanently colour coated metal sheeting at roof and side open. However, kerb wall shall be provided all around the plinth/ floor area above the Finished Floor Level (FFL). For other buildings brick wall cladding on exterior face shall be provided.

iii. Unless specified, the wall cladding for buildings shall be with minimum one brick thick on exterior face. However, brick wall for buildings adjacent to transformers shall be minimum 345mm thick.

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

5.02.11.01.02 The load and load combinations and design criteria shall be as specified elsewhere in the specification.

5.02.11.01.03 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.

5.02.11.01.04 All liquid retaining and conveying structures shall be designed by working stress method as given in clause 4.5 of IS 3370(Part2).

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.

Wherever sandwich slabs are provided in liquid retaining structures to take care of stability against uplift, only well graded sand 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.

Clear free board of at least 300 mm above design (total) water level shall be provided in all liquid retaining / conveying structures.

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.

The minimum grade of concrete for all RCC structures shall be M30.The minimum concrete clear cover to reinforcement bars in all RCC structures shall be as per IS:456(2000) and IS:3370(Part II) for water retaining structures. Durability of concrete shall conform to severe exposure conditions as per Table-3 of IS 456 except noted specifically otherwise.

5.02.11.01.05 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.

5.02.11.01.06 For detailing of Reinforcement IS 5525, IS 13920, IS 4326 and SP 34 shall be followed.

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

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

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

Suitable shrinkage reinforcement shall be provided at top face of foundations. Minimum shrinkage reinforcement shall be 10 mm dia. @ 200mm c / c.

	Minimum Reinforcement in all elements of liquid retaining / conveying structures shall be 0.24 % of cross sectional area.
	Minimum tensile Reinforcement in each direction for all foundation slabs / rafts shall be 0.2% of cross sectional area.
5.02.11.01.07	Minimum thickness of foundation slab / raft and base slab of all liquid retaining tanks / pits shall not be less than 250 mm.
	Minimum thickness of all other elements of RCC liquid retaining / conveying structures (except effluent drains, launders and aerator waste slab) shall be 200mm. Effluent drains (depth more than 500mm), aerator waste slab and launders shall have minimum element thickness of 150mm.
5.02.11.01.08	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 rods or 6 mm flats.
	Edge protection angles shall be provided as specified elsewhere.
5.02.11.01.09	All water retaining structures shall be tested for water tightness as per provisions of IS: 3370 and IS: 6494.
5.02.11.01.10	2.0m wide walkway with M25 grade concrete paving over an under bed specified elsewhere shall be provided connecting all structures, buildings and facilities. The top of walkway shall be minimum 200mm above FGL 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.
5.02.11.02	**Coating on RCC water retaining structures (other than drinking water)**
	Epoxy phenolic coating shall be applied on (i) internal surfaces of the RCC water retaining structures and (ii) external surfaces of RCC Neutralisation-pit which is in contact with earth, as per details specified below: a) All concrete surfaces shall be provided with two component transparent polyamide cured epoxy sealer coating (having solid by volume minimum 40% ±2%) of minimum 50 micron DFT. Surface to be coated shall be absolutely dry, clean and dust free. b) Sealer coat shall be followed with the application of epoxy phenolic coating (solid by volume minimum 63%) of minimum 400 micron DFT. This coat shall be applied after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.
5.02.11.03	**Coating on RCC water retaining structures (drinking water)**
	Internal surfaces of RCC water retaining structures shall be provided with minimum 400 micron Food grade epoxy coating complying to FDA Title 21, Part 175.300. Surface to be coated shall be absolutely dry, clean and dust free.
5.02.11.04	**Architectural Concepts and Finishing Schedule**
	Architectural concepts and finishing schedule shall be as specified elsewhere in architectural specification.
5.02.11.05	**Acid / Alkali Resistant Treatment:**
	Acid / alkali resistant lining treatment shall be provided in different areas as follows: Neutralization Pit: The walls shall be provided with one coat of bitumen primer, followed by 18 mm thick bitumastic layer, 115 mm thick Acid Resistant (A.R.) bricks, 6 mm thick under bed of potassium silicate mortar, pointing the joints of bricks with acid / alkali resistant epoxy / furane mortar upto a depth of 20 mm and bitumastic end sealing. Suitable pilasters shall be provided with A.R. bricks at regular intervals depending upon the height of lining, as per the specification.

The floor of neutralization pit shall be provided with acid / alkali resistant lining treatment as given in the above para, except that the 115 mm thick A.R. bricks layer shall be replaced by 75 mm thick A.R. tile layer and pilasters shall be omitted.

The ceiling of neutralization pit shall be provided with one coat of epoxy primer followed by 2 coats of epoxy paint (150 micron).

Acid / Alkali storage area / projections above the floor, pedestals projecting from the floor / saddles. The floor shall be provided with one coat of bitumen primer followed by 12 mm thick bitumastic layer, 20 mm thick A.R. tiles, 6 mm thick under - bed by potassium silicate mortar, 6mm thick pointing of joints of tiles with acid / alkali resistant epoxy / furane mortar up to a depth of 20 mm and bitumastic end sealing. Dado of 1.0M high with above treatment shall also be provided if applicable in case of walls nearby.

The floor shall be provided with acid / alkali resistant lining treatment as given in the above para except that the 75 mm thick A.R. tile layer shall be replaced by 12 mm thick A.R. tile layer.

Basket of Alum Solution Preparation tank: 5mm thick epoxy lining over a coat of epoxy primer.

Curved surfaces of saddles shall have minimum 12 MM thick bitumastic layer to support the vessel / tanks.

Effluent Drains: Acid Resistant lining treatment indicated for the storage area shall be provided on the bed as well as walls of the drains with 38 MM AR tiles. The underside of the pre-cast slab cover shall be applied with one coat of epoxy primer and two coats of epoxy coating, total DFT 150 microns.

Lime tank: Two coats of bitumen paint conforming to IS: 9862, with total DFT 150 microns.

Guarantee

The Contractor 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 Contractor shall replace / rectify defects is any, observed in the lining to the satisfaction of the Engineer without any extra cost during this period.

5.02.11.06 **Foundation of Over Ground Steel Circular Water Storage Tanks**

General Requirements

The tank foundation shall be as per IS 803 and as specified in relevant clause of foundation chapter.

Sub Grade Preparation

The surface of natural soil shall be thoroughly compacted by rolling or other means, as directed by Engineer, to obtain 95% of max. laboratory dry density for the soil, as per IS:2720 (Part-VII).

Anti Corrosive Layer

Anti-corrosive layer shall consist of screened coarse sand, mixed with 80/100 bitumen or equivalent 8% to 10% by volume.

Bitumen shall be heated to a temperature 175^0C to 190^0 C, with 3% kerosene, if required. Sand shall be thoroughly mixed with it in a mixing drum to obtain uniform mixture and shall be laid over the compacted surface, laid in line, grade and levels and as directed by the Engineer. Bitumen shall not be heated beyond the temperature limits given above.

The premix carpet shall be laid in two layers of 3 cm and 2 cm respectively. After compacting and laying the first layer of 3cm, a tack coat of hot bitumen at the rate of 1 Kg. per Sq.m. shall

be uniformly applied to the surface, by means of Sprayer and the Second layer of 2cm thick shall be laid, tamped and compacted to the satisfaction of the Engineer.

Sand shall be spread on the final surface at the rate of 0.5 Cu. m per 100Sq.m.

5.02.11.07 **Premix**

Materials

Sand

Sand shall be clean, dry, coarse, hard angular, free from coatings of clay, dust and mix of vegetable and organic matters and shall conform to IS 383 (Grade -III).

Stone Chippings

Stone chippings shall be hard black trap or granite or locally available stone and shall conform to IS 383. The grading shall be of normally 12mm down size and 6mm down size, in the ratio of 3:2 respectively.

Bitumen

Bitumen required for the work shall be 80/100 grade or its equivalent quality.

Laying

Areas on which the premix is to be laid shall be thoroughly cleaned of all dust and loose materials. On the cleaned surface, a tack coat at the rate of 1.0 Kg. per Sq.M. of hot Bitumen shall be uniformly applied by Sprayers. The applied Binder shall be evenly brushed.

The Binder bitumen 80/100 shall be heated to the temperature of about 190^0 C with 3% kerosene, if required and mixed with stone chippings of size, as mentioned above, at the rate of 400 KG, with Six (6) Cu. M. of stone chips, for 100 Sq.M. of surface. The total mixed quantity, as mentioned above, is the quantity required for the total 50mm thick for 100 Sq. m. of area. Mixing shall continue until the aggregate is well coated.

5.03.00 CHIMNEY

5.03.01 Salient Features

Configuration and height of chimney(s) shall be as specified in mechanical portion of technical specification. There shall be one flue (liner) for each unit.

The chimney shell (windshield) shall be constructed using slip form shuttering. Internal platforms of steel structure shall be provided for enabling access to various elevations of the chimney and to provide support to the flue liners. Spacing of internal platforms shall not exceed 45.0 M. The platform beams shall be supported on concrete shell using suitable load bearing arrangement in the recesses provided for the purpose. The platform beams getting supported in the chimney shell shall have complete bearing support within the thickness of shell at that location and shall in no case be supported completely/partially on corbels/ brackets from the shell. "Through openings" in shell if provided to facilitate erection of platform beams shall be closed with cast-in-situ RCC closure wall on the external face of the shell. Necessary dowel bars shall be provided in the shell during construction for this purpose. Openings in the concrete shell for flue duct entry, access door & truck entry door at ground level, air ventilation etc shall be provided. Hand railing shall be provided all around internal staircase & around the ventilation voids in the internal platform using min. 32 mm nominal bore MS pipes of medium class conforming to IS:1161. Spacing of railing posts shall not be more than 1500 mm centre to centre with a minimum height of 1200 mm. The handrail shall have three rows of horizontal members between the railing posts including the top member. Kick plate of min. size 100x6 thick shall be provided in the hand railing.

The flue duct outside the chimney shall be suitably connected to the vertical flue liner inside the chimney as per EPRI Wet Stack Design Guidelines.-Expansion Joint shall be provided at the interface between the flue liner and the absorber outlet duct as per design.

The expansion joint in the flue liner shall comprise of non-metallic material suitable for wet stack operations, shall be acid resistant to withstand acidic flue gas condensates arising out of flue gas parameters & operating conditions as specified elsewhere in the specification and shall also prevent dust accumulation. Based on the design requirement and expansion joint manufacturer's recommendation the space between the expansion joint material and the liner shall be packed and sealed by providing a bolster made up of light weight compressible material suitable for wet stack operations and acid resistant to withstand acidic flue gas condensates arising out of flue gas parameters & operating conditions as specified elsewhere in the specification. The bolster shall be confined in texturized glass fabric having a final covering of stainless steel wire mesh. Design of expansion joint shall comply EPRI guidelines to avoid contact of condensate with expansion joint material and to ensure drainage of condensate.

Chimney roof shall be of RCC slab over a grid of structural steel beams and provided with rainwater drainage system. An internal structural steel staircase supported from chimney shell with chequered plate floor panels and pipe handrails, shall be upto the platform just below roof platform and an internal cage ladder for a small height, over last staircase landing to access the chimney roof through a roof access hatch.

The other components of the chimney include liner test ports (for continuous pollution monitoring), liner hatches, grade level slab of RCC with metallic hardener floor finish, acid resistant treatment on roof slab, a large electrically operated grill type roll-up door and personnel access metallic door at grade level, roof drain basin, rain water down comer pipe (150 mm diameter galvanized pipe), connection to plant drains, louvers with bird screens for ventilation and all other openings in the wind shield, all finishing works, electrical power distribution boards, lighting panels, power & control cabling and wiring systems, stair and platforms lighting, socket outlet, lightning protection and grounding system, aviation obstruction lighting with photoelectric controller etc, communication system, a rack and pinion elevator and other items, though not specifically mentioned but reasonably implied and necessary to complete the job in all respects.

Aviation Warning Lights (AWL) shall be mounted on door panel of required size (open able from interior of chimney shell) fixed to openings in the chimney shell at locations and levels specified elsewhere. Suitable provision for approach to the AWL shall be provided at the platform level. AWL shall be located at about 1-1.5 metre above the top of platform to enable easy handling for maintenance.

The size of roll-up door shall be determined based on minimum requirement for ventilation and transportation & erection of flue segments.

5.03.02 Design Concept

Design and construction of various components and systems of the chimney shall be in accordance with relevant Indian Standard and where provisions are not covered in Indian Standard, reference shall be made to ACI, BS, CICIND and other international standards.

In case of any conflict between this document and the Indian and International Standards, the stipulations of this document shall prevail.

Imposed loading for design of all chimney components shall not be less than 5 kN/ Sq.m. An additional 25% of liner load shall be taken as impact loading for liner erection in addition to the liner load.

The min. thickness of web for plate girders shall be kept as 12 mm.

Seismic forces on the chimney system shall be determined based on site specific seismic information provided elsewhere in this document.

Wind forces on the chimney system shall be determined based on site specific wind design criteria provided elsewhere in this document.

The chimney and its components shall be designed to resist the most onerous forces resulting from all the possible combinations of the various loadings.

5.03.03 Wind Shield

The wind shield shall be designed for vertical loading, cross wind loading, seismic loading, circumferential wind loading, thermal gradients etc. The load calculation and load combinations shall be as detailed in IS 4998. The wind shield shall be analysed for cases with and without flue liner loads.

Forces/stresses in the wind shield due to eccentricity effects of local loadings, insolations effects, rotation of chimney foundations, construction tolerances and moments of second order shall also be considered.

Seismic response of the chimney shall be computed by the response spectrum method. Dynamic modulus of Elasticity shall be considered for calculating natural frequencies of the chimney. At least, the first five modes of vibrations shall be used for this analysis.

The across wind analysis of the chimney shall be carried out as per the provisions of IS 4998. Across wind loads shall be combined with co-existing along wind loads.

The effect of the openings/cut-outs in the chimney shell shall be duly considered in the design of the windshield. The minimum thickness of shell shall not be less than 500mm.

The minimum vertical reinforcement shall be 0.3% of the concrete area. The maximum spacing of the reinforcement bars shall not be more than 250 mm on each face. The minimum circumferential reinforcement shall be 0.2% of the concrete area. The maximum spacing of the reinforcement bars shall not be more than 200 mm on each face. The circumferential reinforcement in the top 3 meters of the windshield shall be twice that required from design forces. The clear cover to reinforcement shall be 50 mm.

There shall be a continuous ring of concrete shell without any opening for a height of atleast 5m below the soffit of flue duct openings.

There shall not be any reverse (outward) slope in the inside face of chimney shell. Where there is a sudden change in slope/ profile of the shell, the circumferential reinforcement shall be increased to twice the requirement as per the design in a circumferential band extending atleast 3m above and below such slope/profile change level.

The diameter of the reinforcing bar for the main vertical reinforcement of shell shall not be less than 25mm for a shell height up to the top level of flue duct opening.

Shell thickness between any two 10m reference levels shall not vary more than 150mm.

The minimum thickness of shell/closure wall at beam support recess/ opening locations shall be 100mm.

Grade of concrete for chimney shell, and other super structure shall be minimum M30. Only OPC cement shall be used for Chimney shell and other super structure.

The final design shall be checked & verified by 'Wind Tunnel Test' and shall be conducted at a reputed institution. Dynamic interference effects due to additional chimney(s)/NDCTS's and other tall structures located upto distance of 20 times diameter at 2/3rd height of subject chimney in the area or in the future expansion stage of the project, as envisaged by the owner at the time testing, shall be determined along with the other topographical features of the local area through model test.

5.03.04 Flue Liners

The flue gas parameters & various operating conditions for selection of flue liner material, material specification for flue liner and the criteria of flue gas exit velocity for sizing the flue liner shall be as specified elsewhere in the specification.

For flue liner with base metal as mild steel, the thickness of the base metal shall be determined from structural considerations. The thickness of any clad metal/coating/block lining etc. provided on the base metal shall not be considered for computing the structural strength of flue liner. The minimum thickness of the mild steel base metal shall, however, not be less than that specified elsewhere in the specification.

Two manholes placed diametrically opposite shall also be provided in each flue at all internal platform levels.

The supporting/restraining arrangements of the liners should be such that expansion of the liners longitudinally or circumferentially is not restrained.

5.03.05 Internal Platforms

The platforms shall be designed for dead, imposed (live), erection work and other possible loadings and temperatures effects. These platforms shall provide support and lateral restraint to the steel liners and provide access for inspections and maintenance. Forces imposed on the floors due to lateral restraint of flues shall be enhanced aptly for impact effects. These platforms shall also be designed suitably for the liner erection works. The platform shall be made up of chequered floor panels supported on grid of structural steel beams. All beams shall have bolted connections. The maximum permissible deflection in main steel girders supporting flue liner shall be span/1000.

5.03.06 Internal Staircase

The staircase shall have a clear passage way width of not less than 800 mm and a clear headroom of not less than 2100 mm. The riser height shall not be more than 175 mm and tread width shall not be less than 225 mm.

5.03.07 Foundation

The chimney foundation shall be designed as per limit state method as per IS 4998 for the most critical combination of forces and moments, resulting from all possible combinations of the various loadings from the chimney system during all stages of constructions. The effect of water table shall be considered and the foundation shall be checked for overturning for minimum and maximum vertical loads. There should be no uplift under any portion of the foundation/piles for any loading condition. Since chimney is a wind sensitive structure no allowance shall be made in the load carrying capacity of the bearing strata / piles under any load case/combination with wind. The foundation diameter to depth ratio shall not exceed 12. The diameter of the reinforcing bar for the main radial and tangential reinforcement for the foundation shall not be less than 25mm. The spacing of radial steel at the outer edge of the foundation shall not be more than 250mm. Grade of concrete for foundation shall be minimum M 30.

5.03.08 Thermal insulation (Applicable in case of Titanium / C-276 Flue Liner)

The insulation shall be semi-rigid, resin bonded type, in the form of slabs and shall conform to IS: 8183. Blanket type insulation shall not be used. The density of insulation shall not be less than 64 kg/cu.m for resin bonded glass wool insulation and 100 kg/cu.m for resin bonded rock wool. The coefficient of thermal conductivity of insulation shall not be more than 0.52mW/cm/^{o}C at a mean temperature of 100^{o}C.

The insulation thickness shall not be less than 100 mm, in any case, and shall be provided in two layers with the second layer of insulation covering the joints of the first layer. The insulation

shall be wrapped on the outer-most surface with galvanised wire mesh using MS galvanised pins and speed washer.

5.03.09 **Chimney Painting**

(i) All exposed steel surfaces (including exterior surface of mild steel flue liner in case the design does not envisage provision of thermal insulation on the exterior surface of flue liner) except surfaces of steel wind strakes shall be painted as specified in corrosion protection clause of this specification.

(ii) All steel parts embedded in concrete like Strake embedment assembly including bolts, nuts, washers, pipe sleeves and insert plate shall be galvanized as per IS:4736. The minimum weight for galvanizing shall be 610 g/sq.m and shall comply with relevant IS Codes.

(iii) The inside surface of chimney shell above roof, horizontal surface of shell at top, underside of concrete roof slab, etc shall be painted with epoxy phenolic coating system having total 220 microns DFT.

a) All concrete surfaces shall be provided with two component transparent polyamide cured epoxy sealer coating (having solid by volume minimum 40% ±2%) of minimum 50 micron DFT to be applied over cleaned surface in multiple coats. Surface to be coated shall be absolutely dry, clean and dust free.

b) Sealer coat shall be followed with the application of Intermediate coat of epoxy phenolic coating (solid by volume minimum 63%) of minimum 100 micron DFT. This coat shall be applied after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.

c) 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 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.

(iv) The entire external surface of chimney shell shall be painted with epoxy phenolic coating as specified in (iii) above in alternate bands of 'signal red' and 'bright white' colours.

5.03.10 Rack and Pinion Elevator

A rack and pinion elevator, with a load carrying capacity of 400 kg (min) (passenger cum goods), cabin floor size of 1100 mm x 1000 mm (min.) and an operating speed of 40 m/min. (approx.), shall be provided for travel from the grade level to the top of the chimney. A landing platform shall be provided at all access/ platform levels. The elevator shall be of a proven and approved make. Enclosure shall be fabricated from tubular steel and expanded metal or wire mesh, 2.1 m high (Approx.).

A Safety device comprising of an over speed governor in constant mesh with the rack by means of a flame hardened steel pinion shall be provided to protect the cab against over speed during the cab downward motion and the same shall actuate the brake mechanism and stop the down ward motion gradually. The lift shall be installed using anchor fasteners. The electrical requirement of the system shall conform to the main electrical specification. Drive motor shall be of S3 duty class with CDF of 25% and maximum number of 120 starts per hour in 55 degree Celsius ambient temperature. The motor shall be provided with internal 220V AC single phase space heaters or an alternate heating system. The elevator shall be supplied, installed, painted, tested, commissioned etc. complete with all mandatory spares (as specified in Part-F of this specification) and operation maintenance manual.

5.04.00 RAW WATER RESERVOIR

5.04.01 Scope

The scope of work for Raw water reservoir generally involves design, preparation of general arrangement drawings, construction drawings, supply of labour, materials and construction of all civil and structural works like site clearance, site leveling & grading, excavation, filling, construction of earthen embankment, providing sand filters, sand chimney, sand blanket in embankment, cut-off trench, mechanical compaction, slope protection, HDPE lining, PCC lining, non woven geotextile, Inlet and Outlet Structures, RCC spillways, supplying & laying of MS pipes and associated Civil Works, road works, construction of drains along the reservoir boundary etc. and other ancillary works associated with the completion of reservoir as per directions of the Engineer.

5.04.02 General Requirements

Raw water reservoir shall have gross usable capacity as indicated in the tender drawing.

5.04.03 Design Requirement

Sizing of the reservoir shall be such so as to utilize the maximum allocated area for the reservoir as per the layout drawing of the plant and as directed by the Owner. Bottom 500 mm (minimum) depth of water shall be treated as dead storage for settlement of any silt etc. The dead storage shall be over and above the total required capacity of the reservoir. The reservoir shall be provided with a free board as per requirements of IS 10635, but in no case, the same shall be less than 1500mm.

Earthen embankment shall be designed as an earthen dam as per IS: 12169 with internal drainage system i.e. sand chimney and sand blanket of 500mm (min.) thickness shall be provided inside the embankment. Slope stability of embankment shall be analyzed as per IS: 7894. However, the minimum slope of embankment shall be 1V:2.5H with a berm of 3.0m at every 6.0m interval. The founding level of embankment shall be at least 300mm below natural ground level. The top soil shall be stripped to a minimum depth of 300mm. However, the stripping depth, if required, shall be increased to the required level as per actual conditions to totally remove all vegetations, organic matters, roots, soft spots, etc.

The whole area of reservoir bed shall be graded & leveled by cutting and filling.

Wherever filling is required at the bed of the reservoir, area shall be stripped first and then embankment filling shall be done in layers of 300mm compacted thickness and compacted to minimum 90% of maximum dry density (Standard Proctor) by mechanical means at optimum moisture content.

Minimum top width of embankment shall be 6.0m with provision of single lane WBM road including black topping all around on top of embankment. WBM road shall be constructed in accordance with IRC: 19 (latest edition). On downstream slope of the embankment, rip-rap shall be provided from toe up to or higher level than the HFL. Turfing shall be provided from embankment top to rip-rap/HFL level. Rock-toe with toe drain shall be provided at the toe (bottom) of the embankment all around the reservoir. Toe drain shall be of adequate capacity to be constructed in RCC grade M30. An approach ramp of minimum 6m width and min. 1V:8H slope shall be provided for access to the top of reservoir embankment along with single lane WBM road including black topping. The side slope of ramp embankment shall be minimum 1V:2.5H and shall be provided with rip-rap/turfing (as required) on side slopes.

In order to arrest the seepage/percolation losses through reservoir bed/embankment, 1mm thick high density polyethylene (HDPE) liner shall be provided at entire bed and upstream side slopes. HDPE liner shall be laid on the prepared soil bed which is free from any sharp objects, roots or any other organic materials. HDPE liner shall be anchored in PCC filled trench at the edge of top of embankment. HDPE liner shall be protected by providing non woven geotextile and 75 thick PCC lining.

Suitable underdrainage system consisting of Pressure Relief Valves (PRV) shall be provided below the HDPE liner in the reservoir bed to counter uplift forces on HDPE liner occurring when the reservoir is empty and ground water table in the vicinity is above the reservoir bed level. PRVs shall conform to IS 4558.

5.04.04 **Earthen Embankment**

Material for Filling

Material to be used for embankment filling shall be of approved quality excavated from inside the reservoir/plant area or brought from borrow area arranged by the Contractor. Material used for embankment filling shall not be organic soils, peat, cohesionless soil, sand dust, expansive soils and chemically aggressive soils. They shall be clean and free from shingle, salts, organic roots and sod, lumps, concrete or any other foreign substances. Fill shall be placed in horizontal layers not exceeding 300 mm compacted thicknesses. Compaction shall be done to achieve minimum 95% standard Proctor density by mechanical means.

Filling shall be accurately finished to line, slope, cross-section and grade as shown on the approved drawings. Finished surface shall be free of irregularities and depressions and shall be within (+/-) 20mm of the specified level.

When the borrow area is located contiguous to the embankment alignment then it must be ensured that the borrow area shall not be opened within a distance of 5 times the height of embankment contiguous to the heel or the toe of the embankment or 25 metre whichever is more.

The required approach roads and haul roads shall be constructed and maintained by the Bidder. The Bidder shall divert the existing roads, nallah/drain if any which are in the Raw Water Reservoir area at his own cost before the start of work.

Frequency of sampling and testing including the methods for conducting the tests are as given in Table-1. The testing frequencies set forth are desirable minimum and Engineer shall have the full authority to carry out or call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications.

Following Acceptance Criteria shall be followed:

a. All individual samples collected and tested should pass without any deviation when only one set of sample is tested.

b. For re-test of any sample, two additional samples shall be collected and tested, and both should pass without any deviation.

c. Where a large number of samples are tested for a particular test then 9 samples out of every 10 consecutive samples tested shall meet the specification requirement.

5.04.05 **DELETED**

5.04.06 **Graded Coarse Aggregate Filters**

Graded coarse aggregate shall be used in filters below rip-rap and rock-toe as per IS 8237. The coarse aggregate material shall consist of durable well graded broken rock of hard stone. The materials shall range in the size from 10mm to 75mm and shall satisfy the filter criteria.

The rock material used in the aggregate filters shall satisfy the following condition:

a) Specific gravity shall not be less than 2.50.
(As per IS 1122)

b) Sulphate soundness less than 10% loss of weight after 5 (Five) cycles
(As per IS 1126)

c) Aggregate Impact value shall not exceed 30%
(As per IS 2386)

d) Water absorption shall not exceed 2.5%
(As per IS 2386)

a) In slake durability test (as per IS 10050), the percentage retained after two ten (10) minutes cycles shall be more than 85%.

5.04.07 **DELETED**

5.04.08 **HDPE Liner**

The proposed lining system consisting of High Density Polyethylene (HDPE) membrane shall form the water-tight barrier to prevent seepage/leakage. Bidder shall examine in detail the prevailing conditions and provide a liner system to meet the above requirement.

The specification as outlined hereunder shall be treated as bare minimum. However, bidder shall offer the system to meet the site specific requirements and shall provide complete details in the offer. In case bidder deems it necessary to provide additional measures over and above what has been specified, he may do so at the quoted rate against the schedule of item. Bidder shall guarantee the satisfactory performance of the proposed liner system for a period of five years from the end of defect liability period.

REQUIREMENT OF HDPE MATERIAL

The High Density Polyethylene (HDPE) Liner shall be manufactured out of polyethylene resin. The resin composition and production shall meet the intended purpose as specified above. The natural polyethylene resin without the carbon black shall meet density of 0.932 g/cc or higher and melt index less than 1.0 g/10min. The test methods shall conform to ASTM D 1505 or ASTM D792 or equivalent for density test and ASTM D1238, condition E or equivalent for Melt Index test.

The HDPE liner shall not be less than 6.0 M in width. Carbon Black shall be included in the resin to render it ultra-violet resistant. The Carbon Black content shall be between 2-3 percent as per ASTM D 1603. The surface of liner shall not have striations, roughness, pinholes or bubbles. The liner may be smooth. The liner sheet thickness shall be 1.0MM (40 Mil) with sheet density not less than 0.94 g/cu.cm. The Melt Flow Index shall be less than 1.0 g/10min. The method for testing melt flow index shall be as per ASTM D 1238 or equivalent. The Tensile stress at yield shall not be less than 17.0 N/mm and the yield strain not less than 12%. The strain at break shall not be less than 700%. The Tear Strength as per ASTM D 1004 or equivalent shall not be less than 130 N. The Puncture Resistance as per ASTM D 4833 (or equivalent) shall not be less than 390 N. For all other properties & test methods specified elsewhere in this specifications shall conform to GRI test method GM13 (Latest revision).

Any sealants used shall be of type as per the recommendations of the HDPE manufacturer compatible with the intended use. However, before the use, Owner's approval shall be obtained.

INSTALLATION AND LAYING OF LINING SYSTEM

The HDPE Liner sheet (Geo-membrane rolls) shall be brought to site by trailer/truck or by any suitable transport without damaging the geo-membrane. The geo-membrane rolls shall be stored in such a way that they are protected from puncture, dirt, grease, moisture and heat. In case any material gets damaged, it shall be segregated and stored separately for replacement. All the geo-membrane rolls shall be stored on a prepared smooth surface. The HDPE Liner works shall be executed at site by the supplier of HDPE liner only.

Subgrade (reservoir bed) shall be rolled and compacted and made flat and smooth. The top layer of reservoir bed subgrade shall be compacted with 2 passes of 8 to 10 flat footed roller over rock and soil surface. Any weak and soft spots, if present shall be removed and replaced with compacted fill. All subgrade surface where lining shall be placed should be smooth, free of all foreign and organic matter, sharp objects. Standing water or excess moisture shall not be allowed.

For the purpose of anchoring the geo-membrane, anchor trench shall be excavated to the line, grade and width as shown in the drawings, rounded corners shall be provided in the trench to avoid sharp bends in the geo-membranes.

Geo-membrane shall be laid using a spreader bar assembly attached to a loader bucket or any other method as approved by the Engineer. While laying the geo-membrane precaution shall be taken to avoid any damage to the lining system. Equipment or tools shall not damage the geo-membrane during handling, transportation and laying. Personnel working on the liners shall not smoke or wear shoes that may damage the geo-membrane. The method of unrolling the panels should be such that it should not cause scratches or crimps in the geo-membrane. While unrolling due care shall be taken to ensure that the subgrade is not damaged. In order to prevent uplift by wind, adequate loading by sand bags or similar items that will not damage the geo-membrane shall be placed over the geo-membrane. Continuous loading along the edges of the geo-membrane panels shall be provided in order to minimize the risk of wind flow under the panels.

Geo-membrane shall not be laid when ambient temperature is above 50°C. Placement of geo-membrane shall not be carried during rains or in presence of excessive moisture such as fog, dew, etc. In presence of high winds also laying of geo-membrane shall not be taken up.

Deployment of geo-membrane shall immediately followed by field seaming operation. The field seaming shall be as per manufacturer's recommended process. The field operation shall either be hot shoe fusion type or extraction welding type. Any other process may be acceptable subject to approval of the Owner.

On embankment slopes and other slopes, in general, seams shall be oriented in the general direction of maximum slopes. In other words, the seams shall orient down and not across the slope. In corners and other geometric forms, the number of field seams shall be minimized. At the base, T-seam shall not be closer than 1.5m from the toe of the slope. Seams shall be aligned with the least possible number of wrinkles and fishmouths. If a fishmouth or wrinkle is found, it shall be relieved and cap stripped.

All geo-membrane panels shall have a finished overlap of 100mm (minimum) in case of hot wedge welding and 75mm (minimum) for extrusion welding. Unless approved by the Engineer-in-Charge, cleaning solvents shall not be used.

Bidder shall provide all equipment as approved by the Owner. The equipment shall consist of, but not limited to, hot-wedge welder, Extrusion Welder, high speed side grinder, generator, necessary power grid, Vacuum Box Test Equipment for non-destructive seam testing, Air pressure test equipment for non-destructive seam testing, Field Tensiometer for performing shear and peel tests.

In order to verify that seam conditions are acceptable, field test on seams shall be conducted. Test seams shall be carried out at the outset of each seaming period and at least once every four hours for each seaming instruments and personnel deployed that day. All test seams shall be made in contact with the subgrade. All welding rods used for extrusion welding shall have the same properties as the resin used in the geo-membrane. The length of test seam sample shall be 3.0 meter in case of hot wedge welding and 1.0 meter in case of extrusion welding. At least five test specimens shall be cut from each end of the test seam. A tensiometer shall be used to test five specimens for shear and five specimens for peel. Each specimen shall be at least 25mm wide with a 100 mm plus width of the seam as grip separation, the seam shall be centered between the clamps. The rate of grip separation shall be 50mm per minute. Average of five specimens test results shall be considered for seam strength properties, four out of five

specimens shall pass seam acceptance criteria. Shear and peel test shall result in film Tearing Bond (FTB), as defined in NSF std. 54 or equivalent, which is a failure in ductile mode of one of the bonded area. In case a test seam fails to meet the field seam requirements of the specification, the apparatus for seaming and / or seamer shall not be used until the deficiencies are corrected and a successful test seam results.

All fields seams are over their full length shall be tested non-destructively. The non-destructive test shall be conducted either by vacuum Box Testing Method and /or Air pressure testing Method.

Vacuum Box Testing (VBT)

VBT shall be carried out by bidder as per the procedure outlined hereunder. A vacuum box assembly consisting of a rigid housing with a transparent window and having a soft rubber gasket attached to be bottom, porthole or valve assembly and a vacuum gauge shall be used. A soapy solution in plastic bucket with a mop shall be made available. The excess sheet overlap, if any, shall be properly trimmed away. Then a strip or geo-membrane of length 300 mm shall be wetted by the length of box with the soapy solution. The box shall be place over the wetted area and compressed. Create a vacuum of 0.2kg/sw.cm to 0.35 kg/sq.cm. Care shall be taken to ensure that a leak proof seal is created. Vacuum shall be maintained for sufficient time. For a period of approximately 15 seconds, examine the geo-membrane through the viewing window for presence of any animated soap bubbles. In case no animated bubbles appears after 15 seconds, close the vacuum valve and open the bleed valve. Thereafter, move the box over the next area adjoining the tested area with a minimum 75 mm overlap. Repeat the process as described above.

In case animated soap bubbles appear all such areas shall be marked, repaired and then retested successfully.

In locations where seams cannot be non-destructively tested, the seam shall be spark tested according to the manufacturer's recommendations and directions of the Engineer.

Air Pressure testing (APT)

APT shall be applicable for all double fusion seams, only. Bidder shall furnish all required equipment. An air pump equipped with pressure gauge capable of generating and sustaining a pressure between 1.7 kg/sq.cm and 2.1 kg/sq.cm. The pressure gauge shall be equipped with a sharp hollow needle.

The Bidder shall seal one end of the seam to be tested. Then insert needle or any other approved pressure feed device through the sealed end of the channel created by the double wedge fusion weld. Then energize the air pump to verify the unobstructed passage of air through the channel. Seal the other end of the channel. Then energize the air pump to about 2.1 kg/sq.cm. Close the valve and allow 2 minutes for the injected air to come to equilibrium in the channel and keep the pressure approximately for 5 minutes. In case loss of pressure exceeds 0.28 kg/sq.cm or even pressure does not stabilize, then locate faulty area. The area to be repaired and then retested successfully. In case the test is successful, the air channel should be deflated.

Destructive seam testing shall be carried out as per the recommendations of the manufacturer. One destructive test shall be carried out for every 150 meter length of seam or as directed by the Engineer. Holes in the geo-membrane resulting from obtaining the seam samples shall be immediately patched and vacuum tested. The sample shall be 300mm wide and 1.0 meter long with the seam centered lengthwise. The sample shall be cut into three equal length pieces. One piece to be given to the Engineer and the other shall be with bidder for testing. Bidder shall test ten 25mm wide specimens, five specimens for shear strength and give for peel strength. To be acceptable, four out of five specimens must pass.

The Owner may send seam samples, at his own discretion, to a laboratory for testing.

In case the sample fails the destructive test, then the Bidder shall cap strip the seam between the failed locations. If the test fails, then process is repeated. Over the length of seam failure, the Bidder shall either cut out the old seam, then reposition the panel and re-seam or add a cap strip.

Bidder shall thoroughly inspect all seams and non-seams areas of the geo-membrane for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Surface of the geo-membrane shall be cleaned at the time of inspection by the Bidder. Each suspect location in seam and non-seam areas shall be further non-destructively tested in presence of Engineer, if so desired. Each location that fails the non-destructive e testing shall be marked and repaired by the Bidder. The defective seams shall be cap stripped or replaced. Small holes shall be repaired by extrusion welding. If the holes are larger than 6mm, if should be patched to the satisfaction of the Engineer. All tears shall be repaired by patch work, where the tear is on a slope or an area susceptible to stress and has a sharp end; the same shall be properly rounded before patching. Blisters, large cuts and undispersed raw materials shall be repaired by patches; Patches shall be done by extrusion welding. The weld area shall be ground not more than 10 minutes prior to welding. It shall be ensured that no more than 10% of the thickness is removed by grinding. Welding shall commence immediately after grinding and must overlap the previous seam by at least 50mm. Re-seaming over an existing seam shall be carried out, if permitted, only after regrinding. Generally, welding shall restart by grinding the existing seam and re-welding a new seam. Patches shall be round or oval in shape, made of the same geo-membrane, and extend a minimum of 150mm beyond the defective areas.

Each repair shall be non-destructively tested to the satisfaction of the Engineer-in-Charge. Repairs that pass the non-destructive tests shall be considered as an acceptable repair. In case the tests fails, the repair shall be repeated and retested until passing test results are obtained. The bidder shall keep daily reports and details of all non-destructive and destructive testing. The report/ documentation shall clearly identify all seams that initially failed the test and include all evidence/ certification from the Engineer that these seams were satisfactorily repaired and successfully retested.

All anchor trenches shall be casted by the bidder. Anchor trench material shall be plain cement concrete. It shall be suitably placed to the size as specified in the drawings without damaging geo-membrane. If damage occurs, it shall be repaired immediately.

For attachments to concrete, stainless steel concrete anchors and epoxy anchors, stainless steel nuts and washers along with stainless steel slotted flat bars (6mm thick) shall be provided at no extra cost to the owner. Bidder shall also provide closed cell neoprene gaskets and associated adhesive with no extra cost to the owner. Bidders shall make their own assessment of the requirements and include all cost in the quoted price of geo-membrane (HDPE Liner).

Wherever pipe penetrations are to be sealed, the geo-membrane shall be formed around the pipes with stainless steel clamps, closed cell neoprene gaskets, etc shall be provided all around the pipe to make it leak proof. The details of the seal generally follow the manufacturer's recommendations subject to the owner's approval. No separate payment shall be made for all pipe penetration sealing works. The bidder shall make his own assessment of the total work and provide for the same in the unit rate quoted for geo-membrane (HDPE Liner).

All quality control measures shall be deployed by the bidder. All tests are required to be carried out at Bidder's own cost during the production of materials as well as during laying operation.

All resins for use in geo-membrane shall conform to the requirements. Each lot shall be sampled with following tests conforming to manufactures specifications.

1. Density	:	ASTM D 1505
2. Melt Index	:	ASTM D 1238

All additives are to be tested and approved prior to use with the following testing performed and compared to the manufacture's requirements'.

1. Carbon Black content : ASTM D 1603

Manufacturer's quality Assurance Testing shall conform to the provisions as stipulated here. Full width samples shall be taken as tokens from the end of each roll. The HDPE liner that is to be supplied, quality control testing shall meet following frequency.

Test	Description	Method	Frequency
1.	Thickness	ASTM D 5199	Every roll
2.	Tensile properties	ASTM D 638	Every 5000 Sq.m.
	a. Tensile strength at yield.		
	b. Tensile strength at Break		
	c. Elongation at Yield.		
	d. Elongation at Break.		
3.	Tear resistance	ASTM D 1004	Every 5000 Sq.m.
4.	Puncture Resistance	ASTM D 4833	Every 5000 Sq.m.
5.	Carbon Black Content	ASTM D 1603	Every 5000 Sq.m.
6.	Dimensional Stability	ASTM D 1204	Every 5000 Sq.m.
7.	Carbon Black Dispersion	ASTM D 5596	Every 5000 Sq.m.
8.	Density	ASTM D 1505/D792	Every 5000 Sq.m
9.	Melt Index	ASTM D 1238	Every 5000 Sq.m.
10.	Oxidative Induction Time	ASTM D 3895	Every 5000 Sq.m.
11.	Low Temperature Brittleness	ASTM S 746	One per resin lot
12.	Environmental Stress resistance	ASTM D 1693	Every 5000 Sq.m.
13.	High Pressure Oxidative Induction Time	ASTM D 5885	Every 5000 Sq. m.

14. Oven Aging at 85 Deg C – High Pressure OIT (min. ave.)- % retained after 90 days – ASTM D 5885 - Every 15000 Sq. m. and each formulation

15. UV Resistance – High Pressure OIT (min. ave.)- % retained after 1600 hrs – ASTM D 5885 - Every 15000 Sq. m. and each formulation

Welding rod samples shall be tested at the frequency of once per 25 rolls of welding rod. Following tests shall be performed on the samples.

1. Thickness/diameter as per ASTM D751 : ASTM D 751
2. Density as per ASTM D 1505 : ASTM D 1505
3. Melt Index as per ASTM D 1238 : ASTM D 1238
4. Carbon black content as per ASTM D 1603 : ASTM D 1603

All the reference to ASTM codes shall be tested as the base requirement. Other International codes of practices, which are equivalent to the above ASTM, shall also be acceptable to the owner subject to prior approval.

Results of all the tests shall be furnished to the owner for his review. Owner or his authorized representative reserve the right to inspect the testing facilities and witness the tests as and when desired.

Owner or his authorized representative reserve the right to retest some or all the parameters of HDPE liner at NTPC identified 3rd party testing laboratory anytime during the execution of contract. Sample shall be selected from site randomly jointly by NTPC and contractor. Cost of

all testing shall be borne by the contractor. In case the sample does not meet the requirement of Technical Specifications, then owner reserve the rights to reject the HDPE liner lot from which the sample is selected.

Precautions to be taken for HDPE liner laying:

1. After the construction of reservoir embankment, the slopes shall be dressed properly and shall be free from any gravel or sharp rock pieces. The slopes & bed of reservoir shall be free from any gravel or sharp rock pieces which can puncture the HDPE liner.
2. After the bed preparation, HDPE liner roll shall be unrolled one at a time. The liner shall be adequately loaded with the sand bags and shall be immediately welded with the adjacent liner roll.
3. Once the welding of previous liner rolls is completed then only the next roll shall be unrolled.
4. The loading of HDPE liner shall be continuous at the edges and in a dense grid of 1mX1m at over the liner area.
5. Liner shall not be left open without adequate loading and it shall be pressed properly (in order to take out air pockets which causes undulation) before welding.
6. Anchoring of HDPE liner at reservoir top shall be done as per the construction drawing.
7. Non-Woven geotextile & over that 75 thick PCC M20 layer shall also be placed over HDPE liner to get finished surface.
8. In the reservoir bed, 300mm thick layer of specified soil shall be provided in rocky surface. Bed shall not consist of gravels and sharp rock pieces.
9. The welding of HDPE liner rolls shall be carried out simultaneously. Large number of rolls should not be left un-welded to avoid tearing off of liner.

5.04.09 **PCC Lining**

75mm thick Plain Cement Concrete of grade M-20 (design mix) shall be provided over non-woven geotextile laid over HDPE liner at all levels on the inner surface of reservoir embankment (upstream side slope) and reservoir bed with graded stone chips (12.5 mm nominal size).

Synthetic Polyester triangular fibre of length 12mm,effective diameter 10-40 microns and specific gravity of 1.34 to 1.40 shall be mixed in Plain Cement Concrete of grade by using 125gms of synthetic Polyester triangular fibre for 50 Kg cement used as per directions of Engineer.

Placing

After the slope & bed of reservoir has been dressed to line and HDPE liner has been provided over the compacted earth/soil, the entire upstream slope surface & bed shall then be covered with non woven geotextile followed by placing of 75 thick PCC lining. The PCC lining shall be free from impurities like particles of stone, lime and other foreign materials visible to the naked eye on the surface and shall be of uniform texture. On completion of PCC lining, the surface presented by the lining shall be even throughout, free from irregularities.

5.04.10 **Non-Woven Geotextile**

This specification covers the technical requirements for the Manufacturing and Installation of the nonwoven geotextile. All materials meet or exceed the requirements of this specification, and all work will be performed in accordance with the procedures provided in these specifications.

Submittals

A. Prior to material delivery to project site, the contractor shall provide the engineer with a written certification or manufacturers quality control data which displays that the geotextile meets or exceeds minimum average roll values (MARV) specified herein.

B. The contractor shall submit, if required by the engineer, manufacturer's quality control manual for the geotextile to be delivered to the site.

Geotextile

A. Geotextile shall be Needle punched Non-woven type.

B. The geotextile shall be manufactured from prime quality virgin polymer.

C. Geotextile shall be with U-V (Ultra-violet) treatment suitable for a temperature range from 0 Deg. C to 50 Deg. C so that the strength and the life of the same is not affected due to exposure to ultraviolet

D. Geotextile shall meet or exceed all material properties as given below.

E. In addition to the above, geotextile shall have good resistance to chemicals and to biological degradation

1. Material for Geotextile filter	100% Polypropylene
2. Mass per unit area	250 g/sq.m (ISO 9864)
3.Thickness in mm	2.2 (min.) (ISO 9863)
4. Tensile strength	19 kN/m (ISO 10319)
5. Elongation at break	80/35(md/cd)(ISO 10319)
6. Puncture strength	2900 N (ISO 12236)
7. Effective opening size	0.09mm (ISO 12956)
8. Horizontal water flow 20kPa	13 l/m.h (ISO 11058)
Horizontal water flow 200kPa	3.0 l/m.h (ISO 11058)
9. Vertical water flow 50mm head	72.0 l/sqm.h (ISO 11058)
10. Width to be supplied	minimum 3.5 m

MANUFACTURE

All rolls of the geotextile shall be identified with permanent marking on the roll or packaging, with the manufacturers name, product identification, roll number and roll dimensions.

TRANSPORT

A. Transportation of the geotextile shall be the responsibility of the contractor.

B. During shipment, the geotextile shall be protected from ultraviolet light exposure, precipitation, mud, dirt, dust, puncture, or other damaging or deleterious conditions.

C. Upon delivery at the job site, the contractor shall ensure that the geotextile rolls are handled and stored in accordance with the manufacturer's instructions as to prevent damage.

INSTALLATION

A The geotextile shall be handled in such a manner as to ensure that it is not damaged in any way. Any damage to the geotextile to the extent that it is no longer usable as determined by these specifications or by the engineer, the contractor shall replace the geotextile at his own cost.

B The geotextile shall be rolled down the slope in such a manner as to continuously keep the geotextile in tension by self-weight. The geotextile shall be securely anchored in an anchor trench where applicable, or by other approved or specified methods.

C. In the presence of wind, all geotextiles shall be weighted by sandbags or approved equivalent. Such anchors shall be installed during placement and shall remain in place until replaced with cover material.

D. The contractor shall take necessary precautions to prevent damage to adjacent or underlying materials during placement of the geotextile. Any damage to such material occur due to the fault of the contractor, the contractor shall repair the damaged materials at his own cost and to the satisfaction of the engineer.

E. During placement of the geotextile, care shall be taken not to entrap soil, stones or excessive moisture that could hamper subsequent seaming of the geotextile as judged by the engineer.

F. The geotextile shall not be exposed to precipitation prior to being installed and shall not be exposed to direct Sun light for more than 15 days after installation.

G. The geotextile shall be seamed using heat seaming or stitching methods as recommended by the manufacturer and approved by the engineer. Sewn seams shall be made using polymeric thread with chemical resistance equal to or exceeding that of the geotextile. All sewn seams shall be continuous. Seams shall be oriented down slopes perpendicular to grading contours unless otherwise specified. For heat seaming, fusion welding techniques recommended by the manufacturer shall be used.

H. The contractor shall not use heavy equipment to traffic above the geotextile without approved protection.

I. The geotextile shall be covered (as per drawings) as soon as possible after installation and approval. Installed geotextile shall not be left exposed for more than 15 days.

J. Material overlying the geotextile shall be carefully placed to avoid wrinkling or damage to the geotextile.

5.04.11 Spillways/Over Flow Structures

Bidder shall suitably design and construct spillways/over flow structures to prevent overtopping of the embankment. The discharge from the spillways/overflow structures shall flow to the nearest nallah or drains with capacity to accommodate it.

5.04.12 Inlet /Outlet Structures

Suitable outlet pipes of mild steel (MS) as per IS: 3589 shall be provided. The adequate nos. of outlet pipes (as per design requirement) of suitable diameter and minimum 500mm thick RCC encasement with concrete Grade M20 as per IS 456. Pipes shall be laid as per IS 783.

Inlet structure shall be suitably designed & constructed. Inlet pipes shall be of MS as per IS: 3589 and laying shall be done as per IS 783. The number and diameter of pipes shall be suitably designed to meet the capacity requirement. A minimum 500mm thick RCC encasement with concrete Grade M20 as per IS: 456 within the embankment shall be provided. To dissipate the turbulence and energy of the falling water suitable energy dissipation devices/system shall be provided.

5.04.13 Rip-Rap

Rip-rap shall be hand placed on the slopes of the embankment as per IS: 8237 - "Code of practice for Protection of slope for reservoir embankments". The thickness shall be 300mm and

shall be measured normal to slope of the embankment. The rock materials used for rip-rap shall satisfy the quality requirements specified in IS code.

5.04.14 Rock Toe

The rock material used for the rock toe shall satisfy the quality requirements. Rock toe shall be formed with rock material consisting of sound, durable and well graded broken rock obtained from approved quarries and shall be of approved quality. The materials shall range in size from 10 to 45 cm. All brush, roots or other perishable materials shall be removed from rock-fill during spreading and disposal off. Contamination of the rock with finer materials from any other zones shall be avoided. Accumulations of soil caused by contamination shall be removed. Rock materials shall not be dumped directly but shall be hand placed in layers.

5.04.15 D/S Slope Protection Works – Turfing

The D/S slope of embankment including berms, if any, shall be turf sodded from top of embankment to rip-rap level. Turfing shall consist of at least 5 cm thick grass turf sods of approved variety obtained from the tank beds or river margins for use in this work. The sod shall include a mat of roots and earth at least 5cm thick. Sod containing an excessive amount of obnoxious weed growth shall be excluded. The block of sod shall be laid on the slope in close contact and then tampered firmly in place so as to fill and close the joints between blocks.

5.04.16 Diversion of Surface & Under Ground Water

The whole of the works shall be carried out in the dry condition. Water from any source shall be diverted or pumped as required, clear of the works. Bidder shall make all necessary arrangement whatsoever required for keeping the work area dried by diverting and pumping of water, and also provision and operation of all temporary works including pumps, motors, fuel, piping and for the formation of any sumps, drainage channels, flumes, coffer dams and other protective works.

5.04.17 Rainfall Run-Off

As part of the work may have to be carried out in wet season, Bidders programme and methods must be capable of dealing with run-off from rainfall on the adjacent catchment area. The associated flow in the nallahs etc. shall be diverted clear of the works by an approved system of bunds and channels. Bidder shall supply, install and operate his own temporary pumping installation.

5.04.18 Prevention of Pollution

Arrangement shall be made by the Bidder to prevent pollution of the water in any streams, springs, nallahs and lakes. Arrangements for sprinkling of water in the construction and borrow area to prevent any dust blowing also shall be done by the Bidder. Bidder 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 Bidder

Table-1
Frequency of sampling and testing

S.No.	Nature of test/Characteristics	Method of test	No. of samples & frequency of test	Remarks

1	Suitability of fill material		One in every 2000 cum for each type and each source of fill materials subject to a minimum of two samples	Test for soil and sand
	a) Grain size analysis	IS: 2720 (Part-IV)		
	b) Liquid limit and Plastic limit	IS: 2720 (Part-V)		
	c) Shrinkage limit	IS: 2720 (Part-VI)	One in every 5000 cum for each type and each source of fill material	Test for soil The frequency of test can be increased depending on type of soil
	d) Free swell Index	IS: 2720 (Part-XL)		
	e) Chemical Analysis	IS: 2720	One in every 5000 cum for each type and each source of fill material	Test for soil and sand
	i) organic matter	Part-XXIL		
	ii) calcium carbonate	Part-XXIII		
	iii) Ph	Part-XXVI		
	iv) total soluble sulphate	Part-XXVII		
2.	Standard proctor Test	IS: 2720 (Part-VII)	One in every 2000 cum for each type and each source of fill material	Test for soil for determining optimum moisture content, dry density etc
3.	Moisture content for fill before compaction	IS: 2720 (Part-II)	One in every 2000 cum for each type and each source of fill material	Test for soil
4.	Degree of compaction of fill			
	a) Dry density by core cutter method or dry density in place for sand displacement method	IS: 2720 (Part-XXIX)	For area filling, one for every 1000 sqm area for each compacted layer	Test for soil
	b) Relative density (density Index)	IS: 2720 (Part-XIV)	For area filling, one for every 1000 sqm area for each compacted layer	Test for soil
	c) Dry Density for proctor needle penetration	Standard practice	Random checks to be carried out for each compacted layer in addition to tests	Test for soil

			mentioned under IV(a) above	

5.05.00 ASH HANDLING AND ASH WATER RECIRCULATION SYSTEM

5.05.01 The civil works for Ash handling system (both wet and dry) shall comprise of bottom ash and fly ash handling systems, which includes Combined Ash slurry pump house and their related sumps/tanks, Ash water pump house, Bottom Ash (BA) slurry transportation pump pit and their related sumps/tanks (In case of SCC system), Transport/instrument Air Compressor house, Conveying air compressor house, Switchgear /Control/RIO rooms, Ash Water Recirculation System (AWRS) pump house complex and their related sumps/tanks, supporting structures and foundations for Bottom ash hopper, Buffer hoppers/Collector tanks, bottom ash overflow tank, Settling tanks and Surge tanks, Seal water tank, Ash Classifier, Bagging plant Complex, Silo Utility Building complex with Fly & Bottom Ash Silos, including development of silo area (i.e. paving, fencing/boundary-wall, access roads, office block and watchman cabin), miscellaneous equipment foundations, trenches, pipe racks, pedestals/thrust blocks for BA / AWR pipe supports (both inside and outside the plant boundary) including bridges/ culverts for road/rail/drain/nallah as required.

5.05.02 Transport air compressor houses, Conveying air compressor houses, Ash slurry Pump House shall have steel shed building with side sheeting and Silo utility building, & Ash Water Recirculation pump houses shall have RCC framed structure, with RCC columns and profiled metal deck sheet roofing (filled with RCC) supported on steel purlins & truss / girders. Other buildings like MCC /switchgear rooms, control room, Disaster management room etc. shall have RCC framed structure with cast-in-situ RCC roof slabs. Bagging plant Complex building shall be closed steel shed. All RCC buildings shall have brick cladding. Crane girders or monorails shall be provided as per requirement and the same shall be of structural steel construction.

5.05.03 The documents and drawings as listed below are to be submitted for the approval of the Employer unless specified otherwise. The list given below is not exhaustive but indicative only.

a) Project design intent document giving the basis of design, which shall cover all the design philosophy aspects, parameters, assumptions, references, loading cases, load combinations, analysis and design of all buildings, structures, facilities etc. shall be furnished for approval, before commencement of detailed engineering.

b) Structural analysis, design calculations and drawings of substructures and super structures for all buildings/structures, facilities like pump houses/shed, compressor houses, sumps / tanks, channels, pipe support structures, culverts/ bridges, pedestals, thrust blocks transformer yards, etc. shall be submitted for approval of the owner.

c) The design and drawings for the equipment and their supporting structures like bottom ash hopper, buffer hopper/collector tanks, surge tank/settling tank, silos/bins, etc. associated with Ash Handling System, shall be submitted to the Owner for information only. However, the structural design criteria and basis of design as mentioned at (a) above, for these structures also shall be approved by the Owner.

d) Top of RCC pedestal of foundation for bottom ash hopper, fly ash silo, other columns etc. shall be 300 mm above paving level or surrounding finished ground level (FGL).

5.05.04 The finished floor level (FFL) of Ash Water Recirculation (AWR) pump house complex shall be 500 mm above FGL. However, in order to facilitate approach/connection to the road on top of mine void with AWR pump house complex, if required FGL may be fixed at higher level than 1.5 m above HFL. AWR System shall include Ash water recirculation pump house complex near mine void along with related sumps/tanks, MCC/Switchgear building, maintenance room, control room, disaster management room (single storey room of approx. size 15 m x 7.5 m and

	1.5m wide verandah along the larger dimension), transformer yard, miscellaneous equipment foundations, trenches inside roads/RCC paving and area drainage etc. The peripheral drain inside the complex of suitable capacity & slope shall be suitably connected to the natural drain available outside the complex. The AWRPH complex shall be confined with boundary wall and a security gate. The complex shall be suitably connected to the road to plant and road on mine voids. Since the complex is situated outside the plant boundary, an Independent sewerage system including soak pit/ inspection chamber shall be provided.
5.05.05	The Silo utility building complex shall be fenced with chain linked fencing, if placed inside the plant boundary and shall be confined with boundary wall if placed outside plant boundary. Gates shall be provided for rails, truck movement and transformers. The boundary wall shall be of one brick thick of height 2.4 m with a 600 mm high galvanized concertina at top, such that total height is 3.0 m above formation level. The fencing shall be PVC coated G.I. Chain link of minimum 4 mm thickness (including PVC coating) of mesh size 75mm x 75 mm and of height 2.4 m above toe wall. The toe wall shall be 1 brick thick, minimum 200 mm high above paving/formation level and 300 mm below paving/formation level on 75 mm thick PCC (1:4:8) bedding. Entire area in the silo area complex shall be paved and have a peripheral RCC drain of adequate capacity & slopes covered with perforated precast RCC slabs of minimum 150 mm thickness with provision of openable galvanized steel grating covers of 1.0 m at every 4 m interval .The complex shall be provided with a sump for collection of ash water. In addition to the outer confinement, additional fencing with gates should be provided for all transformers in the complex. A watchman cabin with a minimum area of 5 Sq.m shall also be provided in this area.
5.05.06	For AWR system, the pedestals/thrust blocks for pipe supports from mine voids to AWR sump & AWRPH to ash water PH including bridges/ culverts for road/rail/drain/nallah etc, shall be provided as per the system requirement. The pedestals for AWR pipes may be combined with the pedestals for Bottom ash pipes in the corridor common for pipes. Pipe supports shall be provided for bottom ash slurry pipes, ash slurry pipes, AWR pipes, dust suppression pipes, dry fly ash(FA) pipes including RCC thrust blocks and any other supports required to complete the system. Over-ground pipes shall be supported on RCC pedestals except for FA pipes which shall be on elevated steel trestles. Unless noted otherwise, the top of concrete pedestals shall be minimum 500 mm above surrounding ground level/paving level. Pipes shall be suitably anchored with RCC pedestals to resist lateral and vertical movements as per system requirement. B.A. slurry disposal pipe line pedestals and thrust block/culverts including garlanding of bottom ash slurry mine voids. If the layout requires the pipes to cross the road on top of mine voids, all ash pipes shall be laid in hume pipes of suitable diameter (NP-3 class) encased in RCC(minimum 200 mm thick) forming a hump on the road. The road shall be modified such that the slope of road along the length, at hump section, shall not be steeper than 1:20.
5.05.07	Single lane maintenance / Inspection road with 1.5m wide shoulders on both sides of the road shall be provided along the entire route of the ash slurry pipeline & recovery pipe line from plant boundary wall to the mine voids along ash pipelines including road for garlanding. Required leveling and grading for ash pipe corridor road shall be provided such that longitudinal slope of road shall not more than 1:30 at any stretch of the road. The details of road shall be as specified elsewhere for patrol road in the specification. However, shoulders shall consist of 150mm thick compacted layer of moorum in place of interlocking blocks specified therein. Based on the actual survey, if it is established that, there is a space constraint in accommodating the maintenance road in the ash pipe corridor, the road width (of 6.75 m including shoulders as per specification), may be adjusted with the approval of NTPC, by reducing the width of shoulders in such stretches. For stretches of roads in cutting and other stretches wherever necessary, longitudinal rectangular brick side drains with minimum 500 wide and 300 deep shall be provided. Only the inside faces and top surfaces of the drains shall

	be plastered with 1:4 (cement: sand mortar). These drains shall be connected to the nearest available natural drain or low lying area. Adequate cross drainage with RCC box culvert or RCC pipe culverts (NP-3) as per topography requirement shall be provided under the access/maintenance road to cater to the surface drainage due to rainfall and other existing drain/nallah. Camber shall be provided on the road. The finished top (crest) of all roads shall be minimum 350 mm above the surrounding finished ground level, however based on the site conditions / low lying areas the height of road top shall be increased.
5.05.08	Where the pipes are crossing the road through RCC box culverts, the culvert top generally, shall not be not more than 100 mm above the road top and a hump with slope of 1:35 shall be provided on the road. All other road crossings inside the plant area can be either underground or overhead road crossings with necessary headroom clearance. For any boundary wall crossings, pipe shall be laid through casing pipe / RCC culvert. After laying the pipe, the boundary wall shall be restored. For other water body crossings, such as local Nallah / canal, local water bodies, local drains etc. suitable structural arrangement with 800 mm wide walkway shall be provided. Minimum clearance of the bottom of pipeline for all such locations shall be 1.50 M above the High flood level (HFL). Bidder to take all statutory clearance from concerned authorities for crossing his pipe/trestles over road / rail / culverts / nallah etc. at his own cost and initiative, without any commercial implication to the owner. For any other additional works, bidder have to make their own assessment too of the quantity/ number of culverts, existing pipe pedestal crossings, nallah crossings etc., based on their site visit before quoting.
5.05.09	All ash handling system/ ash water recirculation system pipe crossings with Railway Lines including MGR lines shall be laid by method excepted by concerned railway authorities for existing rail lines & by cast in situ RCC box culvert for future envisaged rail lines. The railway track crossings are to be designed in accordance with railway Standard/RDSO guidelines and all necessary approvals from the concerned Railway authorities shall be obtained by the Bidder, without any financial implications to the owner.
5.05.10	Survey inside and outside plant boundary, required for finalization of layout for maintenance road, FA transportation pipe trestles, pipe pedestals up to mine voids including mine voids, is in the bidder's scope. The survey shall include the longitudinal section of the entire corridor
5.05.11	All liquid retaining structure shall be designed by working stress method as per IS 3370 (Part-1&2):2009. The thickness of base slab in liquid retaining/ carrying structures shall be minimum 150mm. Minimum grade of concrete for liquid retaining structures like Sumps/tanks/drain sumps etc shall be M-30.
5.05.12	For liquid retaining structures, the minimum reinforcement in each direction shall not be less than 0.24% of the gross cross-sectional area.
5.05.13	All liquid retaining structures shall be tested for leak proofness with full water level in accordance with clause no.12 of IS 3370(Part 1):2009 and IS 6494.
5.05.14	All pump houses and other substructures shall be checked for stability as per the following guidelines: a) Stability of structure against sliding during construction as well as operating conditions for various combinations of applied characteristic loads. In case where dead load provides the restoring moment, only 0.9 times the characteristic dead load shall be considered. Factor of safety against sliding shall not be less than 1.4 under most adverse combination of applied characteristic loads. b) Stability of structure as a whole against overturning. It shall be ensured that the resisting moment shall be not less than the F.O.S. times the maximum overturning moment. Factor of safety against overturning shall not be less than 1.2 due to characteristic dead load and shall not be less than 1.4 due to characteristic imposed load. c) Stability of structure against uplift due to the ground water table at finished ground levels during construction and after construction stages. Minimum factor of safety of

1.2 against uplift shall be ensured considering 0.9 times dead weight, empty condition inside and ignoring the superimposed loadings. Inclined wedge action shall be limited to 15 degree with vertical plane. Provision of pressure relief valve / flap valves etc. shall not be permitted to counter the uplift. Also FOS against uplift, to be taken as 1.0 considering the dead weight of structure and soil resting on side projections, if any, in the vertical plane. Inclined wedge action of soil shall not be considered in this case.

5.05.15 **Architectural Features of Ash Handling and Ash Water Recirculation System Buildings**

a. All buildings shall be fully covered with brick masonry cladding and Aluminium and Steel doors/ windows/ rolling shutters / ventilators.

b. Safety norms shall be followed as applicable. The buildings shall be provided for Pump houses, Switch Gear Room, Control Room etc. as per ash handling system requirements.

c. External finish shall be of premium acrylic smooth exterior paint with silicon additives.

d. All the air conditioned rooms shall be provided with hermetically sealed double glazing in windows and false ceiling.

e. Encased staircase shall be provided for double storeyed buildings and cage ladder shall be provided for roof access in single storeyed building.

f. Each building shall have one toilet block with drinking water facility.

g. Ash water recirculation building shall have Bio toilet as mentioned else where in the specification.

5.06.00 FGD SYSTEM

5.06.01 The civil works for FGD system shall comprise of civil, structural and architectural works below and above ground level of Ball mill building, Ball mill foundations, FGD control room building, slurry re-circulating pumps & oxidation blowers building, tank foundations, absorber tower foundation, MCC building, gypsum dewatering building, transformer foundation, equipment foundations, pipe & cable gallery/ trestles, drainage, sanitation, water supply (from terminal points to various buildings/facilities) and all other civil, structural and architectural works associated with the complete FGD system specified elsewhere in this specification. Bidder may also refer terminal points & exclusions in this regard.

5.06.02 **Buildings for FGD System**

FGD System may comprise of various buildings based on the functional requirement viz. Ball Mill building, MCC/Control room building, Gypsum dewatering building, re-circulating pumps & oxidation blowers building, Gypsum storage shed etc.

5.06.02.01 **Control building, M. C. C. Buildings**

These shall be steel/RCC framed building with RCC roof and floor. For steel framed building roof /floor shall comprise of RCC slab over profiled metal deck sheets (to be used as permanent shuttering only) over structural beams. Cladding shall be of brickwork/concrete block work with plastering on both sides. Roof shall be provided with roof water proofing treatment, as specified elsewhere in the Technical specification. Suitable arrangement shall be provided so as to prevent ingress of water into the cable trenches inside the building from cable entry locations. All air - conditioned areas, shall be provided with false ceiling system (details specified elsewhere) with under deck insulation.

5.06.02.02 **Limestone Grinding System building/Ball Mill building**

This shall be steel framed building with R. C. C. roof and floor. For steel building roof /floors shall comprise of RCC slab over profiled metal deck sheets (to be used as permanent shuttering only over structural beams). Cladding shall be of single skin metal sheeting or

brickwork/concrete block work with plastering on both sides. Roof shall be provided with roof water proofing treatment, as specified elsewhere in the Technical specification.

5.06.02.03 **Gypsum Dewatering Building**

This shall be steel framed building with R. C. C. roof and floor. For steel building roof /floors shall comprise of RCC slab over profiled metal deck sheets (to be used as permanent shuttering only over structural beams). Cladding shall be of single skin metal sheeting or brickwork/concrete block work with plastering on both sides. Roof shall be provided with roof water proofing treatment, as specified elsewhere in the Technical specification

5.06.03 **Booster Fan and Ball Mill foundations**:

Fan, Mill foundations shall be RCC block foundation directly resting on virgin soil/ pile below Ground level. The vertical faces of this block foundation shall be isolated from adjacent footings by providing minimum 100mm thick polystyrene board of type-1 conforming to IS: 4671 with density 20 kg/cum sandwiched between the vertical face of block foundation and 230 thick brick wall all round.

ii) **Design Concept:**

a) For the foundations of Fans, Mills, etc. detailed static and dynamic analysis shall be done.

b) Wherever block foundation is adopted by the bidder for mill or FAN foundations, suitable provisions to be ensured by the bidder in their General Arrangement and design to prevent transmission of vibration from these machine foundations to other nearby structures / foundations.

The bidder or his consultant should have adequate prior experience in design of machine foundations and the machines should be in successful operation for at least one year prior to the date of submission of bid.

5.06.04 Pipe and cable gallery/ trestles shall be as per details given in clause no. 5.02.08.

5.06.05 **RCC Floors, Paving & Grade Slab details**

Passages shall be provided inside the FGD area 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 equipment lay down area, unloading & maintenance area, storage area with 50 mm thick metallic hardener topping.

Lightly loaded areas such where no heavy traffic movement is envisaged shall be provided with Normal Duty paving. However, corridors below pipe/cable trestle gallery 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 facility/buildings 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 minimum 7.5m width all around the tank foundations and other facilities/buildings shall be paved. This paving shall be beyond the extent of plinth protection. Further, heavy duty paving shall be provided for passages connecting the outer periphery road to have access to the various facilities/buildings.

Wherever multiple FGD facilities are located in a cluster in the areas proposed for FGD, the entire extent of the cluster shall be provided with area paving maintaining minimum 7.5 m width around the facility buildings. Paving shall be extended up to nearest road for easy access to FGD facilities. Any functional requirement of paving for FGD facility not specifically mentioned in this document is also in scope of bidder.

GRADE SLAB OF BUILDINGS AT GROUND FLOOR

In buildings, the grade slab shall consist of 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 dia. bars @ 200 mm c/c at top & bottom of the slab in both directions. However, at unloading & maintenance area, gypsum storage shed stone soiling of minimum 400mm thick and grade slab with minimum 10mm dia bars @ 200 mm c/c at top and bottom in both directions shall be provided.

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

5.06.08 Bidder shall provide permanent access to all facilities/structures from the nearby existing roads of the Owner.

Roads shall be of concrete as per IRC standards, with minimum thickness of pavement (PQC) as 250mm (in M 35 grade) and DLC of 150 thick (in M 10 grade). Double lane road (width 12m having 7.5m wide pavement & 2.25m wide shoulders on both sides) shall be provided.

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.

5.08.00 PLANT STORM WATER DRAINAGE SYSTEM

Complete storm water drainage system of Plant area is in bidder's scope. Storm water drain shall be designed taking into account the finished ground levels of the plant/township area, drainage pattern, intensity of rainfall, etc as stipulated/mentioned in 'Area drainage study report'. These values shall be based on minimum rainfall intensity of 75mm/hr. All RCC drains shall be either RCC Cast-in-Situ or RCC Pre-cast drains. The minimum grade of concrete shall be M25 for RCC Cast-In-Situ drains and M30 for RCC Pre-cast drains.The maximum velocity for RCC open drains shall be limited to 1.8 metre per second. However, minimum velocity of 0.6 metre per second for self - cleansing shall be ensured. Bed slope not milder than 1 in 1000

shall be provided. The inside drain dimension at any point should not be less than 0 .45m (height) x 0.75m (breadth).

Open RCC rectangular section, unless required otherwise due to functioned requirement, shall be provided for all drains. The thickness of side walls and bottom slab of RCC drains shall be minimum 150mm or as per design considerations whichever is higher for drains upto depth of 1m from formation level. For depth of drain more than 1m from formation level, the thickness of side walls and bottom slab of RCC drains shall be minimum 200mm or as per design considerations whichever is higher.

The drains shall be provided on both sides of the double lane roads and single lane roads. The drains shall be provided on one side of the patrol roads along boundary wall. These shall be designed to drain the road surface as well as all the free and covered areas, etc. Box culverts shall be provided at all rail, road and other crossings.
Layout of drain shall be as per layout given in tender drawing “Layout of drain’.

Complete drainage upto outfall point to be completed to avoid flooding in the respective area.

5.09.00 TRANSFORMER FOUNDATION

Foundations of transformers shall be designed for seismic and wind loads in addition to other applicable loads. Solid RCC block foundation shall be provided for the main transformer block. Alternatively, transformer shall be supported on a RCC foundation comprising of common raft for rail supporting walls up to rail-cum-road along with pedestals for jacking pad, roller lock etc. Tie beams connecting roller lock pedestals at rail level shall also be provided. Common raft/solid RCC block shall be supported on soil or pile based on requirement specified elsewhere in the specification.

Oil soak pit / oil water separation pit for transformer shall be provided as envisaged elsewhere in the specification.
The oil soak pit shall be provided for each transformer and shall be filled with gravel of size 40mm. The volume of the soak pit shall be sufficient to store one-third (1/3) of the oil volume of transformer/reactor considering only 40% of the volume as available voids between gravel filling. The oil soak pit shall also be provided with a sump at the corner to allow drainage of water/oil from the soak pit. Oil soak pits sump of individual transformers shall be connected to common oil retention /oil water separation pit through hume pipes and manholes.
Separate common oil retention pit/oil water separation pit shall be provided for a group of transformers in transformer yard area of each generation unit of plant.
The Oil-water Separation pit shall be designed for an effective capacity of complete oil of one transformer having highest volume of oil along with 10 minutes of firewater. For calculating effective capacity of oil-water separation pit, effective depth excluding 200 mm freeboard below invert level of inlet pipe shall be considered. Plan area and depth of oil-water separation pit shall be decided based on above consideration.
Oil-water Separation pit shall be provided with five separate chambers interconnected by pipes.
First chamber shall be for collecting oil-water mix from transformers’ soak pits in case of fire. After entering into first chamber, oil being the lighter in density floats above the water. The water from lower elevation flows in to subsequent chambers interconnected through galvanized MS pipes. The accumulated oil in the first chamber to be pumped out for subsequent usage or disposal. Water collected in the last chamber to be pumped out for subsequent disposal after treatment. Invert level of inlet Hume pipes (of NP-3 grade and adequate capacity), carrying oil and water from transformers soak pits, shall be designed for gravity flow. Freeboard of 200 mm shall be provided below the invert level of inlet pipes. Invert levels of interconnecting pipes of subsequent chambers shall be decided accordingly.

Arrangement for moving the transformer into place using rail cum road, jacking pads and pulling blocks including inserts, as required, shall be provided along with the transformer/reactor foundations.
RCC Firewall shall also be provided between the transformers wherever required.
300 mm thick PCC M20 encasement all around the Pylon supports inside soak pit for firefighting system shall be provided up to top of gravel filling. However, the supply and erection of Pylon supports with anchor fasteners for HVW spray system are not under the scope of this package. Coarse aggregate filling inside the transformer oil soak pit shall be carried out only after construction/erection of Pylon supports and PCC encasement.

5.10.00 **Roads**

All roads shall be of rigid pavements unless otherwise specified. Rigid pavements shall be constructed with either conventional cement concrete or with Geopolymer concrete. Concrete road/pavement or rigid pavement, mentioned in specification, shall mean road /pavement constructed with either Cement Concrete (CC) or Geopolymer Concrete. All concrete roads shall be unreinforced jointed plain concrete pavement having dowels in transverse joints and tie bars at longitudinal joints.

A 40mm bitumen mastic wearing course over concrete pavement shall be provided with industrial bitumen of grade 85/25 conforming to IS : 702, prepared by using mastic cooker and laid to required level and slope, including providing antiskid surface with bitumen fine grained hard stone chipping of approved size at the rate of 0.005 precoated cum per 10 sqm and at approximate spacing of 10 cm centre to centre in both directions, pressed into surface protruding 1 mm to 4 mm over mastic surface, including cleaning the surface, removal of debris etc. all complete. (Considering bitumen using 10.2% as per MORTH specification).
This 40mm bitumen mastic wearing course shall be laid after completion of construction activities i.e at the time of handover.

All the road shall again be repaired/made good as per IRC : SP :83 after completion of construction activities i.e at the time of handover.

All service and utility lines like fire water line, sewerage line, electric cables line etc. crossing the road shall be taken through NP3 class RCC Hume pipe. Hume pipe shall be laid before road work so that the road shall not be damaged.

Construction of road work shall be as per priorities given in Tender drawing ‘Layout of Road Drawing’.

5.10.00.01 **For road to be constructed with Cement Concrete-**

The design of rigid pavement shall be carried out as per IRC: 58. The effects of design wheel load, maximum tyre inflation pressures, tyre contact area for the vehicle, traffic loads, environmental factors such as temperature changes in the pavement, other factors, like impact, load repetitions, etc., are to be taken. The design traffic load shall be a minimum value of 4 million standard axles. The road shall be designed for 30 years of life and considering a minimum traffic growth rate of 1 per cent per annum. The concrete pavement for roads shall be minimum 250 mm thick slab.

The road construction including its shoulders, base, sub base and concrete pavement shall be as per MORTH. The road base shall be with minimum 150 mm thick dry lean concrete over granular sub base. Dry lean concrete shall be laid by a mechanical paver and compacted by vibratory rollers. Concrete pavement of the road shall be done with fully mechanized paver fitted with electronic sensors for construction techniques.Laying /placing of Concrete DLC and PQC manually with hand-guided means or by semi-mechanized methods may be permitted around BTG area provided acceptance criteria as per MORT&H

specification is achieved. Dry lean concrete shall be minimum M10 grade and concrete pavement slab shall be minimum M35 grade concrete pavement shall be provided with 125 micron polythene sheet below it. Concrete pavement shall also be provided with contraction and expansion joint with MS dowel bars and as per Ministry of Road Transport and Highways (MORTH) specification.

The finished top (crest) of all roads shall be 350 mm above the surrounding finished ground level.

All culverts and RCC bridges at crossings of all roads / rail tracks / facilities with drains / nallahs / channels / roads / rail tracks / pipes / other facilities, etc. are to be designed and constructed.

Unless otherwise specified, all roads (excluding access roads to all buildings / facilities / structures, patrol road along boundary wall and road inside the switchyard) shall be double lane roads.

5.10.00.02 **For road to be constructed with Geopolymer concrete-**

Geo-polymer concrete road shall be constructed over soil sub-grade/embankment. Road section shall comprise of Granular Sub base over soil sub-grade, Dry Lean Concrete of M10 Grade (DLC) base and Pavement Quality Concrete of M35 grade (PQC) top layer. Thickness of different layers of pavement section shall be as per design. However, minimum thickness shall be 150 mm for DLC and 250 mm for PQC. Provisions of Clause 5.10.00.01 in respect of design, construction and other requirement shall also be applicable for Geopolymer concrete road. In addition, specific information pertaining to geopolymer concrete is provided at the end of Chapter D-1-8.

5.10.01 **Double Lane Roads**

The double lane roads shall be (12 metre wide) with 7.5 metre wide concrete pavement and 2.25 metre wide raised shoulders on both sides of the roads as given in tender drawing “Details of road” .

5.10.02 **Single Lane Roads**

All access roads to all buildings / facilities / structures, road approaches / connections, access roads to liquid fuel storage areas and other equipment areas where access is necessary from inspection, operation and maintenance point of view and all roads inside the switchyard shall be single lane roads as given in tender drawing “Details of road” .

5.10.03 **PATROL ROADS**

All patrol roads along the boundary wall shall be single lane roads with 3.75 metre wide concrete pavement and 1 metre wide shoulders on one side of the road. as given in tender drawing “Details of road”.

5.11.00 Pre-cast Boundary WALL

A pre-cast boundary wall all around the land acquisition line as shown in the General layout Plan for plant area shall be provided. The total height of boundary wall shall be 3600mm above formation level (natural ground level in case formation level is less than natural ground level). Upto height of 3000mm it shall be constructed with precast reinforced cement concrete panels / cast in situ RCC panels and over that for 600mm concertina coil with maximum loop spacing of 125mm shall be provided with Y-shaped MS angle. The RCC precast/cast in situ reinforced concrete columns shall be provided at spacing not more than 2500mm centre to centre.

The RCC precast/cast in situ reinforced concrete columns and footing shall be minimum 1500mm below finished formation level with suitable foundation designed for horizontal and

vertical loads. However, foundations /footings shall not rest in filled up strata. The precast reinforced concrete panels/ cast in situ RCC panels shall be at least 600m below formation level. The RCC precast concrete columns/ cast in situ RCC panels of minimum size 300mmX350mm shall be provided with two grooves of minimum size 115mmX50mm, so as to receive Precast Concrete RCC panels spanning from column to column with minimum width of 600mm and minimum thickness of 100mm as filler wall. The grade of concrete for all precast/cast in situ work shall be of M30 grade conforming to IS 456.

The boundary wall shall be designed as per relevant IS codes and as per standard practices. The same shall be submitted to Owner for approval at the time of detailed engineering, The architecture of boundary wall shall be finalized in consultation with Owner. The precast/ cast in situ reinforced cement concrete coping with minimum projections of 150mm on each side shall be provided at the top of the precast reinforced cement concrete panels / cast in situ RCC panels with suitable provision for MS angle Post for concertina throughout the boundary wall. Opening for gates/drains and for other crossing shall be suitably provided as per the requirement.

All exposed concrete surfaces of all precast members/ cast in situ RCC members have high quality shuttering finish with tolerance of +/- 5mm. Plinth protection of 150mm thickness PCC (M20) shall be provided on both side of boundary wall extending upto 300mm from centre line of boundary wall. High quality shuttering to be approved by Owner.

5.12.00 Fuel Oil Handling system

The civil works are to be provided for following fuel oil handling system areas as mentioned below:

a. Fuel Oil pressurizing pump house.

b. Foundation and dyke wall and all associated works for LDO tanks.

c. Pedestals and foundations to support the interconnecting piping between LDO tanks to the pressurizing pumps as well as piping from tanker unloading area to the Unloading pump house and further on to the LDO tank.

d. Tanker unloading platform.

e. Fuel Oil Unloading Pump House.

f. Oil water separator pit.

5.12.01 **Fuel Oil Pressurising Pump House**

Salient Features:

This building shall be a single storeyed framed superstructure with RCC columns, 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 sheet. Waterproofing on Roof slab shall be done as per architectural specifications. The building shall be completely covered with 230mm thick brick wall with provisions for doors, windows, rolling shutters. The building shall have separate enclosures for the control room and the switchgear room. All rainwater down comers shall be concealed with brick wall. The minimum floor area of this building shall be as per the equipment layout plan of the bidder/ EPC contractor.

Design Concept:

The grade of concrete shall be M 25 for all columns, beams, footing and slabs. The building shall be designed as per IS: 456, IS 800, IS 1893, IS 13920 (for ductility detailing).

5.12.02 **Fuel Oil Storage Tank Foundations**

The Fuel Oil Storage Tank foundations shall be either RCC raft or RCC Ring Beam system with compacted infill. The RCC raft /RCC ring beam shall be supported on virgin soil or pile foundation depending on the load bearing capacity of the soil. The tank bottom base plate shall

be supported on flexible compacted fill comprising 75mm thick Bitumen aggregate mix on top and compacted sand/ soil fill below, compacted in layers of 200mm to minimum 85% relative density as per IS:2720. The bitumen-aggregate mix shall consist of compact crushed stone, screenings, fine gravel, clean coarse sand(river sand) mixed in hot asphalt (8 to 10 percent by volume) and rolled or compacted. In the GA & detailing of foundation RCC ring wall/ beam it should be ensured that no bearing stress from tank superstructure is transmitted to the concrete surface. The top of flexible compact fill and top of RCC Circular wall shall be atleast 325mm above the surrounding ground surface for effective drainage.

The finished tank grade (Top surface of flexible compact fill) shall be crowned from its outer periphery to its centre at a slope of 1 in 100.

The Tank foundations shall be inside a RCC dyke wall enclosure. The entire area outside the tank foundations and within the surrounding RCC dyke walls shall be paved with concrete. The thickness of concrete paving shall be minimum 100mm.The single layer reinforcement in paving slab shall be min 10 Tor@200c/c. The area paving RCC slab shall be supported on 230mm thick Rubble soling with the internal voids filled with coarse sand. The height of the RCC dyke wall shall be evaluated based on the depth of Oil spillage for full oil volume of one storage Tank in addition to a free board of 300mm. Structural steel cross over ladder shall be provided (min 2 numbers) for each RCC wall dyke enclosure. Operating platforms wherever required as per functional requirement shall be provided.

5.12.03 **Tanker unloading platform**

The road tanker unloading platform shall be heavy duty RCC paving minimum 250 thick RCC slab resting on elevated compacted ground surface. A minimum slope of 1:250 shall be provided (in one direction) for the slab for Oil-Water Surface run-off to the peripheral drain. Expansion joints shall be provided in chess board fashion. RCC ramp shall be provided for approach of truck.

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. The basement RCC slab & RCC wall shall be designed as for uplift and external surcharge load as per the design criteria specified elsewhere. All fuel oil pump foundations shall be designed for both static & dynamic loading. The roof slab shall comprise 40th RCC slab over profiled permanent metal deck sheet (min 0.80mm thick) connected through shear anchor studs specified elsewhere in this specification.

In case common fuel oil unloading and pressurizing pump house is envisaged, type of building as mentioned in this clause shall be applicable.

5.12.05 **Oil Water Separator Pit**

The Oil-Water Separator RCC structure (pit) shall be designed as an underground structure. The sizing of the separator shall be based on the total surface run-off from the Fuel Oil Handling area and Hydraulic design for the oil separation. Surcharge load and ground water table up to ground surface shall be considered in addition to other functional loads for structural design of RCC wall for the separator pit.

Drainage trenches with proper bed slopes towards the oil-water separator pit shall be provided around the tank foundation. The entire area outside tank foundation shall have slope towards the drain trenches

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.

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 Deleted

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.

d) The steel structure shall be provided to carry EOT crane of the CW and Raw Water pump houses. The over ground portion of Raw Water Pump House including maintenance bay shall be framed structure of structural steel work with permanently colour coated metal sheeting at roof and side open. However 4m high steel sheet side cladding shall be provided at the top under the roof for protection against rain. At the ground level, brick cladding of 0.9m height above the finished floor level, plastered on both sides shall be provided for all pump houses.

e) The pump house including its forebay shall be of RCC with M-30 grade of concrete conforming to IS 456. The CWPH pump house shall be structurally separated from forebay by providing an expansion joint. The pump house shall be provided with separate maintenance bay

f) For raw Water Pump House (RWPH), connection shall be provided to meet the flow requirement with all necessary arrangement & precautions. Further, associated structure for & including supply of valves/gates are also to be provided for isolation of the connection.

5.18.01.02 The Make-up water pump house (MUWPH) shall be of reinforced cement concrete (RCC). The MUWPH shall be consisting of pump house with steel super structure, forebay, channel including maintenance bay. The MUWPH shall house three (3) number of Make-up water pumps (2 working + 1 standby) each of capacity 3000 cum/hr for stage-III. Separate bays shall be provided for each pump by providing intermediate dividing piers of RCC between the pumps.

a) All bays of MUWPH shall be provided with a removable trash rack including electrically operated hoisting arrangements and cleaning arrangements. Moreover, one spare trash rack shall also be supplied for MUWPH. Steel embedment required for trash-racks shall be provided for all the bays.

b) Stop-logs, trash-racks and hoists shall be supplied in accordance with the specifications covered elsewhere.

The sub-structure of the pump house including its forebay and channel shall be of RCC with M-30 grade of concrete conforming to IS 456. The pump house shall be structurally separated from forebay by providing an expansion joint. Each pump house shall be provided with a separate maintenance bay for maintenance of various equipment. Length of maintenance bay shall be adequate for one pump maintenance or minimum dimension indicated in the tender drawing, whichever is higher. Hand-rail with 32 NB (medium) pipes shall be provided around the operating floor on the forebay side in the stoplog and trash rack area.

5.18.01.03 **Sump model study for CWPH**

Sump model study for circulating water pump house shall be carried out as specified elsewhere in the specification.

5.18.01.04 **Design requirement for CWPH, RWPH and MUWPH**

Design of substructure shall be divided into two parts, namely,

(a) Stability analysis, and

(b) Structural analysis and design.

For the design of substructure, a surcharge load of 2.0 T / Sq.m shall be assumed at the finished ground level for nearby vehicular movement.

(a) Stability Analysis

The Pump House sub structure shall be analyzed and designed for following load combinations: -

1. Under Operation Stages

Maximum load from super structure + equipment load + load from sub structure + no water in the pump chambers + earth pressure at rest from outside with surcharge and maximum ground water pressure.

2. Condition (1) + earthquake/ wind

3. Under Construction Stages

No load from super structure and deck slab, load from sub structure with no water in the pump chambers, pump units not installed, earth pressure at rest from sides with surcharge and maximum ground water pressure.

4. Condition (3) + earthquake

Following stability checks will be made for the above load combinations:

i) Check for overturning

Factor of safety against overturning, i.e, the ratio of stabilizing moment to overturning moment shall be as per IS: 456.

For the above condition, uplift due to maximum Ground water table (GWT) acting on the base slab and side pressures on the walls due to earth and ground water shall be considered as destabilizing forces. In order to have no tension condition at tip of the base slab, resultant of all the forces acting on the pump house under different conditions of loading as listed above shall fall within middle one third of the base width provided. Maximum compressive stress at other end of the base slab shall be within the safe bearing capacity of soil / rock.

Under earthquake condition, resultant of all the forces including earthquake force shall fall within middle three fourth of the base width provided. An increase of 25% shall be allowed in the safe bearing capacity of soil when earthquake forces are considered.

ii) Check for Sliding

Factor of safety against sliding under static condition, i.e. ratio of horizontal frictional resistance to horizontal sliding force shall be as per IS:456. For this condition, earth pressure at rest and the maximum GWT pressure from sides shall be taken as de - stabilizing forces. Keys shall be provided, if found necessary, to increase the factor of safety against sliding.

To ensure an adequate factor of safety under earthquake condition, the factor of safety against sliding shall not be less than 1.2.

iii) Check for Uplift

Right from construction to operating stage, minimum factor of safety against uplift due to ground water shall be 1.2. Installation of pressure release valves shall not be permitted in the base slab (raft) of the pump houses to counter the uplift due to ground water.

(b) Structural Analysis

1) Base Slab

Base slab of the pump houses shall be designed as a raft foundation supported at locations of piers. Following load cases shall be considered:

i. Maximum water level in the sumps with maximum GWT.

ii. No water in the sumps and maximum GWT.

iii. Alternate bays of sumps filled with water with maximum GWT.

iv. Same as in (iii) above but with minimum water level.

2) Intermediate Piers

Intermediate piers shall be designed by working stress method as per IS: 456 (latest), with limiting crack width of 0.2mm for the worst combination of maximum water pressure on one side and no water in the adjacent sump. These shall be designed as RC walls fixed at base and supported (hinged) at top by the deck slab. Since a breast wall may be provided for stop logs and back wall is provided connecting all the piers at the rear end, additional restraints for the pier due to breast walls and back wall may also be accounted for.

Intermediate piers are also to be checked for the combined action of direct load due to superstructure and bending due to water pressure from one side.

3) End Piers

Design of end piers will be similar to the intermediate piers. The end piers shall be designed for the following conditions:

I. Soil pressure + maximum GWT + surcharge of 2 Ton / Sq.m. at FGL from outside or design surcharge load at floor level with no water in the sumps.

II. Only maximum water level in the sump.

End piers shall be designed by working stress method as per IS: 456 (latest), with limited crack width of 0.2mm on water face and the outside, i.e., earth side shall be designed as cracked section as per IS : 456. Since end piers are fixed at base and supported (hinged) at top by deck slab, there will be negligible yielding of the wall at top. This will give rise to earth pressure at rest and therefore an earth pressure at rest, Ko = (1 - Sin f) is considered where f =angle of internal friction of soil.

End piers shall also be checked for the combined action of direct load due to super structure and bending due to earth pressure with surcharge and ground water pressure.

4) Back Wall

Back walls shall be designed as fixed at bottom of the base slab and on two vertical sides by the piers and supported at top by the deck slab. Since back walls are also of the unyielding type, earth pressure at rest, Ko, shall be considered for design.

Back walls shall be designed by working stress method as per IS: 456, with crack width limited to 0.2 mm on water face and as cracked section on outer face as cracked section as per IS : 456.

Following load combinations shall be considered:

i. Soil pressure + maximum GWT + surcharge of 2 T / sq.m. at FGL from outside with no water inside the sump.

ii. Only maximum water level inside the sump.

5) Operating Floor Slab

Operating floor slab or deck slab shall be designed for loads of the pumps and other equipment, which may be placed on it. A live load of 1.5 ton / Sq.m. shall be considered on the deck slab. The deck / slab shall have monolithic construction with the piers and shall be designed as a continuous RC slab supported on piers. Design of bottom face shall be by working stress method as per IS: 456, with crack width limited to be 0.2 mm. Floor slab of maintenance bay may be designed as slabs on grade. A live load of 3 T / Sq. m. may be considered for the maintenance bay floor slab. Dynamic analysis

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.

Regarding requirement of corridor for power supply line laying in areas of canal crossing, road crossing etc. following shall be applicable:

a. Wherever culverts is being used for crossing of existing roads highways etc. necessary space provision for laying of 2 nos. 200mm dia HDPE/hume pipe shall be considered along both sides of pipe line for laying of cables.
b. At locations where canal/nallah/submergence area crossing is involved, necessary space provision shall be considered for laying of cable trays (vertical formation) along both sides of the trestle structure.
c. At other areas, cable (wherever applicable) shall be directly buried in ground, a space provision of 800mm on both sides of pipe shall be required.

5.18.06 **Make-Up Water Pipe Crossings At National Highway / State Highway / Railway**

Pipe crossing through culverts (Culverts to be constructed by owner)

There are two railway crossings (TP 132 to TP133 and TP 24 to TP25), one no. road crossing (TP 35 to TP 36), and one no NH Crossing (TP 101 to 102), as mentioned in tender drawing no 4540-001-POC-A-010) for which culverts (Box culvert/pipe culvert) will be constructed by the owner, However, pipe line laying along with associated RCC pedestal/thrust block and RCC pits at entry/ exit points shall be in bidder's scope.

Pipe crossing through culverts (Culverts to be constructed by Bidder)

There are 4 no. road crossings (of PWD/R&B department) 1) TP 30 to TP 31, 2) TP 109 to TP 110, 3) TP 114 to TP 115, 4) TP 120 to 121, as mentioned in tender drawing no 4540-001-POC-A-010, shall be constructed by Bidder.

The following works pertaining to culverts required for crossing of roads/state highway shall be in Bidder's scope.

a) Design of culvert considering the applicable superimposed load for roads/ highways
b) Getting the design /drawing approved from the PWD/R&B department
c) Preparation of design/drawing of diversion road as per PWD standards required during construction period of the culvert and getting the same approved from PWD/ R&B.
d) Construction of culverts, diversion roads etc.

There is one road (Bund Road of Samal Barrage) crossing (between TP 11 and TP 12) maintained by Samal Barrage Authority-WRD. This crossing work is also in the scope of Bidder. This road crossing shall be through casing/hume pipe by pipe pushing method as per requirement/approval of concerned authorities (i.e.Samal Barrage Authority-WRD).

Kuccha village road crossings will be through hume pipe / box culverts by open cut & fill method.

In addition to these, there are many other minor/metalled road crossings (approx. 18 Nos. crossings) in the scope of bidder, for which, bidder has to take permission/approval from the concerned authority and lay the pipe lines through casing/hume pipe / culverts as per approval.

Between TP 43 & TP 44, the pipelines are to be laid below & along the service/inspection road of the irrigation canal, which is in the scope of Bidder. In this stretch, the pipelines shall be encased in RCC or laid through box/pipe culvert as per the approval from the concerned Authority.

Bidder to note that, necessary permission for Right of use for laying the pipe line is being obtained by NTPC Ltd. However, Bidder has to submit the final design and accord necessary permission from Railways, NHAI, WRD, Irrigation, R&B Department, MCL Authorities, Govt. before start of the work for all rail, road, river, nallah, and canal crossings.

For any other additional works, bidder have to make their own assessment too of the quantity/ number of culverts, existing pipe pedestal crossings, nallah crossings etc., based on their site visit before quoting.

For any boundary wall crossings, pipe shall be laid through casing pipe / RCC culvert. After laying the pipe, the boundary wall shall be restored.

NTPC will provide assistance in getting approvals such as signing the application for submission to concerned authorities etc. as an Owner of the power project. However, expediting and obtaining all approvals shall be the responsibility of the Bidder. All statutory fees/payments required to be deposited to the concern authorities for approval/permissions of rail/road/canal crossings shall be paid by NTPC on submission of demand letters from concerned authorities.

5.19.00 **WATER TREATMENT PLANT-DM Plant, PT Plant, ETP and CW Chemical Treatment Civil Works, CSSP etc**

5.19.01.00 **Design Concepts for Buildings/ Shed**

i. All buildings shall have framed super structure.

ii. Equipment/facilities with shed shall have structural steel superstructure with permanently colour coated metal sheeting at roof and side open. However, kerb wall shall be provided all around the plinth/ floor area above the Finished Floor Level (FFL). For other buildings brick wall cladding on exterior face shall be provided.

iii. Unless specified, the wall cladding for buildings shall be with minimum one brick thick on exterior face. However, brick wall for buildings adjacent to transformers shall be minimum 345mm thick.

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

5.19.01.03 The load and load combinations and design criteria shall be as specified elsewhere in the specification.

5.19.01.04 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.

5.19.01.05 All liquid retaining and conveying structures shall be designed by working stress method as given in clause 4.5 of IS 3370(Part2):2009.

5.19.01.06 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.

5.19.01.07 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.

5.19.01.08 Clear free board of at least 300 mm above design (total) water level shall be provided in all liquid retaining / conveying structures.

5.19.01.09 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.

5.19.01.10 The minimum grade of concrete for all RCC structures associated with DM plant, PT plant, ETP and CW chemical treatment and CSSP shall be of grade M30.The minimum concrete clear cover to reinforcement bars in all RCC structures shall be as per IS:456(2000) 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.

5.19.01.11 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.

5.19.01.12 For detailing of Reinforcement IS 5525, IS 13920, IS 4326 and SP 34 shall be followed.

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

5.19.01.14 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

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

5.19.01.16 Suitable shrinkage reinforcement shall be provided at top face of foundations. Minimum shrinkage reinforcement shall be 10 mm dia. @ 200mm c / c.

5.19.01.17 Minimum Reinforcement in all elements of liquid retaining / conveying structures shall be 0.24 % of cross sectional area distributed equally over top and bottom faces.

5.19.01.18 Minimum tensile Reinforcement in each direction for all foundation slabs / rafts shall be 0.2% of cross sectional area.

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

5.19.01.20	Minimum thickness of all elements of RCC liquid retaining / conveying structures (except effluent drains, launders and aerator waste slab) shall be 200mm. Effluent drains (depth more than 500mm), aerator waste slab and launders shall have minimum element thickness of 150mm.
5.19.01.21	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.
5.19.01.22	All water retaining structures shall be tested for water tightness as per provisions of IS: 3370 and IS: 6494.
5.19.01.23	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.
5.19.02.00	**Architectural Concepts and Finishing Schedule** Architectural concepts and finishing schedule shall be as specified elsewhere in architectural specification.
5.19.02.01	**Acid / Alkali Resistant Treatment:** Acid / alkali resistant lining treatment shall be provided in different areas as follows: Neutralization Pit: The walls shall be provided with one coat of bitumen primer, followed by 18 mm thick bitumastic layer, 115 mm thick A.R. bricks, 6 mm thick under bed of potassium silicate mortar, pointing the joints of bricks with acid / alkali resistant epoxy / furane mortar upto a depth of 20 mm and bitumastic end sealing. Suitable pilasters shall be provided with A.R. bricks at regular intervals depending upon the height of lining, as per the specification. The floor of neutralization pit shall be provided with acid / alkali resistant lining treatment as given in the above para, except that the 115 mm thick A.R.bricks layer shall be replaced by 75 mm thick A.R. tile layer and pilasters shall be omitted. The ceiling of neutralization pit shall be provided with one coat of epoxy primer followed by 2 coats of epoxy paint (150 micron). Acid / Alkali storage area / projections above the floor, pedestals projecting from the floor / saddles. The floor shall be provided with one coat of bitumen primer followed by 12 mm thick bitumastic layer, 20 mm thick A.R. tiles, 6 mm thick under - bed by potassium silicate mortar, 6mm thick pointing of joints of tiles with acid / alkali resistant epoxy / furane mortar up to a depth of 20 mm and bitumastic end sealing. Dado of 1.0M high with above treatment shall also be provided if applicable in case of walls nearby. Alum/Lime Storage area and first floor of Chemical House : One coat of bitumen primer followed by 12mm thick bitumastic layer, 20 mm thick A.R. tiles, 6 mm thick underbed of potassium silicate mortar, 6mm thick pointing of joints of tiles with acid /alkali resistant epoxy /furane mortar up to a depth of 20 mm and bitumastic end sealing. Alum solution preparation tank: The wall shall be provided with one coat of bitumen primer followed by 12 mm thick bitumastic layer, 75 mm thick A.R. tiles, 6 mm thick underbed by potassium silicate mortar, pointing of joints of tiles with acid / alkali resistant epoxy / furane mortar upto a depth of 20 mm and bitumastic end sealing. The floor shall be provided with acid / alkali resistant lining treatment as given in the above para except that the 75 mm thick A.R. tile layer shall be replaced by 12 mm thick A.R. tile layer. Basket of Alum Solution Preparation tank: 5mm thick epoxy lining over a coat of epoxy primer. Curved surfaces of saddles shall have minimum 12 MM thick bitumastic layer to support the vessel / tanks.

Effluent Drains: Acid Resistant lining treatment indicated for the storage area shall be provided on the bed as well as walls of the drains with 38 MM AR tiles. The underside of the pre-cast slab cover shall be applied with one coat of epoxy primer and two coats of epoxy coating, total DFT 150 microns.

Lime tank: Two coats of bitumen paint conforming to IS : 9862, with total DFT 150 microns.

Guarantee

The Contractor 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 Contractor shall replace / rectify defects is any, observed in the lining to the satisfaction of the Engineer without any extra cost during this period.

5.19.02.02 DM Tank Foundation

5.19.02.02.01 General Requirements

The tank foundation shall be as per IS:803 and as specified in Cl. No.7.01.04.

5.19.02.02.02 Sub Grade Preparation

The surface of natural soil shall be thoroughly compacted by rolling or other means, as directed by Engineer, to obtain 95% of max. laboratory dry density for the soil, as per IS:2720 (Part-VII).

5.19.02.02.03 Anti Corrosive Layer

Anti-corrosive layer shall consist of dscreened coarse sand, mixed with 80/100 bitumen or equivalent 8% to 10% by volume.

Bitumen shall be heated to a temperature 175^0 C to 190^0 C, with 3% kerosene, if required. Sand shall be thoroughly mixed with it in a mixing drum to obtain uniform mixture and shall be laid over the compacted surface, laid in line, grade and levels and as directed by the Engineer. Bitumen shall not be heated beyond the temperature limits given above.

The premix carpet shall be laid in two layers of 3 cm and 2 cm respectively. After compacting and laying the first layer of 3cm, a tack coat of hot bitumen at the rate of 1 Kg. per Sq.m. shall be uniformly applied to the surface, by means of Sprayer and the Second layer of 2cm thick shall be laid, tamped and compacted to the satisfaction of the Engineer.

Sand shall be spread on the final surface at the rate of 0.5 Cu. m per 100Sq.m.

5.19.02.02.04 Premix Materials

Sand

Sand shall be clean, dry, coarse, hard angular, free from coatings of clay, dust and mix of vegetable and organic matters and shall conform to IS 383 (Grade -III).

Stone Chippings

Stone chippings shall be hard black trap or granite or approved locally available stone and shall conform to IS 383. The grading shall be of normally 12mm down size and 6mm down size, in the ratio of 3:2 respectively.

Bitumen

Bitumen required for the work shall be 80/100 grade or its equivalent quality.

Laying

Areas on which the premix is to be laid shall be thoroughly cleaned of all dust and loose materials. On the cleaned surface, a tack coat at the rate of 1.0 Kg. per Sq.M. of hot Bitumen shall be uniformly applied by Sprayers. The applied Binder shall be evenly brushed.

The Binder bitumen 80/100 shall be heated to the temperature of about 190^0 C with 3% kerosene, if required and mixed with stone chippings of size, as mentioned above, at the rate of 400 KG, with Six (6) Cu. M. of stone chips, for 100 Sq.M. of surface. The total mixed quantity, as mentioned above, is the quantity required for the total 50mm thick for 100 Sq. m. of area. Mixing shall continue until the aggregate is well coated.

5.20.00 Switchyard Civil Works

5.20.01 Civil works for switchyard includes:

a. Towers, girders, lightning masts and equipment supporting structures including proto type assembly etc.,

b. Foundations and supporting pedestals for towers, lightning masts, equipment supporting structures etc.,

c. GIS/Control room/Auxiliary building as required for switchyard, foundation for AC Kiosks etc.

d. Foundations for transformers and reactors including oil pit, stone filling, laying and fixing of rails for movement of Transformers / reactors, rail track, jacking pad and fire walls as required, arrangement for cabling etc. all complete

e. Earthing mat, single lane roads and R.C.C. drains in switchyard area including road/drain/trench crossings etc.,

f. All necessary embedments, inserts, supporting structures & supporting members as required etc.

g. Cable trenches in switchyard and inside GIS/Control room/Auxiliary building including civil works for panel fixing etc.

5.20.02 Design Criteria

5.20.02.01 Gantry structure, which consists of open web towers connected by girders, shall be made of structural steel conforming to IS 2062 and duly galvanized conforming to IS: 2629 and IS 4759. All joints shall be bolted connections. All bolts for connections shall be of 16mm dia conforming to IS 12427 and of property class 5.6 as per IS 1367 (Part 3). Nuts shall conform to IS 1363 (Part 3) of property class 5. Foundation bolts shall conform to IS 5624 and property class shall be 4.6 as per IS 1367 (Part-3). Butt splice shall be used for splicing the main members and splice shall be located away from the node point. IS 802 “Code of practice for use of structural steel in overhead transmission line towers” shall be followed for design of structures. Height & type of towers shall be established based on electrical requirements. A provision of ± 30 degree angle of deviation of line in horizontal plane and ± 20 degree deviation in vertical plane is considered and the resulting worst combination of forces shall be considered for design. For all outgoing and incoming feeders, the conductor span shall be taken as 200m for design purpose.

The analysis of towers and gantries shall be carried out with combined model of critical configurations of towers and gantries using any established structural analysis software like STAAD Pro. etc.

5.20.02.02 Switchyard structures shall be designed for the worst combination following loads:

1) Dead loads (load of wires/conductors, insulator, electrical equipment and structural members),

2) Live loads,

3) Wind loads

a. Switchyard gantries, towers, equipment supporting structures and lightning mast shall be designed as per IS 802. The wind load calculations shall be made as per IS: 802 except the parameters basic wind speed (Vb) and terrain category as stipulated in

"Criteria for wind resistant design of structures and equipment".

b. All other structures shall be designed as per IS 456 / IS 800. The wind load calculations to be made as per IS: 875 shall be with the parameters as stipulated in "Criteria for wind resistant design of structures and equipment".

4) Seismic loads,

5) Loads due to deviation of conductor (gantries shall be checked for ± 30 deg. deviation in horizontal plane and ± 20 degree deviation in vertical plane),

6) Loads due to unbalanced tension in conductor/wire,

7) Torsional load due to unbalanced vertical and horizontal forces,

8) Erection loads,

9) Short circuit forces including snap in case of bundled conductors, etc.

Note:

i. The occurrence of earthquake and maximum wind pressure is unlikely to take place at the same time. The structure shall be designed for either of the two. However, temperature stresses can be ignored, as these towers are freestanding structure in open space.

ii. Short Circuit forces and Wind pressure shall be considered to act together for design of switchyard structures

iii. Direction of wind shall be assumed such as to produce maximum stresses in any member for the combination of wind load with conductor tensions. The wind acting perpendicular and parallel to bus conductor and shield wire shall be considered separately.

iv. The conductor tension shall be assumed as acting on only one side of the gantry for the analysis and design of switchyard gantries.

v. The distance between terminal and dead end gantry shall be taken as 200 meters.

5.20.02.03 **Factor of safety:**

The factor of safety for the design of members shall be considered as 2.0 for normal condition and broken wire condition, 1.5 for combined short circuit and broken wire condition. Foundation shall be designed for a factor of safety of 2.2 for normal and broken wire condition and 1.65 for combined short circuit and broken wire condition.

5.20.02.04 **Design consideration for switchyard equipment support:**

The supporting structure for B.P.I., LA, CVT & Isolator equipments shall be comprised of GI (ERW) pipe of grade YST:210 or of higher grade conforming to IS: 1161 & shall be designed as per IS 806 "Code of Practice for use of steel tubes in general building construction".

Minimum diameter of the pipe type support for 765kV structure shall be 300NB, 400kV structure shall be 250NB, for 220kV & 132kV structures shall be 200NB and that for 66kV & 33kV shall be 150 NB.

The supporting structure for CT, CSE & Wave Trap equipment shall be comprised of lattice structural steel conforming to IS 2062 and shall be designed as per IS: 802.

Common raft foundation shall be provided for each pole of isolator.

5.20.02.05 **Special design consideration for lightning Mast:**

Diagonal wind condition shall be considered for lightning masts. Diagonal wind shall be taken as 1.2 times the wind calculated on Longitudinal/Transverse side. Lightning mast shall be provided with minimum two nos. of platforms as per requirement and an\ ladder for climbing

purpose shall be provided up to platform at top level. Top of platform shall have grating, railing and toe guard plates. The minimum width of platform shall be 900mm. Live load of 300kg/m2 above platforms shall be considered for design of Lightning Mast.

5.20.02.06 Design Criteria for structures not covered under Cl. 5.20.02.01 to Cl. 5.20.02.05

The Switchyard Control Room building shall have RCC framed super structure with one brick thick wall cladding on exterior face. The Control room building shall consist of rooms/facilities/ equipment/ monorail as per system requirement. An open space of one meter width (minimum) shall be provided on the periphery of the panel rows and equipment to allow easy operator movement and access for maintenance purposes.

The design of RCC structures shall generally be carried out using limit state method of design as per IS 456. The minimum grade of concrete shall be of RCC M25 as per IS 456.

The GIS building shall be a Steel framed superstructure with troughed permanently colour coated sheet wall cladding and roof sheeting. However, brick cladding shall be provided up to a height of 900mm from Finished Floor Level (FFL). Above 900mm brick wall, the sheet metal cladding shall be provided with adequate overlapping with brick wall. Steel framed structures shall be made of rolled steel section or built-up section. The GIS building shall consist of rooms/facilities/equipment/EOT crane as per system requirement. Design of steel superstructure of GIS Building shall be carried out as per IS:800 and other relevant IS standards.

5.20.03 The architectural features including roof water proofing, rain water down comers and RCC parapet walls etc. shall be as specified elsewhere in the specifications.

5.20.04 The fabrication and erection of the switchyard works shall be carried out generally in accordance with IS 802 and IS 800. All materials shall be completely shop fabricated and galvanised.

5.20.05 All structural steel members including stub members, bolts, nuts, spring washers, etc., shall be hot dip galvanised after fabrication. Minimum section thickness should not be less than 4 mm. Weight of zinc coating shall be at least 0.610 kg/m2 and foundation bolts shall have heavier zinc coating at least 0.80 kg/m2.

5.20.06 Cable Trenches

Cable trenches shall be provided for routing of cables as required and shall be of adequate size. The trenches located within switchyard shall project at least 300 mm above the finished formation level so that no storm water shall enter into the trench. The bottom of trench shall be provided with a longitudinal slope of 1:500. The downstream end of cable trenches shall be connected to sump pits. The precast covers shall not be more than 300mm in width and shall not be more than 65 kg. Lifting hooks shall be provided in the precast covers. Trenches shall be given a slope of 1:250 in the direction perpendicular to the run of the trenches. Angle of size 50x50x6 mm (minimum) with lugs shall be provided in the edges of RCC cable trenches and any other place where breakage of corners of concrete is expected. All cable trenches shall be provided with suitable insert plates for fixing support angles of cable trays. All internal cable trenches shall have minimum 6mm thick (o/p) chequered plate covers while external cable trenches shall have pre - cast RCC covers. However, the portion of the cable trench behind and sides of control panel / MCC shall be provided with suitable chequered plate covers as directed by the Engineer. Cable trenches inside switchyard, having depth more than 500mm, shall have wall thickness of minimum 150mm with two layer reinforcement.

5.20.07 PCC Layer & Gravel Filling:

PCC Layer and Gravel filling shall be provided as specified elsewhere in the specifications. Before laying of PCC layer, the subgrade shall be properly compacted and the top layer of the soil shall be treated for anti-weed considering the type of weeds found in the vicinity. The anti-weed - soil sterilization details such as manufacturer's name, their specification, test certificate, etc. shall be furnished for Owner's approval. Any modification if required in the proposed anti-

weed treatment chemical shall have to be done by the contractor at no extra cost to the Owner. The contractor shall be required to furnish a performance guarantee of three years for the anti-weed treatment. This guarantee shall be commenced from the date of completion of work or date of handing over, whichever is later. Stone/gravel shall be chemically inert, hard, strong durable against weathering, of limited porosity and free from deleterious materials. It shall be properly graded and shall meet the requirements of IS: 383.

5.20.08 Transformer/reactor foundations

Foundations of transformers/reactors shall be designed for seismic and wind loads in addition to other applicable loads. Solid RCC block foundation shall be provided for the main transformer/reactor block. Alternatively, transformer shall be supported on a RCC foundation comprising of common raft for rail supporting walls up to rail-cum-road along with pedestals for jacking pad, roller lock etc. Tie beams connecting roller lock pedestals at rail level shall also be provided. Common raft/solid RCC block shall be supported on soil or pile based on requirement specified elsewhere in the specification. Oil soak pit / oil water separation pit for transformer/reactor shall be provided as envisaged elsewhere in the specification. The oil soak pit shall be provided for each transformer and shall be filled with gravel of size 40mm. The volume of the soak pit shall be sufficient to store one-third (1/3) of the oil volume of transformer/reactor considering only 40% of the volume as available voids between gravel filling. The oil soak pit shall also be provided with a sump at the corner to allow drainage of water/oil from the soak pit. The Oil-water Separation pit shall be designed for an effective capacity of complete oil of one transformer having highest volume of oil along with 10 minutes of firewater. For calculating effective capacity of oil-water separation pit, effective depth excluding 200 mm freeboard below invert level of inlet pipe shall be considered. Plan area and depth of oil-water separation pit shall be decided based on above consideration. Oil-water Separation pit shall be provided with five separate chambers interconnected by pipes. First chamber shall be for collecting oil-water mix from transformers' soak pits in case of fire. After entering into first chamber, oil being the lighter in density floats above the water. The water from lower elevation flows in to subsequent chambers interconnected through galvanized MS pipes. The accumulated oil in the first chamber to be pumped out for subsequent usage or disposal. Water collected in the last chamber to be pumped out for subsequent disposal after treatment. Invert level of inlet Hume pipes (of NP-3 grade and adequate capacity), carrying oil and water from transformers soak pits, shall be designed for gravity flow. Freeboard of 200 mm shall be provided below the invert level of inlet pipes. Invert levels of interconnecting pipes of subsequent chambers shall be decided accordingly.

Arrangement for moving the transformer into place using rail cum road, jacking pads and pulling blocks including inserts, as required, shall be provided along with the transformer/reactor foundations.

RCC Firewall shall also be provided between the transformers wherever required.

300 mm thick PCC M20 encasement all around the Pylon supports inside soak pit for fire fighting system shall be provided up to top of Stone filling. Coarse aggregate filling inside the transformer oil soak pit shall be carried out only after construction/erection of Pylon supports and PCC encasement.

5.20.09 The switchyard roads, drains, fencing and gate shall be as specified elsewhere in the specification.

5.21.00 **FIRE WATER PUMP HOUSE, FIRE WATER BOOSTER PUMP HOUSE& FOAM SYSTEM**

Salient Features:

The scope of the Bidder shall be design and construction of Civil, Structural, Architectural, Water Supply, Plumbing and Sanitary Works of Fire Water Pump House, Fire Water Booster Pump House and Foam system including supply of all materials.

The fire water Pump House shall be single storeyed and single bay RCC superstructure

provision for a structural steel monorail. MCC /switchgear rooms, control room etc. shall have RCC framed structure with cast-in-situ RCC roof slabs with brick cladding. The building shall be fully covered with external brick wall with provision for doors, windows, rolling shutters and exhaust fans.

The Fire Water Booster Pump House shall be structural Steel Shed superstructure with provision for a structural steel monorail. Control room shall have RCC framed structure with cast-in-situ RCC roof slabs with brick cladding. . The shed and building shall be fully covered with external brick wall with provision for doors, windows, rolling shutters and exhaust fans.

Steel shed with roof covering with provision for a structural steel monorail shall be provided for foam system including associated civil works for foam bladder tank foundations, grade slab, pipe pedestals etc. Control room shall have RCC framed structure with cast-in-situ RCC roof slabs with brick cladding. The shed and building shall be fully covered with external brick wall with provision for doors, windows, rolling shutters and exhaust fans. Fire water storage tank foundation shall be provided as detailed elsewhere.

Fire water pipes shall be provided with either RCC trench or buried underground as per requirement. Tender drawings shall also be referred.

Fire water trenches shall be open RCC type trench with removable RCC cover.

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

At road/rail/ drain crossings of fire water pipes, the fire water pipes shall be provided with minimum 200mm thick PCC encasement all around the pipe.

5.22.00 **DELETED**

5.23.00 **COAL, LIMESTONE & GYPSUM HANDLING SYSTEM**

5.23.01 **Track Hopper, Reclaim Hopper, Underground TP's & Tunnel**

Track Hopper, Underground portion of TP's and Underground Tunnel shall be of RCC. Structural steel Shed shall be provided over Track Hopper.

The vertical and inclined portion of coal hopper and beams in reclaim hoppers shall be provided with 50 mm thick guniting (shotcreting). Details of shotcreting have been given elsewhere in this specification.

Expansion joints shall also be provided at locations wherever tunnel connects with Underground TP's, penthouse etc. width of 600mm water stop fabricated with 22G copper plate with bitumen board fillers and polysulphide sealing compound as specified elsewhere shall be used as expansion joint material. Reinforcement detailings at the expansion joint shall be done in such a way that there is no obstruction to copper plate installation.

Track hopper, machinery hatches shall consist of underground portion, which shall be of RCC, and above ground portion, which shall be of structural steel shed covered with permanently Colour coated profiled steel sheets.

The structural arrangement to be adopted for the design and construction of underground portion of track hopper and machinery hatches shall be as shown in tender drawing. It essentially consists of RCC frames spaced at approx. 3.0M centers with RCC wall panels on the sides and RCC raft/ raft and beam arrangement at the bottom, fixed to the frames. The top beam of the RCC frame supports the rail supporting beams and the coal hopper. Minimum

thickness of RCC raft at bottom shall be 600 mm. Minimum thickness of RCC side walls shall be 600 mm at bottom and 300 mm at top.

No columns shall be provided inside the Machinery Hatches.

Foundation of all underground structures like underground TP's & tunnels shall be of solid RCC raft. Raft cum beam/sandwich slab arrangement shall not be acceptable.

The vertical and inclined portion of coal hopper, the beams and top of coal tray in the track hopper structure as shown in the tender drawing shall be provided with 50 mm thick guniting (shotcreting). Details of shotcreting have been given elsewhere in this specification.

Expansion joints shall be provided in track hopper at a maximum distance of 40m unless otherwise shown in the tender 600 mm wide water stop fabricated with 22G copper plate with bitumen board fillers and polysulphide sealing compound as specified elsewhere shall be used as expansion joint material. Detailing of expansion joints and the reinforcement shall be coherent.

Floor shall be provided with cross slope not flatter than 1 in 50 towards side drains. Side drains shall be sloped towards sump where sump pumps as specified elsewhere, shall be provided. The slope of side drains shall not be flatter than 1 in 400. Side drains and sump shall have removable type steel grating cover. Gratings shall be galvanized to grade 610 gm/m^2.

Water proofing / Damp proofing of underground portion of Track Hopper, reclaim hoppers, tunnels, underground (i. e. basement) portion of transfer houses shall be done by providing the following treatments:

(A) Chemical injection grouting for inner faces (details as specified elsewhere)

(B) Polymer modified cementitious coating on earth side face as per the following :

(1.) On the outer surface of walls, frames and roof slabs coming in contact with earth, polymer modified cementitious coating in two layers as specified and as per manufacturer's specifications shall be provided directly on the concrete surface.

(2.) 50 mm thick PCC (1 : 2 : 4 with 10 mm nominal size stone aggregates) shall be provided under the raft i.e. over the lean concrete, followed by polymer modified cementitious coating in two layers (slurry mix application) as per manufacturer's specification. 50 mm thick PCC (1 : 2 : 4) with 10 mm nominal size stone aggregates shall then be laid over the polymer modified cementitious coating before laying the raft.

Steel gratings of mesh size 300 mm x 320 mm for track hopper shall be provided. The grating shall be built of min. 200mm x 28mm thick flats in main direction and min. 100mm x 20mm thick in secondary direction. The hopper and gratings shall be designed for movement of front end loader/ bulldozer over them. Bull-dozer weight shall be considered as about 35T. No painting/galvanization shall be provided in gratings. However, two coats of Red oxide Primer to be provided immediately after fabrication.

Earth pressure to be considered for design shall be due to earth pressure at rest (K_o) condition only. Earth pressure due to surcharge intensity of Railway Loads (where applicable) or Uniformly Distributed Load (U. D. L) of intensity 2 T / Sq. M. whichever is critical, shall be

considered in the design.

A minimum safety factor of 1.2 against uplift of wagon tippler/track hopper, transfer points (underground or with basement) and tunnels, due to ground water shall be ensured during execution and after execution, considering dead weight of the structure to be 0.9 times only, ground water table at adjoining formation level and soil wedge angle of not more than 15 degrees.

Also, FOS against uplift, to be taken as 1.0, considering the dead wt. of structure and soil resting on side projections if any in the vertical plane. Inclined wedge action of soil shall not be considered in this case.

Wherever, slope of tunnel exceeds 10^{o}, RCC steps shall be provided for the entire width of each walkway.

5.23.02 **Overhead / Ground Conveyor Galleries and Trestles**

Overhead conveyors for trough belt conveyor shall be located in a suitably enclosed gallery of structural steel. The overhead gallery shall consist of two vertical latticed girders having rigid jointed portal frame at both ends. 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**.** Horizontal bracings are to be provided at top & bottom plan of the gallery (latticed girders shall be braced together in plan at the top and bottom). Common end portal frame shall not be used for adjacent conveyor spans. Roof truss shall be provided at upper node points of latticed girders to form an enclosure.

The maximum span of overhead gallery shall be limited to 25 meter unless higher span is required due to site conditions, which shall be subject to approval of the Engineer. The gallery should as far as possible be erected as a box section keeping all the vertical and horizontal bracing tied in proper position. The gallery should be checked for all erection stresses that are likely to develop during handling and erection and if required, temporary strengthening of gallery members during erection shall be made. Contractor can also use tubular steel sections for roof truss of conveyor galleries only. 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 conform 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 1993-1-8:2005.

Seal plates under the conveyor galleries shall be provided in such a way that complete gallery bottom shall form a leak proof floor.

Grade slab with brick toe wall and plinth protection along with drains shall be provided throughout the length of the ground conveyors.Top of pedestal for ground conveyor portals shall be 300mm above FFL. Bottom of the base plate of the columns of the trestles in Main Plant Block Area shall be kept 1.2m below the finished floor level of ground floor of Main Power House.

For double stream conveyor gallery, two side and one central walkway of minimum width 800 mm and 1100 mm respectively shall be provided. The minimum width of two side walkways for single stream conveyor gallery shall be 800 mm and 1100 mm respectively. Both sides of central and side walkways shall be provided with pipe handrails all along the conveyor gallery.

Hand railing should not be supported on conveyor supporting stringers. The walkways shall be chequered plate construction with anti - skid arrangement. The anti - skid arrangement will consist of welding of 10 mm square steel bars at a maximum spacing of 500 mm along the length of the gallery. Where the slope of walkway is more than 10^{o}, chequered plate steps with nosing and toe guard shall be provided. The floor of conveyor gallery all along the gallery length, shall be provided with minimum 12 gauge thick seal plates (suitably stiffened) and other drainage arrangements as specified elsewhere.

Trough belt conveyor gallery shall have permanently colour coated steel sheet covers on roof and both sides. However, in roof, a panel of minimum 1.5 m x 1.5 m area at about 6.0 m center alternatively on both slopes, shall be provided with translucent sheets of polycarbonate material for natural lighting. A continuous slit opening of 500 mm shall be provided on both sides just below the roof sheeting. Adequate provision of windows shall be kept on both sides of conveyor gallery as appended in Mechanical Section (Belt conveyor system). Windows shall be provided with wire mesh as specified elsewhere in this specification.

Cross - over with chequered plate platform and ladder for crossing over the conveyors shall be provided at approximately every 90m intervals of conveyor. Crossover shall preferably be located over four-legged rigid trestle location.

For railway tracks passing below overhead conveyor gallery and along conveyors, the railway clearances both underground as well as over ground shall have to be adhered to for design, execution and erection of foundations, trestles, galleries etc., so that movement of locomotives and wagons is not hampered in any way during execution and afterwards. However, 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.

For calculation of material load on moving conveyor, a multiplication factor 1.6 shall be used to take care of inertia force, casual over burden and impact factor etc.

Thus material load per unit length of each moving conveyor shall be

$$1.6 \times \frac{\text{Rated Capacity of Conveyor system}}{\text{Conveyor Belt Speed}} \times F$$

Where, F = 1100/800 for coal, 1700/1400 for lime & 1250/900 for gypsum

It should be noted that for structural design, unit weight of lime shall be considered as 1700 kg/cu. m, unit weight of gypsum shall be considered as 1250 kg/cu. m.

It should be noted that for structural design, unit weight of coal shall be assumed as 1100 kg/cu. m.

Conveyor Gallery structure shall be designed considering both conveyors operating simultaneously.

Conveyor gallery and supporting trestles located between transfer houses / buildings shall be

arranged in any one of the following ways.

a) All gallery supporting trestles shall be four legged type only. One end of each gallery span shall be hinged to the supporting trestle and the other end shall be slide type. Slide type support shall be with PTFE bearings to allow both rotation & longitudinal movements.

OR

b) In between transfer houses / buildings, four legged trestles shall be placed at a maximum interval of 90 metres. The arrangement shall be such so as to ensure that force in the longitudinal direction (i. e. along the conveyor length) of conveyor gallery of length not more than 90 m is transferred to any four legged trestle. In the space between each successive four legged trestles, two legged trestles shall be provided at regular intervals. The end supports resting on the four-legged trestle can have either ends hinged or one hinge and the other on slide type depending on the arrangements. Slide type support shall be with PTFE bearings to allow both rotation & longitudinal movements.

End of conveyor gallery which will be supported over transfer house, shall be so detailed that only vertical reaction is transferred from conveyor gallery and no horizontal force in longitudinal direction is transferred from conveyor gallery to transfer house structure and vice - versa.

5.23.03 For trestles and trestle foundations for conveyor galleries located adjacent to existing structures, over ground and underground facilities, location and details of these trestles and foundations shall have to be decided such that there is no interference both underground as well as over ground with existing structures and facilities. Base plates of trestle columns shall be kept 300 mm above the finished ground level.

5.23.04 **Transfer Houses**

The over ground portion of all transfer houses shall be framed structure of structural steel work with permanently colour coated profiled steel sheet side cladding (from lowest working floor level till top) and RCC floors comprising of RCC slab over profiled metal deck sheets (to be used as permanent shuttering without considering any composite action effect of metal deck sheet) over structural beams. Shear anchor studs shall be provided through metal deck at regular interval on all top flange/flange plate of structural beams.However, 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. In some areas like MCC floors etc., one brick thick wall cladding shall be provided. Brick wall cladding shall be supported on encased wall beams and suitably anchored to adjoining columns and beams. Vertical bracings shall be provided only on four sides along the periphery. Grade slab with brick cladding of 0.9 m height, plastered on both sides shall be provided for all transfer houses. Bottom of the base plate of the columns of the transfer houses in Main Plant Block Area shall be kept 1.2m below the finished floor level of ground floor of Main Power House.

Adequate steel doors and windows for proper natural lighting and ventilation shall be provided. In addition to steel windows, panels of suitable size to suit the architectural treatment and made of translucent sheets of polycarbonate material shall also be provided on the side cladding for natural lighting.

The roof of Transfer points shall be provided with pre-fabricated insulated metal sandwich panels. Pre-Fabricated Insulated Metal Sandwich Panel for Roofing shall be laid to specified slope. Composition of Insulated Metal Sandwich Panels shall be as described in relevant

section of Technical Specification. Adequate slope shall be provided for quick drainage of rain water.

For Lime handling transfer house RCC floors comprising of RCC slab over profiled metal deck sheets (to be used as permanent shuttering without considering any composite action effect of metal deck sheet) over structural beams.

5.23.05 Crusher Houses

The crusher house shall be framed structure of structural steel work with permanently colour coated profiled steel sheet side cladding. However, panels of suitable size to suit the architectural treatment and made of translucent sheets of polycarbonate material shall also be provided on the side cladding for natural lighting. The lower portion of side cladding, at ground, for a height of minimum 0.9m above the finished floor level shall be of one brick thick wall plastered on both faces. Floors shall be of RCC comprising of RCC slab over profiled metal deck sheets (to be used as permanent shuttering without considering any composite action effect of metal deck sheet) over structural beams. Shear anchor studs shall be provided through metal deck at regular interval on all top flange/flange plate of structural beams. Within this building, cubicles for resting room of operators shall be constructed with one brick thick brickwork having both sides plastered and roof slab. Adequate steel doors and windows for natural lighting and ventilation shall be provided. Vertical bracings shall be provided only on four sides along the periphery.

The roof of crusher 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. Composition of Insulated Metal Sandwich Panels shall be as described in relevant section of Technical Specification. Adequate slope shall be provided for quick drainage of rain water.

If any equipment to be located on the roof of lime crusher house, roof shall comprise 150 mm thick RCC slab(measured over crest of the metal deck) over profiled metal deck sheets (to be used as permanent shuttering without considering any composite action effect of metal deck sheet) over structural beams.

Crushers shall be supported on RCC deck, which in turn will rest on suitable vibration isolation system consisting of springs and dampers. This RCC deck shall be isolated from the floor. However, the vibration isolation system consisting of springs and dampers may rest on main building framework. Detailed specification of vibration isolation system including the unbalanced force, frequency and amplitude criteria and other design requirements are appended elsewhere in this specification.

5.23.06 Stacker Reclaimer Foundation

Stacker – Reclaimer (S/R) foundation shall be in RCC and shall be designed as RCC framed structures (in longitudinal & transverse direction). Lateral tie beams between two rail supporting elements shall be provided at a regular interval of approx. 3.0 m center. Conveyor short posts shall be supported on RCC beams at grade level. The foundation shall be designed for the most critical combination of loads as furnished by the equipment supplier. RCC retaining wall on both sides of the S/R foundation shall be provided as shown in the tender drawing.

The portion between the two rails and between rail and retaining wall on both sides shall be paved in concrete as per specification for grade slab of ground level specified elsewhere. However no metallic hardener finish over RCC slabs is to be provided. Drains shall be provided along the rails for drainage of rain / dust suppression / floor washing water. Drains shall be routed on both sides of the foundation along the rail as shown in Tender Drawing. Drains shall be connected to the network drainage system for finally discharge into coal settling tank. RCC drains shall be provided in Coal stockyard area with precast RCC covers.

5.23.07 **Control building, M. C. C. Buildings**

These shall be steel or RCC framed building with RCC roof and floor. For steel framed building roof/floor comprise of RCC slab over profiled metal deck sheets (to be used as permanent shuttering only) over structural beams. Shear anchor studs shall be provided through metal deck at regular interval on all top flange/flange plate of structural beams. Cladding shall be of brickwork/concrete block work with plastering on both sides. Bidder has also the option to supply and construct pre-engineered buildings. Roof shall be provided with roof water proofing treatment, as specified elsewhere in the Technical specification. Suitable arrangement shall be provided so as to prevent ingress of water into the cable trenches inside the building from cable entry locations.

All air - conditioned areas, shall be provided with the false ceiling system(details specified elsewhere) with under deck insulation.

Adequate aluminium doors and windows shall be provided for natural lighting, ventilation and view. All windows in air conditioned rooms shall have hermetically sealed double glazing.

5.23.08 **Pump Houses**

These shall be framed structure of structural steel work with permanently colour coated profiled steel sheet roof, grade slab and RCC foundations etc. Roof shall be provided with troughed profile permanently colour coated sheet with slope of 1 in 5 for quick drainage of rain water. Brick wall cladding (1m height above FFL) shall be provided all around the periphery of pump houses

5.23.09 **Pent House**

These shall be of RCC framed structures with columns, beams, slabs and foundations etc. Cladding shall be of brickwork with plastering on both sides. Roof shall be provided with roof water proofing treatment as specified elsewhere. Adequate nos. of steel doors and windows shall be provided for natural lighting and ventilation.

5.23.10 **Gypsum Storage Shed**

The Gypsum storage shed shall be RCC framed structure with RCC wall (upto Tripper floor) and structural steel shed with permanently colour coated profiled steel sheet roof and side cladding (above Tripper floor). Roof shall be provided with troughed profile permanently colour coated sheet with slope of 1 in 5 for quick drainage of rain water. At grade level Heavy duty paving as detailed elsewhere in the specification shall be provided inside the shed.

Finished floor level of Gypsum storage shed shall be kept at least 500mm above the finished

ground level. The building shall be provided with 750 mm wide plinth protection all around as detailed elsewhere in the specification.

5.23.11 Toilets

Toilet with potable water line facilities shall be provided in each of the following locations:

(A) Crusher House (Ground Floor) – (Gents Toilet – 1 No for each.)

(B) In CHP/LHP/GHP Control Room building – (Gents and Ladies Toilets-1 No. each)

(c) Wagon Tippler control room building- (Gents Toilet-1 No for each.)

Each Gents toilet shall have brick enclosure, and the following fittings.

i)	Wall mounted glazed vitreous china European water closet with low flush having flow rate of 6.0 litres and 3.0 litres of water per flush, dual flush adopters for standard flushing for solid waste and a modified smaller flush for liquid waste flushing valves shall be provided.	1 no.
ii)	White glazed vitreous china flat back lipped urinal 390x375x610 mm (approx.) fitted with photovoltaic controls for flushing system and all requisite fittings.	1 no.
iii)	Wash Basin 450x550 mm (approx.) mounted over 18 mm thk granite beveled edge counter fitted with photovoltaic control system for water controls, bottle trap with two taps and all requisite items.	1 no.
iv)	Mirror 600x900x6mm thk. with beveled edges (Superior sheet glass) mounted with teak wood beading and minimum 12 mm thk. plywood backing.	1 no.
v)	C.P. Brass Towel Rod 600 x 20 mm	1 no.
vi)	Liquid Soap Container	1 no.
vii)	Washing Tap (CP Brass)	1 no.
viii)	Overhead Polyethylene water tank (min. 500 litres capacity)	1 no.
ix)	Suitable provision for installation of drinking water cooler.	1 no.
x)	Space for Janitor room	1 no.

Ladies toilet shall be similar to gent's toilet as detailed above, except item at s.no. ii and ix (urinal and provision for drinking water cooler). Package type STP shall be to be provided.

No other facilities shall be provided below toilet block except toilet. Toilet facilities shall be provided at control room floor level.

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.

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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.

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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

•	The crushers shall be supported on vibration isolation system consisting of steel helical springs and viscous dampers. The supporting arrangement for each crusher shall consist of an RCC deck supported on steel helical spring units and viscous damper units which in turn shall be supported on girders. The girders shall be an integral part of the crusher house building. The part of the structure consisting of the RCC deck, springs and viscous dampers shall hitherto be referred to as “spring supported foundation”. The part of the structure, which is below the spring shall hitherto be called “supporting structure”. The Contractor should do the Engineering / design, supply and erection of vibration isolation system consisting of steel helical spring units and viscous dampers supporting the top deck which in turn would support the coal/limestone crushers. The vibrations isolation system supplied shall be of a proven make. The Contractor or his sub - contractor who designs and supplies the system should have designed, supplied and installed such systems for not less than five machines of speeds and unbalance forces comparable to the machine proposed by the vendor. The vibration isolation systems installed by the contractor or his sub - contractor in such machines should have been working satisfactorily for atleast five years
5.24.00	**CHP Workshop cum Office Building** This shall be RCC framed structure having two storeys in office area and single storey (double height) in workshop area. Total floor area of the building shall be 900 Sq.m (700 Sq.m. Office area and 200 Sq.m. Workshop).
5.25.00	**O&M WORKSHOP BUILDING** The O&M Workshop Building shall be a two bay fully covered building. The two bays shall comprise of workshop bay and office complex bay. The minimum span of workshop bay shall be 25m with RCC columns with structural steel roof truss and purlins supporting pitched roof. Roofing shall be permanently colour coated insulated sandwiched metal roofing sheet. The Gantry girder for the EOT crane in the workshop building shall be structural steel plate girder supported on RCC corbels at column locations. The gantry girder shall be complete with chequered plate walkways (at both sides) and the cage ladder. The Central Workshop Building shall be designed considering EOT crane of 50T capacity. The adjacent Office Complex bay shall have RCC superstructure. The minimum bay width shall be 6.50m. **Architectural Features:** The building shall be fully covered with brick wall masonry in office portion. For workshop portion brickwall shall be provided upto lintel level and permanently colour coated insulated sandwiched metal cladding sheet above lintel level upto the roof. Provision of doors, windows & Rolling shutters shall be included based on architectural detailed drawing to be developed by the bidder. The rainwater down comers shall be provided at every column location and they shall be suitably connected to the building surface drain. The minimum operating floor area for the workshop bay shall be 20mX50m. The minimum head room of workshop bay shall be evaluated by the bidder based on approved EOT Crane Clearance diagram and crane rail level. The office complex shall be 6.50mX110m in plan area. The office complex shall be made 2 storied for adequate space for operating personnel, MCC room, stores, Laboratories, Toilets, Conference room & Tool room. The floor to floor/ roof clear height shall be 4.50m.
5.26.00	**CANTEEN** **Salient Features**

The Canteen Building shall be a RCC framed superstructure with large span roof system. The building shall be designed as per the latest guidelines of IS:456, IS 1893 & IS 13920(for seismic ductility requirement)

Architectural Features

This building shall be of RCC Frame structure& Autoclave Aerated Concrete Block masonry. The area of building shall be 1100 sq.m.

The building shall have entrance lobby, dining hall for staff, dining room for executives, pantry, kitchen, office, stores, wash areas, rest room for kitchen staff, toilets, etc.

External finish shall be of Premium Acrylic Smooth Paint with Silicone additives.

There shall be separate service road and entrance for supply of cooking materials and garbage disposal.

5.27.00 FIRE STATION BUILDING

Salient Features

The Fire Station Building shall be a RCC framed superstructure. The building shall be designed as per the latest guidelines of IS:456, IS 1893 & IS 13920(for seismic ductility requirement)

Architectural Features

It shall be of RCC Frame structure& Brick masonry. The building shall be provided with area 600 sq. m required to accommodate Fire tenders and fire personnel including Dy./Asst. Commandant's (Fire) office. The number of fire tenders shall be provided as per CISF norms. The number of fire tenders/**equipments shall be provided as given in else where in specication.** One drill tower per station shall be provided. Facilities for the staff including Kitchen, Dining Hall, Rest Rooms, Stores, First Aid Room shall be provided as applicable.

External finish shall be Premium Acrylic Smooth Paint with Silicone additives.

5.28.00 DOZER SHED

Architectural Feature

This building shall be prefabricated steel framed structure with brick wall up to window sill height & prefabricated insulated double skin metal sheeting cladding above it. Roof of the building shall be prefabricated insulated double skin metal sheeting on steel roof truss. The building shall provide for Dozer shed space, Workshop space, Office Rooms, Stores, Toilet & Pantry as per functional requirement. Minimum size of the dozer shed shall be 500 Sq.m.

Metal side cladding shall be composed of different colour shades to match with the other buildings. External finish for brick walls shall be of Premium Acrylic Smooth Paint with Silicone additives.

5.29.00 OWNER'S CONSTRUCTION OFFICE

The construction office shall be single storey building. The floor area for owner's construction office shall be 1025 Sqm. The building should be as per the tender drawing.

5.30.00 ADMINISTRATION BUILDING

Salient Features

The Administration Building shall be a multi–storied RCC frame superstructure. The building shall have an RCC Lift structure accommodating the Lifts. The structural framing plan and elevations shall be based on the architectural concept to be developed by the bidder. The minimum thickness of Lift Superstructure RCC Wall shall be 230mm.

Design Concept

The building shall be designed as moment resisting RCC sway frame in both the orthogonal

directions. For general design guidelines IS 456 shall be followed and for ductile detailing (against seismic load) IS: 13920 shall be followed.

Architectural Features

This building shall be three storeyed (G+3 stories above)and area 2800 sq.m. with RCC Frame structure& Autoclave Aerated Concrete Block masonry. Floor-to-floor height shall be minimum 4.50m. The building shall be designed based on Tender drawing of Administration Building. It shall have features of local architecture.

Hermetically sealed double glazing with toughened Glass to be provided for external glazing.

There shall be provisions for Exhibition Hall, Conference Room for 50 persons, Canteen for 30 persons, Bank, Bank ATM space, AHU.,MCC Room, First Aid Centre, Library, offices. Separate toilet facilities shall be provided for ladies and gents in each floor. One toilet shall be provided for physically handicapped at each floor. The building shall have provision of attached toilet with the cabin for senior executives and conference rooms.

2Nos Lifts and minimum 2Nos stairs shall be provided. Lift shaft shall be of R.C..C wall.

Covered parking space for 25 nos. cars shall be provided. Covered parking shall be of RCC construction. Open parking space for 40 nos. cars & 75 nos. scooters shall be provided. Minimum 23 sq.m./car (including circulation area) and 5 sq.m./Scooter (including circulation area) shall be considered for working out parking space.

The Admin building shall be fully IT enabled. 300x40 mm GI Raceway with standard length 2500 mm single compartment trunking raceways made from 14 gauge (minimum) pre-galvanised sheet including fasteners, floor support, connectors, bends cross-way, earthing stud for fixing etc. complete as per requirement, drawings and instructions of EIC shall be laid under floors of service building for IT enablement. 350x350x50 mm Junction boxes of pre-galvanised sheet with cover plate for raceways shall also be provided. Minimum 70mm Floor finish margin shall be kept for installing metallic raceways.

The rain water down comers shall be provided as per General architectural specification.The rain water down comers shall be suitably concealed by the external wall enclosure.

Structural Glazing shall have hermetically sealed double glazing.

Windows on south side shall have Building Integrated Photovoltaic Cell as Glazing. The glazing area shall be increased accordingly for proper lighting. External finish shall be combination of GRC Tile & aluminium composite panel.

5.31.00 FQA BUILDING

FQA building shall be RCC construction of single or double storey. Total area shall be decided based on the requirements based in QA chapter, however, minimum area shall not be less than 800 Sqm. Apart from space required to accommodate and operate all the equipments mentioned in the equipment list, office space for 5 executives, one meeting room, spectroscope room, NDT lab, storage room, welding booth, welding simulator area, platforms for instruments/equipments, ladies and gents toilets, space for water cooler and pantry has to be provided as per specifications mentioned elsewhere in the technical specifications.

5.32 RAILWAY SIDING SYSTEM

Talcher is a 'B' Class station located at Km: 469.069 which is the serving station for the existing siding of the TTPS. The siding takes off from Talcher Railway Station at the Rajatgarh Jn. end of the station. The present Talcher Station is also a terminus station and is the facilitating serving station for the Talcher Thermal Power station and its rail yard. Talcher is having eleven lines. A High-Level Passenger platform along with a station building and other passenger amenities exists adjacent to Line No.1.

The private siding of Talcher Thermal Power Station siding is taking off from the Down Main Line of Talcher station east end at Ch. 861.865M from Centre line of Talcher station. The lead line of the private siding is 691.765m from proposed take-off point. Dead end of the siding is at Ch: 2529.200m from proposed take-off point..

5.32.1 Survey

The bidder shall carry out detailed topographical survey along the selected alignment of siding as per the approved FSR. This survey shall include field data for preparation of index plans, engineering scale plan, longitudinal section & cross sections, detailed engineering of bridges and culverts, opening and level crossings, foot over bridges, drains for the rail track, determination of road crossings at grade or grade separators, road diversions, utility shifting etc.

5.32.1.1 The alignment of Railway Siding is to be accommodated within the available NTPC land as per the FSR. The assessment of additional land requirement (if any), which may crop up during preparation of Engineering scale plan/ construction stage of the Railway siding, including preparation of land requirement plan with details such as private, govt., forest etc. on Khasara map (including schedules & cadastral map) shall also be in the scope of the Bidder. Identification of structures/buildings required to be demolished and its cost estimate including compensation to be paid to the owner of structure/buildings, if any, shall also worked out by the Bidder and submitted to NTPC.

5.32.1.2 Identification of culverts for drain, pipe crossings, level crossings, bridges, Foot Over Bridges etc.

5.32.2 System Design

5.32.2.1 System Design shall include the following:

a) Consolidated traffic study for coal and non-coal movement to the project in view of receipt of coal through BOY, BOX, BOXNHA, BOY25, BOXNLW, BOXNHL, BOXN25, BOX32.5 BOXN and BOBR wagons (in line with RDSO G33, Rev 1 latest guidelines) for Talcher Stage-III (2x660MW).
b) Study of additional facilities required inside plant , siding and serving station including the drainage system and other facilities crossing the proposed railway tracks. Study the requirement of locomotives for marshalling /shunting of rakes inside plant, recommended numbers and rating of locomotives required. Finalise the location of track hopper and disposition of inhaul & outhaul tracks.
c) Optimize the track work and use of facilities to achieve designed unloading rate on a long term basis. Suggest procedures to deal with exigencies during shunting/marshalling. Study is required for engine on load scheme.
d) The system should have capability to release the coal rakes received at the project within the free permissible time.
e) Arrangements for Communication system in consultation with Indian Railways, Provision of FOIS (Freight Operation Information System) to know the rake status for Power station at any time.
f) Study the manpower requirement/ railway staff requirement to be posted at the cost of Talcher STPP and facilities to be provided. Study should elaborate the advantages and disadvantages on liberalized siding rules and possibility of handling of heavy haul rakes (longer rakes)
g) Assessment of electrical (OHE) and S & T requirement
h) Assessment of locos and workshop facilities, if any, as required.
i) Preparation of detailed system of working and station working rules. The report should

contain the traffic study/turnaround time etc. the study may also indicate number of crossing stations/block sections/facilities required for movement

j) Construction methodology for the execution of work.

5.32.3 Detailed Project Report

Preparation of Detailed Project Report (DPR) as per the latest Policy guidelines of Indian Railways, for the proposed railway siding and augmentation of serving station it includes finalization and submission of Detailed Project Report based on final survey results, system design, manpower requirement etc. The detailed project report shall identify the cost estimates inclusive of the work executed through Railways as deposit works and the time schedule for execution of the works.

5.32.4 Detailed Engineering

5.32.4.1 Detailed Engineering of complete railway siding system for Stage III project from Railway serving station(s) to the plant including in-plant yard & augmentation of serving station. This covers in general the electrified and non-electrified track, bridges, culverts, buildings, control rooms etc. This will include but not limited to the following:

a) Preparation and submission of detailed technical specifications with applicable tender drawings, BOQ, cost estimates with unit rates for each and every item of civil work in tender schedules covering all types of bridge/ culverts, banks and cutting, drainage works, cable trenches, gumties, control rooms, station buildings, track and permanent way including rails,sleepers, points and crossings, fish plates and other track fittings etc.

b) Preparation of schedule of quantities of materials for which advance procurement action will be necessary viz. Cement, sleepers, track fittings, rails, ballast, etc. schedule of quantities forworks to be done through deposit work shall also be prepared and submitted separately.

c) Preparation and submission of detailed design and construction drawings for each and every item of civil work as elaborated above including geo-technical investigation as required for detailed design of bridges, culverts, embankments etc. All clarifications/ queries on theconstruction drawings during execution including any revision thereof shall be furnished.

d) Preparation of detailed design and drawings (and obtaining the approval of Railways and other concerned authorities) for the following.

   i. Permanent-way
   ii. Yard Modifications
   iii. Formation of bank and cuttings
   iv. Bridges, culverts, crossovers etc.(Incl. Proof checking from concerned Institutes/body's)
   v. All civil and structural works pertaining to OHE and S&T works(Incl. inspection & commissioning)

e) For design of bridges following shall be considered:

   i. The rainfall storm and catchment area considered for determining flood discharge and criteria for fixing waterway. The expected afflux and its impact on nearby habitated areas should also be examined.
   ii. Calculations of scour depth for foundation design of bridges.
   iii. Upstream, downstream and bed protection design and criteria, if any.
   iv. Design of bridge across canal shall be done as per requirements of the Water Resources Department of Odisha. In addition to obtaining approval of the Railways, the Bidder shall submit the detailed design of the bridge to WRD of Odisha and obtain their approval prior to start of the construction work.

5.32.5 Signalling & Telecommunications

Existing Signalling arrangements at Talcher Station

Existing Talcher Station is on double line electrified section. Signalling is controlled by Electronic Interlocking with of Multiple Aspect Colour Light Signals (MACLS), electrical Motor operated points, track detection with digital axle counters. Traffic monitored and controlled by a Electronic Interlocking Console/VDU with standard III interlocking under Khurda Road division of East Coast Railway.

1.0 Proposed Signalling arrangements:

1.0.1 It is proposed to take off siding from CH.861.865 from central line of Station building. with the Insertion of crossover point and provision of signalling arrangement for trains to proceed towards NTPC proposed In plant yard with all compliments of signalling gears at par with existing signalling at Talcher station in agreement with ECOR including alterations to existing installation

1.0.2 Preparation of detailed system design for signalling, telecommunication works from serving station to In-Plant yard at par with Talcher Station of ECoR and as per the latest RDSO/ Railway specifications.

1.0.3 Construction of Signalling Cabins as finalised in the above scheme for controlling and monitoring of complete traffic from serving station to Talcher plant and rake handling/shunting operation at in-plant yard. It is proposed to install Electronic Interlocking system, Absolute block working system with BPAC(Block Proving by digital Axle Counter) using UFSBI(Universal Fail Safe Block Instrument), console and VDU(Visual Display Unit) with same type and specifications of signalling gears such as Motor operated Points, LED Colour Light Signals, Turn outs, Digital Axle counters, SSDAC(Single Section Digital Axle Counter),MSDAC(Multi Section Digital Axle Counter) for detecting railway track occupancy in plant yard as per latest RDSO specifications.

1.0.4 All the Control communication available at Talcher station which is extended to proposed Signaling cabins at proposed Railway Siding through OFC and Quad cable including Emergency communication.

1.0.5 Approved ESP and SIP for the proposed NTPC Talcher siding takeoff from station and New proposed cabin to be followed while execution of proposed work. Signaling cables as per RDSO specifications and practice followed in ECOR to be followed.

5.32.6 OVER HEAD ELECTRIFICATION(OHE)

EXISTING TRACTION ARRANGEMENTS AT TALCHER STATION

Presently Talcher Station is on double line electrified section with 25 kV OHE which is tapping power from the nearest substation under Khurda Road division of East Coast Railway.

5.32.6.1 PROPOSED TRACTION ARRANGEMENT

1. The Proposed siding of 2x660 MW of NTPC is to be fully electrified with 25 KV Overhead Electrification which is taking off from CH.861.865 from central line of Talcher Station building of Khurda Road Division of ECR.
2. The total track length for overhead electrification is about 7.10 Tkm. It also includes charging of complete OHE of 7.1 Tkm and trial run of electric locomotive.
3. It is proposed to do the Survey and Design for Overhead Electrification work and General Electrification work for NTPC siding line including Testing & Commissioning.

4. The OHE will be Regulated Conventional type as per RDSO design.
5. The OHE masts will be of fabricated/Rolled type. The proposed OHE will be supported by single masts/portals with minimum implantation of 2.8/3.10 meters on tangent track and considering the versine & degree of curvature.
6. Railway Approved ESP(Engineering Scale Plan), SWD(Sectioning Wiring Diagram), LOP(Lay Out Plan), CSD(Cross Section Drawing) and SED(Structural Erection Drawing) for the proposed NTPC Talcher siding take off from station to be followed while execution of proposed work.

5.32.7 Construction of Railway Siding System

5.32.7.1 Construction of the Railway siding system is to be undertaken as per Latest Railways guidelines under supervision of Railway approved agency/consultant.

5.32.7.2 Construction of the complete railway siding system including in-plant rail yard for stage-III (2x600MW) including augmentation of siding from serving station to plant, Augmentation of serving station as per Railways' requirement, in-plant rail yard, Bridges/ culverts, necessary drainage arrangements, including S&T, OHE and other associated works such as panel buildings, TXR building etc as per railways requirement. Suitable drainage arrangements with connections up to final disposal points are to be provided to avoid water-logging.

5.32.7.3 Facilities of in-motion weigh bridge (150T capacity) for weighment of all inward & outward rakes is in the scope of bidder. In-motion weigh bridge to be provided as per RDSO specifications. The location of the weigh bridge is to be finalized by the bidder.

5.32.7.4 Safe access is to be provided to various facilities/ yard.

5.32.8 General Requirements

5.32.8.1 Preparation and submission of Detailed Project Report incorporating above details to obtain approval from NTPC/Railways. The report should include recommendation clearly based ona techno-economic study bringing out tangible/intangible benefit to NTPC on the subject.

5.32.8.2 Complete co-ordination and liaison with Railway, state/central govt. including the approval of the scheme from Railways and other agencies would be in the scope of Executing Agency.

5.32.8.3 Traffic study, Staffing study for O&M, railway staff to be deployed at the proposed TTPS at NTPC cost.

5.32.8.4 All coordination with any other agency whose facilities have interface with the Railway siding/coal transportation system.

5.32.8.5 The consultant appointed for the DPR, Detailed Engineering and Construction should have valid enlistment with the concerned Railways till the validity of this contract.

5.32.8.6 The geo technical investigations shall be done strictly as per RDSO/ Railway's guidelines. Copies of RDSO/railway's guidelines (latest revisions) required for the detailed Engg work shall be made available to NTPC.

5.32.8.7 The Bidder shall be responsible to provide all necessary services, documents and technical information consisting of and relating to detailed engineering, procurement, construction, and supervision and commissioning activities of the PROJECT as applicable in accordance with Standard Engineering Practice/ Railways/RDSO guidelines. Documents shall also include all relevant RDSO drawings required for inspection and execution of the job.

5.32.8.8 5(five) sets of all relevant RDSO drawings OHE, S&T manuals and IRPWM etc shall be handed over to NTPC upon commissioning of the Project.

5.32.8.9 The Bidder would be required to supervise the operations for a period of 12 months beyond the successful commissioning of the system for stabilizing of the system and resolution of

problems/ issues arising out of the same including coordination with concerned agency/ Railways.

5.32.9 Deliverables

The Bidder shall submit, the following documents to NTPC:

i.	Draft DPR including drawings and land planassessment.	Three (03) Sets
ii.	Final DPR & ESP along with the drawings	Six (06) Sets
iii.	Construction drawings & As-built drawings:	Four (04) Sets
iv.	Reproducible copy of Draft DPR, final DPR along with the ESP, Construction Drawings and As built drawings	Electronic Format

Note: The above requirement is exclusive of submissions required for clearance/approvals from Railways/ State/ Central Govt agencies/ NH etc.

5.33.00 Safety Control Room

Safety control room shall be a single storyed RCC framed building of minimum area 60sqm to accommodate equipments and personals as mentioned in C&I chapter for 24X7 operation. Additionally, it shall have ladies and gents toilet, space for water cooler and Pantry.

5.34.00 BIO TOILET

Bio-Toilet shall be provided near all the modular worker's sheds/accommodation, the makeup water pump house building, CHP building outside the plant boundary and near AWRS building. Besides these areas, any toilet block provided in area far from plant boundary shall be a Bio-toilet.

Bio-toilets shall be made for anaerobic bacterial decomposition of human waste. After decomposition and treatment of the human waste, the residual water from Bio-Toilet shall be: colorless, odorless , devoid of any solid particles and shall have pathogen inactivation by 99%. The water thus obtained shall require no further treatment / waste management and shall be used for irrigation purposes.

Bio toilet shall have all fixtures that shall include following fixtures besides the requirements stipulated by DRDO standards.

a) One number wall mounted colored (excluding premium colors) glazed vitreous China European water closet and flushing valve system, water faucet, toilet paper holder as per IS:2556

or

One number white glazed vitreous China Orissa pan (580 x 440 mm) and flushing valve system, toilet paper holder as per IS:2256

b) One number colour (excluding premium colors) glazed ceramic oval shaped wash basin 450x 550 mm (approx.) mounted over 20mm thick granite beveled edge counter fitted with photo-voltaic control system for water controls, bottle trap as per IS:2556. For common toilets, number of washbasins shall be as per requirement. However, for Pump Houses the same shall be provided without photo voltaic control system for water control.

c) For Male Toilets Urinal as per requirements, with all fittings with photovoltaic control flushing system as per IS: 2556.

d) One number looking mirror 600 x 900 x 6 mm, edge mounted with teak beading and

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:**

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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.

Minimum size of the angle section to be used as structural members shall be 50 X 50 X 6. Minimum weld size shall be 6 mm. 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 1993-1-8:2005. Minimum grade of steel & thickness of Tubular/Hollow sections shall be Yst 240 Mpa & 4.0mm respectively. Minimum thickness for rolled/ built up section shall be 6mm.

Slotted holes shall not be assumed to act as expansion joint for relieving of stresses and suitable bearings shall be provided at the supports.

All gallery supporting trestles shall be so proportioned that the transverse deflection of gallery due to wind / seismic load should not exceed trestle height / 1000 as stipulated in IS: 11592. Peak wind speed method shall be considered for checking the transverse deflection. Longitudinal deflection for all conveyor trestles (along the conveyor direction) shall be Height/500 for peak wind speed.

Vertical & horizontal deflection of conveyor gallery shall be restricted to span/500.

The crusher and transfer house structures shall be so designed that transverse deflection at places where conveyor galleries meet, should be equal to the respective transverse deflection of conveyor supporting trestles.

For transfer house and crusher houses monorail loads of two floors having highest capacity of monorails shall be considered in addition to other gravity loads along with wind/seismic load. Wind load/seismic load shall be considered along with Running belt tension for the analysis of transfer house and crusher house, however monorail load may not be considered.

Stresses for all CHP structures shall be checked for the higher of the forces obtained from gust factor method and the peak wind speed method.

The permissible vertical deflection for beams supporting drive machinery shall be restricted to span / 500 and for other beams it shall be within span / 325.

Horizontal bracing system shall be provided at floor levels around the openings for plan area greater than 2 sqm.

Shear force in steel columns shall be transferred to the pedestals / foundations exclusively either through foundation bolts or the shear key arrangement.

Contractor can also use tubular steel sections for roof truss of conveyor galleries/cable trestle only.

For design of liquid retaining structures, IS : 3370 (Part - I to IV) (latest) shall be followed. Face of the structure in contact with liquid shall be designed as un - cracked section. For design of RCC pipes for culverts, latest editions of IS: 458, IS: 783 should be followed.

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.

Design of Hopper walls shall be done for both Static & Dynamic flow condition using Walker's theory.

	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

these frequencies shall be checked against the design criteria.

Forced response dynamic analysis shall be carried out for the operating condition unbalance forces using a sinusoidal forcing function. Unbalance forces as given by this specifications shall be used for his purpose. The amplitudes shall be checked against the design criteria. The dynamic forces from this analysis shall be used for structural design with a suitable fatigue factor.

Isolation Efficiency

The vibration isolation system shall be designed for about 90 % isolation efficiency.

De-coupling

A ratio of the least 10 (ten) shall be ensured between the stiffness of the supporting structure and the stiffness of the spring system in the vertical direction to achieve de-coupling between the two (the stiffness of the spring system being lower). This ensures that dynamic analysis of the supporting structure need not be carried out.

Frequency Criteria

The frequency criterion has already been laid down implicitly by the isolation efficiency criteria and de-coupling required.

The first bending mode frequency of the top deck shall be at least 20 % above the operating speed.

Unbalance Forces

Unbalance forces arising out of all the following cases shall be considered for checking the design and amplitudes.

I. Balance quality grade G 16 as per IS/ISO:21940-11.

II. One hammer broken condition. The missing hammer shall be assumed to be closest to the crusher non - drive end of the crusher.

III. Three hammers broken condition. All the three hammers broken shall be assumed to be from the same suspension bar and located at the non - drive end of the crusher.

Amplitude Criteria

The calculated amplitudes (mean to peak values) shall not exceed following limits under the specified conditions.

Operating speed of 750 RPM

I. 150 microns for an unbalance force arising out of balance quality grade G 16 as per IS/ISO:21940-11-2016.

II. 300 microns in case of a one hammer broken condition.

III. Amplitudes need not be checked for a three hammer broken condition.

Operating speed of 450 RPM

I. 200 microns for an imbalance force arising out of balance quality grade G 16 as per IS/ISO:21940-11.

II. 400 microns in case of a one hammers broken condition.

III. Amplitude need not be checked for a three hammer broken condition.

For intermediate operating speed between 450 to 750 RPM the amplitude limits can be linearly interpolated.

The amplitude limits mentioned above are in both vertical and horizontal directions. The amplitudes shall be calculated at critical points on the top surface of the RCC deck. The amplitudes shall be checked for the most unfavorable superposition of modes in any direction. However, phase difference between the maximum amplitude occurring in different directions due to the rotating vetor may be considered while superimposing the modes.

Transient Resonance

Transient resonance, which may occur during the start - up or coasting down condition of the crusher, shall be checked, and the amplitudes in such a condition should not exceed one - and - half times those at operating speed for each design condition.

Strength Criteria

The following criteria shall apply for the design of top deck :

a) Dead loads, live loads, Seismic loads and dynamic loads shall be considered for the design. The most unfavorable combination shall considered for design.

b) Seismic loads shall be assumed to act together with dynamic loads for a one millimeter eccentricity in the rotor. However, seismic loads and dynamic loads arising out of hammer breakage need not be considered together

c) Fatigue shall be considered while designing for dynamic forces. A fatigue factor of 2.0 shall be used on all dynamic forces to arrive at the equivalent static force for the purpose of design.

d) Working stress method shall be used for the design of RCC deck. In survival condition, 10 % overstressing may be permitted.

e) The RCC top deck shall be at least of M35 grade of concrete as per IS : 456.

f) Fatigue need not be considered for the three hammer broken condition.

g) For calculating unbalance forces, the heaviest hammer (plain or toothed) shall be considered.

6.03.09 Horizontal Deflection criteria

The maximum Horizontal Deflection for various structures shall not exceed and be limited to the following:

Sl. No.	Description	Maximum value of
1.	For Trestles and transfer points (Transverse deflection at Conveyor gallery supporting level)	Height/1000 (For Wind load by Peak Wind Speed Method / Seismic Load)
2.	For ESP Control Building, Compressor House, and all other steel buildings envisaged in this specification	Height /325
3.	Vertical Metal Sheeting in Cladding	Span/250

However, the maximum deflection of Grating / Chequered Plate Shall be limited to 6mm.

Note: 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.

6.03.10

a) Dispersion of load in any direction through soil shall be as per IS 8009 (relevant part).

b) Dispersion of load through concrete shall be considered at an angle of 45 degrees with horizontal from the edge of contact area.

6.03.11

a) Permissible deflection (unless specified otherwise in this specification) for latticed framework and beams of floors other than drive floor shall be span/325.

b) The allowable deflection for beams directly supporting drive machinery and equipment shall be restricted to span/500 unless specified otherwise in this specification.

c) The deflection for manually operated cranes & monorail supporting beams shall not exceed span/500.

For electric overhead cranes :

1) upto 50 Tonne capacity : span/750

2) over 50 Tonne capacity : span/1000

d) The vertical deflection of beams supporting LP Heater, HP Heater and Deaerator shall be limited to Span/500.

e) The vertical deflection of metal deck sheet for floor shall be limited to span/250.

f) Permissible deflection for all purlins, cladding runners, roofing/cladding sheets and grating / chequered plates shall be span/250. However, the maximum vertical deflection of Grating/ Chequered plate shall be limited to 6 mm.

6.03.12

Transverse coal pressure on Bunker/Silo/Hopper walls shall be calculated as per IS: 9178. The Coal Bunker/Silo/Hopper shall be designed for the following conditions

i) The Bunker/Silo/Hopper is full up to its full capacity with top surface nearly horizontal.

ii) The Bunker/Silo/Hopper is partially empty with the top surface of coal at an angle of

repose of 37 degrees.

6.03.13 Design criteria for ash silo

1. The pressure due to ash filling on the side wall and the bottom portion of ash bins/silos shall be taken as the maximum of (a) static pressure determined in accordance with the Jansen's formula multiplied by an impact factor of 1.4 and (b) pressure determined as per Walker's formula for static as well as dynamic conditions. The silo shall be designed for the following conditions:

   (a) The silo is full up to its full height / capacity

   (b) The silo is partially empty with top surface of ash, at an angle of repose less than 30 degrees.

2. The following loads are to be considered for design.

   a) Density of bottom ash to be considered for volume calculation shall be 650 kg. /cum.

   b) Density of bottom ash to be considered for load calculation shall be 1600 kg/cum.

   c) Density of fly ash to be considered for volume calculation shall be 750 kg/cum.

   d) Density of fly ash to be considered for load calculation shall be 1600 kg./cum.

   e) Density of dry fly ash, to be considered for the design of supporting structures for dry fly ash conveying pipes, shall be taken as 1000 kg/cum. The pipe shall be considered full with dry fly ash.

3. Other requirements are as follows:

   a) Independent supporting structure shall be provided for each silo.

   b) The joint between the wall and roof of the silo shall be properly sealed by welding or by any other approved means.

   c) Operating platform covering total plan area wise in silo structure made of grating shall be provided below the hopper outlet.

   d) The bracing system shall be provided in such a way that the trucks and closed tankers can have a clear passage to approach the underside of the silos for unloading dry ash from the silos.

4. Trestles supporting ash pipes shall be so proportioned that the transverse deflection of trestles due to wind/seismic load shall not exceed trestle height/325.

5. The corrosion allowance for design of Silo, Buffer Hopper, Bottom ash hopper, tanks etc. shall be considered as per IS9178 considering structure exposed to atmosphere. The corrosion allowance shall be provided in addition to the requirement of minimum thickness of steel plate as per IS9178.

6.03.14 Coal Bunker (inside Mill Bunker Building) shall be of MS while the hopper shall be of MS with stainless steel (grade SS 304) lining. The minimum thickness of MS plate and SS lining in hopper portion shall be as per the design concept of Mill Bunker Building specified elsewhere in the specification. Pre-formed flexible open ended bellow strap of neoprene is to be provided between top of bunker and bottom of tripper floor to avoid coal dust leakage / escape. The bellow strap shall be of minimum 200 mm wide under un-stretched condition and shall be of minimum 2mm thick.

The hopper angle with the horizontal plane be as specified elsewhere in the specification.

6.03.15 The live storage capacity of each coal bunker shall be greater of the following:

a) Total 10 hours coal requirement of the boiler for BMCR duty with worst coal firing,

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For all capacity (volume) calculation and structural design (load calculation) unit weight of biomass blended coal shall be assumed as 760 kg/cum. and 1100 kg/cum respectively

equally distributed ... he coal mills) required in service for this duty conditi...

b) Total 10 hours coa... MCR duty with design coal firing, equally distributed ... he coal mills) required in service for this duty conditi...

c) Total 10 hours coa... MCR duty with worst coal firing, equally distributed ... the coal mills) required to be in service for this duty condition as specified elsewhere.

6.03.16 For all capacity (volume) calculation and structural design (load calculation) unit weight of coal shall be assumed as 800 kg/cum. and 1100 kg/cum respectively.

6.03.16 a) The design and construction of RCC structures shall be carried out as per IS: 456. Working stress method shall be adopted for the design wherever specifically mentioned in this specification.

b) For design and construction of steel-concrete composite members, IS: 11384 shall be followed.

c) For reinforcement detailing, IS 5525 and SP 34 shall be followed.

d) Two layers of reinforcement (on both inner and outer faces) shall be provided for RCC wall sections having thickness 150 mm or more.

6.03.17 a) **Design of Foundation for Coal Mills and Fans**

Structural Arrangement of foundations for various machine foundations like TG, TDBFP, MDBFP, Coal Mills and Fans shall be as specified elsewhere in the specification.

Analysis for the foundation

For the foundations of the all equipment, details static and dynamic analysis shall be done. The static analysis shall include all operating condition, load cases and abnormal loads like short circuit, loss of blades & unbalance and seismic forces as per IS1893. The dynamic analysis shall consist of free vibration analysis and forced vibration analysis. A minimum fatigue factor of 2.0 shall be considered for dynamic forces.

The vibration amplitudes shall be calculated at the machine bearing locations and at any other points of interest by a forced response analysis. The unbalance forces used for this analysis shall correspond to the balance quality grade of the machine as per ISO 1940 /IS:11723 or the unbalance forces as provided by the machine manufacturer whichever is higher. It shall be ensured that the calculated amplitudes do not exceed the limits specified by the machine manufacturer and relevant Standards such as ISO 10816/IS:14817.

Bidder to consider the acceleration at the top of the deck for the design of supporting / fixing arrangement of machine.

Design criteria for steel helical springs and viscous dampers

The isolation efficiency for steel helical springs and viscous dampers shall be at least 90%. The ratio of actual spring supported weight to the nominal spring capacity shall not exceed 0.80. At least 5% to 10% of critical damping shall be provided in the form of viscous dampers.

Reinforcement Design

Working stress method as per IS 456 shall be used for reinforcement design. The design shall be done for the worst load combination. Minimum reinforcement shall be provided as per IS 456 and IS2974 (Part-III), if the calculated reinforcement is less than the minimum.

For TG Raft/ Pilecap, minimum percentage of reinforcement at top and bottom faces of foundation shall be same as that stipulated for beam as per IS456.

c) **Block Foundations:**

	Block foundation resting on soil shall be analyzed using elastic half space theory. In case the foundation is supported over piles, Novak's approximation shall be used for determining the spring constant and damping ratio of pile groups. The mass of the RCC block shall be at least three times the mass of machine. Free vibration analysis of the foundation shall be carried out to evaluate the natural frequencies. The fundamental natural frequency shall be kept at least 20% away from the operating frequency (speed). Forced vibration analysis shall be carried out if the dynamic forces are made available by the machine supplier in which case the amplitude limits stipulated by the machine supplier and ISO 10816, whichever is lower, shall be satisfied. Reinforcement design shall be done by working stress method as per IS 456 and IS 2974 (Part-IV). For the foundations supporting minor rotating equipment weighing less than one ton or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structure, floors, etc., suitable vibration isolation shall be provided by means of springs, neoprene pads, etc., and such vibration isolation system shall be designed suitably.
6.03.18	If RCC floor/roof is assumed to act as diaphragm, transmitting lateral loads to braced bays, it shall be provided with shear connectors. The spacing of shear anchor studs on structural beams shall be minimum of the spacing required for i) Restraining the compression flanges of beams and ii) Transfer of the horizontal shear at floor/roof to the supporting beams. However, whenever large / more number of cut-outs are provided in the floor slab, horizontal floor bracings shall be provided below slab to transfer horizontal force to columns without considering diaphragm action from slab.
6.03.19	All roads shall be rigid pavements specified elsewhere in this specification. The design traffic load shall be a minimum 4 million cumulative standard axle. The design of concrete pavement shall be carried out as per IRC-58.
6.03.20	a) No cable/pipe trench is envisaged in the plant area. However, if required, pipe/cable trench can be provided inside the buildings and inside switchyard or some other localised areas. b) All pipes and cable shall generally be routed above ground. c) A minimum clearance (clear headroom) of 8m shall be kept for all over-ground pipe/cable trestles for all road/rail crossings. For other areas, the requirement of trestle height is specified elsewhere in the specifications. All trestles shall be provided with continuous walkway of minimum 600mm width with hand-rails and toe-guards all along the length of the trestle along with approach ladders near roads, passageways, etc. Before and after the road/rail crossings, a barrier of suitable height shall be constructed so as to prevent the approach of cranes (having height more than 8 m) etc., upto the pipe/cable racks/trestles. d) Within AB bay in Main plant area, generally grating shall be provided for Mezzanine floor except for valve room area, cable spreader floor, air washer units, feed water heaters, equipment foundations, miscellaneous skids, etc. where the floor shall be of RCC. Oil equipment room shall also have RCC floor below the grating floor.
6.03.21	The maximum velocity for pipe drains and open drains shall be limited to 2.4m/sec and 1.8 m/sec. respectively. However, minimum velocity of 0.6m/sec. for self-cleansing shall be ensured. Bed slope not milder than 1 in 1000 shall be provided. The open drains shall be open rectangular drains of RCC unless required otherwise due to functional requirement. RC box culverts shall be provided at rail, road or other crossings.
6.03.22	Sewers shall be designed for a minimum self-cleansing velocity of 0.75m/sec and the maximum velocity shall not exceed 2.4m/sec.

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

6.03.22 Foundations for all tanks shall be designed for as per IS: 803.

6.03.23 Footings shall be so proportioned to as to minimise the differential settlement.

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

6.03.24 **Boiler/ ESP support structures shall be designed for:**

a. Dead load

b. Live/Imposed loads

c. Static and dynamic loads of piping, movable equipment and maintenance parts.

d. Loads from cable trays and walkways supported on columns.

e. Ash water piping supported on the outermost row of boiler columns.

f. All ESP hoppers filled up with ash upt o the top of the hoppers or the bottom of electrodes (whichever is more) using a bulk density of not less than 1350 kg/cu.m. for the ash, along with additional ash build-up from the end of the third field up to the inlet duct bottom level at a natural repose angle (not less than 30 degree to horizontal in any case).

g. Ash load at bottom ash hopper and pent house of the boiler shall be as mentioned in the mechanical chapter of the specifications.

h. Seismic and wind loads as specified elsewhere in the specifications.

i. Temperature Loads.

j. Temperature variations under ESP operating condition.

k. The loads listed above indicate the minimum requirements.

l. For the Design of ESP Supporting Structures for Seismic, Ash Load in Hoppers filled upto to the top of the Hoppers or bottom of the electrode (whichever is higher) shall be considered as permanent Loads along with other applicable Loads.

m. Following Ash density shall be considered for the Design :

Sl. No.	Description	Density (kg/Cu. M.)
a)	Bottom Ash for volume calculations	650
b)	Bottom Ash for Load calculations	1600
c)	Fly Ash for volume calculations (For Boiler)	750
d)	Fly Ash for volume calculations (For ESP)	650
e)	Fly Ash for Load calculations	1350
f)	Dry Fly Ash for dry fly ash Pipeline supporting Structures (Pipe to be considered full)	1000

6.03.25 Boiler supporting structures shall be so configured that the temperature of steel does not exceed 60 °C unless specified otherwise. Brackets shall be provided on both sides of the outermost row of columns of both the boiler and ESP for supporting cable trays and walkways, at a height not exceeding 10.0 m. The exact levels shall, however, be decided during detailed engineering. Each ESP hopper shall be supported at four corners by providing four columns from the ground.

6.03.26 The bracings in boiler structure shall be provided such that under no circumstance normal/convenient access to all points in the boiler is blocked or obstructed.

6.03.27 In design of boiler/ ESP support structures, dynamic piping loads need not be considered acting simultaneously with wind or seismic loads. Increase in permissible stresses shall be allowed in load combinations where dynamic piping loads are considered and shall be as permitted under seismic load conditions.

6.03.28 Design Criteria for foundations and some other facilities/areas are covered separately in this specification.

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

Finished floor level of boiler area paving shall be kept about 200 mm lower than the finished floor level of Main Plant buildings.

6.03.30 Joints/Connections in steel structures:

Steel structures shall be detailed and connection and joints provided as per the provisions of IS 800, IS 816, IS 9595, IS 1367, and IS 9178 and as per following requirements.

a) Connection of vertical bracings with connection members and diagonals of truss members shall be designed for full tensile capacity of the bracings unless actual loads are indicated on the drawings.

b) Size of fillet weld for flange to web connection for built up section shall be as follows:

i) For box section weld size shall be designed for full shear capacity or actual shear whichever is more. Where fillet weld is not possible, full penetration butt weld shall be provided.

ii) For built up I section, weld size shall be designed for 80% of full shear capacity or actual shear, (if indicated, in drawings) whichever is more. However, weld size shall not be less than 0.5 times the web thickness. Weld shall be double fillet.

iii) All welds shall be continuous unless otherwise specifically approved. The minimum size of the fillet weld shall be 6mm.

c) Shear connections shall be designed for 60% of section strength for rolled sections and 80% of section strength for built up section or rolled section with cover plates. However, if load is more than above, the connection shall be designed for actual load.

d) Moment connections between beam and column shall be designed for 100% of moment capacity of the beam section.

e) All butt welds shall be full penetration butt welds.

f) The connection between top flange and web of crane girder shall be full penetration butt weld. Bottom flange, connection with web can be fillet weld or butt weld as directed by Engineer.

g) Connection of base plate and associated stiffeners with the columns shall be designed considering the total load transferred through welds. However, minimum weld size (double fillet) shall not be less than 0.6 times the thickness of stiffeners.

h) Splicing: All work shall be full strength. Field splicing shall be done with web and flange

cover plates for full strength. Shop splicing for all sections other than rolled shall be carried out by full penetration butt welds with no cover plates. Splicing for all rolled sections shall be carried out using web and flange cover plate.

6.03.31 Pipe Pedestals, pipe supports and other structures for Ash handling system:

a) The design of Pipe Pedestal and pipe supports shall be carried out considering Dead load, live load & seismic load / wind load. In addition to above, longitudinal forces equal to product of Co - efficient of friction (between contact surface of pipe and pedestal) with the load coming on each pedestal shall also be considered for the design of pedestal. In bends, suitable thrust block shall be provided to withstand the thrusts transferred from the pipelines.

b) All RCC pipes carrying water under gravity shall be designed for earth pressure, water and surcharge. Minimum grade of pipe shall be of NP - 2 class or heavier required as per design / specification.

c) The design and construction of RCC structures shall be carried out as per IS: 456. In general, limit state theory shall be followed for the design of RCC structures, however, working stress method shall be adopted for the design, wherever specifically mentioned in this specification.

d) Two layers of reinforcement (on inner and outer face) shall be provided for RCC wall sections having thickness 150mm and above.

6.03.32 **Design Criteria of RCC Floors**

a) For Mill Bunker Building, Main Power House, ESP Control Building, Transfer Houses, and other structural steel framed buildings:

These buildings being steel framed structure, all RCC floors shall comprise RCC slab supported on troughed, profiled metal deck sheet (to be used as permanent shuttering). The RCC slab shall be minimum 150mm thick above the top surface (crest) of the metal deck sheet. The spacing of structural steel secondary beams shall be based on the bending capacity of the metal deck sheet for self-weight of green concrete and additional construction load of 100 kg/m^2.

The permanent metal deck sheets shall be fixed to the top flange of secondary beams by means of drawn arc welding of headed shear anchor studs directly through the metal sheet. The details of shear anchor studs are specified elsewhere in this specification.

The RCC slab shall be designed without considering any composite action effect of metal deck sheet (i.e. the structural strength of metal deck sheet shall not be considered for RCC slab design).

(b) For Service Building & other RCC buildings.

These buildings being complete RCC framed structures, conventional RCC slabs of minimum thickness 150 mm shall be provided. The RCC slabs shall be monolithic with RCC beams and RCC columns

6.03.33 **Design Criteria of RCC roofs**

a) For Main Power House, Compressor House, ESP Control Building and Other Steel framed Buildings:

The roof system shall comprise minimum 40mm thick RCC slab on top of profiled permanent metal deck sheet. The permanent metal deck sheets shall be fixed to the top flange of secondary beams by means of arc welding of headed shear anchor studs to the purlins directly through the metal sheet. The details of shear anchor studs are specified elsewhere in this specification. Water proofing treatment to roof slab shall be provided as per details specified elsewhere in this specification).

The RCC slab shall be designed without considering any composite action effect of metal deck sheet (i.e. the structural strength of metal deck sheet shall not be considered for RCC slab design.

b) For Mill Bunker Building, Transfer Houses.

Insulated sandwiched metal sheet for roofing shall be provided comprising troughed permanently colour coated sheet at top and plain permanently colour coated sheet at bottom with 50mm thick insulation sandwiched between the two sheets, the details of which are specified elsewhere in this specification.

c) Roofing system for Ash Handling Plant Pump Houses and Buildings shall be as specified in relevant clauses

d) Other RCC Buildings.

Cast-in-Situ RCC slab shall be provided using removable plywood shuttering. Water proofing treatment to roof slab shall be provided as per details specified elsewhere in this specification).

6.03.34 **Design Criteria for Foundation**

The founding depth / cut off level of piles shall be decided based on functional requirement.

Where structural steel columns are envisaged, the bottom of the base plate shall be kept suitably below the paving level such that the top level of the gusset plate and foundation bolt remain at least 200 mm below the top level of paving except for Boiler Structure, Bunker Building Columns, TP & Trestle Columns, ESP Control Building Columns for which the requirement of levels for bottom of base plates is specified elsewhere in this specification. Further the gusset plate and foundation bolts are to be encased in concrete up to the top of the paving level. For outdoor structural steel columns, about 300 mm height of steel columns above the top of paving level shall be provided with at least 125 mm thick encasement with minimum reinforcement to prevent corrosion of the steel columns from surface water

a) OPEN Foundations

For foundations, the minimum founding depth and the minimum size of foundation shall be as per foundation system and geotechnical data specified in the foundation chapter include hereafter in this specification.

For open foundations, the total permissible settlement shall be as per the criteria furnished under the foundation system specified elsewhere in this specification.

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 both in case of bottom face and also for tension face of foundation shall be same as that stipulated for beam as per IS:456.

b) PILE Foundations

Minimum centre to centre spacing of the piles shall be as per IS: 2911. Incase single piles are used, these piles are to be interconnected with tie beams along both orthogonal directions perpendicular to each other.

Minimum penetration of piles into Pilecap shall be 75 mm and clear cover to the main reinforcement at the bottom face of the pile cap shall be 100 mm. Structural design of pile cap and reinforcement shall conform to IS:2911 and IS:456. However minimum 0.12% of cross section of the pile cap shall be provided on the top face of the pile cap along two orthogonal directions and minimum percentage of reinforcement at bottom face of pile cap shall be same as that stipulated for beam as per IS:456.

Detailed requirement of pile foundation have been presented in the foundation chapter specified hereafter in this specification.

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 point (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

i) **Supply**

Steel helical springs and viscous dampers and associated auxiliaries shall consist of:

(a) Steel helical springs units (fully pre-stressable) and viscous dampers units along with viscous liquid including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads, etc.

(b) Frames for pre-stressing of spring elements.

(c) Suitable hydraulic jack system including electric pumps, high pressure tubes etc. required for the erection, alignment etc., of the spring units. One set of extra hydraulic jacks, and hand operated pumps shall also be provided.

(d) Any other items which may be required for the pre-stressing, erection, release of pre-stress, alignment, and commissioning of the Steel helical springs and viscous dampers.

ii) **Design**

The spring units should have stiffness in both vertical and horizontal directions with the horizontal stiffness not less than 50% of vertical stiffness. However, for projects in high seismic zones, the minimum stiffness in horizontal direction shall be reviewed based on the design requirement and in no case it shall be less than 15% of vertical stiffness.

The stiffness should be such that the vertical natural frequency of any spring unit at its rated load carrying capacity is between 2 Hz to 4 Hz. The damper units or spring-cum-damper units should be of viscous type offering velocity proportional damping. The damper units should be suitable for temperatures ranging from 0 to 50°C. The damping resistance of individual damper units should be such that the designed damping can be provided using reasonable number of Units.

The Steel helical spring units and viscous damper units and their housings shall be designed for a minimum operating life of 30 years. Steel helical spring units shall conform to infinite life fatigue load calculations as per DIN EN 13906-1.

8.08.04 Manufacturing & Testing

Complete manufacturing and testing of the Steel helical springs and viscous dampers shall be done at the manufacturing shop of the approved sub vendor / supplier. For this purpose the contractor / sub vendor shall submit the detailed quality plan for approval of engineer and take up the manufacturing / testing after approval of such quality plan. The quality plan shall include

(a) Manufacturing schedule and quality check exercised during manufacturing.

(b) Detail of test to be carried out at the manufacturing shop with their schedule.

(c) Special requirements, if any, regarding concreting of top deck.

(d) Complete step-by-step procedure covering the installation and commissioning of the spring system.

(e) Manuals for erection, commissioning, testing and maintenance of the Steel helical springs and viscous dampers.

(f) A checklist for confirming the readiness of the civil fronts for erection of Steel helical springs and viscous dampers.

(g) Checklist for equipment required at each stage of erection.

(h) Bill of materials and data sheet of various elements such as spring units, viscous dampers, with their rating, stiffness etc. included in the supply.

(i) Bill of material and data sheet for frames for pre stressing, hydraulic jack including

electric pump, high pressure tubes, hand operated pump etc., with their rating and umbers.

(j) Any other details which may be necessary to facilitate design and construction of the foundations / structures.

8.08.05 The springs shall conform to codes DIN EN 13906-1 and DIN 2096. The quality assurance and inspection procedure shall be finalized on the basis of the above codes and the quality plans be drawn accordingly.

8.08.06 Transportation

Steel helical springs and viscous dampers shall be suitably protected, coated, covered, boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection.

8.08.07 Erection and Commissioning

Complete erection and commissioning of the Steel helical springs and viscous dampers including pre-stressing of elements, placing of elements in position, checking clearances on the shuttering of the RCC top deck, releasing of pre-stress in spring elements, making final adjustments and alignments etc. shall be carried out by a specialist supervisor of vendor.

The contractor shall guarantee the performance of the Steel helical springs and viscous dampers for 24 months from the date of commissioning of each machine which shall be termed as Guarantee Period".

8.08.08 Supervision

The supervision of installation of Steel helical springs and viscous dampers including pre-stressing, placing, releasing and alignment of spring units shall be done by a specialist supervisor of sub vendor / supplier, trained for this purpose.

8.08.09.1 Realignment of Spring System

If any realignment of the Steel helical springs and viscous dampers is required to be done for aligning the shaft or for any other reasons during the first one year of operation from the date of commissioning of the machine, the same shall be done by the contractor.

8.08.09.2 Acceptance Criteria

Stiffness values shall be checked. The permissible deviations shall be as per DIN 2096.

Following acceptance criteria shall be followed:

General workmanship is being good as recommended by the manufacturer and approved by Equipment supplier.

Tolerances are within the specified limit.

Manufacturer's test certificate (MTC) shall be in compliance with the applicable codes / standards.

Bought out material is from the approved manufacturer / vendor.

Bought out material is matching with the approved sample.

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

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.

Galvanised MS pipe of medium class conforming to IS:1239 shall be used for internal piping works for service water and potable water supply. The pipes shall be concealed, and painted with anti-corrosive bituminous paint (as per IS: 158) wherever required.

UPVC (conforming to IS:13592) shall be used for sanitary works above ground level.

All Buildings shall be designed with Toilets as per NBC norms.

All buildings shall have minimum one toilet block each. The facilities provided in the toilet block shall depend on the number of users. However, minimum facilities to be provided shall be as stipulated in subsequent clause. IS:1172 shall be followed for working out the basic requirements for water supply, drainage and sanitation.

In addition, IS:2064 and IS:2065 shall also be followed.

9.03.02 Each Toilet block shall have the following minimum facilities. Unless specified all the fittings shall be of Chromium plated brass (fancy type).

a) One number wall mounted coloured glazed vitreous China European water closet and flushing valve system, water faucet, toilet paper holder as per IS:2556

b) One number colour glazed ceramic oval shaped wash basin 450x 550 mm (approx.) mounted over 18mm thick granite beveled edge counter fitted with photo-voltaic control system for water controls, bottle trap as per IS:2556. For common toilets, number of washbasins shall be as per requirement. However, for Pump Houses the same shall be provided without photo voltaic control system for water control.

c) For Male Toilets Urinal as per requirements, with all fittings with photovoltaic control flushing system as per IS: 2556.

d) One number looking mirror 600 x 900 x 6 mm, edge mounted with teak beading and minimum 12 mm thick plywood backing, one number stainless towel rail 600 x 20 mm, one number liquid soap dispenser

e) One toilet with required facilities shall be provided for physically challenged persons as per National Building Code requirements

f) Janitor Space & space for drinking water cooler.

g) Electric operated hand dryer with photo voltaic control.

h) The pantry shall consist of one number stainless steel pantry sink, as per IS : 13983, of size 610 x 510 mm, bowl depth 200 mm with drain board of at least 450 mm length with trap, hot and cold water mixer, one number geyser of 25 liters capacity, with inlet and outlet connections, one number over head water storage tank, as per IS : 12701 and of 500 liters capacity, complete with float valve, overflow drainage pipe arrangement, GI concealed water supply pipe of minimum 12 mm diameter of medium class, cast iron sanitary pipe (with lead joints) of minimum 75 mm diameter, floor trap with Stainless

Steel grating, inlet and outlet connections for supply and drainage, with all bends, tees, junctions, sockets, etc., as are necessary for the commissioning and efficient functioning of the pantry (all sanitary fittings shall be heavy duty chrome plated brass, unless noted otherwise)

One number of pantry shall be provided on each floor of ESP control room building and One number of pantry shall be provided in Buildings having Control Room and at each floor of Service Building.

i) Laboratory sink shall be of white vitreous china of size 600x400x200 mm conforming to IS: 2556 (Part-5).

	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

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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

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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.

9.10.10 **Aluminium Composite Panel**

Aluminum Composite Panel cladding with open grooves shall be designed, fabricated, tested installed and fixed for linear as well as curvilinear portions of the building for all heights and levels including:

a) Structural analysis & design and preparation of shop drawings for pressure equalization or rain screen principle as required, proper drainage of water to make it watertight including checking of all the structural and functional design.

b) Aluminium Composite Panel cladding in pan shape in metallic/ solid colour of approved shades made out of 4mm thick aluminium composite panel. ACP consisting of 3mm thick Fire Retardant mineral filled Core comprising of around 70% Inorganic compound which is 100% non-combustible mineral and balance 30% is food grade virgin polymer sandwiched between two Aluminium sheets (each 0.5mm thick). The aluminium composite panel top and bottom skin should confirm to Aluminium Alloy 5005 (AlMg 1) marine grade series and H 22/24 temper.

The ACP sheet shall be coil coated with Kynar 500 based (70:30 ratio) PVDF / Lumiflon based fluoropolymer resin coating of approved colour and shade on face # 1 and polymer (Service) coating on face # 2 as specified using stainless steel screws, nuts, bolts, washers, cleats, weather silicone sealant, backer rods etc.

c) The fastening brackets of Aluminium alloy 6005 T5 / MS with Hot Dip Galvanised with serrations and serrated washers to arrest the wind load movement, fasteners, SS 316 Pins and anchor bolts of approved make in SS 316, Nylon separators to prevent bi-metallic contacts all complete required to perform as per specification and drawing.

9.10.11 **GRC Wall Cladding Tiles**

GRC Wall Cladding Tiles shall be of Unistone or equivalent company.

Glass Reinforced Concrete (G.R.C) Wall Cladding Tiles shall be of approved design, size, texture, thickness, patter and color. The thickness of the tiles shall range between 12 to 18mm (depending on the texture of the tile), allowing variance of 2 mm in accordance with IS: 1237□1980. The composition of tiles shall be '43' Grade Portland cement, reinforced with Alkali Resistant Glass Fiber and homogeny pigmentation shall be done with exterior grade synthetic inorganic iron oxide pigments manufactured by 'BAYFERROX / Lanxess (Germany)' or equivalent.

The pigmentation shall be homogeneous and in accordance with British Standards BS EN 12878:1999. The other additives shall be fine washed graded quartz, super plasticizers and integrated water proofing agents and others.

The tiles shall be produced with high vibration technology and concrete mix design compressive strength equivalent to M□40 Grade@28 days. The top surface of the tiles shall be sealed with acrylic lacquer resulting in surface water absorption of tiles, less than 1% and water absorption by 24 hrs immersion method, less than 8%. The tiles shall be applied on a rough plaster of 1:3 cement mortar 1:3 (1cement: 3 coarse sand) and the fixing of tiles shall be done by 'Unistone' tile adhesive or equivalent as per manufacturer's laying instruction.

9.10.11 **GRC Customized Screens and Dome in shapes as Specified**

GRC Customized Screens shall be of 'Unistone', make or equivalent.

Glass Reinforced Concrete (G.R.C) Screens shall casted with 'Spray Mix' concrete design in approved size, pattern, thickness of 50mm on the outer Border & 25-30mm for Internal

	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

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	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.

TABLE –A

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
1.	Main power house Building.			
	a) Unloading Bay	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)
	b) Cable vault	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)
	c) Balance area including passage	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)
	d) SWAS Room	Matt Finished Vitrified ceramic tiles.	Aluminium composite panel cladding on walls and columns upto false ceiling level	Alluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design
	e) Equipment Area, ESP SWGR/ ACP Room/ UAF Room	Cement concrete with Metallic hardener topping	Acrylic distemper.	Acrylic distemper (except metal deck area
	f) UPS Battery charger room	Matt finished Vitrified ceramic tiles.	Aluminium composite panel cladding on walls and columns upto false ceiling level	Alluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design
	g) Deaerator floor	Cement concrete with Metallic hardener topping.		-

TABLE –A

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
	h) Operating Floor	20 mm thick heavy duty anti skid full body vitrified tile in TG Hall. Rubber flooring at TG deck.	Colour coated Metal cladding on A-Row& Gable end, up to crane girder level.	Metal deck roofing (bottom of sheeting with RAL 9002 finish)
	i) General circulation and movement areas	20 mm thick heavy duty anti skid full body vitrified tile		Acrylic distemper (except metal deck area).
	j) Switchgear room	Heavy duty tiles (Cement Concrete tiles 300mmx300mm)	Acrylic distemper	Acrylic distemper (except metal deck area)
	k)MCC Room	Heavy duty tiles (Cement Concrete tiles 300mmx300mm)	Acrylic distemper	Acrylic distemper (except metal deck area)
	l) Control room area including control room	Matt Finish Vitrified ceramic tiles flooring of size 1000 x1000 mm	Partition in fire rated glass with fire rated frames with 2 hr fire rating & Aluminium composite panel cladding for columns and walls	Alluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design

TABLE –A

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
	m) control equipment room,	Matt finish Vitrified ceramic tiles.	Partition in fire rated glass with fire rated frames with 2 hr fire rating & Aluminium composite panel cladding for columns and walls	Allluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design
	n)Conference room, senior executive room., Computer Room	Matt finish Vitrified ceramic tiles	Partition in fire rated glass with fire rated frames with 2 hr fire rating & Aluminium composite panel cladding for columns and walls	Alluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design
	o)Record room	ceramic tiles	Acrylic distemper.	Alluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design
	p)Locker room	Ceramic Tiles	Acrylic Emulsion Paint	Alluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design
	q)Toilet area	ceramic tiles	Digitally glazed ceramic wall tiles up to False Ceiling Height	Alluminium False ceiling in size 600x 600

TABLE –A

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
	r) Office Room, Staff Room	Matt Finished Vitrified ceramic tiles.	Partition in fire rated glass with fire rated frames with 2 hr fire rating & Aluminium composite panel cladding for columns and walls	Alluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design
	s) Laboratory area	Vitrified Ceramic / Acid/alkali resistant tiles.	Designer ceramic wall tiles up to False Ceiling Height/ Aluminium composite panel cladding for columns and walls in case of A.C Panel	Alluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design
	t) RCC Stair case	18mm thick Granite (Polished and honed Finished) stone	Polished Granite Stone up to 1.2m. ht. & Acrylic Distemper Paint over wall putty finish for balance height.	Acrylic Distemper
	u) Lift and Staircase Lobby	18mm thick polished granite stone as pattern.	18mm thick polished granite & glass mosaic tile cladding up to False Ceiling Height	Alluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design
	v) Passages and general circulation areas.	Deleted	Deleted	Deleted

TABLE –A

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
	w) Battery Room	Acid and alkali resistant tile.	Acid and alkali resistant tile up to 1.2m height and chemical resistant paint for balance height	Chemical Resistant paint except in locations where Metal deck has been provided
	x) Oil canal, oil room, oil purification Tank and other areas where oil spillage is likely to occur.	Oil resistant paint (epoxy based) 150 micron over primer.	As above except oil canal Oil resistant Paint	As above except oil canal.
	y)Pathways including roof area.	22mm thick concrete chequered tiles.	-	-
2.	Service Building/Administration Building			

TABLE –A

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
	a) Entrance Lobbies and Lift areas/Foyer/Exhibition space.	18mm thick polished granite stone as/ pattern.	Combination of 18mm thick polished granite cladding, lacquered glass cladding and Fiber Reinforced Plastic murals based on local art in lift lobby & foyer	Alluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design
	b) Conference room, senior executive room.	11 mm thk. Laminated wooden flooring	Glazed partition with Aluminium frame/ Acrylic emulsion paint.	Mineral fiber board false ceiling in combination with GRG plaster board border in column depth or as per approved design.
	c) Office Room, Staff Room	Digitally glazed Vitrified ceramic tiles.	Acrylic emulsion paint./ Designer Glass mosaic tile mural in combination with textured paint in Canteen	Mineral fiber board false ceiling in combination with GRG plaster board border in column depth or as per approved design
	d) Passage	Digitally glazed Vitrified ceramic tiles.	Acrylic emulsion paint.	Alluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design

TABLE –A

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
	e) RCC Stair case	18mm thick Granite (Polished and Honed Finished) stone	Glass Mosaic Tile cladding in murals and pattern based on local art upto ceiling level	Acrylic Distemper.
	f) Toilet/ Pantry/ Kitchen	ceramic tiles	Digitally glazed ceramic wall tiles up to False Ceiling Height	Acrylic distemper in kitchen / Calcium Silicate false ceiling in toilet and pantry
	g) AHU/ A.C. Plant room/MCC Room/Store	Cement concrete with Metallic hardener topping.	Acrylic distemper / Wall insulation in AHU as per HVAC Requirement	Acrylic distemper / Underdeck insulation in AHU as per HVAC Requirement
	h) Stilt parking area	Cement concrete with Non-Metallic hardener topping.	-	-
	i) Pathways including roof area.	22mm thick concrete chequered tiles.		
3	ESP control building/Air compressor house			
	a) Operating/Maintenance areas	Cement concrete with Metallic hardener topping	Pre color coated metal panel cladding.	Acrylic distemper (except metal deck area)

TABLE –A

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
	b) Office Room, Staff Room	Digitally glazed Vitrified ceramic tiles.	Aluminium composite panel cladding on walls and columns	Mineral fiber Board False Ceiling
	c) Control Room	Digitally glazed Vitrified ceramic tiles.	Aluminium composite panel cladding on walls and columns in ESP Control Room Building	Alluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design
	d) MCC Room	Heavy duty tiles (Cement Concrete tiles 300mmx300mm)	Acrylic distemper	Acrylic distemper (except metal deck area)
	e) RCC Stair case	18mm thick Granite (Polished and Honed Finished) stone	Polished Granite stone up to 1.2m.ht. & Acrylic Distemper	Acrylic Distemper (except metal deck area)
	f) Battery Room	Acid, Alkali resistant tile	Acid, Alkali resistant tile 1.2m height / chemical resistant paint above dado	Chemical resistant paint (except metal deck area)
	g) AHU/ AC Plant room/ Cable vault	Cement concrete with Metallic hardener topping	Acrylic Distemper	Acrylic Distemper (except metal deck area)
	h) Toilets	ceramic tiles.	Designer ceramic wall tiles dado up to false ceiling level.	Calcium silicate false ceiling.

TABLE –A

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
4.	Mill & Bunker building/ T.P.s / Conveyor Galleries	Cement concrete with Metallic hardener topping	Acrylic distemper on masonry walls/ color coated Metal panel cladding	color coated Metal panel cladding
5.	Fire water pump house	Not Used	Not Used	Not Used
6.	Fire water booster water pump house.			
	a) Maintenance /Pump floor/PLC	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)
	b) Control room /PLC.	Matt Finished Vitrified Ceramic Tiles	Acrylic emulsion paint.	Mineral fiber board false ceiling.
	Toilet area	ceramic tiles.	Digitally glazed ceramic wall tiles dado up to false ceiling level.	Acrylic distemper

TABLE –A

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
7.	Ash slurry pump house/ Ash water pump house / Silo Area Utility Building / Ash Water recirculation Pump House/ Transport air compressor house/ HCSD pump house/Fuel Oil Unloading Pump House with switchgear building& control room /H2 generation Building/ Miscellaneous Switchgear room CW Pump house, Switchgear room, control room/ RW Pump house, Switchgear room, control room/Any other Building..			
	a) Operating/Maintenance areas/ MCC room	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)
8.	DELETED		.	
9.	O&M store building/Dozer Shed			

TABLE –A

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
	a) Stores/dozer shed	Cement concrete with Metallic hardener topping.	Acrylic distemper/ color coated Metal panel cladding	Acrylic distemper (except metal deck area)
	b)Office Room, Staff Room/ Electronic Store	Matt Finished Vitrified ceramic tiles.	Acrylic emulsion paint.	Acrylic Emulsion Paint. / Mineral Fibre Board False Ceiling in A.C area
	c)Passages	Matt Finished Vitrified Ceramic Tiles	Acrylic distemper	Acrylic distemper
	d)RCC Stair case	18mm thick polished Marble stone finish.	Marble stone up to 1.2m.ht. & Acrylic Distemper above.	Acrylic Distemper
	e) Toilets	ceramic tiles.	Designer ceramic wall tiles dado up to 2.1 m Height from FFL.	Acrylic distemper
10	Rest Room for O&M Workers			
	Rest room	Cement concrete with Metallic hardener topping.	Acrylic distemper	Metal roof

TABLE –A

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
	Toilets	ceramic tiles.	Digitally glazed ceramic wall tiles dado up to 2100 high, Acrylic Distemper paint above	Metal roof
10	**Occupational Health Centre with Crèche Facilities**			
	a)Waiting Lobby cum Reception/ Doctor's Chamber /First Aid Room/ Patient Room	Matt finish vitrified tiles	Acrylic Emulsion paint	Acrylic Emulsion paint
	b)Driver's Room	Digitally Glazed vitrified tiles	Acrylic Distemper Paint	Acrylic Distemper Paint
	c)Toilet area	ceramic tiles.	Digitally glazed ceramic wall tiles dado up to false ceiling level.	Calcium Silicate False Ceiling

TABLE –A

INTERIOR FINISHING SCHEDULE

S.NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
	Creche	5 mm thick vinyl flooring	Glass mosaic tiles in murals & patterns and Acrylic Emulsion Paint	Acrylic Emulsion paint

Note :

1. All wall and roof areas above false ceiling shall be plastered.
2. The colour and pattern of finish shall be as per approved details.
3. All materials shall be of reputed and established brand approved by Engineer-in-charge.
4. Wherever alternative materials are specified, the final selection rests with Engineer-in-charge.
5. This finishing schedule shall also be applicable to similar functional areas for all other buildings and facilities.
6. All the finishing materials shall be applied/provided as per manufacturer specification and guidelines under the supervision & guidelines of manufacturer.
7. Requirement given above are suggestive and minimum. Bidder is welcome to suggest alternative scheme conforming to design functional requirement subject to approval of the Engineer-in-charge.

TABLE –B

EXTERIOR FINISHES SCHEDULE

Sl.No.	DESCRIPTION OF AREA	WALL AND PROJECTIONS	SOFFIT OF PROJECTIONS
1.	Auxiliary building in steel framed structure.	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Water Proof Cement Paint over plastered surface/ Aluminium Composite Panel Approved colour/ colour combination of colour coated metal cladding	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Water Proof Cement Paint over plastered surface Approved colour/ colour combination of colour coated metal cladding
2.	Building with concrete frame work, etc.	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Water Proof Cement Paint over plastered surface	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Water Proof Cement Paint over plastered surface
3.	Steel Structure, trestles, etc.	High performance Paint of approved specification and shade.	
4.	Administration Building, Gate Complex and CISF building	GRC Tiles, GRC Customized Screens, Domes, design developed based on Tender Drawing	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Water Proof Cement Paint over plastered surface

5	Service Building	GRC Tiles, GRC Customized Screens and Aluminium Composite Panel	Premium Acrylic Smooth exterior paint with silicon additives over suitable primer of Water Proof Cement Paint over plastered surface

NOTE : 1. The colour and pattern of finish shall be as finalized by Engineer.

2. All materials shall be of reputed and established brand approved by Engineer.

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(C)

Annexure (C)

GEOTECHNICAL DATA

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 02/09/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 1

Co-ordinates E=1321 N=4260

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	2	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	2
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 20/08/17
Completion Date : 23/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 71.273 m.
Water Struck At :
Standing Water Level : 1.80 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Very dense, yellowish grey, silty sand with boulder. (SM)		100 5.0 cm Penth. Refusal	DS-1	0.50
1.10m.		100 2.0 cm Penth. Refusal	*SPT-1	1.00-1.05
			*SPT-2	1.10-1.12
		NX rotary drilling from 1.10m to 16.10m	R1	CR=56% RQD=NIL 1.10-1.85
Moderately to slightly weathered, yellowish grey, fine grained, highly fractured sandstone.			R2	CR=52% RQD=NIL 1.85-2.60
			R3	CR=60% RQD=16% 2.60-3.35
			R4	CR=64% RQD=NIL 3.35-4.10
			R5	CR=66% RQD=18% 4.10-4.85
			R6	CR=72% RQD=NIL 4.85-5.60
5.60m.			R7	CR=68% RQD=NIL 5.60-6.35
			R8	CR=72% RQD=NIL 6.35-7.10
			R9	CR=70% RQD=32% 7.10-7.85
			R10	CR=84% RQD=32% 7.85-8.60
			R11	CR=76% RQD=23% 8.60-9.35
			R12	CR=78% RQD=16% 9.35-10.10
Slighty weathered / fresh, grey, fine grained, moderately fractured sandstone.			R13	CR=82% RQD=24% 10.10-10.85
			R14	CR=76% RQD=23% 10.85-11.60
			R15	CR=83% RQD=36% 11.60-12.35
			R16	CR=78% RQD=48% 12.35-13.10
			R17	CR=88% RQD=24% 13.10-13.85
			R18	CR=85% RQD=52% 13.85-14.60
			R19	CR=96% RQD=80% 14.60-16.10
N.B. - '*' means sample could not be recovered. 16.10m.				

BH-1/Sheet-1

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 17/08/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 2

Co-ordinates E=1420 N=4257

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	1

Commencement Date : 29/07/17
Completion Date : 02/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 72.492 m.
Water Struck At :
Standing Water Level : 1.20 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Medium dense, brownish yellow silty sand with kankars. (SM)		10 8 16 — 24	DS-1	0.50
			UDS-1	1.00-1.45
			WS-1	1.20
			SPT-1	1.45-1.90
			DS-2	2.50
3.00m		32		
Hard, deep yellow, silty clay / clayey silt with sand mixture. (Cl)		6 10 22	SPT-2	3.00-3.45
			DS-3	4.00
		Refusal	SPT-3	4.50-4.60
		100 10.0 cm Pentn.		
4.80m		Refusal 100 2.0 cm Pentn.	*SPT-4	4.80-4.82
		NX rotary drilling from 4.60m to 30.05m	R1	CR=28% RQD=NIL 4.80 - 5.55
			R2	CR=32% RQD=NIL 5.55 - 6.30
			R3	CR=26% RQD=NIL 6.30 - 7.05
Highly weathered, greyish yellow, fine to medium grained, fractured sandstone.			R4	CR=30% RQD=NIL 7.05 - 7.80
			R5	CR=30% RQD=NIL 7.80 - 8.55
			R6	CR=28% RQD=NIL 8.55 - 9.30
			R7	CR=30% RQD=NIL 9.30 - 10.05
			R8	CR=27% RQD=NIL 10.05 - 10.80
11.50m			R9	CR=28% RQD=NIL 10.80 - 11.50
			R10	CR=75% RQD=53% 11.50 - 12.25
			R11	CR=85% RQD=19% 12.25 - 13.00
Slightly weathered / fresh, deep grey, fine to medium grained, fractured sandstone.			R12	CR=76% RQD=20% 13.00 - 13.75
			R13	CR=72% RQD=NIL 13.75 - 14.50
			R14	CR=75% RQD=NIL 14.50 - 15.25
15.25m				

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST			
Job No : 3975	Created by : Chandrani	Created on : 17/08/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 2

Co-ordinates E=1420 N=4257

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 : 29/07/17
Completion Date : 02/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 72.492 m
Water Struck At :
Standing Water Level : 1.20 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
15.25m.				
			R15	CR=85% RQD=NIL
				16.00
			R16	CR=89% RQD=NIL
				16.75
			R17	CR=81% RQD=NIL
				18.25
			R18	CR=61% RQD=NIL
				19.75
			R19	CR=85% RQD=NIL
				20.50
			R20	CR=83% RQD=NIL
				21.25
			R21	CR=80% RQD=NIL
Slightly weathered / fresh, deep grey, fine to medium grained, fractured sandstone.				22.75
			R22	CR=87% RQD=NIL
				24.25
			R23	CR=92% RQD=25%
				25.75
			R24	CR=81% RQD=NIL
				27.25
			R25	CR=85% RQD=NIL
				28.75
			R26	CR=86% RQD=08%
30.05m.				30.05

N.B. – '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975	Created by : Chandrani	Created on : 22/09/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 3

Co-ordinates E=1510 N=4270

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 19/08/17
Completion Date : 20/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 70.643 m.
Water Struck At :
Standing Water Level : 1.10 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	Depth (m)
0.00m.				
Filled up soil consists of deep brownish grey, silty sand with brick bats.			DS-1	0.50
			*UDS-1	1.00-1.45
1.65m.		16		
Very stiff to hard, greyish brown, silty clay with fine sand mixture. (Cl)		5 7 9	SPT-1	1.55-2.00
		42 57 >100	SPT-2	2.10-2.30
2.30m.		5.0 cm Penth.		
Very dense, yellowish brown, silty fined sand with rock dust. (SM)		100 Refusal	*SPT-3	2.45-2.48
		3.0 cm Penth.	DS-2	2.50
2.55m.		100 Refusal	*SPT-4	2.55-2.58
		3.0 cm Penth.		2.55
			R1	CR=24% RQD=NIL
		NX rotary drilling from 2.55m to 20.00m		3.25
			R2	CR=28% RQD=NIL
				4.00
			R3	CR=36% RQD=NIL
				4.75
Highly to moderately weathered, yellowish brown, fine to medium grained, highly fractured sandstone.			R4	CR=46% RQD=NIL
				5.50
			R5	CR=40% RQD=16%
				6.25
			R6	CR=42% RQD=18%
				7.00
			R7	CR=48% RQD=NIL
7.75m.				7.75
			R8	CR=50% RQD=30%
				8.50
Moderately weathered, yellowish brown, fine to medium grained, highly to moderately fractured sandstone.			R9	CR=56% RQD=16%
				9.25
			R10	CR=45% RQD=17%
				10.00
			R11	CR=48% RQD=22%
10.50m.				

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 22/09/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 3

Co-ordinates E=1510 N=4270

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 19/08/17
Completion Date : 20/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 70.643 m.
Water Struck At :
Standing Water Level : 1.10 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
				10.75
			R12 CR=57% RQD=40%	11.50
			R13 CR=62% RQD=20%	12.25
Moderately weathered, yellowish brown, fine to medium grained, highly to moderately fractured sandstone.			R14 CR=46% RQD=16%	13.00
			R15 CR=49% RQD=18%	13.75
			R16 CR=48% RQD=22%	14.50
10.50m.				
			R17 CR=69% RQD=20%	15.25
			R18 CR=64% RQD=NIL	16.00
			R19 CR=79% RQD=48%	16.75
Slightly weathered, brownish grey, medium grained, moderately fractured sandstone.			R20 CR=62% RQD=36%	17.50
			R21 CR=64% RQD=23%	18.25
			R22 CR=76% RQD=33%	19.00
			R23 CR=78% RQD=38%	20.00
14.50m.				
20.00m.				

N.B. – '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 17/08/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 4

Co-ordinates E=1607 N=4245

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	3	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	3
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 04/08/17
Completion Date : 06/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 70.719 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				
Dense, yellowish brown, silty sand / sandy silt. (SM)		4 16 24 40	DS-1	0.50
			UDS-1	1.00-1.45
			SPT-1	1.45-1.90
			DS-2	2.50
3.00m				
Very dense, yellowish grey, clayey silty sand with decomposed rock. (SM)		45 56 >100 7.0 cm Pentn. Refusal	SPT-2	3.00-3.22
4.00m		100 2.0 cm Pentn.	*SPT-3	4.00-4.02
Slightly weathered / fresh, greyish yellow, medium to fine grained, fractured sandstone.		NX rotary drilling from 4.00m to 17.50m	R1	CR=68% RQD=23% 4.00-4.75
			R2	CR=68% RQD=15% 4.75-5.50
			R3	CR=79% RQD=31% 5.50-6.25
			R4	CR=92% RQD=NIL 6.25-7.00
			R5	CR=75% RQD=40% 7.00-7.75
			R6	CR=91% RQD=24% 7.75-8.50
			R7	CR=79% RQD=15% 8.50-9.25
			R8	CR=73% RQD=15% 9.25-10.00
10.00m				
			R9	CR=87% RQD=37% 10.00-10.75
			R10	CR=88% RQD=17% 10.75-11.50
			R11	CR=83% RQD=15% 11.50-13.00
Fresh, deep grey, medium to fine grained, fractured sandstone.			R12	CR=84% RQD=24% 13.00-14.50
			R13	CR=83% RQD=29% 14.50-16.00
			R14	CR=82% RQD=33% 16.00-17.50
17.50m				

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).				CETEST
Job No : 3975	Created by : Chandrani	Created on : 18/08/2017	Sheet No:	

BORE LOG DATA SHEET

BORE HOLE NO. 5

Co-ordinates E=1210 N=4230

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 : 02/08/17
Completion Date : 02/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 72.492 m.
Water Struck At :
Standing Water Level : 1.55 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Filled up soil consists of yellowish grey, silty medium to coarse grained sand. Obs. boulders.			DS-1	0.50
			*UDS-1	1.00-1.30
1.50m.		>100		
Very dense, yellowish grey, silty medium grained sand. Obs. decomposed rock. (SM)		23 46 21 5.0 cm Penetn. Refusal	SPT-1	1.50-1.85
		102 4.0 cm Penetn.	*SPT-2	2.20-2.24
2.50m.		106 Refusal 4.0 cm Penetn.	*SPT-3	2.50-2.54
Moderately to slightly weathered, brownish grey, fine grained, fractured sandstone.		NX rotary drilling from 2.50m to 10.00m	R1	CR=53% RQD=19%
			R2	CR=64% RQD=51%
4.00m.			R3	CR=93% RQD=90%
			R4	CR=92% RQD=84%
			R5	CR=87% RQD=19%
Fresh, brownish grey to grey, fine grained, fractured sandstone.			R6	CR=85% RQD=77%
			R7	CR=98% RQD=78%
10.00m.				

2.50 → 3.25 → 4.00 → 4.75 → 5.50 → 7.00 → 8.50 → 10.00

N.B. – '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 28/08/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 6

Co-ordinates E=1218 N=3946

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	3	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	3
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date : 14/08/17
Completion Date : 17/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 71.242 m.
Water Struck At :
Standing Water Level : 1.9 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Filled up soil consists of yellowish grey, silty sand with gravels & boulders.			DS-1	0.50
			DS-2	1.00
1.60m. Hard, light grey, silty clay. Obs. decomposed rock. (Cl)		≥100 (16 51/33) 5.0 cm Pentn.	*UDS-1	2.00-2.20
			SPT-1	2.30-2.65
3.00m. Very dense, yellowish grey, silty sand with decomposed rock. (SM)		≥100 (100) 3.0 cm Pentn.	DS-3	3.00
			*SPT-2	3.60-3.63
3.70m.		Refusal (100) 2.0 cm Pentn.	*SPT-3	3.70-3.72
Moderately to slightly weathered, yellowish grey, medium grained, fractured rock.		NX rotary drilling from 3.70m to 20.00m	R1 CR=58% RQD=19%	3.70 - 4.40
			R2 CR=56% RQD=NIL	4.40 - 5.15
			R3 CR=55% RQD=24%	5.15 - 5.90
			R4 CR=76% RQD=40%	5.90 - 6.65
			R5 CR=72% RQD=NIL	6.65 - 7.40
7.40m.			R6 CR=60% RQD=NIL	7.40 - 8.15
			R7 CR=72% RQD=46%	8.15 - 8.90
			R8 CR=56% RQD=NIL	8.90 - 9.65
			R9 CR=72% RQD=14%	9.65 - 10.40
			R10 CR=68% RQD=24%	10.40 - 11.15
			R11 CR=72% RQD=20%	11.15 - 11.90
			R12 CR=76% RQD=14%	11.90 - 12.65
			R13 CR=72% RQD=NIL	12.65 - 13.40
Slightly weathered / fresh, grey, medium grained, fractured sandstone.			R14 CR=68% RQD=24%	13.40 - 14.15
			R15 CR=77% RQD=22%	14.15 - 14.90
			R16 CR=68% RQD=20%	14.90 - 15.65
			R17 CR=72% RQD=40%	15.65 - 16.40
			R18 CR=74% RQD=20%	16.40 - 17.15
			R19 CR=76% RQD=56%	17.15 - 17.90
			R20 CR=81% RQD=22%	17.90 - 18.65
			R21 CR=84% RQD=72%	18.65 - 19.40
N.B. - '*' means sample could not be recovered. 20.00m.			R22 CR=80% RQD=35%	19.40 - 20.00

BH-6/Sheet-1

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 17/08/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 7

Co-ordinates E=1140 N=4009

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 11/08/17
Completion Date : 12/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 71.120 m.
Water Struck At :
Standing Water Level : 0.95 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m Brownish grey, silty sand. Obs. boulders. (SM)			DS-1	0.50
			*UDS-1	1.00-1.45
1.50m		9 13 14 (27)	SPT-1	1.60-2.05
Stiff to very stiff, brownish grey, silty clay. Obs. kankars. (Cl)			DS-2	2.50
		4 6 8 (14)	SPT-2	3.00-3.45
3.70m				
Very dense, brownish grey, silty sand with decomposed rock. (SM)		48 52 (>100) 10.0 cm Pentn.	SPT-3	4.00-4.25
		100 4.0 cm (>100) Pentn.	*SPT-4	4.40-4.44
4.70m		100 4.0 cm Refusal Pentn.	*SPT-5	4.70-4.74
Highly weathered, brownish grey, medium to fine grained fractured sandstone.			R1	CR=28% RQD=NIL
5.25m				5.25
		NX rotary drilling from 4.70m to 15.00m	R2	CR=65% RQD=44%
				6.00
			R3	CR=76% RQD=48%
Slightly weathered, brownish grey to deep grey, medium to fine grained fractured sandstone.				6.75
			R4	CR=71% RQD=22%
				7.50
			R5	CR=68% RQD=NIL
8.25m				8.25
			R6	CR=84% RQD=74%
				9.00
			R7	CR=81% RQD=52%
				9.75
			R8	CR=88% RQD=21%
				11.00
Fresh, deep grey, fine grained, fractured rock			R9	CR=87% RQD=72%
				12.50
			R10	CR=86% RQD=23%
				14.00
			R11	CR=81% RQD=64%
15.00m				15.00

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 17/08/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 8

Co-ordinates E=1110 N=3920

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 09/08/17
Completion Date : 11/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 71.142 m.
Water Struck At :
Standing Water Level : 1.80 m

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Medium dense, brownish grey, silty medium sand. Obs. kankars & traces of clay binders. (SM)		8 11 12 — 23	DS-1	0.50
			*UDS-1	1.00-1.45
			SPT-1	1.45-1.90
2.00m			DS-2	2.50
Very dense, yellowish grey, silty fine to medium grained sand. Obs. decomposed rock. (SM)		28 32 40 — >100	SPT-2	2.80-3.19
		100 — 9.0 cm Penetn. Refusal	*SPT-3	3.50-3.54
		100 — 4.0 cm Penetn. Refusal	*SPT-4	3.80-3.83
3.80m		3.0 cm Penetn.		
		NX rotary drilling from 3.80m to 15.00m	R1	CR=42% RQD=NIL
Moderately to slightly weathered, yellowish grey, medium to fine grained, fractured sandstone.			R2	CR=52% RQD=NIL
			R3	CR=64% RQD=NIL
			R4	CR=70% RQD=NIL
			R5	CR=69% RQD=NIL
			R6	CR=68% RQD=NIL
8.25m			R7	CR=80% RQD=76%
			R8	CR=92% RQD=22%
			R9	CR=88% RQD=80%
Fresh, grey to deep grey, medium to fine grained, fractured sandstone.			R10	CR=83% RQD=70%
			R11	CR=84% RQD=20%
			R12	CR=85% RQD=72%
15.00m				

3.80 4.50 5.25 6.00 6.75 7.50 8.25 9.00 9.75 11.00 12.50 14.00 15.00

N.B. – '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 03/08/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 9

Co-ordinates E=1100 N=3826

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	3	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	3
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 22/07/17
Completion Date : 24/07/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 71.497 m.
Water Struck At :
Standing Water Level : 1.52 m.

DESCRIPTION		SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
Grey, Silty sand. Obs. gravels. (SM)	0.00m				
	0.40m			DS-1	0.50
Medium, yellowish grey, silty clay with sand mixture & kankars. (Cl)			8	UDS-1	0.70-1.05
	1.05m		3 4 4	SPT-1	1.05-1.50
Loose, yellowish grey, silty sand / sandy silt. Obs. kankars. (SM)				DS-2	2.00
	2.50m		Refusal 100. 6.0 cm Penth.	SPT-2	2.50-2.56
Very dense, yellowish grey, silty sand with decomposed rock. (SM)	2.70m		Refusal 100 2.0 cm Penth.	*SPT-3	2.70-2.72
				R1	CR=29% RQD=NIL 2.70 - 3.40
				R2	CR=27% RQD=NIL 3.40 - 4.15
				R3	CR=29% RQD=NIL 4.15 - 4.90
				R4	CR=24% RQD=14% 4.90 - 5.65
Highly weathered, yellowish grey, medium grained, highly fractured sandstone.			NX rotary drilling from 2.70m to 15.00m	R5	CR=28% RQD=NIL 5.65 - 6.40
				R6	CR=27% RQD=NIL 6.40 - 7.15
				R7	CR=27% RQD=NIL 7.15 - 7.90
				R8	CR=21% RQD=NIL 7.90 - 8.45
				R9	CR=35% RQD=NIL 8.45 - 9.20
	9.20m			R10	CR=84% RQD=NIL 9.20 - 9.95
				R11	CR=88% RQD=NIL 9.95 - 10.70
				R12	CR=82% RQD=24% 10.70 - 12.20
Fresh, deep grey, medium grained, fractured sandstone.				R13	CR=80% RQD=29% 12.20 - 13.70
				R14	CR=81% RQD=66% 13.70 - 15.00
	15.00m				

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 03/08/2017	Sheet No:

BORE LOG DATA SHEET

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		Refusal 100 — 6.0 cm Pentn.	*SPT-2	2.50-2.56
Very dense, yellowish grey, silty sand with kankars. Obs. decomposed rock dust. (SM)		Refusal 100 — 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.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 03/08/2017	Sheet No:

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

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975 | **Created by : Chandrani** | **Created on : 17/08/2017** | **Sheet No:**

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.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 17/08/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 13

Co-ordinates E=1290 N=3713

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
		Disturbed (DS)	2
Vane (V)		Water Sample (WS)	0

Commencement Date : 30/07/17
Completion Date : 31/07/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 68.955 m.
Water Struck At :
Standing Water Level : 1.40 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	Depth (m)
0.00m.				
Stiff, deep grey, silty clay. Obs. kankars. (Cl)		5 7 7 (14)	DS-1	0.50
			UDS-1	1.00-1.45
			SPT-1	1.45-1.90
			DS-2	2.50
3.00m.			*UDS-2	3.00-3.10
		9 16 26 (42)	SPT-2	3.10-3.55
Dense to very dense, silty fine to medium grained sand with decomposed rock. (SM)		24 52 24 (>100) 9.0 cm Penetn.	SPT-3	4.10-4.49
		100 Refusal	*SPT-4	4.60-4.64
4.75m.		100 4.0 cm Penetn. Refusal	*SPT-5	4.75-4.78
		3.0 cm Penetn.	R1	CR=48% RQD=17%
		NX rotary drilling from 4.75m to 13.50m	R2	CR=67% RQD=20%
Moderately to slightly weathered, brownish grey to grey, medium to fine grained, fractured sandstone.			R3	CR=80% RQD=64%
			R4	CR=77% RQD=20%
7.75m.			R5	CR=82% RQD=32%
			R6	CR=80% RQD=20%
			R7	CR=90% RQD=22%
Fresh, grey, fine grained, fractured sandstone.			R8	CR=93% RQD=87%
			R9	CR=97% RQD=93%
13.50m.				

4.75
5.50
6.25
7.00
7.75
8.50
9.25
10.50
12.00
13.50

N.B. - '*' means sample could not be recovered.

BH-13/Sheet-1

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 03/08/2017	Sheet No:

BORE LOG DATA SHEET

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.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 03/08/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 15

Co-ordinates E=1523 N=3681

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 26/07/17
Completion Date : 28/07/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 67.092 m.
Water Struck At :
Standing Water Level : 1.20 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Medium to stiff, yellowish brown, silty clay / clayey silt with sand mixture. (Cl)		2 4 4 (8)	DS-1	0.50
			UDS-1	1.00-1.45
			SPT-1	1.45-1.90
			DS-2	2.50
		2 4 7 (11)	SPT-2	3.00-3.45
4.00m				
Very dense, yellowish grey, clayey silty sand with decomposed rock. (SM)		70 5.0 cm Pentn. (>100)	SPT-3	4.20-4.25
4.30m		100 Refusal 2.0 cm Pentn.	*SPT-4	4.30-4.32
Moderately weathered, greyish yellow, medium grained, fractured sandstone.			R1	CR=53% RQD=NIL
5.00m				5.00
			R2	CR=69% RQD=20%
Slightly weathered, yellowish grey, medium grained, fractured sandstone.				5.75
			R3	CR=72% RQD=NIL
6.50m		NX rotary drilling from 4.30m to 12.50m		6.50
			R4	CR=81% RQD=17%
				7.25
			R5	CR=84% RQD=19%
				8.00
			R6	CR=80% RQD=24%
				9.50
Fresh, grey, medium grained, fractured sandstone.			R7	CR=84% RQD=35%
				11.00
			R8	CR=86% RQD=47%
12.50m				12.50

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 03/08/2017	Sheet No:

BORE LOG DATA SHEET

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.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 03/08/2017	Sheet No:

BORE LOG DATA SHEET

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

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST			
Job No : 3975	Created by : Chandrani	Created on : 03/08/2017	Sheet No:

BORE LOG DATA SHEET

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.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 12/09/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 19

Co-ordinates E=1319 N=3415

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date : 19/08/17
Completion Date : 20/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 67.452 m.
Water Struck At :
Standing Water Level : 2.20 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Filled up soil consists of brownish grey, silty clay followed by ash from 0.80m.		2 3 4 (7)	DS-1	0.50
			*UDS-1	1.00-1.45
			SPT-1	1.55-2.00
2.50m.			DS-2	2.50
Stiff, greyish yellow, silty clay with sand mixture. (Cl)		2 4 4 (8)	SPT-2	3.00-3.45
			UDS-2	4.00-4.45
		4 6 7 (13)	SPT-3	4.45-4.90
			DS-3	5.50
5.80m.				
Very dense, yellowish brown, silty sand with decomposed rock. (SM)		100 8.0 cm Penth. (>100)	SPT-4	6.00-6.08
6.20m.		100 2.0 cm Penth. Refusal	*SPT-5	6.20-6.22
Highly to moderately weathered, yellowish brown, medium to fine grained, fractured sandstone.		NX rotary drilling from 6.20m to 15.00m	R1	CR=40% RQD=23% (6.20-7.00)
			R2	CR=53% RQD=17% (7.00-7.75)
			R3	CR=59% RQD=NIL (7.75-8.50)
			R4	CR=45% RQD=17% (8.50-9.25)
9.25m.			R5	CR=64% RQD=16% (9.25-10.00)
Slightly weathered / fresh, light grey, medium to fine grained, moderately fractured sandstone.			R6	CR=67% RQD=15% (10.00-10.75)
			R7	CR=68% RQD=40% (10.75-11.50)
			R8	CR=72% RQD=24% (11.50-12.25)
			R9	CR=85% RQD=48% (12.25-13.00)
			R10	CR=83% RQD=32% (13.00-13.15)
			R11	CR=84% RQD=53% (13.15-15.00)
15.00m.				

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975 | Created by : Chandrani | Created on : 03/08/2017 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 20

Co-ordinates E=1399 N=3412

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 : 21/07/17
Completion Date : 23/07/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 68.317 m.
Water Struck At :
Standing Water Level : 3.40 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Filled up soil consists of brownish grey, silty clay with ash.			DS-1	0.50
1.00m. Filled up soil consists of brownish grey, silty sand / sandy silt.			UDS-1	1.00-1.45
		3 3 4 (7)	SPT-1	2.00-2.45
2.60m. Medium to stiff, deep grey, silty clay with sand mixture. Obs. kankars. (Cl)			DS-2	3.00
		3 4 4 (8)	SPT-2	3.50-3.95
			UDS-2	4.10-4.55
		3 4 5 (9)	SPT-3	4.55-5.00
5.10m. Very dense, grey, silty sand, decomposed rock. Obs. traces of clay. (SM)		20 41 53 (>100) 8.0 cm Pentn.	SPT-4	5.40-5.78
		(>100)	DS-3	6.00
		46 61 (>100) 5.0 cm Pentn.	SPT-5	6.30-6.50
		104 Refusal 4.0 cm Pentn.	*SPT-6	6.90-6.94
7.20m. Highly to moderately weathered, grey, medium grained, fractured sandstone.		101 Refusal 4.0 cm Pentn.	*SPT-7	7.20-7.24
		NX rotary drilling from 7.20m to 15.00m	R1	CR=47% RQD=30% (7.20 - 8.00)
			R2	CR=44% RQD=20% (8.00 - 8.75)
			R3	CR=56% RQD=15% (8.75 - 9.50)
			R4	CR=47% RQD=NIL (9.50 - 10.25)
			R5	CR=28% RQD=NIL (10.25 - 11.00)
			R6	CR=27% RQD=NIL (11.00 - 11.75)
			R7	CR=29% RQD=NIL (11.75 - 12.50)
			R8	CR=33% RQD=NIL (12.50 - 13.25)
			R9	CR=32% RQD=NIL (13.25 - 14.00)
			R10	CR=36% RQD=NIL (14.00 - 15.00)
15.00m. N.B. - '*' means sample could not be recovered.				

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 03/08/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 21

Co-ordinates E=1299 N=3336

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
		Disturbed (DS)	3
Vane (V)		Water Sample (WS)	1

Commencement Date : 17/07/17
Completion Date : 20/07/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 67.346 m.
Water Struck At :
Standing Water Level : 2.45 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Filled up soil consists of brownish grey, silty clay followed by ash from 0.60m to 2.40m.		3 3 3 — 6	DS-1	0.50
			*UDS-1	1.00-1.45
			SPT-1	1.60-2.05
			WS-1	2.45
			DS-2	2.50
2.40m.				
Stiff, grey, silty clay with sand mixture. (Cl)		3 4 6 — 10	UDS-2	3.00-3.45
			SPT-2	3.45-3.90
4.30m.				
Very dense, grey, silty sand with decomposed rock. (SM)		16 29 64 — >100	DS-3	4.50
		5.0 cm Pentn. Refusal	SPT-3	5.00-5.35
		53 — 4.0 cm Pentn. Refusal	*SPT-4	5.60-5.64
5.80m.		51 — 4.0 cm Pentn.	*SPT-5	5.80-5.84
		NX rotary drilling from 5.80m to 10.00m	R1	CR=40% RQD=31% (5.80 - 6.50)
			R2	CR=58% RQD=47% (6.50 - 7.25)
Highly to moderately weathered, yellowish grey to grey, fine grained fractured sandstone.			R3	CR=42% RQD=24% (7.25 - 8.00)
			R4	CR=25% RQD=NIL (8.00 - 8.75)
			R5	CR=28% RQD=NIL (8.75 - 9.50)
			R6	CR=38% RQD=NIL (9.50 - 10.00)
10.00m.				

N.B. – '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 08/09/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 22

Co-ordinates E=1024 N=4670

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	3
Cone (Pc)		Penetrometer (SPT)	7
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date : 24/08/17
Completion Date : 25/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 74.312 m.
Water Struck At :
Standing Water Level : 4.50 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
			DS-1	0.50
			*UDS-1	1.00-1.10
		4 7 22 (29)	SPT-1	1.25-1.70
Filled up soil consists of silty clay with boulders & ash.				
			DS-2	2.50
		5 7 9 (16)	SPT-2	3.00-3.45
4.00m				
			UDS-2	4.00-4.45
		4 6 8 (14)	SPT-3	4.45-4.90
Stiff to very stiff, light grey, silty clay. Obs. kankars. (Cl)				
			DS-3	5.50
		5 7 9 (16)	SPT-4	6.00-6.45
7.00m				
		20 36 48 (84)	*UDS-3	7.00-7.10
Very dense, grey, silty fine grained sand with decomposed rock. (SM)			SPT-5	7.10-7.55
		100 Refusal 4.0 cm Pentn.	*SPT-6	7.80-7.84
8.10m		100 Refusal 4.0 cm Pentn.	*SPT-7	8.10-8.14
			R1	CR=48% RQD=17% (8.10 - 8.75)
Moderately to slightly weathered, deep grey, fine grained, fractured sandstone.		NX rotary drilling from 8.10m to 10.00m	R2	CR=69% RQD=31% (8.75 - 9.50)
			R3	CR=74% RQD=41% (9.50 - 10.00)
10.00m				

N.B. – '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 29/08/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 23

Co-ordinates E=855 N=4610

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
		Disturbed (DS)	3
Vane (V)		Water Sample (WS)	0

Commencement Date : 20/08/17
Completion Date : 20/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 72.812 m.
Water Struck At :
Standing Water Level : 1.20 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m Filled up soil consists of silty clay with road materials.			DS-1	0.50
0.80m Stiff, grey, silty clay. Obs. kankars. (Cl)		3 4 5 (9)	UDS-1	1.00-1.45
			SPT-1	1.45-1.90
			DS-2	2.50
		4 5 6 (11)	SPT-2	3.00-3.45
			UDS-2	4.00-4.45
		5 6 8 (14)	SPT-3	4.45-4.90
			DS-3	5.50
6.00m Very stiff, grey, silty clay. Obs. kankars. (Cl)		7 8 9 (17)	SPT-4	6.00-6.45
6.80m Very dense, brownish grey, silty medium grained sand with decomposed rock. (SM)		100 10.0 cm Pentn. (>100)	SPT-5	7.00-7.10
7.30m		100 4.0 cm Pentn. (>100)	*SPT-6	7.30-7.34
		NX rotary drilling from 7.30m to 15.00m	R1	CR=62% RQD=16% 7.30-8.00
			R2	CR=61% RQD=52% 8.00-8.75
			R3	CR=71% RQD=54% 8.75-9.50
			R4	CR=76% RQD=17% 9.50-10.25
Slightly weathered / fresh, brownish grey to grey, medium to fine grained, fractured sandstone.			R5	CR=79% RQD=72% 10.25-11.00
			R6	CR=88% RQD=60% 11.00-11.75
			R7	CR=82% RQD=75% 11.75-12.50
			R8	CR=84% RQD=22% 12.50-13.25
			R9	CR=82% RQD=42% 13.25-14.00
			R10	CR=86% RQD=70% 14.00-15.00
15.00m				

N.B. – '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975	Created by : Chandrani	Created on : 08/09/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 24

Co-ordinates E=867 N=4703

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date : 22/08/17
Completion Date : 23/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 73.124 m.
Water Struck At :
Standing Water Level : 2.30 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Filled up soil consists of grey to brownish grey, silty clay with boulder & coal dust.		2 3 4 (7)	DS-1	0.50
			*UDS-1	1.00-1.45
			SPT-1	1.60-2.05
2.20m.			DS-2	2.50
Stiff, light grey, silty clay. Obs. kankars. (Cl)		3 5 5 (10)	SPT-2	3.00-3.45
			UDS-2	4.00-4.45
		4 5 7 (12)	SPT-3	4.45-4.90
			DS-3	5.50
5.90m.		(>100)		
Very dense, brownish grey, silty fine sand with decomposed rock. (SM)		42 58 7.0 cm Penth.	SPT-4	6.00-6.22
6.40m.		100 Refusal 4.0 cm Penth.	*SPT-5	6.40-6.44
Highly to moderately weathered, brownish grey, fine grained, fractured sandstone.		NX rotary drilling from 6.40m to 15.00m	R1	CR=33% RQD=NIL (6.40-7.00)
			R2	CR=49% RQD=NIL (7.00-7.75)
			R3	CR=48% RQD=15% (7.75-8.50)
8.50m.			R4	CR=64% RQD=28% (8.50-9.25)
Slightly weathered / fresh, grey to blackish grey, fine grained, fractured sandstone.			R5	CR=45% RQD=27% (9.25-10.00)
			R6	CR=61% RQD=NIL (10.00-10.75)
			R7	CR=63% RQD=21% (10.75-11.50)
			R8	CR=68% RQD=NIL (11.50-12.25)
			R9	CR=71% RQD=NIL (12.25-13.00)
			R10	CR=92% RQD=76% (13.00-13.75)
			R11	CR=82% RQD=20% (13.75-14.50)
15.00m.			R12	CR=83% RQD=47% (14.50-15.00)

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 17/08/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 25

Co-ordinates E=783 N=4670

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	7
		Disturbed (DS)	4
Vane (V)		Water Sample (WS)	0

Commencement Date : 07/08/17
Completion Date : 09/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 70.552 m.
Water Struck At :
Standing Water Level : 1.70 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Filled up soil consists of deep grey to brownish grey, silty sand. Obs. kankars.			DS-1	0.50
0.80m. Stiff, grey, silty clay. (Cl)		3 5 6 (11)	UDS-1	1.00-1.45
			SPT-1	1.45-1.90
			DS-2	2.50
		5 7 8 (15)	SPT-2	3.00-3.45
4.00m. Very dense, brownish grey, silty medium to fine grained sand & decomposed rock. (SM)		>100	*UDS-2	4.00-4.10
		42 58 12.0 cm Penth.	SPT-3	4.10-4.37
		100 Refusal 4.0 cm Penth.	*SPT-4	4.60-4.64
4.90m. Completely weathered, yellowish grey, fine grained rock fragment collected as sludge.		100 Refusal 3.0 cm Penth.	*SPT-5	4.90-4.93
			R1	CR=NIL RQD=NIL
			DS-3	4.90
		50 Refusal 3.0 cm Penth.	*SPT-6	5.50-5.53
			R2	CR=NIL RQD=NIL
		Refusal	DS-4	5.50
6.25m. Moderately weathered, yellowish grey to deep grey, medium to fine grained, fractured sandstone.		50 3.0 cm Penth.	*SPT-7	6.25-6.28
			R3	CR=41% RQD=23%
		NX rotary drilling from 4.90m to 11.50m		7.00
			R4	CR=46% RQD=20%
7.75m. Moderately to slightly weathered, yellowish grey to deep grey, medium to fine grained, fractured sandstone.				7.75
			R5	CR=51% RQD=20%
				8.50
			R6	CR=56% RQD=31%
				9.25
			R7	CR=68% RQD=34%
				10.00
			R8	CR=72% RQD=31%
				10.75
			R9	CR=73% RQD=37%
11.50m.				11.50

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 08/09/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 26

Co-ordinates E=781 N=4713

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 23/08/17
Completion Date : 24/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 70.588 m.
Water Struck At :
Standing Water Level : 1.10 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Filled up soil consists of silty clay with fly ash.				
0.80m. Stiff to very stiff, deep grey to light grey, silty clay. Obs. kankars. (Cl)		3 4 5 (9)	DS-1	0.50
			UDS-1	1.00-1.45
			SPT-1	1.45-1.90
			DS-2	2.50
		4 6 6 (12)	SPT-2	3.00-3.45
			UDS-2	4.00-4.45
		7 9 13 (22)	SPT-3	4.45-4.90
5.00m. Very dense, brownish grey, silty medium grained sand with decomposed rock. (SM)		42 58 (>100) 10.0 cm Pentn.	SPT-4	5.10-5.35
5.50m. Moerately to slightly weathered, yellowish grey, fine grained, fractured sandstone.		100 Refusal 4.0 cm Pentn. NX rotary drilling from 5.50m to 15.00m	*SPT-5	5.50-5.54
			R1	CR=43% RQD=18% 5.50 - 6.25
			R2	CR=65% RQD=NIL 6.25 - 7.00
			R3	CR=67% RQD=23% 7.00 - 7.75
			R4	CR=65% RQD=27% 7.75 - 8.50
			R5	CR=71% RQD=39% 8.50 - 9.25
			R6	CR=74% RQD=41% 9.25 - 10.00
10.00m. Fresh, yellowish grey to blackish grey, fine grained, fractured sandstone.			R7	CR=80% RQD=22% 10.00 - 10.75
			R8	CR=83% RQD=43% 10.75 - 11.50
			R9	CR=81% RQD=39% 11.50 - 12.25
			R10	CR=86% RQD=49% 12.25 - 13.00
			R11	CR=81% RQD=20% 13.00 - 14.00
			R12	CR=88% RQD=51% 14.00 - 15.00
15.00m. N.B. - '*' means sample could not be recovered.				

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Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 12/09/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 27

Co-ordinates E=698 N=4635

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date : 16/08/17
Completion Date : 17/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 70.642 m.
Water Struck At :
Standing Water Level : 1.80 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Filled up soil consists of ash.			DS-1	0.50
0.80m.			UDS-1	1.00-1.45
Stiff deep grey, silty clay. Obs. kankars. (Cl)		4 6 9 (15)	SPT-1	1.45-1.90
			DS-2	2.50
3.00m.		6 8 10 (18)	SPT-2	3.00-3.45
Very stiff deep grey, silty clay. Obs. kankars. (Cl)		7 9 10 (19)	UDS-2	4.00-4.45
			SPT-3	4.45-4.90
5.20m.			DS-3	5.50
Very dense, brownish grey, silty medium grained sand with decomposed rock. (SM)		43 57 (>100) 12.0 cm Penetn.	SPT-4	6.00-6.27
6.40m.		100 Refusal 4.0 cm Penetn.	*SPT-5	6.40-6.44
		NX rotary drilling from 6.40m to 13.75m	R1	CR=40% RQD=20% 6.40-7.00
			R2	CR=56% RQD=23% 7.00-7.75
			R3	CR=61% RQD=31% 7.75-8.50
			R4	CR=60% RQD=40% 8.50-9.25
Moderately to slighly weathered / fresh, brownish grey, medium to fine grained, fractured sandstone.			R5	CR=63% RQD=40% 9.25-10.00
			R6	CR=65% RQD=13% 10.00-10.75
			R7	CR=76% RQD=69% 10.75-11.50
			R8	CR=81% RQD=67% 11.50-12.25
			R9	CR=80% RQD=57% 12.25-13.00
			R10	CR=93% RQD=89% 13.00-13.75
13.75m.				

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 12/09/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 28

Co-ordinates E= 692 N=4708

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date : 13/08/17
Completion Date : 14/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 71.903 m.
Water Struck At :
Standing Water Level : 1.80 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Filled up soil consists of ash.				
0.60m. Stiff to very stiff, brownish grey, silty clay. Obs. kankars. (Cl)		4 6 9 (15)	DS-1	0.50
			UDS-1	1.00-1.45
			SPT-1	1.45-1.90
			DS-2	2.50
		5 8 10 (18)	SPT-2	3.00-3.45
4.00m. Dense to very dense, brownish grey, silty medium grained sand with decompoosed rock. (SM)			*UDS-2	4.00-4.45
		10 16 21 (37)	SPT-3	4.60-5.05
			DS-3	5.50
		100 4.0 cm (≥100)	*SPT-4	6.00-6.04
6.30m. Moderately weathered, brownish grey, medium to fine grained, fractured sandstone.		100 3.0 cm Refusal	*SPT-5	6.30-6.33
		NX rotary drilling from 6.30m to 15.00m	R1	CR=44% RQD=18% 6.30-7.00
			R2	CR=41% RQD=NIL 7.00-7.75
			R3	CR=43% RQD=NIL 7.75-8.50
			R4	CR=58% RQD=25% 8.50-9.25
9.25m. Slightly weathered, brownish grey to deep grey, medium to fine grained, fractured sandstone.			R5	CR=73% RQD=28% 9.25-10.00
			R6	CR=68% RQD=16% 10.00-10.75
			R7	CR=69% RQD=32% 10.75-11.50
			R8	CR=67% RQD=39% 11.50-12.25
			R9	CR=72% RQD=17% 12.25-13.00
			R10	CR=69% RQD=NIL 13.00-13.75
			R11	CR=73% RQD=13% 13.75-14.50
15.00m.			R12	CR=70% RQD=NIL 14.50-15.00

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 29/08/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 29

Co-ordinates E=596 N=4668

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 23/08/17
Completion Date : 24/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 69.262 m.
Water Struck At :
Standing Water Level : 1.06 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Filled up soil consists of blackish grey, silty clay with ash. 0.60m.			DS-1	0.50
		2 4 6 (10)	UDS-1	1.00-1.45
			SPT-1	1.45-1.90
Stiff, steel grey, silty clay. (Cl)			DS-2	2.50
		3 5 8 (13)	SPT-2	3.00-3.45
3.90m. Very dense, yellowish brown, silty sand with deocomposed rock. (SM)		65 35 (>100) 5.0 cm Pentn.	SPT-3	4.00-4.20
4.50m.		100 (>100) 2.0 cm Pentn.	*SPT-4	4.50-4.52
Moderately weathered, light grey, medium grained, fractured sandstone.		NX rotary drilling from 4.50m to 15.00m	R1	CR=41% RQD=13% 5.25
			R2	CR=44% RQD=28% 6.00
			R3	CR=42% RQD=20% 6.75
			R4	CR=44% RQD=16% 7.50
8.25m.			R5	CR=43% RQD=17% 8.25
			R6	CR=61% RQD=28% 9.00
			R7	CR=52% RQD=37% 9.75
			R8	CR=62% RQD=16% 10.50
Slightly weathered, light grey, medium grained, fractured sandstone.			R9	CR=60% RQD=27% 11.25
			R10	CR=62% RQD=31% 12.00
			R11	CR=63% RQD=20% 12.75
			R12	CR=68% RQD=32% 13.50
			R13	CR=71% RQD=52% 14.25
15.00m.			R14	CR=79% RQD=25% 15.00

N.B. - '*' means sample could not be recovered.

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Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975	Created by : Chandrani	Created on : 02/09/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 30

Co-ordinates E=871 N=4772

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date : 23/08/17
Completion Date : 24/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 73.442 m.
Water Struck At :
Standing Water Level : 1.45 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Filled up soil consists of blackish grey to brownish grey, silty clay / clayey silt with ash & boulders		4 6 90 (≥100) 5.0 cm Penetn.	DS-1	0.50
			*UDS-1	1.00-1.45
			SPT-1	1.60-1.95
2.50m.			DS-2	2.50
Very stiff, brownish grey, silty clay. (Cl)		5 7 9 (16)	SPT-2	3.00-3.45
			UDS-2	4.00-4.45
		7 9 11 (20)	SPT-3	4.45-4.90
5.30m.		36 64 (≥100) 10.0 cm Penetn.	SPT-4	5.30-5.55
Very dense, grey, silty medium grained sand. Obs. decomposed rock. (SM)		100 Refusal 4.0 cm Penetn.	*SPT-5	5.70-5.74
5.80m.		100 Refusal 3.0 cm Penetn.	*SPT-6	5.85-5.88
Moderately weathered, yellowish grey, fine grained, fractured sandstone.			R1	CR=45% RQD=NIL (5.80-6.50)
			R2	CR=48% RQD=NIL (6.50-7.25)
7.25m.		NX rotary drilling from 5.80m to 15.00m	R3	CR=62% RQD=15% (7.25-8.00)
Moderately to slightly weathered, yellowish grey, fine grained, fractured sandstone.			R4	CR=52% RQD=25% (8.00-8.75)
			R5	CR=77% RQD=49% (8.75-9.50)
9.50m.			R6	CR=80% RQD=21% (9.50-10.25)
			R7	CR=84% RQD=77% (10.25-11.00)
			R8	CR=80% RQD=28% (11.00-11.75)
Slightly weathered / fresh, yellowish grey to deep grey, fine grained, fractured sandstone.			R9	CR=83% RQD=45% (11.75-12.50)
			R10	CR=92% RQD=21% (12.50-13.25)
			R11	CR=82% RQD=56% (13.25-14.00)
			R12	CR=92% RQD=85% (14.00-15.00)
15.00m.				

N.B. – '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 29/08/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 31

Co-ordinates E=747 N=4828

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 18/08/17
Completion Date : 20/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 71.993 m.
Water Struck At :
Standing Water Level : 1.25 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Filled up soil consists of silty clay with boulders, moorum & ash.		7 15 12 (27)	DS-1	0.50
			*UDS-1	1.00-1.35
			SPT-1	1.45-1.90
2.00m.				
Stiff, deep grey, silty clay. (Cl)		4 5 5 (10)	DS-2	2.50
			SPT-2	3.00-3.45
4.00m.				
Very dense, brownish grey, silty sand with decomposed rock. (SM)		16 29 32 (61)	*UDS-2	4.00-4.30
			SPT-3	4.55-5.00
		100 5.0 cm Penth. (>100)	*SPT-4	5.30-5.35
5.60m.		100 3.0 cm Penth. (>100)	*SPT-5	5.60-5.63
		NX rotary drilling from 5.60m to 15.00m	R1	CR=41% RQD=NIL 5.60-6.25
			R2	CR=48% RQD=15% 6.25-7.00
Highly to moderately weathered, brownish grey to grey, medium to fine grained, fractured sandstone.			R3	CR=36% RQD=15% 7.00-7.75
			R4	CR=31% RQD=NIL 7.75-8.50
			R5	CR=47% RQD=NIL 8.50-9.25
9.25m.			R6	CR=60% RQD=NIL 9.25-10.00
			R7	CR=64% RQD=NIL 10.00-10.75
			R8	CR=71% RQD=43% 10.75-11.50
Slightly weathered, grey, medium to fine grained, fractured sandstone.			R9	CR=76% RQD=73% 11.50-12.25
			R10	CR=78% RQD=43% 12.25-13.00
			R11	CR=72% RQD=15% 13.00-13.75
			R12	CR=77% RQD=60% 13.75-14.50
15.00m.			R13	CR=79% RQD=61% 14.50-15.00

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975	Created by : Chandrani	Created on : 29/08/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 32

Co-ordinates E=637 N=4914

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 21/08/17
Completion Date : 22/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 70.335 m.
Water Struck At :
Standing Water Level : 0.80 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Very stiff to hard, brownish grey, silty clay with sand mixture. (Cl)		8 9 10 (19)	DS-1	0.50
			UDS-1	1.00-1.45
			SPT-1	1.45-1.90
2.95m		16 19 23 (42)	SPT-2	2.50-2.95
Very dense, brownish grey, silty sand with decomposed rock. (SM)		100 4.0 cm Penetn. (>100)	*SPT-3	3.20-3.24
3.40m		100 3.0 cm Penetn. (>100)	*SPT-4	3.40-3.43
Moderately weathered, brownish grey, fine grained, fractured sandstone.		NX rotary drilling from 3.40m to 15.00m	R1	CR=42% RQD=NIL
4.75m			R2	CR=41% RQD=13%
			R3	CR=73% RQD=56%
			R4	CR=72% RQD=63%
Slightly weathered, brownish grey, fine grained, fractured sandstone.			R5	CR=76% RQD=58%
			R6	CR=75% RQD=22%
			R7	CR=77% RQD=50%
8.50m			R8	CR=82% RQD=57%
			R9	CR=81% RQD=38%
			R10	CR=85% RQD=20%
Fresh, light grey, fine grained, fractured sandstone.			R11	CR=81% RQD=48%
			R12	CR=83% RQD=23%
15.00m			R13	CR=84% RQD=72%

3.40 4.00 4.75 5.50 6.25 7.00 7.75 8.50 9.25 10.00 11.50 13.00 14.50 15.00

N.B. – '*' means sample could not be recovered.

BH-32/Sheet-1

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 29/08/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 33

Co-ordinates E=512 N=4853

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	1

Commencement Date : 21/08/17
Completion Date : 22/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 70.642 m.
Water Struck At :
Standing Water Level : 1.10 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Blackish grey, silty clay. (Cl)				
0.70m.			DS-1	0.50
			UDS-1	1.00-1.45
			WS-1	1.10
		12		
Stiff to very stiff, steel grey, silty clay. (Cl)		3 5 7	SPT-1	1.45-1.90
			DS-2	2.50
		16		
		4 7 9	SPT-2	3.00-3.45
3.50m. Very dense, yellowish brown, silty sand with decomposed rock. (SM)		>100		
		100 14.0 cm Penetn.	SPT-3	3.80-3.94
4.20m.		100 >100 3.0 cm Penetn.	*SPT-4	4.20-4.23
Moderately weathered, yellowish brown, medium grained fractured sandstone.		NX rotary drilling from 4.20m to 15.00m	R1	CR=44% RQD=24% 4.20-5.00
			R2	CR=42% RQD=14% 5.00-5.75
			R3	CR=42% RQD=NIL 5.75-6.50
			R4	CR=50% RQD=14% 6.50-7.25
			R5	CR=60% RQD=13% 7.25-8.00
8.00m.			R6	CR=56% RQD=NIL 8.00-8.75
			R7	CR=48% RQD=16% 8.75-9.50
			R8	CR=54% RQD=30% 9.50-10.25
			R9	CR=40% RQD=NIL 10.25-11.00
Moderately to slightly weathered, light grey, medium grained, fractured sandstone.			R10	CR=61% RQD=15% 11.00-11.75
			R11	CR=56% RQD=17% 11.75-12.50
			R12	CR=55% RQD=17% 12.50-13.25
			R13	CR=53% RQD=35% 13.25-14.00
			R14	CR=62% RQD=37% 14.00-14.50
15.00m.			R15	CR=71% RQD=46% 14.50-15.00

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 19/08/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 34

Co-ordinates E=1032 N=3212

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	3	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	3
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 12/08/17
Completion Date : 13/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 67.594 m.
Water Struck At :
Standing Water Level : 1.10 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Filled up soil consists of silty sand with moourm & brick pieces.			DS-1	0.50
0.80m. Stiff, yellowish brown, clayey sandy silt. (Cl)		3 4 4 (8)	UDS-1	1.00-1.45
			SPT-1	1.45-1.90
2.50m. Medium dense, yellowish brown, silty sand with clay binders. (SM)		5 7 13 (20)	DS-2	2.50
			SPT-2	3.00-3.45
4.00m. Highly to moderately weathered, yellowish brown to whitish grey, medium grained, fractured sandstone.		Refusal 100 3.0 cm Penth. NX rotary drilling from 4.00m to 10.00m	*SPT-3	4.00-4.03
			R1	CR=30% RQD=16% 4.00-4.75
			R2	CR=46% RQD=NIL 4.75-5.50
			R3	CR=44% RQD=14% 5.50-6.25
			R4	CR=48% RQD=20% 6.25-7.00
7.00m. Moderately to slightly weathered, yellowish brown to whitish grey, medium grained, moderately fractured sandstone.			R5	CR=60% RQD=22% 7.00-7.75
			R6	CR=62% RQD=40% 7.75-8.50
			R7	CR=72% RQD=44% 8.50-9.25
			R8	CR=76% RQD=56% 9.25-10.00
10.00m. N.B. - '*' means sample could not be recovered.				

BH-34/Sheet-1

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975 | Created by : Chandrani | Created on : 19/08/2017 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 35

Co-ordinates E=972 N=3163

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 13/08/17
Completion Date : 14/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 67.392 m.
Water Struck At :
Standing Water Level : 1.00 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m Filled up soil consists of silty sand with boulders & brick bats.				
0.80m			DS-1	0.70
			UDS-1	1.00-1.45
		2 3 4 (7)	SPT-1	1.45-1.90
Medium to stiff, yellowish brown, silty clay with grey patches. Obs. boulders. (Cl)			DS-2	2.50
		5 6 8 (14)	SPT-2	3.00-3.45
3.90m		34 68/8.0 cm Pentn. (>100)	SPT-3	3.90-4.13
Hard, yellowish brown, silty clay with decomposed rock. (Cl) 4.30m		100/4.0 cm Pentn. Refusal	*SPT-4	4.30-4.34
		NX rotary drilling from 4.30m to 10.00m	R1	CR=38% RQD=16% 4.30-5.00
			R2	CR=44% RQD=13% 5.00-5.75
Highly to moderately weathered, yellowish brown to brownish grey, medium grained, fractured sandstone.			R3	CR=48% RQD=14% 5.75-6.50
			R4	CR=40% RQD=NIL 6.50-7.25
			R5	CR=48% RQD=14% 7.25-8.00
8.00m			R6	CR=54% RQD=16% 8.00-8.75
Moderately to slightly weathered, brownish grey, medium grained, fractured sandstone.			R7	CR=50% RQD=32% 8.75-9.50
			R8	CR=64% RQD=20% 9.50-10.00
10.00m				

N.B. – '*' means sample could not be recovered.

BH-35/Sheet-1

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 08/09/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 36

Co-ordinates E=925 N=3070

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date : 22/08/17
Completion Date : 23/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 68.212 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.				
Filled up soil consists of light grey, silty sand, fly ash mixed.			DS-1	0.50
			*UDS-1	1.00-1.45
		2 2 2 (4)	SPT-1	1.55-2.00
2.00m.				
Very stiff, light brownish grey, silty clay with fine sand mixture. (Cl)			DS-2	2.50
		5 8 11 (19)	SPT-2	3.10-3.55
3.70m.			DS-3	3.80
Very dense, greyish brown, silty sand with rock dust. (SM)		33 67 (>100) 3.0 cm Penetn.	SPT-3	4.00-4.18
		100 Refusal 3.0 cm Penetn.	*SPT-4	4.25-4.28
4.40m.		100 Refusal 2.0 cm Penetn.	*SPT-5	4.40-4.42
				4.40
Highly weathered, yellowish brown, fine grained, highly fractured sandstone.		NX rotary drilling from 4.40m to 10.00m	R1	CR=21% RQD=NIL
				5.25
			R2	CR=22% RQD=NIL
6.00m.				6.00
			R3	CR=26% RQD=13%
				6.75
Highly to moderately weathered, yellowish brown to grey, fine grained, highly fractured sandstone.			R4	CR=38% RQD=31%
				7.50
			R5	CR=37% RQD=NIL
				8.25
			R6	CR=28% RQD=NIL
9.00m.				9.00
Moderately weathered, yellowish brown to grey, fine grained, highly fractured sandstone.			R7	CR=56% RQD=16%
10.00m.				10.00

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 08/09/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. 37

Co-ordinates E=875 N=3159

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	4
		Disturbed (DS)	4
Vane (V)		Water Sample (WS)	0

Commencement Date : 23/08/17
Completion Date : 24/08/17
Bore Hole Diameter : 150 mm. / N. X.
Level Of Ground : 68.414 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				
Loose, yellowish brown, silty sand. (SM)		2 2 2 — 4	DS-1	0.50
			*UDS-1	1.00-1.45
			SPT-1	1.60-2.05
2.70m			DS-2	2.60
Very sitff to hard, deep grey, silty clay with calcareous nodules. Obs. decomposd rock pieces. (Cl)		2 5 13 — 18	SPT-2	2.80-3.25
		100 Refusal 10.0 cm Pentn.	SPT-3	3.40-3.50
3.55m		100 Refusal 3.0 cm Pentn.	*SPT-4	3.55-3.58
		NX rotary drilling from 3.55m to 10.00m	R1	CR=29% RQD=NIL (3.55 - 4.25)
			R2	CR=42% RQD=16% (4.25 - 5.00)
Highly to moderately weathered, yellowish brown, medium grained, highly to moderately fractured sandstone.			R3	CR=44% RQD=16% (5.00 - 5.75)
			R4	CR=46% RQD=38% (5.75 - 6.50)
			R5	CR=45% RQD=19% (6.50 - 7.25)
			R6	CR=53% RQD=21% (7.25 - 8.00)
8.00m			R7	CR=64% RQD=24% (8.00 - 8.75)
Slightly weathered, grey, fine grained, moderately fractured sandstone.			R8	CR=61% RQD=20% (8.75 - 9.50)
			R9	CR=64% RQD=28% (9.50 - 10.00)
10.00m				

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975 | Created by : Chandrani | Created on : 20/09/2017 | Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. CST- 01(M) | Co-ordinates E=1469 N=3904

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	2	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	2
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 16/08/17
Completion Date : 17/08/17
Bore Hole Diameter : 150 mm./ N.X.
Level Of Ground : 69.906 m.
Water Struck At :
Standing Water Level :

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN=15CM	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Greyish yellow, silty clay with kankars. Obs. sand mixture. (Cl)			DS-1	0.60
		>100	UDS-1	1.00-1.45
1.50m. Very dense, greyish brown, silty sand with decomposed rock. (SM)		35 54 11	SPT-1	1.45-1.78
1.90m. Highly to moderately weathered, yellowish brown, fine to medium grained, fractured rock.		100 3.0 cm Pentn. Refusal 3.0 cm Pentn. NX rotary drilling from 1.90m to 16.00m	*SPT-2	1.90-1.93
3.25m. Moderately to slightly weathered, yellowish brown, fine to medium grained, fractured rock.			R1	CR=35% RQD=NIL 1.90-2.50
			R2	CR=44% RQD=20% 2.50-3.25
			R3	CR=62% RQD=40% 3.25-4.00
			R4	CR=56% RQD=23% 4.00-4.75
			R5	CR=72% RQD=42% 4.75-5.50
			R6	CR=52% RQD=16% 5.50-6.25
			R7	CR=64% RQD=17% 6.25-7.00
			R8	CR=80% RQD=44% 7.00-7.75
			R9	CR=66% RQD=20% 7.75-8.50
			R10	CR=80% RQD=NIL 8.50-9.25
9.25m. Slightly weathered / fresh, brownish grey, medium to fine grained, fractureed rock.			R11	CR=76% RQD=32% 9.25-10.00
			R12	CR=69% RQD=22% 10.00-10.75
			R13	CR=84% RQD=18% 10.75-11.50
			R14	CR=84% RQD=40% 11.50-12.25
			R15	CR=78% RQD=24% 12.25-13.00
			R16	CR=80% RQD=14% 13.00-13.75
			R17	CR=72% RQD=52% 13.75-14.50
			R18	CR=91% RQD=37% 14.50-15.25
16.00m.			R19	CR=94% RQD=48% 15.25-16.00

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975 | Created by : Chandrani | Created on : 21/09/2017 | Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. CST- 03(M) | Co-ordinates E=1305 N=3987

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	2	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	2
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 09/08/17
Completion Date : 10/08/17
Bore Hole Diameter : 150 mm./ N.X.
Level Of Ground : 70.006 m.
Water Struck At :
Standing Water Level :

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN=15CM	SAMPLES Ref. No	Depth (m)
0.00m. Very dense, greyish yellow, silty sand with decomposed rock. (SM)		Refusal 76 8.0 cm Penetn.	DS-1	0.50
1.00m.		100 Refusal 2.0 cm Penetn.	*SPT-1	0.60-0.68
			*SPT-2	1.00-1.02
Moderately weathered, brownish yellow, medium to fine grained, fractured rock.		NX rotary drilling from 1.00m to 16.00m	R1	CR=53% RQD=29%
			R2	CR=56% RQD=51%
			R3	CR=65% RQD=51%
3.00m. Moderately weathered, deep grey, medium to fine grained, fractured rock.			R4	CR=67% RQD=36%
4.20m. Slightly weathered / fresh, yellowish grey, medium to fine grained, fractured rock			R5	CR=48% RQD=35%
			R6	CR=65% RQD=28%
6.25m.			R7	CR=87% RQD=45%
			R8	CR=72% RQD=64%
			R9	CR=82% RQD=56%
Slightly weathered / fresh, deep grey, fine grained, fractured rock.			R10	CR=83% RQD=82%
			R11	CR=84% RQD=74%
			R12	CR=85% RQD=82%
			R13	CR=81% RQD=73%
			R14	CR=83% RQD=72%
16.00m.				

1.00 1.75 2.50 3.25 4.00 4.75 5.50 6.25 7.00 8.50 10.00 11.50 13.00 14.50 16.00

N.B. - '*' means sample could not be recovered.

BH-3/Sheet-1

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975 | Created by : Chandrani | Created on : 22/09/2017 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. PMT- 02

Co-ordinates E=1317 N=3914

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	2	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	2
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 13/08/17
Completion Date : 14/08/17
Bore Hole Diameter : N.X.
Level Of Ground : 70.132 m.
Water Struck At :
Standing Water Level : 2.10 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN=15CM	SAMPLES Ref. No	Depth (m)
0.00m.				
Stiff, light grey, silty clay / clayey silt with sand mixture & decomposed rock. (CI)		3 4 6 — 10	DS-1	0.50
			SPT-1	1.50-1.95
		Refusal		
2.00m.		100 — 2.0 cm Pentn.	*SPT-2	2.00-2.02
		NX rotary drilling from 2.00m to 12.50m	R1	CR=54% RQD=30% 2.00 / 2.75
Moderately to slightly weathered, yellowish grey, medium to fine grained, slightly fractured rock.			R2	CR=58% RQD=48% 2.75 / 3.50
			R3	CR=67% RQD=53% 3.50 / 4.25
			R4	CR=53% RQD=40% 4.25 / 5.00
			R5	CR=69% RQD=32% 5.00 / 5.75
5.75m.			R6	CR=89% RQD=47% 5.75 / 6.50
			R7	CR=95% RQD=64% 6.50 / 7.25
			R8	CR=87% RQD=56% 7.25 / 8.75
Fresh, deep grey, fine grained, fractured rock.			R9	CR=86% RQD=84% 8.75 / 10.25
			R10	CR=90% RQD=80% 10.25 / 11.75
N.B. - '*' means sample could not be recovered.			R11	CR=91% RQD=82% 11.75 / 12.50
12.50m.				

BH-2/Sheet-1

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 22/09/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. PMT-03

Co-ordinates E=1504 N=3979

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	2	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	2
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 16/08/17
Completion Date : 17/08/17
Bore Hole Diameter : N.X.
Level Of Ground : 70.180 m.
Water Struck At :
Standing Water Level : 1.90 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN=15CM	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Filled up soil consists of brownish yellow, silty clay.			DS-1	0.50
0.70m. Very dense, brownish yellow, silty sand with decomposed rock. (SM)		39 61 >100	SPT-1	1.00-1.17
1.20m.		100 2.0 cm Pentn. Refusal	*SPT-2	1.20-1.22
		2.0 cm Pentn.	R1	CR=29% RQD=NIL
Highly to moderately weathered, deep yellow, medium to fine grained, highly fractured rock.			R2	CR=44% RQD=16%
2.50m.		NX rotary drilling from 1.20m to 12.50m	R3	CR=83% RQD=24%
			R4	CR=86% RQD=26%
			R5	CR=90% RQD=18%
Fresh, deep yellow, medium to fine grained, highly fractured rock.			R6	CR=81% RQD=21%
			R7	CR=84% RQD=36%
8.50m.			R8	CR=93% RQD=NIL
Fresh, deep grey, medium to fine grained, fractured rock.			R9	CR=87% RQD=58%
			R10	CR=94% RQD=72%
N.B. - '*' means sample could not be recovered. 12.50m.				

1.20 1.75 2.50 3.25 4.00 5.50 7.00 8.50 10.00 11.50 12.50

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 22/09/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. PMT-04

Co-ordinates E=1400 N=4240

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 12/08/17
Completion Date : 13/08/17
Bore Hole Diameter : N.X.
Level Of Ground : 72.312 m.
Water Struck At :
Standing Water Level : 1.20 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN=15CM	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Medium dense, silty sand / sandy silt with decomposed rock & clay mixture. (SM)		3 4 8 (12)	DS-1	0.50
			SPT-1	1.50-1.95
			DS-2	2.50
		5 8 12 (20)	SPT-2	3.00-3.45
3.50m		69 Refusal 5.0 cm Pentn.	*SPT-3	3.50-3.55
Very dense, silty sand / sandy silt with with decomposed rock & clay mixture. (SM) 4.00m		100 Refusal 2.0 cm Pentn.	*SPT-4	4.00-4.02
Highly to moderately weathered, greyish yellow, medium to fine grained, fractured rock.		NX rotary drilling from 4.00m to 12.0m	R1	CR=39% RQD=19% 4.00-4.75
			R2	CR=51% RQD=NIL 4.75-5.50
			R3	CR=49% RQD=20% 5.50-6.25
6.25m			R4	CR=52% RQD=NIL 6.25-7.00
Moderately to slightly weathered, greyish yellow, medium to fine grained, fractured rock.			R5	CR=55% RQD=20% 7.00-7.75
			R6	CR=67% RQD=33% 7.75-8.50
9.00m			R7	CR=65% RQD=56% 8.50-9.25
			R8	CR=71% RQD=51% 9.25-10.00
Slightly weathered / fresh, deep grey, fine grained, slightly fractured rock.			R9	CR=97% RQD=67% 10.00-10.75
			R10	CR=98% RQD=97% 10.75-11.50
			R11	CR=86% RQD=94% 11.50-12.00
12.00m				

N.B. - '*' means sample could not be recovered.

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 1	CO-ORDINATES: East: 1413.2	North: 3923.08
SITE LOCATION :	Tr Yard	START DATE: 5/26/2009	END DATE: 5/28/2009
GROUND REDUCED LEVEL:	69.930	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.45	CASING DIA:	150mm upto 2.00m & Nx from 2.00 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
1			Stiff greyish brown Clay with low plasticity	1	UDS				Recovered	---	---		
2	67.93			2	SPT				8 cm in 100 blows,N>100	---	---		
	67.83		Completely weathered deeply decomposed light yellowish Sandstone	2.1	RC					68	16		
3			Moderately weathered light yellowish medium grained Sandstone	3.1	RC					65	12		
4	65.83			4.1	RC								
	65.43		Moderately weathered,light yellowish fine grained Siltstone with carbonaceous Clay							88	36		
5				5.1	RC								
6			Moderately to slightly weathered dark medium grained yellowish brown Sandstone	6.1	RC					75	60		
7										77	77		
	62.83			7.1	RC								
8			Slightly weathered light greyish fine grained Sandstone	8.1	RC					78	40		
	61.83												
9			Moderately to slightly weathered light greyish fine grained Sandstone	9.1	RC					79	54		
10										68	11		

SPT N = STANDARD PENETRATION TEST VALUE
RC = ROCK CORE
RQD = ROCK QUALITY DESIGNATION
DS = DISTURBED SAMPLE
UDS = UNDISTURBED SOIL SAMPLE
VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:
PAGE 1 OF 2

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 1	CO-ORDINATES: East: 1413.2	North: 3923.08
SITE LOCATION :	Tr Yard	START DATE: 5/26/2009	END DATE: 5/28/2009
GROUND REDUCED LEVEL:	69.930	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.45	CASING DIA:	150mm upto 2.00m & Nx from 2.00 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	59.83			10.1	RC								
										77	48		
11			Slightly weathered dark greyish medium grained Sandstone	11.1	RC								
										88	88		
12	57.83			12.1	RC								
			Moderately weathered dark greyish medium grained Sandstone with carbonaceous clay bands							81	27		
13	56.83			13.1	RC								
										75	0		
14				14.1	RC								
			Highly to moderately weathered dark greyish fragmented Sandstone(weak rock)							75	18		
15				15.1	RC								
										85	27		
16	53.83			16.1	RC								
			Slightly weathered light greyish Siltstone with Sandstone patches							80	68		
17	52.83			17.1	RC								
			Highly to moderately weathered light greyish medium grained fragmented Sandstone							80	0		
18	51.83			18.1	RC								
										80	42		
19			Highly to moderately weathered light greyish fine grained Siltstone with Sandstone patches.	19.1	RC								
										80	0		
20	49.93												

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 2	CO-ORDINATES: East: 1500	North: 3923.02
SITE LOCATION :	Tr Yard	START DATE: 5/28/2009	END DATE: 5/30/2009
GROUND REDUCED LEVEL:	69.977	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	3.35	CASING DIA:	150mm upto 3.20m & Nx from 3.20 to 16.20m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
1			Stiff yellowish brown Clay with low plasticity	1.5	UDS				Recovered	---	---		
2	67.477			2.4	SPT				8 cm in 100blows,N>100	---	---		
3	66.777		Completely weathered deeply decomposing light yellowish brown Sandstone	3.2									
4			Highly to moderately weathered yellowish brown fine grained Siltstone with Sandstone patches	4.2						42	10		
5	64.777			5.2						64	12		
6			Slightly weathered yellowish brown fine grained Sandstone	6.2						85	77		
7				7.2						86	62		
8	61.777			8.2						92	88		
9			Slightly weathered medium grained yellowish brown Sandstone	9.2						90	24		
10										78	56		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

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Logged by : Akash
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Job No:

Borehole termination at 16.2 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 2	CO-ORDINATES: East: 1500	North: 3923.02
SITE LOCATION :	Tr Yard	START DATE: 5/28/2009	END DATE: 5/30/2009
GROUND REDUCED LEVEL:	69.977	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	3.35	CASING DIA:	150mm upto 3.20m & Nx from 3.20 to 16.20m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	59.777			10.2						78	56		
11			Slightly weathered light greyish compacted Sandstone	11.2						78	42		
12										90	90		
	57.777			12.2									
	57.477		Medium grained Sandstone with Clay patches										
13			Slightly weathered greyish fine grained compacted Sandstone							90	70		
	56.777			13.2									
14										83	52		
				14.2									
15			Slightly weathered dark greyish compacted medium to coarse grained Sandstone							92	75		
				15.2									
16										92	67		
	53.777												
17													
18													
19													
20													

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

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Job No: | PAGE 2 OF 2

Borehole termination at 16.2 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 3	CO-ORDINATES: East: 1306.11	North: 3967.14
SITE LOCATION :	TG Hall	START DATE: 6/15/2009	END DATE: 6/22/2009
GROUND REDUCED LEVEL:	70.695	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.05	CASING DIA:	150mm upto 2.75m & Nx from 2.75 to 30.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	70.495		Filled up soil consisting of Sand										
1			Stiff greyish Sandyclay	1.5	UDS				Recovered	---	---		
2	68.495												
3			Very dense greyish Clayeysand	2.75	SPT	5	5	48	53	---	---		
	67.495			3.2									
4			Moderately weathered light yellowish fine grained Sandstone with Siltstone patches							67	32		
	66.495			4.2									
5			Slightly weathered light yellowish fine grained Sandstone with thin layer of Shale							94	94		
	65.495			5.2									
6										93	93		
				6.2									
7			Slightly weathered light yellowish brown fine grained Sandstone							100	100		
				7.2									
8										95	80		
	62.495			8.2									
9										80	72		
			Slightly weathered greyish fine grained Sandstone	9.2									
10										84	84		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

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Job No: | PAGE 1 OF 3

Borehole termination at 30 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 3	CO-ORDINATES: East: 1306.11	North: 3967.14
SITE LOCATION :	TG Hall	START DATE: 6/15/2009	END DATE: 6/22/2009
GROUND REDUCED LEVEL:	70.695	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.05	CASING DIA:	150mm upto 2.75m & Nx from 2.75 to 30.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
11			Slightly weathered greyish fine grained Sandstone *(continued)*	10.2						84	84		
				11.2						95	87		
12										92	72		
	58.495			12.2									
13			Moderately weathered greyish laminated Shale							95	37		
	57.495			13.2									
14			Highly to moderately weathered greyish fine to medium grained Sandstone with Siltstone patches							92	0		
	56.495			14.2									
15			Slightly weathered greyish fine grained Sandstone							99	78		
	55.495			15.2									
16			Moderately weathered greyish fine to medium grained Sandstone with Siltstone patches							88	0		
				16.2									
17										94	0		
				17.2									
18										86	0		
	52.495			18.2									
19			Highly to moderately weathered greyish Siltstone with patches of Shale							85	0		
	51.495			19.2									
20			Moderately weathered greyish fine to medium grained Sandstone							68	31		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

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Logged by : Akash | Checked by : S. Padhi

Job No: |

Borehole termination at 30 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 3	CO-ORDINATES: East: 1306.11	North: 3967.14
SITE LOCATION :	TG Hall	START DATE: 6/15/2009	END DATE: 6/22/2009
GROUND REDUCED LEVEL:	70.695	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.05	CASING DIA:	150mm upto 2.75m & Nx from 2.75 to 30.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
21			Moderately weathered greyish fine to medium grained Sandstone *(continued)*	20.2						68	31		
										65	32		
	49.495			21.2									
22			Slightly weathered greyish Siltstone with patches of Shale							95	70		
	48.495			22.2									
23			Moderately to slightly weathered greyish Siltstone to fine grained Sandstone							73	47		
				23.2									
24										83	74		
				24.2									
25										85	50		
				25.2									
26										68	17		
	44.495			26.2									
27			Slightly weathered greyish fine grained Sandstone							93	76		
				27.2									
28										85	71		
				28.2									
29										82	75		
	41.495			29.2									
30	40.695		Highly to moderately weathered greyish Siltstone to Sandstone							80	0		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

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PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

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Job No:

Borehole termination at 30 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 4	CO-ORDINATES: East: 1384.37	North: 3966.57
SITE LOCATION :	TG Hall	START DATE: 5/21/2009	END DATE: 5/23/2009
GROUND REDUCED LEVEL:	70.367	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	0.65	CASING DIA:	150mm upto 3.00m & Nx from 3.00 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
1			Stiff to very stiff greyish brown Clayey Sand	1.5	UDS				Recovered	---	---		
2													
3	67.367			3	SPT				13 cm in 100blows,N>100	---	---		
	66.867		Completely weathered deeply decomposed brownish Sandstone	3.5									
4			Moderately weathered light brownish Siltstone							100	19		
	65.867			4.5									
5			Highly to moderately weathered light greyish medium grained Sandstone							86	0		
	64.867			5.5									
6										84	0		
				6.5									
7										80	47		
			Highly to moderately weathered medium grained greyish Siltstone to fine grained Sandstone	7.5									
8										88	52		
				8.5									
9										84	0		
				9.5									
10										90	0		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 4	CO-ORDINATES: East: 1384.37	North: 3966.57
SITE LOCATION :	TG Hall	START DATE: 5/21/2009	END DATE: 5/23/2009
GROUND REDUCED LEVEL:	70.367	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	0.65	CASING DIA:	150mm upto 3.00m & Nx from 3.00 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
11			Highly to moderately weathered medium grained greyish Siltstone to fine grained Sandstone *(continued)*	10.5						90	0		
										82	0		
12				11.5						70	0		
13				12.5						83	0		
14				13.5						88	0		
	55.867			14.5									
15			Highly to moderately weathered light greyish medium grained Sandstone							81	11		
16				15.5						82	0		
	53.867			16.5									
17			Highly to moderately weathered light greyish Siltstone to fine grained Sandstone							85	0		
				17.5									
18										85	0		
				18.5									
19										78	0		
				19.5									
20	50.367									78	0		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

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PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

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Job No: | PAGE 2 OF 2

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 5	CO-ORDINATES: East: 1451.33	North: 3966.91
SITE LOCATION :	TG Hall	START DATE: 5/28/2009	END DATE: 6/2/2009
GROUND REDUCED LEVEL:	70.704	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	2.35	CASING DIA:	150mm upto 2.90m & Nx from 2.90 to 30.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
1	69.204		Filled up soil consisting of Clay with Gravel & Kankar	1.5	UDS				Recovered	---	---		
2			Stiff greyish Clay with low plasticity										
3	67.804			2.9	SPT				10 cm in 100 blows,N>100	---	---		
	67.504		Completely weathered yellowish brown Sandstone	3.2	RC								
4			Moderately weathered,brownish fine grained Sandstone with close spaced bedding planes	4.2	RC					70	36		
5	65.504			5.2	RC					68	32		
6			Highly to moderately weathered light brown medium graineed Sandstone	6.2	RC					92	0		
7	64.504		Moderately weathered light brown medium grained Sandstone	7.2	RC					86	28		
8	62.504			8.2	RC					78	14		
9			Moderately to slightly weathered greyish medium grained Sandstone	9.2	RC					94	41		
10										88	16		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 30 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 5	CO-ORDINATES: East: 1451.33	North: 3966.91
SITE LOCATION :	TG Hall	START DATE: 5/28/2009	END DATE: 6/2/2009
GROUND REDUCED LEVEL:	70.704	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	2.35	CASING DIA:	150mm upto 2.90m & Nx from 2.90 to 30.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	60.504			10.2	RC					88	16		
11			Moderately weathered greyish sandstone with patches of shale							93	28		
	59.504			11.2	RC								
12			Moderately weathered fine to medium grained greyish Sandstone	12.2	RC					82	10		
13										90	22		
	57.504			13.2	RC								
14			Light greyish Shale							78	0		
	56.504			14.2	RC								
15			Moderately weathered light greyish medium grained Sandstone	15.2	RC					91	12		
16										88	0		
	54.504			16.2	RC								
17			Moderately weathered light greyish fine grained Sandstone with patches of Shale							87	0		
	53.504			17.2	RC								
18			Moderately weathered light greyish fine grained Siltstone							90	37		
	52.504			18.2	RC								
	52.004		Light greyish fine grained Shale										
19										84	17		
				19.2	RC								
20			Highly to moderately weathered greyish medium grained Sandstone							92	31		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash Checked by : S. Padhi

Job No: PAGE 2 OF 3

Borehole termination at 30 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 5	CO-ORDINATES: East: 1451.33	North: 3966.91
SITE LOCATION :	TG Hall	START DATE: 5/28/2009	END DATE: 6/2/2009
GROUND REDUCED LEVEL:	70.704	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	2.35	CASING DIA:	150mm upto 2.90m & Nx from 2.90 to 30.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	50.504			20.2	RC					92	31		
21			Highly to moderately weathered greyish fine grained Siltstone							90	13		
	49.504			21.2	RC								
22			Highly to moderately weathered greyish fine to medium grained Sandstone							94	29		
	48.504			22.2	RC								
23			Moderately weathered greyish medium grained Sandstone with patches of Shale							90	27		
	47.504			23.2	RC								
24										80	21		
				24.2	RC								
25										90	0		
				25.2	RC								
26										92	0		
			Highly to moderately weathered greyish fine grained Sandstone with patches of Clay	26.2	RC								
27										90	0		
				27.2	RC								
28										85	0		
				28.2	RC								
29										90	10		
	41.504			29.2	RC								
30	40.704		Highly to moderately weathered greyish fine to coarse grained Sandstone							90	0		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 30 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 6	CO-ORDINATES: East: 1506.46	North: 3967.48
SITE LOCATION :	TG Hall	START DATE: 5/28/2009	END DATE: 5/30/2009
GROUND REDUCED LEVEL:	70.401	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	2.75	CASING DIA:	150mm upto 3.50m & Nx from 3.50 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
1	69.001		Filled up soil consisting of Clay with Kankar pieces	1.4	SPT	10	23	15	38	---	---		
2			Medium dense to dense yellowish brown SiltySand										
3	66.901			3	SPT	20	35	50	85	---	---		
4													
5			Completely weathered yellowish brown Sandstone	4.5	SPT				11 cm in 100 blows,N>100	---	---		
6	64.301			6	SPT				9 cm in 100 blows,N>100	---	---		
				6.1	RC					75	12		
7				7.1	RC					75	13		
8			Highly to moderately weathered yellowish brown sandstone	8.1	RC					90	20		
9				9.1	RC					83	0		
10													

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

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Job No: | PAGE 1 OF 2

Borehole termination at 20 m

CLIENT:	NTPC
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)
BOREHOLE ID: BH 6	CO-ORDINATES: East: 1506.46 North: 3967.48
SITE LOCATION : TG Hall	START DATE: 5/28/2009 END DATE: 5/30/2009
GROUND REDUCED LEVEL: 70.401	DRILLING METHOD: Rotary
GROUND WATER TABLE DEPTH: 2.75	CASING DIA: 150mm upto 3.50m & Nx from 3.50 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	60.301			10.1	RC					85	23		
11			Highly to moderately weathered greyish Siltstone laminated with Clay portions & consisting of fragments of Coal	11.1	RC					88	0		
12	58.301			12.1	RC					76	10		
13				13.1	RC					92	0		
14			Highly to moderately weathered light greyish to yellowish brown fine to medium grained sandstone	14.1	RC					89	0		
15	55.301			15.1	RC					82	0		
16				16.1	RC					75	0		
17				17.1	RC					85	47		
18			Highly to moderately weathered brownish green Claystone with Siltstone patches	18.1	RC					82	12		
19				19.1	RC					99	0		
20	50.401												

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash Checked by : S. Padhi

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Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 7	CO-ORDINATES: East: 1561.94	North: 3968.06
SITE LOCATION :	TG Hall	START DATE: 5/21/2009	END DATE: 5/23/2009
GROUND REDUCED LEVEL:	70.222	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	0.95	CASING DIA:	150mm upto 2.00m & Nx from 2.00 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	70.072		Concrete pieces										
1			Yellowish brown SandyClay										
	68.822			1.4	RC								
2			Moderately weathered light brown fine to medium grained sandstone							69	17		
	67.822			2.4	RC								
3										80	76		
				3.4	RC								
4			Slightly weathered light greyish Silt to fine grained Sandstone							90	57		
				4.4	RC								
5										90	82		
	64.822			5.4	RC								
6										86	40		
			Moderately to slightly weathered light greyish medium grained Sandstone	6.4	RC								
7										69	47		
	62.822			7.4	RC								
8			Slightly weathered light greyish Siltstone							85	41		
	61.822			8.4	RC								
9										86	61		
			Moderately weathered greyish medium grained Sandstone	9.4	RC								
10										90	0		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 7	CO-ORDINATES: East: 1561.94	North: 3968.06
SITE LOCATION :	TG Hall	START DATE: 5/21/2009	END DATE: 5/23/2009
GROUND REDUCED LEVEL:	70.222	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	0.95	CASING DIA:	150mm upto 2.00m & Nx from 2.00 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
				10.4	RC					90	0		
11			Moderately weathered greyish medium grained Sandstone *(continued)*	11.4	RC					88	13		
12				12.4	RC					86	0		
	57.822												
13			Moderately weathered greyish coarse grained Sandstone	13.4	RC					90	12		
	56.822												
14			Moderately weathered greyish Siltstone(weak rock)	14.4	RC					90	0		
15				15.4	RC					96	0		
	54.822												
16			Moderately weathered greyish medium grained Sandstone(weak rock)	16.4	RC					93	0		
17				17.4	RC					88	0		
	52.822												
18			Highly weathered greyish Siltstone(Laminated weak rock)	18.4	RC					95	10		
19				19.4	RC					55	0		
20	50.222									55	0		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 8	CO-ORDINATES: East: 1292.96	North: 4012.71
SITE LOCATION :	Boiler	START DATE: 6/15/2009	END DATE: 6/19/2009
GROUND REDUCED LEVEL:	71.121	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	0.65	CASING DIA:	150mm upto 3.00m & Nx from 3.00 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	70.921		Filled up soil										
1													
			Loose greyish Clayey sand with gravel.	1.5	UDS				Recovered	---	---		
2													
3	68.121			3	SPT	30			11cm in 100 blows N>100				
										40	20		
4				4	RC								
										80	0		
5			Highly to moderately weathered yellowish brown fine grained Sandstone.	5	RC								
										65	34		
6				6	RC								
										76	0		
7	64.121			7	RC								
			Highly weathered yellowish brown Siltstone.							47	0		
8	63.121			8	RC								
										52	12		
9			Highly to moderately weathered greyish fine grained Sandstone.	9	RC								
										61	28		
10													

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 8	CO-ORDINATES: East: 1292.96	North: 4012.71
SITE LOCATION :	Boiler	START DATE: 6/15/2009	END DATE: 6/19/2009
GROUND REDUCED LEVEL:	71.121	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	0.65	CASING DIA:	150mm upto 3.00m & Nx from 3.00 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
				10	RC					57	0		
11			Highly to moderately weathered greyish fine grained Sandstone. *(continued)*	11	RC					91	0		
12	61.121			12	RC					86	0		
13	58.121		Highly weathered greyish Siltstone with Sandstone patches	13	RC					90	19		
14	57.121		Highly weathered greyish Siltstone with clay patches.	14	RC					87	17		
15				15	RC					93	0		
16			Highly weathered greyish fine grained Sandstone.	16	RC					96	11		
17				17	RC					90	0		
18	53.121			18	RC					99	12		
19			Highly weathered greyish Siltstone with patches of SHALES.	19	RC					96	0		
20	51.121												

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

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Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 9	CO-ORDINATES: East: 1327.16	North: 4038.11
SITE LOCATION :	Boiler	START DATE: 5/4/2009	END DATE: 5/5/2009
GROUND REDUCED LEVEL:	71.323	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	0.6	CASING DIA:	150mm upto 3.50m & Nx from 3.50 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	71.123		Concrete filling										
1			Stiff blakish brown Sandyclay	1.5	UDS				Recovered	---	---		
2	69.223												
3			Medium dense brownish Siltysand	3	SPT	6	8	14	22	---	---		
	67.723			3.45	SPT				15 cm in 100 blows,N>100	---	---		
	67.623		Completely weathered brownish Sandstone	3.7	RC								
4										55	0		
5			Highly to moderately weathered light greyish fine to medium grained Sandstone	4.7	RC					64	64		
	65.623			5.7	RC								
6										76	75		
				6.7	RC								
7			Moderately to slightly weathered light greyish fine to medium grained Sandstone							78	70		
				7.7	RC								
8										77	40		
	62.623			8.7	RC								
9			Highly to moderately weathered greyish Siltstone with Sandstone patches							51	0		
				9.7	RC								
10										71	12		

SPT N = STANDARD PENETRATION TEST VALUE
RC = ROCK CORE
RQD = ROCK QUALITY DESIGNATION
DS = DISTURBED SAMPLE
UDS = UNDISTURBED SOIL SAMPLE
VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 9	CO-ORDINATES: East: 1327.16	North: 4038.11
SITE LOCATION :	Boiler	START DATE: 5/4/2009	END DATE: 5/5/2009
GROUND REDUCED LEVEL:	71.323	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	0.6	CASING DIA:	150mm upto 3.50m & Nx from 3.50 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
11			Highly to moderately weathered greyish Siltstone with Sandstone patches *(continued)*	10.7	RC					71	12		
										75	11		
	59.623			11.7	RC								
12			Moderately weathered greyish fine to medium grained Sandstone							83	14		
	58.623			12.7	RC								
13			Highly to moderately weathered grey Siltstone							80	0		
	57.623			13.7	RC								
14			Highly to moderately weathered greyish Siltstone with fine grained Sandstone patches							72	10		
	56.623			14.7	RC								
15										80	0		
				15.7	RC								
16										79	0		
17			Highly to moderately weathered greyish greyish medium to coarse grained Sandstone(weak rock)	16.7	RC					74	0		
				17.7	RC								
18										80	0		
	52.623			18.7	RC								
19			Highly to moderately weathered greyish Siltstone(weak rock)							73	0		
				19.7									
20	51.323									83	0		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
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Job No:
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Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 10	CO-ORDINATES: East: 1418.78	North: 4011.11
SITE LOCATION :	Boiler	START DATE: 5/21/2009	END DATE: 5/28/2009
GROUND REDUCED LEVEL:	70.777	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1	CASING DIA:	150mm upto 3.00m & Nx from 3.00 to 30.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
1	69.277		Filled up soil consisting of Clay with Kankar & Gravel	1.5	UDS				Recovered	---	---		
2			Stiff greyish brown Clay with low plasticity										
3	67.777			3	SPT				15cm in 100 blows, N>100				
	67.657		Completely weathered deeply decomoposed Sandstone							63	32		
4			Moderately weathered yellowish brown fine grained Sandstone	4	RC					91	44		
5	65.777			5	RC								
			Moderately weathered yellowish brown medium grained Sandstone							90	26		
6	64.777			6	RC								
7	63.777		Moderately weathered light greyish Siltstone	7	RC					88	0		
8				8	RC					90	0		
9			Moderately weathered light greyish medium grained Sandstone	9	RC					90	0		
10	60.777									82	0		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 30 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 10	CO-ORDINATES: East: 1418.78	North: 4011.11
SITE LOCATION :	Boiler	START DATE: 5/21/2009	END DATE: 5/28/2009
GROUND REDUCED LEVEL:	70.777	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1	CASING DIA:	150mm upto 3.00m & Nx from 3.00 to 30.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
				10	RC								
11	59.777		Highly to moderately weathered light greyish Sandstone	11	RC					91	0		
12			Highly to moderately weathered light greyish medium grained Sandstone	12	RC					86	0		
13	57.777			13	RC					90	0		
14			Highly to moderately weathered light greyish to whitish fine grained Sandstone	14	RC					85	0		
15				15	RC					91	0		
16	54.777			16	RC					82	0		
17			Highly to moderately weathered light greyish white Siltstone with patches of Sandstone	17	RC					85	0		
18	52.777			18	RC					55	0		
19	51.777		Highly to moderately weathered light greyish medium greyish Sandstone	19	RC					64	0		
20			Highly to moderately weathered dark greyish fine grained Sandstone							80	11		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash Checked by : S. Padhi

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Borehole termination at 30 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 10	CO-ORDINATES: East: 1418.78	North: 4011.11
SITE LOCATION :	Boiler	START DATE: 5/21/2009	END DATE: 5/28/2009
GROUND REDUCED LEVEL:	70.777	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1	CASING DIA:	150mm upto 3.00m & Nx from 3.00 to 30.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
				20	RC								
										82	0		
21				21	RC								
										74	0		
22			Highly to moderately weathered dark greyish fine grained Sandstone *(continued)*	22	RC								
										90	0		
23				23	RC								
										89	0		
24	46.777			24	RC								
			Highly to moderately weathered greyish brown fine grained Sandstone							85	0		
25	45.777			25	RC								
										59	13		
26			Mederately to slightly weathered greyish fine grained Sandstone	26	RC								
										90	33		
27	43.777			27	RC								
			Highly to moderately weathered greyish medium to coarse grained Sandstone.							73	0		
28	42.777			28	RC								
										73	0		
29			Highly to moderately weathered greyish fine grained Sandstone.	29	RC								
										92	22		
30	40.777												

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash | Checked by : S. Padhi

Job No: | PAGE 3 OF 3

Borehole termination at 30 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 11	CO-ORDINATES: East: 1490.41	North: 4013.42
SITE LOCATION :	Boiler	START DATE: 5/26/2009	END DATE: 5/28/2009
GROUND REDUCED LEVEL:	70.714	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.45	CASING DIA:	150mm upto 2.00m & Nx from 2.00 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
1			Very dense yellowish brown Silty sand.	1.4	SPT	22	37	41	78	---	---		
2	68.714		Completely weathered yellowish brown Sandstone	3.1	SPT				10cm in 100 blows, N>100	---	---		
3	67.514			3.2									
4			Moderately to weathered light brown Siltstone	4.2						65	37		
5	65.514			5.2						70	41		
6			Silghtly weathered medium to coarse grained yellowish brown Sandstone	6.2						84	64		
7				7.2						82	68		
8	62.514			8.2						85	25		
9	61.514		Slighly weathered light greyish brown Siltstone.	9.2						82	55		
10			Moderately weathered yellowish brown medium grained Sandstone.							70	14		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 11	CO-ORDINATES: East: 1490.41	North: 4013.42
SITE LOCATION :	Boiler	START DATE: 5/26/2009	END DATE: 5/28/2009
GROUND REDUCED LEVEL:	70.714	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.45	CASING DIA:	150mm upto 2.00m & Nx from 2.00 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
11			Moderately weathered yellowish brown medium grained Sandstone. *(continued)*	10.2						70	14		
	59.514			11.2						82	10		
12			Moderately weathered light greyish fine grained Sandstone.							90	26		
	58.514			12.2									
13										96	42		
				13.2									
14			Slightly weathered dark greyish medium grained Sandstone.							98	77		
				14.2									
15										90	47		
	55.514			15.2									
16			Slightly weathered dark greyish Siltstone.							90	42		
	54.514			16.2									
17			Slightly weathered light greyish coarse grained Sandstone.							91	74		
	53.514			17.2									
18										84	41		
			Slightly weathered light greyish fine grained Siltstone.	18.2									
19										90	59		
	51.514			19.2									
20	50.714		Slightly weathered light greyish medium grained Sandstone.							87	22		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
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Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 12	CO-ORDINATES: East: 1283.28	North: 4075.82
SITE LOCATION :	Boiler	START DATE: 6/22/2009	END DATE: 6/25/2009
GROUND REDUCED LEVEL:	71.798	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	0.85	CASING DIA:	150mm upto 2.20m & Nx from 2.20 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
0	71.348		Filled up soil										
1			Loose greyish brown Sandy Clay	1.5	UDS				Recovered	---	---		
2	69.598			2.2	SPT				9 cm in 100 blows.N>100	---	---		
	69.348		Completely weathered light yellowish brown Sandstone	2.45	RC								
3										51	20		
				3.45	RC								
4			Moderately weathered light yellowish brown fine grained Sandstone							80	65		
				4.45	RC								
5										89	81		
	66.348			5.45	RC								
6										99	99		
			Slightly weathered light greyish Siltstone	6.45	RC								
7										92	92		
	64.348			7.45	RC								
8										100	100		
			Slight weathered light to fresh greyish fine gained Sandstone	8.45	RC								
9										95	87		
	62.348			9.45	RC								
10			Slightly weathered to fresh greyish Siltstone to fine grained Sandstone patches							84	84		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash Checked by : S. Padhi

Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 12	CO-ORDINATES: East: 1283.28	North: 4075.82
SITE LOCATION :	Boiler	START DATE: 6/22/2009	END DATE: 6/25/2009
GROUND REDUCED LEVEL:	71.798	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	0.85	CASING DIA:	150mm upto 2.20m & Nx from 2.20 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
				10.45	RC					84	84		
11			Slightly weathered to fresh greyish Siltstone to fine grained Sandstone patches *(continued)*	11.45	RC					98	98		
12										60	45		
	59.348			12.45	RC								
13			Highly weathered greyish Siltstone							54	0		
	58.348			13.45	RC								
14			Highly weathered greyish fine grained Sandstone							60	0		
	57.348			14.45	RC								
15			Moderately weathered greyish Siltstone							60	0		
				15.45	RC								
16										74	19		
	55.348			16.45	RC								
17			Moderately weathered greyish fine grained Sandstone							65	10		
				17.45	RC								
18										71	36		
	53.348			18.45	RC								
19			Slightly weathered greyish Siltstone							81	81		
				19.45	RC								
20	51.798									82	71		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
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Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 13	CO-ORDINATES: East: 1363.83	North: 4078.14
SITE LOCATION :	Boiler	START DATE: 5/5/2009	END DATE: 6/8/2009
GROUND REDUCED LEVEL:	71.701	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	0.85	CASING DIA:	150mm upto 1.90m & Nx from 1.90 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
1	70.701		Filled up Soil consisting of Clay with Boulders & Concrete pieces										
2	69.801		Very dense yellowish brown Clayey sand with boulder pieces	1.5	SPT				12 cm in 100 blows,N>100	---	---		
				1.9	RC					66	42		
3	68.801		Moderately weathered light brown medium grained Sandstone	2.9	RC					86	42		
4				3.9	RC					85	0		
5			Moderately to slightly weathered light yellowish brown Sandstone	4.9	RC					84	34		
6	65.801			5.9	RC					89	10		
7				6.9	RC					89	10		
8			Moderately to slightly weathered light greyish Siltstone with fine grained Sandstone patches	7.9	RC					95	13		
9				8.9	RC					95	0		
10				9.9	RC								

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

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Job No: PAGE 1 OF 2

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 13	CO-ORDINATES: East: 1363.83	North: 4078.14
SITE LOCATION :	Boiler	START DATE: 5/5/2009	END DATE: 6/8/2009
GROUND REDUCED LEVEL:	71.701	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	0.85	CASING DIA:	150mm upto 1.90m & Nx from 1.90 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
										94	0		
										94	0		
11				10.9	RC								
										87	11		
12				11.9	RC								
			Moderately to slightly weathered light greyish Siltstone with fine grained Sandstone patches *(continued)*							90	0		
13				12.9	RC								
										88	0		
14				13.9	RC								
										85	15		
15	56.801			14.9	RC								
										89	30		
16			Slightly weathered greyish medium grained Sandstone	15.9	RC								
										85	79		
17	54.801			16.9	RC								
			Slightly weathered greyish coarse grained Sandstone							99	91		
18	53.801			17.9	RC								
										95	63		
19			Slightly weathered greyish Silt to fine grained Sandstone	18.9	RC								
										95	0		
20	51.701												

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

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PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
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Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 14	CO-ORDINATES: East: 1451.3	North: 4044.21
SITE LOCATION :	Boiler	START DATE: 6/1/2009	END DATE: 4/6/2009
GROUND REDUCED LEVEL:	71.049	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	0.95	CASING DIA:	150mm upto 2.00m & Nx from 2.00 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	70.599		Filled up soil consisting of Clayey Sand										
1			Loose yellowish brown Silty Sand	1.5	UDS				Recovered	---	---		
2	69.049			2	RC								
										53	0		
3				3	RC								
			Moderately to slightly weathered medium to coarse grained light brown Sandstone							76	22		
4				4	RC								
										88	82		
5	66.049			5	RC								
										76	34		
6				6	RC								
			Highly to moderately weathered brownish to greyish fine to medium grained Sandstone							70	0		
7				7	RC								
										50	0		
8	63.049			8	RC								
			Highly weathered greyish Claystone with Siltstone patches							51	0		
9	62.049			9	SPT				11cm in 100 blowsN>100	---	---		
			Completely weathered,deeply decomposed greyish Siltstone										
10	61.049												

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

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Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 14	CO-ORDINATES: East: 1451.3	North: 4044.21
SITE LOCATION :	Boiler	START DATE: 6/1/2009	END DATE: 4/6/2009
GROUND REDUCED LEVEL:	71.049	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	0.95	CASING DIA:	150mm upto 2.00m & Nx from 2.00 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
11			Completely weathered deeply decomposed,greyish Siltstone in the form Silty sand	11	SPT				11cm in 100 blowsN>100	---	---		
12				12	SPT				11cm in 100 blowsN>100	---	---		
13	58.049			13	SPT				10cm in 100 blowsN>100	---	---		
				13.1	RC					46	0		
14				14.1	RC					48	15		
15			Highly weathered dark greyish medium grained Sandstone	15.1	RC					62	0		
16				16.1	RC					47	0		
17	54.049			17.1	RC					58	29		
18			Highly to moderately weathered grey Siltstone	18.1	RC					60	0		
19	52.049			19.1						72	72		
20	51.049		Moderately weathered greyish fine grained sandstone										

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
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Job No:

Borehole termination at 20 m

CLIENT:	NTPC
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)
BOREHOLE ID: BH 15	CO-ORDINATES: East: 1477.91 North: 4075.6
SITE LOCATION : Boiler	START DATE: 5/3/2009 END DATE: 6/3/2009
GROUND REDUCED LEVEL: 71.067	DRILLING METHOD: Rotary
GROUND WATER TABLE DEPTH: 1.15	CASING DIA: 150mm upto 4.50m & Nx from 4.50 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	70.667		Fill up soil										
1			Boulder pieces embeded in Clay	1.5	SPT				11cm in 100 blows N>100	---	---		
2													
3	68.267		Medium dense to very greyish Clayey Sand with Gravel	3	SPT	3	6	11	17	---	---		
4													
	66.567			4.5	SPT	18	24	31	55	---	---		
5			Very dense greyish Siltysand										
6				6	SPT				13cm in 100 blows N>100	---	---		
7	64.067												
			Completely weathered greyish Rock	7.5	SPT				12cm in 100 blows N>100	---	---		
8	63.067			8	RC								
			Highly weathered light greyish fine grained Sandstone							56	10		
9	62.067			9	RC								
			Highly weathered greyish fine to medium grained Sandstone							56	0		
10													

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

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Job No: PAGE 1 OF 2

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 15	CO-ORDINATES: East: 1477.91	North: 4075.6
SITE LOCATION :	Boiler	START DATE: 5/3/2009	END DATE: 6/3/2009
GROUND REDUCED LEVEL:	71.067	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.15	CASING DIA:	150mm upto 4.50m & Nx from 4.50 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
				10	RC					49	23		
11			Highly weathered greyish fine to medium grained Sandstone *(continued)*	11	RC					60	21		
12	59.067			12	RC					61	39		
	58.367		Moderately weathered brownish fine to medium grained Sandstone										
13			Moderately weathered light greyish Siltstone	13	RC					69	53		
14	57.567		Highly weathered brownish Siltstone to medium grained Sandstone	14	RC					48	15		
15	56.067			15	RC					56	0		
16			Highly to moderately weathered ,brownish with greyish medium to coarse grained Sandstone patch	16	RC					71	49		
17	54.067			17	RC					72	0		
18	53.067		Highly weathered greyish fine to medium grained Sandstone	18	RC					84	21		
19	52.067		Highly to moderately weathered greyish Siltstone	19	RC					70	13		
20	51.067		Moderately weathered greyish medium grained Sandstone										

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
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Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 16	CO-ORDINATES: East: 1270.53	North: 4118.82
SITE LOCATION :	ESP	START DATE: 6/15/2009	END DATE: 6/18/2009
GROUND REDUCED LEVEL:	72.520	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	0.9	CASING DIA:	150mm upto 3.70m & Nx from 3.70 to 20.9m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
1	71.02		Medium dense to very greyish Clayey Sand with Gravel	1.5	SPT				12cm in 100 blows N>100	---	---		
2	69.82		Completely weathered yellowish brown rock.	2.5	SPT				8cm in 100 blows N>100	---	---		
3				2.7	RC					65	44		
4				3.7	RC					80	54		
5				4.7	RC					95	78		
6				5.7	RC					83	27		
7				6.7	RC					94	0		
8				7.7	RC					87	0		
9			Slightly weathered greyish fine grained Sandstone.	8.7	RC					69	0		
10				9.7	RC					84	0		
11				10.7	RC					85	0		
12				11.7	RC					84	0		
13				12.7	RC					87	0		
14				13.7	RC					87	0		
15				14.7	RC					91	0		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 16	CO-ORDINATES: East: 1270.53	North: 4118.82
SITE LOCATION :	ESP	START DATE: 6/15/2009	END DATE: 6/18/2009
GROUND REDUCED LEVEL:	72.520	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	0.9	CASING DIA:	150mm upto 3.70m & Nx from 3.70 to 20.9m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
16				15.7	RC					91	0		
17				16.7	RC					91	0		
18			Slightly weathered greyish fine grained Sandstone. *(continued)*	17.7	RC					92	0		
19				18.7	RC					93	0		
20	52.52			19.7	RC					97	0		
				20	RC					74	0		
21										---	---		
22													
23													
24													
25													
26													
27													
28													
29													
30													

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 17	CO-ORDINATES: East: 1325.4	North: 4148.92
SITE LOCATION :	ESP	START DATE: 6/25/2009	END DATE: 6/27/2009
GROUND REDUCED LEVEL:	72.109	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1	CASING DIA:	150mm upto 1.75m & Nx from 1.75 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth	SAMPLE	BLOWS/15cm 15	15	15	'N' Field	Core ecovery(%)	RQD (%)	Other Tests	REMARKS
0	72.109		Field of soil consisting of pebbles.										
1	71.259		Completely weathered yellowish brown rock.	1.4	SPT	29			12cm in 100 blows N>100	---	---		
2	70.359		Highly to moderately weathered light yellowish Siltstone to fine grained Sandstone.	1.75	RC					84	62		
3				2.75	RC					78	0		
4	68.359		Moderately to slightly weathered light greyish Siltstone to fine grained Sandstone.	3.75	RC					95	0		
5				4.75	RC					68	40		
6				5.75	RC					75	66		
7				6.75	RC					72	59		
8	64.359		Slightly weathered greyish fine grained Sandstone.	7.75	RC					91	43		
9	63.359		Slightly weathered greyish Siltstone	8.75	RC					99	43		
10				9.75	RC					92	52		

SPT N = STANDARD PENETRATION TEST VALUE
RC = ROCK CORE
RQD = ROCK QUALITY DESIGNATION
DS = DISTURBED SAMPLE
UDS = UNDISTURBED SOIL SAMPLE
VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 17	CO-ORDINATES: East: 1325.4	North: 4148.92
SITE LOCATION :	ESP	START DATE: 6/25/2009	END DATE: 6/27/2009
GROUND REDUCED LEVEL:	72.109	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1	CASING DIA:	150mm upto 1.75m & Nx from 1.75 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
11			Slightly weathered greyish Siltstone *(continued)*	10.75	RC					92	52		
	60.359			11.75	RC					90	90		
12			Slightly weathered greyish Sandstone.	12.75	RC					96	96		
13										93	40		
	58.359			13.75	RC								
14			Slightly weathered greyish fine grained Sandstone.							99	99		
	57.359			14.75	RC								
15			Slightly weathered greyish Siltstone with clay paches.							90	82		
	56.359			15.75	RC								
16			Slightly weathered weathered greyish Siltstone.							99	99		
17				16.75	RC					96	96		
18				17.75	RC					93	88		
19				18.75	RC					97	97		
20	52.109												

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 17	CO-ORDINATES: East: 1325.4	North: 4148.92
SITE LOCATION :	ESP	START DATE: 6/25/2009	END DATE: 6/27/2009
GROUND REDUCED LEVEL:	72.109	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1	CASING DIA:	150mm upto 1.75m & Nx from 1.75 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE		BLOWS/15cm			'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
				Sample Depth (m)	SAMPLE TYPE	15	15	15					
				20						---	---		
21													
22													
23													
24													
25													
26													
27													
28													
29													
30													

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 18	CO-ORDINATES: East: 1413.04	North: 4115.92
SITE LOCATION :	ESP	START DATE: 6/3/2009	END DATE: 6/4/2009
GROUND REDUCED LEVEL:	71.857	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.05	CASING DIA:	150mm upto 3.0m & Nx from 3.00 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
1	70.857		Field of soil consisting of clayey sand with gravel.										
				1.5	UDS				Recovered	---	---		
2			Stiff to hard brownish sandy clay with gravel.										
	69.157			2.7	SPT				10cm in 100 blows N>100	---	---		
3	68.757		Completely weathered deeply decomposed yellowish brown Sandstone.	3.1	RC								
										50	0		
4				4.1	RC								
										54	45		
5			Highly to moderately weathered fine to medium grained yellowish brown Sandstone.	5.1	RC								
										84	22		
6				6.1	RC								
										85	15		
7	64.757			7.1	RC								
			Moderately weathered light greyish fine to medium grained Sandstone.							85	0		
8	63.757			8.1	RC								
										92	0		
9			Moderately weathered light gray silt stone.	9.1	RC								
										95	0		
10													

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 18	CO-ORDINATES: East: 1413.04	North: 4115.92
SITE LOCATION :	ESP	START DATE: 6/3/2009	END DATE: 6/4/2009
GROUND REDUCED LEVEL:	71.857	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.05	CASING DIA:	150mm upto 3.0m & Nx from 3.00 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	61.757			10.1	RC					93	51		
11				11.1	RC					85	58		
12			Slightly weathered dark greyish fine graind Sandstone.	12.1	RC					91	68		
13				13.1	RC					92	0		
14	57.757			14.1	RC					93	67		
15	56.757		Slightly weathered dark greyish fine to medium graind Sandstone.	15.1	RC					96	0		
16	55.757		Moderately weathered dark greyish medium to coarse graind Sandstone.	16.1	RC					96	0		
17			Moderately weathered greyish Siltstone.	17.1	RC					85	0		
18	53.757			18.1	RC					91	0		
19			Moderately weathered greyish medium grained Sandstone.	19.1	RC					85	0		
20	51.857												

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RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 19	CO-ORDINATES: East: 1502.29	North: 4113.5
SITE LOCATION :	ESP	START DATE: 6/8/2009	END DATE: 6/11/2009
GROUND REDUCED LEVEL:	71.574	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.55	CASING DIA:	150mm upto 2.00m & Nx from 2.00 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
1			Medium stiff greyish sandy clay.										
				1.5	UDS				Recovered 13cm in 100 blows N>100	---	---		
2	69.574			2	SPT					---	---		
	69.424		Completely weathered deeply decomposed brownish to greyish Sandstone.	2.15	RC								
			Moderately weathered brownish to greyish fine to medium grained Sandstone.							78	61		
3	68.424			3.15	RC								
			Moderately weathered greyish Siltstone.							78	44		
4	67.424			4.15	RC								
										84	58		
5				5.15	RC								
										96	96		
6			Moderately to slightly weathered light greyish compacted fine to medium grained Sandstone.	6.15	RC								
										82	48		
7				7.15	RC								
										91	63		
8	63.424			8.15	RC								
										75	40		
9			Slightly weathered greyish fine grained Sandstone.	9.15	RC								
										80	44		
10													

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 19	CO-ORDINATES: East: 1502.29	North: 4113.5
SITE LOCATION :	ESP	START DATE: 6/8/2009	END DATE: 6/11/2009
GROUND REDUCED LEVEL:	71.574	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.55	CASING DIA:	150mm upto 2.00m & Nx from 2.00 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	61.424			10.15	RC								
11			Slightly weathered greyish Siltstone.							90	22		
	60.424			11.15	RC								
										65	0		
12			Highly weathered dark greyish medium to coarse grained Sandstone.	12.15	RC								
										93	17		
13													
	58.424			13.15	RC								
			Highly weathered dark greyish fine grained Sandstone.							80	0		
14													
	57.424			14.15	RC								
	57.074		Dark greyish Siltstone.										
										83	0		
15				15.15	RC								
										70	0		
16				16.15	RC								
										76	0		
17			Highly weathered dark greyish medium to carse grained Sandstone.	17.15	RC								
										71	0		
18				18.15	RC								
										62	0		
19				19.15	RC								
										71	18		
20	51.574												

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

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Job No: PAGE 2 OF 2

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 20	CO-ORDINATES: East: 1263.41	North: 4184.35
SITE LOCATION :	ESP	START DATE: 6/23/2009	END DATE: 6/27/2009
GROUND REDUCED LEVEL:	72.319	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.05	CASING DIA:	150mm upto 1.50m & Nx from 1.50 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	72.019		Filled up soil										
			Greyish sand with pebbles.										
1	71.419												
			Completely weathered yellowish brown Sandstone.	1.5	SPT	28			11cm in 100 blows N>100	---	---		
	70.519			1.8	RC								
2			Moderately weathered light yellowish fine grained Sandstone.							79	21		
	69.519			2.8	RC								
3			Moderately weathered light greyish Siltstone.							85	56		
	68.519			3.8	RC								
4										91	78		
				4.8	RC								
5										100	100		
				5.8	RC								
6										96	76		
			Slightly weathered to fresh light greyish fine grained Siltstone	6.8	RC								
7										99	99		
				7.8	RC								
8										97	97		
				8.8	RC								
9										99	91		
				9.8	RC					96	94		
10													

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
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Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 20	CO-ORDINATES: East: 1263.41	North: 4184.35
SITE LOCATION :	ESP	START DATE: 6/23/2009	END DATE: 6/27/2009
GROUND REDUCED LEVEL:	72.319	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.05	CASING DIA:	150mm upto 1.50m & Nx from 1.50 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
11			Slightly weathered to fresh light greyish fine grained Siltstone *(continued)*	10.8	RC					96	94		
12				11.8	RC					97	86		
13	59.519			12.8	RC					95	95		
14			Slightly weathered greyish Siltstone.	13.8	RC					91	91		
15				14.8	RC					90	90		
16	56.519			15.8	RC					92	0		
17			Moderately weathered greyish fine grained Sandstone.	16.8	RC					86	0		
18	54.519			17.8	RC					93	0		
19			Moderately weathered greyish Siltstone.	18.8	RC					91	0		
20	52.319									80	0		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 21	CO-ORDINATES: East: 1374.24	North: 4180.08
SITE LOCATION :	Chimney	START DATE: 6/20/2009	END DATE: 6/23/2009
GROUND REDUCED LEVEL:	72.092	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.1	CASING DIA:	150mm upto 2.10m & Nx from 2.10 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
0	71.442		Filled up soil										
1			Greyish brown Sandy clay with pebbles.										
	70.592			1.5	SPT	32			13cm in 100 blows N>100	---	---		
2			Completely weathered yellowish brown Sandstone.	2.1	RC								
	69.992									85	13		
3			Highly weathered yellowish fine grained Sandstone.	3.1	RC								
4										93	0		
	67.992			4.1	RC								
			Highly weathered light greyish fine grained Sandstone.							86	0		
5	66.992			5.1	RC								
			Highly weathered light greyish medium grained Sandstone.							90	0		
6	65.992			6.1	RC								
										57	0		
7				7.1	RC								
										88	0		
8			Highly weathered light greyish Siltstone to fine grained Sandstone.	8.1	RC								
										92	34		
9				9.1	RC								
										90	0		
10													

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash | Checked by : S. Padhi

Job No: |

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 21	CO-ORDINATES: East: 1374.24	North: 4180.08
SITE LOCATION :	Chimney	START DATE: 6/20/2009	END DATE: 6/23/2009
GROUND REDUCED LEVEL:	72.092	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.1	CASING DIA:	150mm upto 2.10m & Nx from 2.10 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	61.992			10.1	RC								
			Highly weathered greyish fine grained Sandstone.							92	0		
11	60.992			11.1	RC								
										74	10		
12			Highly weathered coarse grained Sandstone.	12.1	RC								
										58	0		
13	58.992			13.1	RC								
			Highly weathered greyish Siltstone with clay paches.							60	10		
14	57.992			14.1	RC								
			Moderately weathered greyish fine grained Sandstone.							82	50		
15	56.992			15.1	RC								
			Slightly weathered greyish fine grained Sandstone.							95	86		
16	55.992			16.1	RC								
										84	54		
17				17.1	RC								
			Moderately weathered light greyish Siltstone.							81	37		
18	53.992			18.1	RC								
										90	90		
19			Higly to moderately weathered greyish fine grained Sandstone.	19.1	RC								
										86	0		
20													

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
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Job No:
PAGE 2 OF 3

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 21	CO-ORDINATES: East: 1374.24	North: 4180.08
SITE LOCATION :	Chimney	START DATE: 6/20/2009	END DATE: 6/23/2009
GROUND REDUCED LEVEL:	72.092	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.1	CASING DIA:	150mm upto 2.10m & Nx from 2.10 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
				20.1	RC								
	51.292		Higly to moderately weathered greyish fine grained Sandstone. *(continued)*							86	0		
21													
22													
23													
24													
25													
26													
27													
28													
29													
30													

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash Checked by : S. Padhi

Job No: PAGE 3 OF 3

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 22	CO-ORDINATES: East: 1451.54	North: 4151.98
SITE LOCATION :	Chimney	START DATE: 6/5/2009	END DATE: 6/8/2009
GROUND REDUCED LEVEL:	72.194	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.98	CASING DIA:	150mm upto 1.98m & Nx from 1.98 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	71.894		Filled up soil consisting of brick and concrete pieces										
1			Very dense yellowish brown clayey sand.	1	SPT	20	28	33	61	---	---		
	70.744												
2				2	SPT	38			10cm in 100 blows N>100	---	---		
3			Completely weathered deeply decomposed brownish Sandstone.										
	68.894			3.3	RC								
4										47	10		
				4.3	RC								
5										69	19		
				5.3	RC								
6			Highly to moderately weathered yellowish brown fine to medium grained Sandstone.							85	10		
				6.3	RC								
7										87	13		
				7.3	RC								
8										92	0		
	63.894			8.3	RC								
9										83	0		
			Highly weathered light greyish Siltstone	9.3	RC								
10										92	0		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 22	CO-ORDINATES: East: 1451.54	North: 4151.98
SITE LOCATION :	Chimney	START DATE: 6/5/2009	END DATE: 6/8/2009
GROUND REDUCED LEVEL:	72.194	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.98	CASING DIA:	150mm upto 1.98m & Nx from 1.98 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	61.894			10.3	RC					92	0		
11										92	0		
				11.3	RC								
12			Highly weathered light greyish medium grained Sandstone.							96	0		
				12.3	RC								
13										87	0		
	58.894			13.3	RC								
14			Highly weathered light greyish fine to medium grained Sandstone.							95	0		
	57.894			14.3	RC								
15			Highly weathered light greyish medium to coarse grained Sandstone.							77	14		
	56.894			15.3	RC								
16										78	39		
			Moderately to slightly weathered greyish Siltstone.	16.3	RC								
17										92	63		
	54.894			17.3	RC								
18										93	58		
			Slightly weathered greyish medium grained Sandstone.	18.3	RC								
19										88	37		
	52.894			19.3	RC								
20	52.194		Slightly weathered greyish Siltstone to fine grained Sandstone.							80	38		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:
PAGE 2 OF 2

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 23	CO-ORDINATES: East: 1492.04	North: 4181.92
SITE LOCATION :	ESP	START DATE: 6/8/2009	END DATE: 6/10/2009
GROUND REDUCED LEVEL:	71.784	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.35	CASING DIA:	150mm upto 2.10m & Nx from 2.10 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
1	70.784		Filled up soil consisting at Clay with gravel										
				1.25	SPT				12cm in 100 blows N>100	---	---		
2	69.684		Completely weathered deeply decomposed brownish Sandstone.	2	SPT				10cm in 100 blows N>100	---	---		
				2.2	RC								
3			Highly weathered yellowish brown, medium to coarse grained Sandstone.							76	0		
	68.584			3.2	RC								
4			Highly weathered yellowish brown medium to fine grained Sandstone.	4.2	RC					78	0		
5										79	0		
	66.584			5.2	RC								
6			Highly to moderately weathered light yellowish brown medium to coarse grained Sandstone.	6.2	RC					86	12		
7										95	0		
				7.2	RC								
8										95	0		
				8.2	RC								
9										97	0		
				9.2	RC								
10										88	11		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash | Checked by : S. Padhi

Job No: | PAGE 1 OF 2

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 23	CO-ORDINATES: East: 1492.04	North: 4181.92
SITE LOCATION :	ESP	START DATE: 6/8/2009	END DATE: 6/10/2009
GROUND REDUCED LEVEL:	71.784	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.35	CASING DIA:	150mm upto 2.10m & Nx from 2.10 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
11			Highly to moderately weathered light yellowish brown medium to coarse grained Sandstone. *(continued)*	10.2	RC					88	11		
	60.584									86	0		
				11.2	RC								
12			Moderately to slightly weathered greyish Siltstone.							90	68		
				12.2	RC								
13										92	28		
	58.584			13.2	RC								
14			Slightly weathered greyish medium grained Sandstone							85	57		
				14.2	RC								
	56.984									87	56		
15			Slightly weathered greyish Siltstone	15.2	RC								
	56.084									83	38		
16			Slightly weathered greyish fine to medium grained Sandstone										
	55.584			16.2	RC								
			Slightly weathered greyish Sandstone.							92	22		
17													
	54.584			17.2	RC								
			Greyish medium grained Sandstone.										
	54.084									92	25		
18			Greyish Siltstone.										
	53.584			18.2	RC								
										93	46		
19			Slightly weathered greyish medium grained Sandstone with some petches of Siltstone	19.2	RC					100	46		
20	51.784												

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash | Checked by : S. Padhi

Job No: | PAGE 2 OF 2

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 24	CO-ORDINATES: East: 1293.53	North: 4225.03
SITE LOCATION :	ESP	START DATE: 6/19/2009	END DATE: 6/22/2009
GROUND REDUCED LEVEL:	72.383	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	0.85	CASING DIA:	150mm upto 2.00m & Nx from 2.00 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	72.183		Concrete pieces										
1			Very dense greyish silty gravel.	1	SPT	22	24	28	52				
	70.883									---	---		
2	70.383		Completely weathered yellowish brown Sandstone.	1.9	SPT				10cm in 100 blows N>100	---	---		
				2	RC					83	60		
3				3	RC								
			Highly to moderately weathered light yellowish fine to medium grained Sandstone.							85	12		
4				4	RC								
										93	12		
5	67.383			5	RC								
										90	29		
6			Highly to moderately weathered light yellowish Siltstone	6	RC								
										80	10		
7	65.383			7	RC								
			Highly to moderately weathered light greyish fine grained Sandstone.							90	37		
8	64.383			8	RC								
			Highly weathered light greyish fine grained Sandstone.							85	0		
9	63.383			9	RC								
			Highly weathered greyish Siltstone.							90	11		
10													

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 24	CO-ORDINATES: East: 1293.53	North: 4225.03
SITE LOCATION :	ESP	START DATE: 6/19/2009	END DATE: 6/22/2009
GROUND REDUCED LEVEL:	72.383	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	0.85	CASING DIA:	150mm upto 2.00m & Nx from 2.00 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
10				10	RC								
										91	0		
11			Highly weathered greyish Siltstone. *(continued)*	11	RC								
										84	34		
12	60.383			12	RC								
										82	58		
13				13	RC								
										84	22		
14				14	RC								
										85	20		
15				15	RC								
										49	0		
16			Highly to moderately weathered light yellowish fine to medium grained Sandstone.	16	RC								
										84	0		
17				17	RC								
										85	0		
18				18	RC								
										90	0		
19				19	RC								
										90	0		
20	52.383												

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

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Job No: | PAGE 2 OF 2

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 25	CO-ORDINATES: East: 1386.16	North: 4272.92
SITE LOCATION :	ESP	START DATE: 6/24/2009	END DATE: 6/29/2009
GROUND REDUCED LEVEL:	73.157	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.05	CASING DIA:	150mm upto 2.50m & Nx from 2.50 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	72.657		Fill up soil with kankar.										
1			Greyish sandy clay	1.5	UDS				Recovered	---	---		
2	70.657			2.5	SPT				13cm in 100 blow N>100	---	---		
	70.527		Completely weathered yellowish brown Sandstone.	2.65	RC								
3										84	33		
				3.65	RC								
4			Highly to moderately weathered yellowish brown fine Sandstone.							87	0		
				4.65	RC								
5										91	21		
	67.507			5.65	RC								
6										90	22		
			Highly to moderately weathered light greyish fine grained Sandstone.	6.65	RC								
7										87	0		
	65.507			7.65	RC								
8			Highly to moderately weathered yellowish brown fine grained Sandstone to greyish Siltstone.							91	0		
	64.507			8.65	RC								
9			Moderately to slightly weathered yellowish brown fine grained Sandstone.							92	42		
10				9.65	RC					84	12		

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ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 30 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 25	CO-ORDINATES: East: 1386.16	North: 4272.92
SITE LOCATION :	ESP	START DATE: 6/24/2009	END DATE: 6/29/2009
GROUND REDUCED LEVEL:	73.157	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.05	CASING DIA:	150mm upto 2.50m & Nx from 2.50 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
11			Moderately to slightly weathered yellowish brown fine grained Sandstone. *(continued)*	10.65	RC					84	12		
				11.65	RC					92	14		
12										92	21		
	60.507			12.65	RC								
13			Slightly weathered dark greyish Siltstone with patches of SHALE.							93	72		
	59.507			13.65	RC								
14			Highly to moderately weathered greyish Siltstone							99	0		
15				14.65	RC					94	13		
	57.507			15.65	RC								
16			Highly to moderately weathered dark greyish fine grained Sandstone.							80	11		
	56.507			16.65	RC								
17										81	0		
				17.65	RC								
18										94	0		
			Highly to moderately weathered dark greyish Siltstone.	18.65	RC								
19										70	12		
				19.65	RC								
20										78	0		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 30 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 25	CO-ORDINATES: East: 1386.16	North: 4272.92
SITE LOCATION :	ESP	START DATE: 6/24/2009	END DATE: 6/29/2009
GROUND REDUCED LEVEL:	73.157	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.05	CASING DIA:	150mm upto 2.50m & Nx from 2.50 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
										78	0		
				20.65	RC								
21										90	0		
				21.65	RC								
22										82	0		
				22.65	RC								
23										89	0		
				23.65	RC								
24										90	0		
				24.65	RC								
25			Highly to moderately weathered dark greyish Siltstone. *(continued)*							92	0		
				25.65	RC								
26										80	0		
				26.65	RC								
27										87	0		
				27.65	RC								
28										88	0		
				28.65	RC								
29										91	0		
				29.65	RC								
30	43.157									84	0		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 30 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 26	CO-ORDINATES: East: 1476.59	North: 4225.03
SITE LOCATION :	Chimney	START DATE: 6/6/2009	END DATE: 6/10/2009
GROUND REDUCED LEVEL:	72.30	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.4	CASING DIA:	150mm upto 2.40m & Nx from 2.40 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
1	70.8		Brownish to brownish sandy clay	1	UDS				Recovered	---	---		
2			Very dense yellowish clayey sand with gravel.	2.4	SPT	30			12cm in 100 blows N>100	---	---		
3	69.3			3	RC								
4	68.3		Highly weathered yellowish brown medium grained Sandstone.	4	RC					46	34		
5			Moderately weathered yellowish brown coarse grained Sandstone.	5	RC					51	35		
6	66.5			5.8	RC					65	15		
	66.1		Moderately weathered brownish Siltstone.	6	RC					60	30		
7			Moderately weathered light brown filled spathic Sandstone.	7	RC					57	0		
8	63.8			8	RC					71	14		
9	62.8		Moderately weathered with coarse grained Sandstone patches of clay.	9	RC					68	31		
10	62.3		Moderately weathered light brown Siltstone.							70	0		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
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ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash Checked by : S. Padhi

Job No: PAGE 1 OF 2

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 26	CO-ORDINATES: East: 1476.59	North: 4225.03
SITE LOCATION :	Chimney	START DATE: 6/6/2009	END DATE: 6/10/2009
GROUND REDUCED LEVEL:	72.30	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	1.4	CASING DIA:	150mm upto 2.40m & Nx from 2.40 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
				10	RC								
11	61.3		Highly weathered greyish Siltstone to fine grained Sandstone.	11	RC					72	0		
12	60.3		Highly weathered light brown medium grained Sandstone.	12	RC					74	0		
13				13	RC					73	0		
14	58.3		Highly weathered greyish medium grained Sandstone.	14	RC					85	0		
15	57.3		Highly weathered greyish Siltstone.	15	RC					75	0		
16				16	RC					78	22		
17				17	RC					80	21		
18			Highly to moderately weathered greyish fine grained Sandstone.	18	RC					87	0		
19				19	RC					82	10		
20	52.3									---	---		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 69.136 m **EAST:** E or X = 1381.14 **NORTH:** N or Y = 3813.05

TYPE OF BORING: Rotary **BORING NO:** BH 42

DIAMETER OF BORING: 150mm upto 4.30m & Nx from 4.30m to 20.00m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: Switch Yard **DATE STARTED:** 20/7/09 **COMPLETED:** 30/7/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	Sample Number	BLOWS/15cm 15 cm	15 cm	15 cm	"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
0																
			Medium stiff to stiff yellowish to greyish Clay													
1											▼					
				1.5	UDS	1	---	---	---					---		
2																
3				3	SPT	1	3	4	4	8				---		
4	65.136			4	SPT	2	36	100	---	N > 100				---		
	64.836		Completely weathered brownish Sandstone	4.3	RC		---	---	---				73	0		
5			Highly to moderately weathered brownish fine grained Sandstone	5.3	RC		---	---	---				71	0		
6				6.3	RC		---	---	---				77	0		
7				7.3	RC		---	---	---				92	0		
8	60.836			8.3	RC		---	---	---				78	0		
			Highly to moderately weathered greyish fine grained Sandstone													
9				9.3	RC		---	---	---				81	10		
10																

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 69.136 m **EAST:** E or X = 1381.14 **NORTH:** N or Y = 3813.05

TYPE OF BORING: Rotary **BORING NO:** BH 42

DIAMETER OF BORING: 150mm upto 4.30m & Nx from 4.30m to 20.00m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: Switch Yard **DATE STARTED:** 20/7/09 **COMPLETED:** 30/7/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
10	58.836		Moderately weathered greyish coarse to fine grained Sandstone consisting of pink feldspar& purple bands	10.3	RC		---	---	---				86	11		
11				11.3	RC		---	---	---				79	23		
12	56.836		Moderately weathered greyish coarse grained Sandstone to Shale with light pink laminations	12.3	RC		---	---	---				87	25		
13	55.836		Moderately weathered greyish Shale	13.3	RC		---	---	---				86	11		
14	54.836		Highly to moderately weathered greyish Siltstone with some portions Shale	14.3	RC		---	---	---				72	0		
15				15.3	RC		---	---	---				83	10		
16	52.836		Moderately weathered greyish, medium to coarse grained Sandstone with pink feldspar	16.3	RC		---	---	---				84	11		
17	51.836		Highly to moderately weathered greyish Siltstone	17.3	RC		---	---	---				85	32		
18				18.3	RC		---	---	---				90	0		
19	49.836		Highly to moderately weathered coarse grained Sandstone with laminated Shale	19.3	RC		---	---	---				52	0		
20	49.136															

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004
PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 71.962 m **EAST:** E or X = 1252.77 **NORTH:** N or Y = 4320.05

TYPE OF BORING: Rotary **BORING NO:** BH 49

DIAMETER OF BORING: 150mm upto 1.20m & Nx from 1.20 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: Track Hopper **DATE STARTED:** 5/8/09 **COMPLETED:** 7/8/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
0																
1	71.062		Stiff greyish Clayey Sand (SC)	0.9	SPT	1	38	---	---	11cm in 100 blows N>100	▼			---		
	70.762		Completely weathered brownish Sandstone	1.2	RC	1	---	---	---							
2			Highly to moderately weathered yellowish brown fine to medium grained Sandstone	2.2	RC	2	---	---	---				65	0		
3				3.2	RC	3	---	---	---				81	11		
4				4.2	RC	4	---	---	---				83	0		
5				5.2	RC	5	---	---	---				91	14		
	66.762		Moderately weathered light greyish Siltstone													
6				6.2	RC	6	---	---	---				84	21		
	65.762		Highly to moderately weathered greyish fine grained Sandstone													
7				7.2	RC	7	---	---	---				88	62		
8				8.2	RC	8	---	---	---				89	80		
9				9.2	RC	9	---	---	---				80	0		
	62.762		Highly to moderately weathered greyish Siltstone													
10													88	79		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

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PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 71.962 m **EAST:** E or X = 1252.77 **NORTH:** N or Y = 4320.05

TYPE OF BORING: Rotary **BORING NO:** BH 49

DIAMETER OF BORING: 150mm upto 1.20m & Nx from 1.20 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: Track Hopper **DATE STARTED:** 5/8/09 **COMPLETED:** 7/8/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
10			Highly to moderately weathered greyish Siltstone *(continued)*	10.2	RC	10	---	---	---				88	79		
													88	26		
11				11.2	RC	11	---	---	---							
													87	0		
12	59.762			12.2	RC	12	---	---	---							
			Highly to moderately weathered greyish fine grained Sandstone										84	0		
13	58.762			13.2	RC	13	---	---	---							
			Highly to moderately weathered greyish Siltstone										86	0		
14	57.762			14.2	RC	14	---	---	---							
			Highly to moderately weathered greyish medium grained Sandstone										89	0		
15				15.2	RC	15	---	---	---							
													91	0		
16				16.2	RC	16	---	---	---							
													86	0		
17				17.2	RC	17	---	---	---							
													83	10		
18				18.2	RC	18	---	---	---							
													88	0		
19	52.762			19.2	RC	19	---	---	---							
			Highly to moderately weathered greyish Siltstone										84	0		
20	51.962															

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 71.826 m **EAST:** E or X = 1377.25 **NORTH:** N or Y = 4331.52

TYPE OF BORING: Rotary **BORING NO:** BH 50

DIAMETER OF BORING: 150mm upto 1.70m & Nx from 1.70 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: AUX Boiler **DATE STARTED:** 4/8/09 **COMPLETED:** 5/8/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
0																
			Greyish Sandy Clay (CI)													
1																
	70.426			1.4	SPT	1	32	---	---	10cm in 100blows N>100				---		
	70.126		Completely weathered deeply decomposed brownish Sandstone	1.7	RC		---	---	---							
2			Highly to moderately weathered reddish brown to greyish brown fine to coarse grained Sandstone										71	23		
				2.7	RC		---	---	---							
3													69	14		
				3.7	RC		---	---	---							
4													74	46		
				4.7	RC		---	---	---							
5													82	15		
				5.7	RC		---	---	---							
6													86	37		
	65.126			6.7	RC		---	---	---							
7			Moderately to slightly weathered greyish Siltstone										89	35		
				7.7	RC		---	---	---							
8													91	45		
				8.7	RC		---	---	---							
9													91	55		
	62.126			9.7	RC		---	---	---							
10													93	72		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

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N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 71.826 m **EAST:** E or X = 1377.25 **NORTH:** N or Y = 4331.52

TYPE OF BORING: Rotary **BORING NO:** BH 50

DIAMETER OF BORING: 150mm upto 1.70m & Nx from 1.70 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: AUX Boiler **DATE STARTED:** 4/8/09 **COMPLETED:** 5/8/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
10			Slightly weathered greyish fine grained Sandstone *(continued)*										93	72		
	61.126		Slightly weathered greyish Siltstone	10.7	RC		---	---	---							
11													92	92		
				11.7	RC		---	---	---							
12													94	89		
	59.126		Moderately to slightly weathered greyish Siltstone with fine grained Sandstone patches	12.7	RC		---	---	---							
13													93	42		
				13.7	RC		---	---	---							
14													97	37		
				14.7	RC		---	---	---							
15													95	23		
	56.126		Moderately to slightly weathered greyish Siltstone with fine grained Sandstone patches	15.7	RC		---	---	---							
16													90	53		
				16.7	RC		---	---	---							
17													90	11		
				17.7	RC		---	---	---							
18													91	24		
				18.7	RC		---	---	---							
19													95	10		
20	51.826															

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

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PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 71.887 m **EAST:** E or X = 1457.05 **NORTH:** N or Y = 4330.21

TYPE OF BORING: Rotary **BORING NO:** BH 51

DIAMETER OF BORING: 150mm upto 2.30m & Nx from 2.30 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: ASH Silo **DATE STARTED:** 31/7/09 **COMPLETED:** 5/8/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
0																
1			Greyish Sandy clay (Cl)								▼					
				1.5	UDS	1	---	---	---	Recovered				---		
2	69.887			2	SPT	1	---	---	---	14cm in 100 blows N>100				---		
	69.587		Completely weathered deeply decomposed yellowish brown Sandstone	2.3	RC		---	---	---							
3			Highly weathered yellowish brown Sandstone										41	0		
				3.3	RC		---	---	---							
4													41	0		
	67.587			4.3	RC		---	---	---							
5			Highly weathered yellowish Siltstone										43	0		
	66.587			5.3	RC		---	---	---							
6			Highly weathered yellowish Sandstone										46	13		
				6.3	RC		---	---	---							
7													49	10		
				7.3	RC		---	---	---							
8													58	22		
	63.587			8.3	RC		---	---	---							
9			Highly to moderately weathered greyish Sandstone										61	12		
	62.587			9.3	RC		---	---	---							
10			Highly to moderately weathered greyish Siltstone										74	0		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 71.887 m **EAST:** E or X = 1457.05 **NORTH:** N or Y = 4330.21

TYPE OF BORING: Rotary **BORING NO:** BH 51

DIAMETER OF BORING: 150mm upto 2.30m & Nx from 2.30 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: ASH Silo **DATE STARTED:** 31/7/09 **COMPLETED:** 5/8/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	Sample Number	BLOWS/15cm 15 cm	15 cm	15 cm	"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
10	61.587			10.3	RC		---	---	---				74	0		
			Highly to moderately weathered greyish fine grained Sandstone										63	0		
11				11.3	RC		---	---	---							
													78	12		
12				12.3	RC		---	---	---							
													68	23		
13	58.587			13.3	RC		---	---	---							
			Highly to moderately weathered greyish Siltstone										63	0		
14	57.587			14.3	RC		---	---	---							
			Highly to moderately weathered greyish Siltstone with Sandstone patches										73	0		
15				15.3	RC		---	---	---							
													66	0		
16				16.3	RC		---	---	---							
													64	10		
17	54.587			17.3	RC		---	---	---							
			Highly to moderately weathered greyish Sandstone with Siltstone patches										62	0		
18				18.3	RC		---	---	---							
													63	0		
19	52.587			19.3	RC		---	---	---							
			Highly to moderately weathered greyish Shale										58	0		
20	51.887															

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

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PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 71.108 m **EAST:** E or X = 1293.585 **NORTH:** N or Y = 4403.211

TYPE OF BORING: Rotary **BORING NO:** BH 52

DIAMETER OF BORING: 150mm upto 3.30m & Nx from 3.30 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: FO Tank **DATE STARTED:** 6/8/09 **COMPLETED:** 8/8/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
0																
1			Greyish brown Clayey Sand (SC)								▼					
				1.5	UDS	1	---	---	---	Recovered				---		
2																
3	68.108			3	SPT	1	40	---	---	12cm in 100 blows N>100				---		
	67.808		Completely weathered deeply decomposed Yellowish brown Sandstone	3.3	RC		---	---	---				70	23		
4			Highly to moderately weathered yellowish brown fine grained Sandstone	4.3	RC		---	---	---				81	72		
5				5.3	RC		---	---	---				85	70		
6				6.3	RC		---	---	---				82	46		
7				7.3	RC		---	---	---				91	49		
8	62.808			8.3	RC		---	---	---				84	0		
			Highly to moderately weathered greyish fine grained Sandstone													
9	61.808			9.3	RC		---	---	---				87	34		
			Moderately weathered greyish Siltstone													
10																

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

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N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 71.108 m **EAST:** E or X = 1293.585 **NORTH:** N or Y = 4403.211

TYPE OF BORING: Rotary **BORING NO:** BH 52

DIAMETER OF BORING: 150mm upto 3.30m & Nx from 3.30 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: FO Tank **DATE STARTED:** 6/8/09 **COMPLETED:** 8/8/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
10			Moderately weathered greyish Siltstone *(continued)*	10.3	RC		---	---	---				84	84		
11	59.808		Highly to moderately weathered greyish Siltstone with Small patches of fine grained Sandstone	11.3	RC		---	---	---				86	11		
12				12.3	RC		---	---	---				88	32		
13				13.3	RC		---	---	---				89	20		
14				14.3	RC		---	---	---				86	0		
15				15.3	RC		---	---	---				85	10		
16				16.3	RC		---	---	---				89	0		
17				17.3	RC		---	---	---				87	27		
18				18.3	RC		---	---	---				96	29		
19	51.808		Slightly weathered greyish Siltstone with Small amount of fine grained Sandstone	19.3	RC		---	---	---				98	98		
20	51.108															

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

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N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 71.163 m **EAST:** E or X = 1364.14 **NORTH:** N or Y = 4400.57

TYPE OF BORING: Rotary **BORING NO:** BH 53

DIAMETER OF BORING: 150mm upto 2.50m & Nx from 2.50 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: FO Tank **DATE STARTED:** 7/8/09 **COMPLETED:** 10/8/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
0																
1			Medium stiff brownish Clayey Sand (SC)								▼					
				1.5	UDS	1	---	---	---	Recovered				---		
2	68.963			2.2	SPT	1	38	---	---	11cm in 100 blows N>100				---		
	68.663		Completely weathered brownish Siltstone	2.5	RC		---	---	---				66	20		
3			Highly to moderately weathered yellowish brown Siltstone													
	67.663			3.5	RC		---	---	---				87	79		
4			Slightly weathered yellowish brown Sandstone													
	66.663			4.5	RC		---	---	---				88	80		
5			Slightly weathered yellowish brown Siltstone													
				5.5	RC		---	---	---				83	60		
6																
	64.663			6.5	RC		---	---	---				89	68		
7			Slightly weathered yellowish brown fine grained Sandstone													
	63.663			7.5	RC		---	---	---				94	42		
8			Slightly weathered greyish Siltstone with Sandstone patches													
				8.5	RC		---	---	---				93	93		
9																
				9.5	RC		---	---	---				93	88		
10																

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

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N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 71.163 m **EAST:** E or X = 1364.14 **NORTH:** N or Y = 4400.57

TYPE OF BORING: Rotary **BORING NO:** BH 53

DIAMETER OF BORING: 150mm upto 2.50m & Nx from 2.50 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: FO Tank **DATE STARTED:** 7/8/09 **COMPLETED:** 10/8/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
10	60.663		Slightly weathered greyish Sandstone	10.5	RC		---	---	---				96	80		
11				11.5	RC		---	---	---				95	72		
12				12.5	RC		---	---	---				95	44		
13				13.5	RC		---	---	---				97	96		
14	56.663		Moderately to Slightly weathered greyish Siltstone	14.5	RC		---	---	---				95	0		
15				15.5	RC		---	---	---				92	0		
16				16.5	RC		---	---	---				96	10		
17				17.5	RC		---	---	---				95	35		
18	52.663		Moderately to Slightly weathered greyish Sandstone	18.5	RC		---	---	---				86	0		
19				19.5	RC		---	---	---				80	0		
20	51.163															

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 71.057 m **EAST:** E or X = 1226.91 **NORTH:** N or Y = 4500

TYPE OF BORING: Rotary **BORING NO:** BH 54

DIAMETER OF BORING: 150mm upto 1.50m & Nx from 1.50 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: CHP Area **DATE STARTED:** 13/8/09 **COMPLETED:** 18/8/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	Sample Number	BLOWS/15cm 15 cm	15 cm	15 cm	"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
0																
			Greyish Clayey Sand (SC)													
1																
	69.757			1.3	SPT	1	35	---	---	4cm in 100blows N>100	▼			---		
	69.557		Completely weathered deeply decomposed yellowish brown Sandstone	1.5	RC	1	---	---	---							
2			Highly to moderately weathered yellowish brown Sandstone										66	10		
				2.5	RC	2	---	---	---							
3													78	0		
	67.557		Slightly weathered greyish Sandstone	3.5	RC	3	---	---	---							
4													87	29		
				4.5	RC	4	---	---	---							
5													91	34		
				5.5	RC	5	---	---	---							
6													94	94		
				6.5	RC	6	---	---	---							
7													89	89		
				7.5	RC	7	---	---	---							
8													85	47		
	62.557			8.5	RC	8	---	---	---							
9			Highly to moderately weathered greyish Siltstone										83	0		
				9.5	RC	9	---	---	---							
10													77	20		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

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PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 71.057 m **EAST:** E or X = 1226.91 **NORTH:** N or Y = 4500

TYPE OF BORING: Rotary **BORING NO:** BH 54

DIAMETER OF BORING: 150mm upto 1.50m & Nx from 1.50 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: CHP Area **DATE STARTED:** 13/8/09 **COMPLETED:** 18/8/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
10	60.557		Highly to moderately weathered greyish Sandstone	10.5	RC	10	---	---	---				77	20		
11				11.5	RC	11	---	---	---				84	0		
12				12.5	RC	12	---	---	---				85	0		
13				13.5	RC	13	---	---	---				80	0		
14	56.557		Highly to moderately weathered greyish Sandstone	14.5	RC	14	---	---	---				84	0		
15				15.5	RC	15	---	---	---				84	0		
16				16.5	RC	16	---	---	---				84	0		
17				17.5	RC	17	---	---	---				79	0		
18				18.5	RC	18	---	---	---				85	0		
19				19.5	RC	19	---	---	---				82	0		
20	51.057												86	0		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 73.928 m **EAST:** E or X = 1170.952 **NORTH:** N or Y = 4431.048

TYPE OF BORING: Rotary **BORING NO:** BH 55

DIAMETER OF BORING: 150mm upto 4.25m & Nx from 4.25 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: CHP Area **DATE STARTED:** 7/8/09 **COMPLETED:** 12/8/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
0																
			Filled up Soil													
1											▼					
	72.428			1.5	UDS	1	---	---	---	Recovered				---		
			Greyish Clayey Sand (SC)													
2																
3				3	SPT	1	3	4	6	10				---		
	70.428															
			Completely weathered yellowish brown Sandstone	3.9	SPT	2	46	---	---	9cm in 100 blows N>100				---		
4																
	69.678			4.25	RC	1	---	---	---							
			Moderately to slightly weathered greyish fine grained Sandstone Stone										86	29		
5				5.25	RC	2	---	---	---							
													95	70		
6																
	67.678			6.25	RC	3	---	---	---							
			Slightly weathered greyish fine grained Sandstone										96	80		
7																
	66.678			7.25	RC	4	---	---	---							
			Slightly weathered greyish Siltstone										85	76		
8																
				8.25	RC	5	---	---	---							
													87	47		
9																
				9.25	RC	6	---	---	---							
													89	88		
10																

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

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PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 73.928 m **EAST:** E or X = 1170.952 **NORTH:** N or Y = 4431.048

TYPE OF BORING: Rotary **BORING NO:** BH 55

DIAMETER OF BORING: 150mm upto 4.25m & Nx from 4.25 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: CHP Area **DATE STARTED:** 7/8/09 **COMPLETED:** 12/8/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
10	63.678		Slightly weathered greyish Siltstone with Shale	10.25	RC	7	---	---	---				89	88		
													93	62		
11				11.25	RC	8	---	---	---							
													86	80		
12	61.678		Slightly weathered greyish Shale with Sandstone	12.25	RC	9	---	---	---							
													86	58		
13	60.678		Moderately to Slightly weathered greyish fine to medium grained Sandstone	13.25	RC	10	---	---	---							
													89	75		
14				14.25	RC	11	---	---	---							
													89	12		
15	58.678		Slightly weathered greyish laminated Shale	15.25	RC	12	---	---	---							
													89	33		
16	57.678		Moderately to Slightly weathered greyish Siltstone	16.25	RC	13	---	---	---							
													87	26		
17				17.25	RC	14	---	---	---							
													86	47		
18				18.25	RC	15	---	---	---							
													87	11		
19				19.25	RC	16	---	---	---							
													81	32		
20	53.928															

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 73.926 m **EAST:** E or X = 1077.728 **NORTH:** N or Y = 4523.986

TYPE OF BORING: Rotary **BORING NO:** BH 70

DIAMETER OF BORING: 150mm upto 4.60m & Nx from 4.60 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: CHP Area **DATE STARTED:** 1/9/09 **COMPLETED:** 5/9/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	Sample Number	BLOWS/15cm 15 cm	15 cm	15 cm	"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
0																
	73.326		Filled up Soil & concrete													
1			Filled up Ash dust													
				1.5	SPT	1	2	3	6	9				---		
2	71.926										▼					
			Greyish coloured Clay													
3				3	UDS	1	---	---	---	Recovered				---		
	70.426			3.5	SPT	2	28	---	---	13cm in 100 blows N >100				---		
4			Completely weathered Siltstone of yellowish grey colour													
	69.326			4.5	SPT	2	---	---	---	10cm in 100 blows N >100				---		
			Moderately weathered yellowish coloured Siltstone	4.6	RC	1	---	---	---							
5													76	0		
				5.6	RC	2	---	---	---							
6													80	0		
	67.326			6.6	RC	3	---	---	---							
			Moderately weathered grey coloured Siltstone													
7													84	0		
				7.6	RC	4	---	---	---							
8													83	0		
				8.6	RC	5	---	---	---							
9													85	0		
				9.6	RC	6	---	---	---							
10													86	23		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 73.926 m **EAST:** E or X = 1077.728 **NORTH:** N or Y = 4523.986

TYPE OF BORING: Rotary **BORING NO:** BH 70

DIAMETER OF BORING: 150mm upto 4.60m & Nx from 4.60 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: CHP Area **DATE STARTED:** 1/9/09 **COMPLETED:** 5/9/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
10			Moderately weathered grey coloured Siltstone *(continued)*													
				10.6	RC	7	---	---	---				86	23		
11													85	0		
	62.326			11.6	RC	8	---	---	---							
12			Slightly weathered grey coloured Siltstone with fine grained Sandstone patches.										86	0		
				12.6	RC	9	---	---	---							
13													85	13		
				13.6	RC	10	---	---	---							
14													97	0		
				14.6	RC	11	---	---	---							
15													91	0		
				15.6	RC	12	---	---	---							
16													95	12		
				16.6	RC	13	---	---	---							
17													93	29		
				17.6	RC	14	---	---	---							
18													91	0		
				18.6	RC	15	---	---	---							
19													94	0		
				19.6	RC	16	---	---	---							
20	53.926												100	0		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 71.668 m **EAST:** E or X = 1253.37 **NORTH:** N or Y = 4427.7

TYPE OF BORING: Rotary **BORING NO:** BH 71

DIAMETER OF BORING: 150mm upto 1.30m & Nx from 1.30 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: CHP Area **DATE STARTED:** 4/9/09 **COMPLETED:** 5/9/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	Sample Number	BLOWS/15cm 15 cm	15 cm	15 cm	"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
0	71.268		Filled up Concrete													
			Completely weathered yellowish brown Siltstone	1	SPT	1	38	---	---	12cm in 100 blows N >100				---		
1				1.3	RC		---	---	---							
2											▼		84	0		
				2.3	RC		---	---	---							
3													88	74		
	68.368			3.3	RC		---	---	---							
4			Slightly weathered grey coloured fine grained Sandstone										100	72		
	67.368			4.3	RC		---	---	---							
5			Slightly weathered grey coloured Shale & Siltstone										95	79		
	66.368			5.3	RC		---	---	---							
6			Slightly weathered grey coloured Siltstone with Fine grained Sandstone patches										91	13		
	65.368			6.3	RC		---	---	---							
7			Slightly weathered grey coloured fine grained Sandstone										98	36		
	64.368			7.3	RC		---	---	---							
8			Slightly weathered dark grey Siltstone										97	74		
	63.368			8.3	RC		---	---	---							
9			Slightly weathered dark grey fine grained Sandstone with some light grey coloured Shale										96	72		
	62.368			9.3	RC		---	---	---							
10			Slightly weathered grey coloured Siltstone										98	98		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004
PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 71.668 m **EAST:** E or X = 1253.37 **NORTH:** N or Y = 4427.7

TYPE OF BORING: Rotary **BORING NO:** BH 71

DIAMETER OF BORING: 150mm upto 1.30m & Nx from 1.30 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: CHP Area **DATE STARTED:** 4/9/09 **COMPLETED:** 5/9/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
10			Slightly weathered grey coloured Siltstone *(continued)*	10.3	RC		---	---	---				98	98		
11													96	90		
	60.368			11.3	RC		---	---	---							
12			Slightly weathered grey coloured Siltstone with Fine grained Sandstone patches										97	97		
	59.368			12.3	RC		---	---	---							
13			Slightly weathered grey coloured fine grained Siltstone with Sandstone patches										97	32		
	58.368			13.3	RC		---	---	---							
14			Slightly weathered grey coloured Siltstone										93	25		
				14.3	RC		---	---	---							
15													93	77		
				15.3	RC		---	---	---							
16													97	81		
				16.3	RC		---	---	---							
17													96	44		
	54.368			17.3	RC		---	---	---							
18			Slightly weathered grey coloured fine grained Sandstone with Siltstone patches.										93	93		
	53.368			18.3	RC		---	---	---							
19			Grey coloured Siltstone										100	100		
				19.3	RC		---	---	---							
20	51.668												100	100		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

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N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 71.762 m **EAST:** E or X = 1252.92 **NORTH:** N or Y = 4382.05

TYPE OF BORING: Rotary **BORING NO:** BH 72

DIAMETER OF BORING: 150mm upto 1.60m & Nx from 1.60 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: CHP Area **DATE STARTED:** 31/8/09 **COMPLETED:** 3/9/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
0	71.262		Filled up soil													
1	70.162		Completely weathered dirty yellow weathered Siltstone	1.5	SPT	1	---	---	---	10cm in 100 blows N >100				---		
2			Moderately weathered dirty yellow Siltstone	1.6	RC		---	---	---		▼		84	53		
3				2.6	RC		---	---	---				81	65		
4				3.6	RC		---	---	---				88	11		
5	66.762			4.6	RC		---	---	---				96	20		
6	66.162		Slightly weathered grey coloured Siltstone	5.6	RC		---	---	---				95	31		
7	65.162		Slightly weathered grey coloured Shale with Siltstone	6.6	RC		---	---	---				97	42		
8	64.162		Slightly weathered grey coloured Siltstone	7.6	RC		---	---	---				97	25		
9	63.162		Slightly weathered grey coloured Shale with Siltstone	8.6	RC		---	---	---				94	13		
10			Slightly weathered grey coloured Siltstone with fine grained Sandstone patches	9.6	RC		---	---	---				98	0		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

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N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 71.762 m **EAST:** E or X = 1252.92 **NORTH:** N or Y = 4382.05

TYPE OF BORING: Rotary **BORING NO:** BH 72

DIAMETER OF BORING: 150mm upto 1.60m & Nx from 1.60 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: CHP Area **DATE STARTED:** 31/8/09 **COMPLETED:** 3/9/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
10													98	0		
	61.162		Slightly weathered grey coloured fine grained Sandstone	10.6	RC		---	---	---							
11													95	24		
				11.6	RC		---	---	---							
12													94	85		
				12.6	RC		---	---	---							
13													96	45		
	58.162		Slightly weathered grey coloured Siltstone with fine grained Sandstone and patches of Shale	13.6	RC		---	---	---							
14													97	35		
	57.162		Slightly weathered grey coloured Siltstone with fine grained Sandstone patches	14.6	RC		---	---	---							
15													99	78		
	56.162		Slightly weathered grey coloured fine grained Sandstone	15.6	RC		---	---	---							
16													95	38		
	55.162		Slightly weathered grey coloured Siltstone & fine grained Sandstone	16.6	RC		---	---	---							
17													97	32		
	54.162		Slightly weathered grey coloured Shale with Siltstone	17.6	RC		---	---	---							
18													96	0		
	53.162		Slightly weathered grey coloured Siltstone with fine grained Sandstone patches	18.6	RC		---	---	---							
19													98	35		
				19.6	RC		---	---	---							
20	51.762												100	50		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 73	CO-ORDINATES: East: 1564.61	North: 4050.12
SITE LOCATION :	CPU Area	START DATE: 9/9/2009	END DATE: 9/12/2009
GROUND REDUCED LEVEL:	70.54	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	2.4	CASING DIA:	150mm upto 2.20m & Nx from 2.20 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
1			Grey coloured Clay										
				1.5	UDS				Recovered				
2	68.54								13cm in 100	---	---		
	68.34		Completely weathered yellowish weathered Siltstone	2	SPT				blows N >100	---	---		
				2.2	RC								
3										89	37		
			Moderately weathered light yellow to grey coloured Siltstone	3.2	RC								
4										88	38		
	66.34			4.2	RC								
5										94	15		
				5.2	RC								
										89	50		
6				6.2	RC								
			Moderately to slightly weathered dirty grey coloured fine grained Sandstone							90	0		
7				7.2	RC								
										89	0		
8				8.2	RC								
										85	0		
9	61.34			9.2	RC								
			Moderately weathered Dirty grey coloured Siltstone							85	0		
10													

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 73	CO-ORDINATES: East: 1564.61	North: 4050.12
SITE LOCATION :	CPU Area	START DATE: 9/9/2009	END DATE: 9/12/2009
GROUND REDUCED LEVEL:	70.54	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	2.4	CASING DIA:	150mm upto 2.20m & Nx from 2.20 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE		BLOWS/15cm			'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
				Sample Depth (m)	SAMPLE TYPE	15	15	15					
	60.34			10.2	RC					85	0		
11			Moderately weathered dirty grey coloured fine grained Sandstone							84	48		
	59.34			11.2	RC								
12			Slightly weathered dirty grey coloured fine to medium grained Sandstone with some patches of Siltstone							90	0		
	58.34			12.2	RC								
13			Slightly weathered dirty grey coloured fine grained Sandstone with some Shale							90	0		
	57.34			13.2	RC								
14			Moderately weathered dirty grey coloured fine grained Sandstone							87	0		
	56.34			14.2	RC								
15			Slightly weathered dirty grey coloured Siltstone	15.2	RC					93	10		
16										90	10		
	54.34			16.2	RC								
17			Slightly weathered dirty grey coloured fine grained Sandstone							91	0		
	53.34			17.2	RC								
18			Slightly weathered dirty grey coloured Siltstone	18.2	RC					92	12		
19				19.2	RC					81	12		
20	50.54									90	18		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 69.053 m **EAST:** E or X = 1298.54 **NORTH:** N or Y = 3769.57

TYPE OF BORING: Rotary **BORING NO:** BH 77

DIAMETER OF BORING: 150mm upto 4.50m & Nx from 4.50 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: SWITCH YARD **DATE STARTED:** 10/9/09 **COMPLETED:** 12/9/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	Sample Number	BLOWS/15cm 15 cm	15 cm	15 cm	"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
0																
			Filled by Sandstone rock (Stray)													
	68.403															
1			Greyish coloured Clay													
				1.5	SPT	1	2	2	3	5						
2											▼			---		
3				3	SPT	2	3	5	8	13						
4														---		
	64.953			4.1	SPT	3	38	44	---	9cm in 100 blows N >100						
	64.553		Completely weathered dirty yellow coloured weathered Sandstone	4.5	RC		---	---	---					---		
5			Slightly weathered dirty yellowish fine grained Sandstone patches										94	87		
				5.5	RC		---	---	---							
6													94	80		
	62.553			6.5	RC		---	---	---							
7			Slightly weathered grey coloured Siltstone with Sandstone										92	86		
	61.553			7.5	RC		---	---	---							
8			Slightly weathered grey coloured Siltstone										96	96		
	60.553			8.5	RC		---	---	---							
9			Slightly weathered fine grained Sandstone with Clay patches										97	47		
	59.553			9.5	RC		---	---	---							
10													97	97		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 69.053 m **EAST:** E or X = 1298.54 **NORTH:** N or Y = 3769.57

TYPE OF BORING: Rotary **BORING NO:** BH 77

DIAMETER OF BORING: 150mm upto 4.50m & Nx from 4.50 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: SWITCH YARD **DATE STARTED:** 10/9/09 **COMPLETED:** 12/9/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
10			Slightly weathered grey coloured fine grained Sandstone with Clay patches *(continued)*	10.5	RC		---	---	---				97	97		
11													93	93		
	57.553		Slightly weathered fine grained sandstone with some Shale intercalation	11.5	RC		---	---	---							
12													84	51		
	56.553		Slightly weathered grey coloured Shale & Siltstone	12.5	RC		---	---	---							
13													90	68		
	55.553		Slightly weathered grey coloured Sandstone	13.5	RC		---	---	---							
14													95	43		
	54.553		Slightly weathered fine grained Sandstone with Siltstone patches	14.5	RC		---	---	---							
15													95	95		
				15.5	RC		---	---	---							
16													92	92		
	52.553		Slightly weathered grey coloured Siltstone with some patches of Sandstone	16.5	RC		---	---	---							
17													91	76		
				17.5	RC		---	---	---							
18													96	96		
				18.5	RC		---	---	---							
19													98	98		
				19.5	RC		---	---	---							
20	49.053												100	100		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

CLIENT:	NTPC		
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)		
BOREHOLE ID:	BH 81	CO-ORDINATES: East: 1227.45	North: 4090.27
SITE LOCATION :	T P	START DATE: 9/7/2009	END DATE: 9/9/2009
GROUND REDUCED LEVEL:	72.238	DRILLING METHOD: Rotary	
GROUND WATER TABLE DEPTH:	2.3	CASING DIA:	150mm upto 3.20m & Nx from 3.20 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
0	71.538		Filled up soil										
1													
				1.5	UDS				Recovered				
2			Greyish coloured Clay							---	---		
3	69.338			2.9	SPT	38			13cm in 100 blows N >100	---	---		
	69.038		Completely weathered yellowish brown weathered Siltstone	3.2	RC								
										77	57		
4			Moderately to slightly weathered yellowish brown Siltstone with fine grained Sandstone patches	4.2	RC								
5										92	85		
	67.038			5.2	RC								
										95	90		
6				6.2	RC								
										100	100		
7			Slightly weathered grey coloured Siltstone with fine grained Sandstone patches	7.2	RC								
										95	35		
8				8.2	RC								
										96	96		
9													
	63.038			9.2	RC								
			Slightly weathered grey coloured Siltstone							87	56		
10													

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

CLIENT:	NTPC
PROJECT NAME:	Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)
BOREHOLE ID: BH 81	CO-ORDINATES: East: 1227.45 North: 4090.27
SITE LOCATION : T P	START DATE: 9/7/2009 END DATE: 9/9/2009
GROUND REDUCED LEVEL: 72.238	DRILLING METHOD: Rotary
GROUND WATER TABLE DEPTH: 2.3	CASING DIA: 150mm upto 3.20m & Nx from 3.20 to 20.0m BGL

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	BLOWS/15cm 15	15	15	'N' Field	Core Recovery(%)	RQD (%)	Other Tests	REMARKS
	62.038			10.2	RC					87	56		
11			Slightly weathered Grey coloured fine grained Sandstone							90	90		
	61.038			11.2	RC								
12			Slightly weathered grey coloured fine grained Sandstone with some Shale intercalation							93	34		
	60.038			12.2	RC								
13			Slightly weathered grey coloured fine to medium grained Sandstone	13.2	RC					97	97		
14										97	97		
	58.038			14.2	RC								
15			Slightly weathered grey coloured Siltstone	15.2	RC					88	52		
16										97	18		
	56.038			16.2	RC								
17			Slightly weathered grey coloured Siltstone with fine grained Sandstone patches.	17.2	RC					95	86		
18				18.2	RC					97	81		
19										96	79		
				19.2	RC								
20	52.238									95	95		

SPT N = STANDARD PENETRATION TEST VALUE RQD = ROCK QUALITY DESIGNATION UDS = UNDISTURBED SOIL SAMPLE
RC = ROCK CORE DS = DISTURBED SAMPLE VST = VANE SHEAR TEST

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD
PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

Logged by : Akash
Checked by : S. Padhi
Job No:

Borehole termination at 20 m

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 70.759 m **EAST:** E or X = 700 **NORTH:** N or Y = 4900

TYPE OF BORING: Rotary **BORING NO:** BH 84

DIAMETER OF BORING: 150mm upto 3.20m & Nx from 3.20 to 25.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 25 m **SOIL SAMPLER USED:**

LOCATION: Reservoir Area **DATE STARTED:** 11/10/09 **COMPLETED:** 11/12/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	Sample Number	BLOWS/15cm 15 cm	15 cm	15 cm	"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
0			Grayish coloured clay													
				1.5	UDS	1	---	---	---	Recovered				---		
3				3	SPT	1	8	---	---					---		
	67.559			3.2	RC		---	---	---							
			Highly to moderately weathered yellowish coloured fine grained sand stone with some Siltstone										50	30		
				4.2	RC		---	---	---							
													50	41		
				5.2	RC		---	---	---							
													53	28		
				6.2	RC		---	---	---							
													66	15		
				7.2	RC		---	---	---							
													68	56		
	62.559			8.2	RC		---	---	---							
			Moderately weathered greyish coloured fine grained sand stone with some patches of shales.										72	47		
				9.2	RC		---	---	---							
													74	59		
10																

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 25 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 70.759 m **EAST:** E or X = 700 **NORTH:** N or Y = 4900

TYPE OF BORING: Rotary **BORING NO:** BH 84

DIAMETER OF BORING: 150mm upto 3.20m & Nx from 3.20 to 25.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 25 m **SOIL SAMPLER USED:**

LOCATION: Reservoir Area **DATE STARTED:** 11/10/09 **COMPLETED:** 11/12/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
10			Moderately weathered greyish coloured fine grained sand stone with some patches of shales. *(continued)*	10.2	RC		---	---	---				74	59		
													73	66		
11				11.2	RC		---	---	---							
													80	14		
12	58.559			12.2	RC		---	---	---							
			Moderately weathered greyish coloured fine grained Sandstone with patches of Siltstone										81	47		
13				13.2	RC		---	---	---							
													80	54		
14				14.2	RC		---	---	---							
													78	10		
15				15.2	RC		---	---	---							
													81	67		
16				16.2	RC		---	---	---							
													84	79		
17	53.559			17.2	RC		---	---	---							
			Moderately weathered greyish coloured shales with some Siltstone patches										73	0		
18				18.2	RC		---	---	---							
	52.259															
			Moderately weathered greyish coloured Siltstone										70	29		
19				19.2	RC		---	---	---							
													73	58		
20																

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 25 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 70.759 m **EAST:** E or X = 700 **NORTH:** N or Y = 4900

TYPE OF BORING: Rotary **BORING NO:** BH 84

DIAMETER OF BORING: 150mm upto 3.20m & Nx from 3.20 to 25.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 25 m **SOIL SAMPLER USED:**

LOCATION: Reservoir Area **DATE STARTED:** 11/10/09 **COMPLETED:** 11/12/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
20	50.559		Moderately weathered greyish coloured sitl stone with some fine grained Sandstone patches	20.2	RC		---	---	---				73	58		
													76	57		
21				21.2	RC		---	---	---							
													71	0		
22				22.2	RC		---	---	---							
													78	63		
23				23.2	RC		---	---	---							
													77	13		
24				24.2	RC		---	---	---							
													90	10		
25	45.759															
26																
27																
28																
29																
30																

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 25 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 70.67 m **EAST:** E or X = 600 **NORTH:** N or Y = 4700

TYPE OF BORING: Rotary **BORING NO:** BH 87

DIAMETER OF BORING: 150mm upto 5.20m & Nx from 5.20 to 25.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 25 m **SOIL SAMPLER USED:**

LOCATION: Reservoir Area **DATE STARTED:** 11/11/09 **COMPLETED:** 13/11/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	Sample Number	BLOWS/15cm 15 cm	15 cm	15 cm	"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
0			Yellowish coloured clay													
				1.5	UDS	1	---	---	---	Recovered				---		
3				3	SPT	1	3	3	5	8				---		
	66.87			3.8	SPT	2	23	32	---	10 cm in 100blows N>100				---		
4			Completely weathered yellowish coloured fine grained Sandstone													
				4.5	SPT	3	34	---	---	11 cm in 100blows N>100				---		
5	65.47			5.2	RC		---	---	---							
			Highly to moderately fine grained Sandstone and Siltstone										53	24		
6				6.2	RC		---	---	---							
													53	0		
7				7.2	RC		---	---	---							
													56	0		
8				8.2	RC		---	---	---							
													61	0		
9				9.2	RC		---	---	---							
													62	0		
10																

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 25 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 70.67 m **EAST:** E or X = 600 **NORTH:** N or Y = 4700

TYPE OF BORING: Rotary **BORING NO:** BH 87

DIAMETER OF BORING: 150mm upto 5.20m & Nx from 5.20 to 25.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 25 m **SOIL SAMPLER USED:**

LOCATION: Reservoir Area **DATE STARTED:** 11/11/09 **COMPLETED:** 13/11/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
10	60.47		Moderately weathered light greyish coloured fine grained Sandstone with Siltstone patches	10.2	RC		---	---	---				62	0		
													64	15		
11				11.2	RC		---	---	---							
													69	19		
12				12.2	RC		---	---	---							
													69	0		
13				13.2	RC		---	---	---							
													71	15		
14				14.2	RC		---	---	---							
													74	12		
15				15.2	RC		---	---	---							
													75	27		
16	54.47		Moderately weathered light greyish coloured shales with some Siltstone	16.2	RC		---	---	---							
													65	0		
17				17.2	RC		---	---	---							
	53.17		Moderately weathered yellowish to grayish coloured Siltstone with some fine grained Sandstone patches										69	23		
18				18.2	RC		---	---	---							
													77	14		
19				19.2	RC		---	---	---							
													79	0		
20																

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 25 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 70.67 m **EAST:** E or X = 600 **NORTH:** N or Y = 4700

TYPE OF BORING: Rotary **BORING NO:** BH 87

DIAMETER OF BORING: 150mm upto 5.20m & Nx from 5.20 to 25.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 25 m **SOIL SAMPLER USED:**

LOCATION: Reservoir Area **DATE STARTED:** 11/11/09 **COMPLETED:** 13/11/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
20																
			Moderately weathered yellowish to grayish coloured Siltstone with some fine grained Sandstone patches *(continued)*	20.2	RC		---	---	---				79	0		
21													82	12		
				21.2	RC		---	---	---							
22													79	37		
	48.47			22.2	RC		---	---	---							
23			Moderately weathered greyish coloured fine grained Sandstone and some Siltstone patches										77	29		
				23.2	RC		---	---	---							
24													80	72		
				24.2	RC		---	---	---							
25	45.67												90	58		
26																
27																
28																
29																
30																

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 25 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004
PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 70.923 m **EAST:** E or X = 500 **NORTH:** N or Y = 4600

TYPE OF BORING: Rotary **BORING NO:** BH 88

DIAMETER OF BORING: 150mm upto 4.90m & Nx from 4.90 to 25.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 25 m **SOIL SAMPLER USED:**

LOCATION: Reservoir Area **DATE STARTED:** 11/8/09 **COMPLETED:** 11/10/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	Sample Number	BLOWS/15cm 15 cm	15 cm	15 cm	"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
0			Grayish coloured clay													
				1.5	UDS	1	---	---	---	Recovered				---		
3				3	SPT	1	2	2	3	5				---		
				4.5	SPT	2	2	3	3	6				---		
5	66.023			4.9	RC		---	---	---							
			Highly weathered yellowish brown Siltstone.										54	0		
6	65.023			5.9	RC		---	---	---							
			Highly to moderately weathered Siltstone with fine grained Sandstone of yellowish brown colour in patches.										71	0		
7				6.9	RC		---	---	---							
													70	28		
8				7.9	RC		---	---	---							
													72	62		
9	62.023			8.9	RC		---	---	---							
			Moderately weathered greyish coloured Siltstone with intercolation of shales.										73	43		
10				9.9	RC		---	---	---							

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 25 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 70.923 m **EAST:** E or X = 500 **NORTH:** N or Y = 4600

TYPE OF BORING: Rotary **BORING NO:** BH 88

DIAMETER OF BORING: 150mm upto 4.90m & Nx from 4.90 to 25.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 25 m **SOIL SAMPLER USED:**

LOCATION: Reservoir Area **DATE STARTED:** 11/8/09 **COMPLETED:** 11/10/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
10			Moderately weathered greyish coloured Siltstone with intercolation of shales. *(continued)*										79	54		
													79	54		
11	60.023		Moderately weathered greyish coloured fine to medium grained Sandstone	10.9	RC		---	---	---							
													78	27		
12				11.9	RC		---	---	---							
													79	44		
13	58.023		Moderately weathered greyish coloured Siltstone.	12.9	RC		---	---	---							
													80	37		
14	57.023		Moderately weathered greyish coloured fine grained Sandstone	13.9	RC		---	---	---							
													78	44		
15				14.9	RC		---	---	---							
	55.423												80	45		
16	54.923		Moderately weathered greyish coloured Siltstone.	15.9	RC		---	---	---							
			Moderately weathered greyish coloured fine grained Sandstone										77	10		
17				16.9	RC		---	---	---							
													82	29		
18				17.9	RC		---	---	---							
													84	0		
19				18.9	RC		---	---	---							
													81	0		
20	50.923			19.9	RC		---	---	---							

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 25 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 70.923 m **EAST:** E or X = 500 **NORTH:** N or Y = 4600

TYPE OF BORING: Rotary **BORING NO:** BH 88

DIAMETER OF BORING: 150mm upto 4.90m & Nx from 4.90 to 25.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 25 m **SOIL SAMPLER USED:**

LOCATION: Reservoir Area **DATE STARTED:** 11/8/09 **COMPLETED:** 11/10/09

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
20													80	0		
			Moderately to slightly weathered greyish coloured Siltstone.										80	0		
21				20.9	RC		---	---	---							
													84	0		
22				21.9	RC		---	---	---							
													83	0		
23				22.9	RC		---	---	---							
													84	0		
24	46.923			23.9	RC		---	---	---							
			Moderately to slightly weathered greyish coloured siltstone with fine grained Sandstone patches										86	52		
25	45.923															
26																
27																
28																
29																
30																

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 25 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 69.559 m **EAST:** E or X = 1280.23 **NORTH:** N or Y = 3842.83

TYPE OF BORING: Rotary **BORING NO:** BH 109

DIAMETER OF BORING: 150mm upto 5.00m & Nx from 5.00 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: Service Building **DATE STARTED:** 28/3/10 **COMPLETED:** 30/3/10

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	Sample Number	BLOWS/15cm 15 cm	15 cm	15 cm	"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
0																
1			Greyish coloured clay								▼					
2				1.5	SPT	1	2	3	4	7				---		
3	66.559		Brownish coloured clay	3	UDS	1	---	---	---	Recovered				---		
4				4.5	SPT	2	4	4	---	5cm in 100 blow N>100				---		
5	64.759															
	64.559		Completely weathered yellowish brown coloured fine grained Sandstone patches.	5	RC		---	---	---				69	47		
6			Moderately weathered yellowish brown coloured fine grained Sandstone with some Siltstone.	6	RC		---	---	---				85	85		
7				7	RC		---	---	---				87	79		
8				8	RC		---	---	---				86	38		
9	60.559		Moderately weathered greyish coloured fine grained Sandstone with intercolation of Shales.	9	RC		---	---	---				93	87		
10	59.759		Slightly weathered greyish coloured fine grained Sandstone.													

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 69.559 m **EAST:** E or X = 1280.23 **NORTH:** N or Y = 3842.83

TYPE OF BORING: Rotary **BORING NO:** BH 109

DIAMETER OF BORING: 150mm upto 5.00m & Nx from 5.00 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: Service Building **DATE STARTED:** 28/3/10 **COMPLETED:** 30/3/10

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	Sample Number	BLOWS/15cm 15 cm	15 cm	15 cm	"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
10			Slightly weathered greyish coloured Shales. *(continued)*	10	RC		---	---	---				91	83		
	58.759															
11			Slighly weathered greyish coloured fine grained Sandstone with some Siltstone patches	11	RC		---	---	---				92	36		
12				12	RC		---	---	---				98	45		
13				13	RC		---	---	---				97	85		
14				14	RC		---	---	---				90	58		
15				15	RC		---	---	---				90	77		
16				16	RC		---	---	---				87	25		
	53.059		Slightly weathered greyish coloured Shales.													
17				17	RC		---	---	---				93	52		
18	51.559		Slightly weathered greyish coloured fine grained Sandstone.	18	RC		---	---	---				89	0		
19				19	RC		---	---	---				95	0		
20	49.559															

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

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PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 69.285 m **EAST:** E or X = 1556.13 **NORTH:** N or Y = 3840.53

TYPE OF BORING: Rotary **BORING NO:** BH 110

DIAMETER OF BORING: 150mm upto 5.60m & Nx from 5.60 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: T.G Hall **DATE STARTED:** 31/3/10 **COMPLETED:** 4/3/10

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	Sample Number	BLOWS/15cm 15 cm	15 cm	15 cm	"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
0			Greyish coloured clay													
				1.5	UDS	1	---	---	---	Recovered				---		
3				3	SPT	1	3	4	5	9				---		
	65.085		Completely weathered yellowish brown coloured fine grained Sandstone with Siltstone patches													
	63.685		Moderately weathered yellowish brown coloured fine grained Sandstone with Siltstone patches	5.6	RC		---	---	---				61	10		
				6.6	RC		---	---	---				71	11		
	61.685		Moderately weathered greyish coloured fine grained Sandstone with Siltstone patches	7.6	RC		---	---	---				70	0		
				8.6	RC		---	---	---				70	0		
	60.085		Moderately weathered greyish coloured fine grained Sandstone.	9.6	RC		---	---	---				75	0		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 69.285 m **EAST:** E or X = 1556.13 **NORTH:** N or Y = 3840.53

TYPE OF BORING: Rotary **BORING NO:** BH 110

DIAMETER OF BORING: 150mm upto 5.60m & Nx from 5.60 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: T.G Hall **DATE STARTED:** 31/3/10 **COMPLETED:** 4/3/10

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
10			Moderately weathered greyish coloured fine grained Sandstone. *(continued)*	10.6	RC		---	---	---				75	0		
11				11.6	RC		---	---	---				82	0		
12				12.6	RC		---	---	---				79	0		
13				13.6	RC		---	---	---				80	0		
	55.685															
14			Moderately weathered greyish coloured Siltstone.	14.6	RC		---	---	---				78	0		
	54.685															
15			Moderately weathered greyish coloured fine grained Sandstone.	15.6	RC		---	---	---				82	0		
16				16.6	RC		---	---	---				85	0		
17				17.6	RC		---	---	---				86	0		
18				18.6	RC		---	---	---				89	0		
19				19.6	RC		---	---	---				76	0		
20	49.285												85	0		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

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PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 70.143 m **EAST:** E or X = 1343.25 **NORTH:** N or Y = 3896.45

TYPE OF BORING: Rotary **BORING NO:** BH 111

DIAMETER OF BORING: 150mm upto 3.20m & Nx from 3.20 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: Boiler **DATE STARTED:** 27/3/10 **COMPLETED:** 30/3/10

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	Sample Number	BLOWS/15cm 15 cm	15 cm	15 cm	"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
0																
1			Brownish gray coloured clay													
2				1.5	UDS	1	---	---	---	Recovered				---		
3				3	SPT	1	5	---	---	6cm in 100 blow N>100				---		
	66.943			3.2	RC		---	---	---							
4			Moderately weathered yellowish brown coloured fine grained Sandstone.										72	12		
				4.2	RC		---	---	---							
5													73	0		
				5.2	RC		---	---	---							
6													70	16		
				6.2	RC		---	---	---							
7													70	0		
	62.943			7.2	RC		---	---	---							
8			Moderately weathered greyish coloured fine grained Sandstone										68	10		
				8.2	RC		---	---	---							
9													65	0		
				9.2	RC		---	---	---							
10													66	17		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 70.143 m **EAST:** E or X = 1343.25 **NORTH:** N or Y = 3896.45

TYPE OF BORING: Rotary **BORING NO:** BH 111

DIAMETER OF BORING: 150mm upto 3.20m & Nx from 3.20 to 20.0m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 20 m **SOIL SAMPLER USED:**

LOCATION: Boiler **DATE STARTED:** 27/3/10 **COMPLETED:** 30/3/10

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
10	59.743			10.2	RC		---	---	---				66	17		
			Moderately weathered greyish coloured Siltstone										70	38		
11	59.143		Moderately to slightly weathered greyish coloured fine grained Sandstone.	11.2	RC		---	---	---				67	0		
12				12.2	RC		---	---	---				62	0		
13				13.2	RC		---	---	---				62	0		
14				14.2	RC		---	---	---				61	0		
15				15.2	RC		---	---	---				82	0		
16				16.2	RC		---	---	---				83	0		
17				17.2	RC		---	---	---				84	0		
18				18.2	RC		---	---	---				86	0		
19				19.2	RC		---	---	---				90	0		
20	50.143															

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 20 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 70.217 m **EAST:** E or X = 791.35 **NORTH:** N or Y = 4831.26

TYPE OF BORING: Rotary **BORING NO:** BH 115

DIAMETER OF BORING: 150mm upto 6.10m & Nx from 6.10 to 24.10m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 24.1 m **SOIL SAMPLER USED:**

LOCATION: Water Treatment Plant **DATE STARTED:** 17/4/10 **COMPLETED:** 21/4/10

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	Sample Number	BLOWS/15cm 15 cm	15 cm	15 cm	"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
0																
1			Filled up soil													
				1.5	SPT	1	3	3	5	8				---		
2																
3	67.417		Greyish coloured clay	3	SPT	2	4	5	7	12				---		
4																
				4.5	UDS	1	---	---	---	Recovered				---		
5																
6	64.117			6	SPT	3	---	---	---	10cm in 100 blow N>100				---		
			Moderately weathered yellowish brown coloured fine grained Sandstone.	6.1	RC		---	---	---				64	10		
7				7.1	RC		---	---	---				66	39		
8				8.1	RC		---	---	---				77	74		
9				9.1	RC		---	---	---				74	74		
10																

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 24.1 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 70.217 m **EAST:** E or X = 791.35 **NORTH:** N or Y = 4831.26

TYPE OF BORING: Rotary **BORING NO:** BH 115

DIAMETER OF BORING: 150mm upto 6.10m & Nx from 6.10 to 24.10m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 24.1 m **SOIL SAMPLER USED:**

LOCATION: Water Treatment Plant **DATE STARTED:** 17/4/10 **COMPLETED:** 21/4/10

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	Sample Number	BLOWS/15cm 15 cm	15 cm	15 cm	"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
10			Moderately weathered yellowish brown coloured fine grained Sandstone. *(continued)*	10.1	RC		---	---	---				86	86		
11	59.117		Moderately weathered greyish coloured laminated Shales with some Siltstone.	11.1	RC		---	---	---				71	0		
12				12.1	RC		---	---	---				77	0		
13				13.1	RC		---	---	---				79	40		
14	56.717		Moderately weathered greyish coloured fine grained Sandstone with some Siltstone patches	14.1	RC		---	---	---				76	58		
15				15.1	RC		---	---	---				74	49		
16				16.1	RC		---	---	---				78	68		
17				17.1	RC		---	---	---				77	63		
18				18.1	RC		---	---	---				80	36		
19				19.1	RC		---	---	---				84	84		
20																

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 24.1 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 70.217 m **EAST:** E or X = 791.35 **NORTH:** N or Y = 4831.26

TYPE OF BORING: Rotary **BORING NO:** BH 115

DIAMETER OF BORING: 150mm upto 6.10m & Nx from 6.10 to 24.10m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 24.1 m **SOIL SAMPLER USED:**

LOCATION: Water Treatment Plant **DATE STARTED:** 17/4/10 **COMPLETED:** 21/4/10

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
20																
			Moderately weathered greyish coloured fine grained Sandstone with some Siltstone patches *(continued)*	20.1	RC		---	---	---				86	58		
21				21.1	RC		---	---	---				84	84		
22				22.1	RC		---	---	---				80	65		
23				23.1	RC		---	---	---				85	85		
24	46.117			24.1			---	---	---					---		
25																
26																
27																
28																
29																
30																

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 24.1 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 71.467 m **EAST:** E or X = 752.75 **NORTH:** N or Y = 4745.75

TYPE OF BORING: Rotary **BORING NO:** BH 116

DIAMETER OF BORING: 150mm upto 5.80m & Nx from 5.80 to 25m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 25 m **SOIL SAMPLER USED:**

LOCATION: Water Treatment Plant **DATE STARTED:** 4/12/10 **COMPLETED:** 15/4/10

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
0																
1			Filled up soil													
2				1.5	SPT	1	2	3	4	7				---		
	68.867										▼					
3			Greyish coloured clay	3	UDS	1	---	---	---	Recovered				---		
4																
5				4.5	SPT	2	3	4	6	10				---		
	65.667															
6			Moderately weathered yellowish brown coloured Siltstone.	5.8	RC		---	---	---				58	0		
7				6.8	RC		---	---	---				65	0		
8				7.8	RC		---	---	---				64	0		
9				8.8	RC		---	---	---				68	23		
10				9.8	RC		---	---	---				65	0		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 25 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 71.467 m **EAST:** E or X = 752.75 **NORTH:** N or Y = 4745.75

TYPE OF BORING: Rotary **BORING NO:** BH 116

DIAMETER OF BORING: 150mm upto 5.80m & Nx from 5.80 to 25m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 25 m **SOIL SAMPLER USED:**

LOCATION: Water Treatment Plant **DATE STARTED:** 4/12/10 **COMPLETED:** 15/4/10

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
10			Moderately weathered yellowish brown coloured Siltstone. *(continued)*										65	0		
11				10.8	RC		---	---	---				72	26		
12				11.8	RC		---	---	---				66	0		
13				12.8	RC		---	---	---				75	0		
	57.967		Moderately weathered greyish coloured Siltstone.													
14				13.8	RC		---	---	---				65	12		
15				14.8	RC		---	---	---				70	0		
16				15.8	RC		---	---	---				72	0		
17				16.8	RC		---	---	---				75	19		
18				17.8	RC		---	---	---				70	0		
19				18.8	RC		---	---	---				72	0		
20				19.8	RC		---	---	---				75	0		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 25 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 71.467 m **EAST:** E or X = 752.75 **NORTH:** N or Y = 4745.75

TYPE OF BORING: Rotary **BORING NO:** BH 116

DIAMETER OF BORING: 150mm upto 5.80m & Nx from 5.80 to 25m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 25 m **SOIL SAMPLER USED:**

LOCATION: Water Treatment Plant **DATE STARTED:** 4/12/10 **COMPLETED:** 15/4/10

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE			BLOWS/15cm			"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
				Sample Depth (m)	SAMPLE TYPE	Sample Number	15 cm	15 cm	15 cm							
20			Moderately weathered greyish coloured Siltstone. *(continued)*										75	0		
				20.8	RC		---	---	---							
21													70	0		
				21.8	RC		---	---	---							
22													68	10		
				22.8	RC		---	---	---							
23													74	0		
				23.8	RC		---	---	---							
24													76	11		
				24.8			---	---	---				75	0		
25	46.467			25			---	---	---					---		
26																
27																
28																
29																
30																

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 25 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 73.811 m **EAST:** E or X = 853.43 **NORTH:** N or Y = 4752.53

TYPE OF BORING: Rotary **BORING NO:** BH 117

DIAMETER OF BORING: 150mm upto 8.60m & Nx from 8.60 to 25m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 25 m **SOIL SAMPLER USED:**

LOCATION: Water Treatment Plant **DATE STARTED:** 4/12/10 **COMPLETED:** 16/4/10

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	Sample Number	BLOWS/15cm 15 cm	15 cm	15 cm	"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
0																
			Filled up soil													
1																
				1.5	SPT	1	2	2	3	5				---		
2																
3	70.911															
			Greyish coloured clay	3	UDS	1	---	---	---	Recovered				---		
4											▼					
				4.5	SPT	2	4	5	6	11				---		
5																
6	67.811															
			Brownish coloured clay	6	UDS	2	---	---	---	Recovered				---		
7																
				7.5	SPT	3	5	5	7	12				---		
8																
	65.211															
			Moderately weathered yellowish brown coloured Siltstone.	8.6	RC		---	---	---							
9													70	24		
				9.6	RC		---	---	---							
10													70	14		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 25 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 73.811 m **EAST:** E or X = 853.43 **NORTH:** N or Y = 4752.53

TYPE OF BORING: Rotary **BORING NO:** BH 117

DIAMETER OF BORING: 150mm upto 8.60m & Nx from 8.60 to 25m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 25 m **SOIL SAMPLER USED:**

LOCATION: Water Treatment Plant **DATE STARTED:** 4/12/10 **COMPLETED:** 16/4/10

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Sample Depth (m)	SAMPLE TYPE	Sample Number	BLOWS/15cm 15 cm	15 cm	15 cm	"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
10			Moderately weathered yellowish brown coloured Siltstone. *(continued)*										70	14		
				10.6	RC		---	---	---							
11													68	37		
				11.6	RC		---	---	---							
12													72	49		
				12.6	RC		---	---	---							
13													66	50		
	60.211			13.6	RC		---	---	---							
14			Moderately weathered greyish coloured Siltstone grading to fine grained Sandstone.										67	43		
				14.6	RC		---	---	---							
15													70	70		
				15.6	RC		---	---	---							
16													64	44		
				16.6	RC		---	---	---							
17													70	60		
				17.6	RC		---	---	---							
18													67	30		
	55.211			18.6	RC		---	---	---							
19			Moderately weathered greyish coloured Shale.										62	23		
	54.211			19.6	RC		---	---	---							
20													68	40		

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 25 m

For O.I.C & R. PVT. LTD

ORBITAL INFRASTRUCTURE CONSULTANCY & RESEARCH PRIVATE LTD

PLOT NO. 1134, MAHANADI BIHAR, CUTTAK - 753 004

PH: 0671- 2443588 Tele Fax: 0671 - 2443408

N: ___

PROJECT NAME Geotechnical Investigation for NTPC Talcher Thermal Stage III (2 x 660 MW)

GROUND SURFACE ELEVATION: 73.811 m **EAST:** E or X = 853.43 **NORTH:** N or Y = 4752.53

TYPE OF BORING: Rotary **BORING NO:** BH 117

DIAMETER OF BORING: 150mm upto 8.60m & Nx from 8.60 to 25m BGL **TYPE OF BIT USED:** Double tube

TOTAL HOLE DEPTH: 25 m **SOIL SAMPLER USED:**

LOCATION: Water Treatment Plant **DATE STARTED:** 4/12/10 **COMPLETED:** 16/4/10

DEPTH (m)	Reduced Level (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE Depth (m)	SAMPLE TYPE	Sample Number	BLOWS/15cm 15 cm	15 cm	15 cm	"N" Field	Water Level	Bulk Density gmc/cc	Recovery Length/ Recovery (%)	RQD (%)	Fracture Frequency per Meter	Serial Number of Recovered
20			Moderately weathered greyish coloured Siltstone. *(continued)*													
				20.6	RC		---	---	---				68	40		
21																
													70	53		
	52.211			21.6	RC		---	---	---							
22			Moderately to slightly weathered greyish coloured fine grained Sandstone.										77	65		
				22.6	RC		---	---	---							
23													73	64		
				23.6	RC		---	---	---							
24													85	36		
				24.6	RC		---	---	---							
25	48.811			25			---	---	---				95	50		

26																
27																
28																
29																
30																

Remarks: Boring, field test and sample collection conducted as per B.I.S Specification only.
Ref: I.S : 1892; 1498; 2131 & 2132.
SPT : Standard Penetration Test & UDS : Undisturbed soil sample.

Borehole termination at 25 m

For O.I.C & R. PVT. LTD

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 11/09/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. MWBH-1

Co-ordinates E=883 N=4587

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	4
		Disturbed (DS)	2
Vane (V)		Water Sample (WS)	0

Commencement Date : 21/08/17
Completion Date : 21/08/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 70.392 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				
Filled up soil consists of yellowish red, silty clay with boulders.			DS-1	0.50
0.90m				
			UDS-1	1.00-1.45
		3 5 6 (11)	SPT-1	1.45-1.90
Stiff, grey, silty clay. Obs. kankars. (Cl)			DS-2	2.50
		3 6 7 (13)	SPT-2	3.00-3.45
4.00m			UDS-2	4.00-4.45
		4 7 9 (16)	SPT-3	4.45-4.90
Very stiff, grey, silty clay. Obs. kankars. (Cl)				
		5 8 11 (19)	SPT-4	5.00-5.45
5.45m				

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 03/10/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. MWBH-2

Co-ordinates E=1358 N=5009

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	3	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	3
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date : 03/09/17
Completion Date : 03/09/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 71.492 M.
Water Struck At :
Standing Water Level : 0.80 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Filled up soil consists of yellowish red silty sand with moorum.			DS-1	0.50
			*UDS-1	1.00-1.45
1.50m		3 3 4 (7)	SPT-1	1.55-2.00
Medium, deep grey, silty clay with kankars. (Cl)			DS-2	2.50
3.50m		4 6 6 (12)	SPT-2	3.50-3.95
Stiff, deep grey, silty clay with kankars. (Cl)			DS-3	4.30
Very stiff, deep grey, silty clay with kankars. (Cl) 5.00m		5 7 9 (16)	SPT-3	5.00-5.45
N.B. - '*' means sample could not be recovered. 5.45m				

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975 | Created by : Chandrani | Created on : 12/09/2017 | Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MWBH-3 | Co-ordinates E=1889 N=5486

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 : 02/09/17
Completion Date : 03/09/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 71.942 M.
Water Struck At :
Standing Water Level : 0.60 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
			DS-1	0.80
Filled up soil consists of silty sand with clay binder. Obs. gravels, boulders & moorum.		4 5 7 (12)	SPT-1	1.30-1.75
			DS-2	2.20
			*UDS-1	2.60-2.72
2.70m		5 7 9 (16)	SPT-2	2.80-3.25
			DS-3	3.80
Stiff / very stiff to hard, grey, silty clay with kankars. (Cl)		5 8 10 (18)	SPT-3	4.20-4.65
		4 6 8 (14)	SPT-4	5.00-5.45
5.45m				

N.B. - '*' means sample could not be recovered.

BH-3/Sheet-1

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975 | Created by : Chandrani | Created on : 12/09/2017 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. MWBH-4

Co-ordinates E=2439 N=5974

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	3	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	3
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date : 30/08/17
Completion Date : 31/08/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 72.592 M.
Water Struck At :
Standing Water Level : 2.10 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
			DS-1	0.50
Filled up soil consists of deep grey to brownish grey, silty clay with boulders & sand mixture.			*UDS-1	0.80-1.20
		7 16 11 (27)	SPT-1	1.35-1.80
1.80m				
			DS-2	2.50
		6 7 6 (13)	SPT-2	3.00-3.45
Stiff, brownish grey, silty clay / clayey silt with sand mixture. Obs. kankars. (Cl)			DS-3	4.00
			*UDS-2	4.50-4.95
Very stiff, brownish grey, silty clay / clayey silt with sand mixture. Obs. kankars. (Cl) 5.10m		6 8 8 (16)	SPT-3	5.10-5.55
5.55m				

N.B. - '*' means sample could not be recovered.

BH-4/Sheet-1

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 12/09/2017	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO. MWBH-5

Co-ordinates E=2763 N=6535

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	3	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	3
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date : 31/08/17
Completion Date : 31/08/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 72.942 M.
Water Struck At :
Standing Water Level : 2.60 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
			DS-1	0.50
Filled up soil consists of reddish brown, silty clay with boulders & moorum.			*UDS-1	1.00-1.45
		6 11 26 (37)	SPT-1	1.60-2.05
2.50m.			DS-2	2.50
		6 7 7 (14)	SPT-2	3.00-3.45
Stiff, brownish grey, silty clay. Obs. kankars & sand mixture. (Cl)			DS-3	4.00
4.60m.			UDS-2	4.60-5.05
Very stiff, brownish grey, silty clay. Obs. kankars & sand mixture. (Cl)		7 8 9 (17)	SPT-3	5.05-5.50
5.50m.				

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 12/09/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. MWBH-6

Co-ordinates E=2942 N=7160

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 : 01/09/17
Completion Date : 01/09/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 73.452 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.				
			DS-1	0.50
Filled up soil consists of yellowish brown, clayey silty sand with moorum.			*UDS-1	1.00-1.45
		4 6 9 (15)	SPT-1	1.55-2.00
			DS-2	2.50
2.60m.				
		8 15 23 (38)	SPT-2	3.00-3.45
Hard, reddish brown, silty clay with kankars. Obs. moorum. (Cl)			*UDS-2	4.00-4.10
		9 16 21 (37)	SPT-3	4.20-4.65
		10 28 36 (64)	SPT-4	5.05-5.50
5.50m.				

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 12/09/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. MWBH-7

Co-ordinates E=2842 N=7830

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 : 01/09/17
Completion Date : 01/09/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 74.755 M.
Water Struck At :
Standing Water Level : 2.30 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
			DS-1	0.70
Filled up soil consists of greyish brown, silty sand with kankars.			*UDS-1	1.20-1.65
		3 4 4 8	SPT-1	1.80-2.25
2.30m				
			DS-2	3.00
Hard, dark greyish brown, silty clay with kankars. Obs. moorum. (Cl)		12 16 19 35	SPT-2	3.40-3.85
			*UDS-2	4.20-4.30
		38 62 >100 8.0 cm Penetn.	SPT-3	4.40-4.63
5.00m				
Very dense, greyish brown, silty sand with clay binder & kankars. Obs. moorum. (SM)		36 39 35 >100 6.0 cm Penetn.	SPT-4	5.00-5.36
5.36m				

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975 | Created by : Chandrani | Created on : 12/09/2017 | Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MWBH-8

Co-ordinates E=2462 N=8499

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 : 31/08/17
Completion Date : 31/08/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 78.052 M.
Water Struck At :
Standing Water Level : 2.90 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
			DS-1	0.50
			*UDS-1	1.00-1.15
Hard, brownish grey, silty clay. Obs. moorum. (Cl)		17 23 35 — 58	SPT-1	1.50-1.95
			DS-2	2.50
2.80m.				
		16 18 23 — 41	SPT-2	3.00-3.45
Hard, brownish grey, silty clay. Obs. traces of moorum & pebbles. (Cl)			*UDS-2	4.00-4.10
		13 20 32 — 52	SPT-3	4.50-4.95
		17 25 37 — 62	SPT-4	5.10-5.55
5.55m.				

N.B. - '*' means sample could not be recovered.

BH-8/Sheet-1

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975 | Created by : Chandrani | Created on : 12/09/2017 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. MWBH-9

Co-ordinates E=2277 N=9277

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 : 01/09/17
Completion Date : 01/09/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 81.812 M.
Water Struck At :
Standing Water Level : 3.20 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
			DS-1	0.50
			*UDS-1	1.00-1.20
Stiff, brownish grey, silty clay. Obs. moorum. (Cl)		10 7 4 (11)	SPT-1	1.40-1.85
			DS-2	2.50
2.70m				
		18 21 32 (53)	SPT-2	3.00-3.45
Hard, yellowish brown, silty clay / clayey silt. Obs. steel grey patches. (Cl)			DS-3	4.00
		16 24 34 (58)	SPT-3	4.50-4.95
		22 27 38 (65)	SPT-4	5.00-5.45
5.45m				

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 12/09/2017	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO. MWBH-10

Co-ordinates E=2472 N=10059

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 : 31/08/17
Completion Date : 31/08/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 79.562 M.
Water Struck At :
Standing Water Level : 3.70 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
			DS-1	0.50
Stiff, deep grey, silty clay. Obs. black spots & kankars. (Cl)			*UDS-1	1.00-1.45
		4 4 5 — 9	SPT-1	1.55-2.00
2.40m				
			DS-2	2.50
Hard, brownish grey, silty clay / clayey silt. Obs. reddish spots. (Cl)		13 22 15 — 37	SPT-2	3.00-3.45
			DS-3	4.00
4.30m				
Hard, brownish grey, clayey silt. Obs. sand mixture. (Cl)		25 47 28 — >100 (5.0 cm Penetn.)	SPT-3	4.50-4.85
		38 62 — >100 (12.0 cm Penetn.)	SPT-4	5.00-5.27
5.27m				

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 12/09/2017	Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MWBH-11 | Co-ordinates E=2627 N=10996

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 : 03/09/17
Completion Date : 03/09/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 78.809 M.
Water Struck At :
Standing Water Level : 3.80 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
			DS-1	0.50
			*UDS-1	1.00-1.45
Medium, deep grey, silty clay. Obs. kankars. (Cl)		2 3 4 (7)	SPT-1	1.60-2.05
			DS-2	2.50
2.80m				
		6 8 11 (19)	SPT-2	3.00-3.45
Very stiff, deep grey, silty clay. Obs. traces of sand mixture. (Cl)				
			DS-3	4.00
4.20m				
		17 26 42 (68)	SPT-3	4.50-4.95
Hard, brownish grey, clayey silt. Obs. traces of sand mixture. (Cl)				
		23 32 45 (>100) 10.0 cm Penetn.	SPT-4	5.10-5.50
5.50m				

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 12/09/2017	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO. MWBH-12

Co-ordinates E=2794 N=11896

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 : 03/09/17
Completion Date : 03/09/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 81.752 M.
Water Struck At :
Standing Water Level : 3.90 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Filled up soil consists of reddish brown, silty clay with moorum.			DS-1	0.50
			*UDS-1	1.00-1.08
1.30m.				
		10 14 20 — 34	SPT-1	1.35-1.80
Hard, brownish grey, silty clay. Obs. moorum. (Cl)				
			DS-2	2.50
2.60m.				
		18 37 45 — >100 (10.0 cm Pentn.)	SPT-2	3.00-3.40
Hard, yellowish brown, silty clay. Obs. boulders pieces & sand mixture. (Cl)			DS-3	4.00
		46 54 — >100 (7.0 cm Pentn.)	SPT-3	4.50-4.72
		100 — >100 (13.0 cm Pentn.)	SPT-4	5.00-5.13
5.13m.				

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 12/09/2017	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO. MWBH-13

Co-ordinates E=2873 N=12436

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 : 02/09/17
Completion Date : 02/09/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 81.269 M.
Water Struck At :
Standing Water Level : 4.20 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Filled up soil consists of brownish grey, silty clay. Obs. boulder pieces.			DS-1	0.50
			*UDS-1	1.00-1.10
1.20m		10 13 18 — 31	SPT-1	1.30-1.75
Very stiff to hard, brownish grey, silty clay. Obs. calcareous nodules. (CI)			DS-2	2.50
		13 17 21 — 38	SPT-2	3.00-3.45
3.80m			DS-3	4.00
Hard, brownish grey, silty clay / clayey silt. Obs. traces of sand mixture & mica. (CI)		21 35 44 — >100 (7.0 cm Penth.)	SPT-3	4.50-4.87
		38 62 — >100 (10.0 cm Penth.)	SPT-4	5.00-5.25
5.25m				

N.B. – '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 03/10/2017	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO. MWBH-14

Co-ordinates E=2913 N=13035

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	4
		Disturbed (DS)	3
Vane (V)		Water Sample (WS)	0

Commencement Date : 03/09/17
Completion Date : 04/09/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 77.956 M.
Water Struck At :
Standing Water Level : 1.20 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
			DS-1	0.60
			UDS-1	1.00-1.45
		2 2 3 (5)	SPT-1	1.45-1.90
Medium to stiff, deep grey, silty clay. Obs. kankars & brownish grey patches. (Cl)			DS-2	2.50
		2 3 4 (7)	SPT-2	3.00-3.45
			DS-3	4.00
		3 4 6 (10)	SPT-3	4.50-4.95
5.05m				
		3 3 8 (11)	SPT-4	5.05-5.50

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975 | Created by : Chandrani | Created on : 03/10/2017 | Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MWBH-15 | Co-ordinates E=2406 N=13511

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	4
		Disturbed (DS)	2
Vane (V)		Water Sample (WS)	0

Commencement Date : 04/09/17
Completion Date : 04/09/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 77.683 M.
Water Struck At :
Standing Water Level : 0.90 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
			DS-1	0.50
Medium, deep grey, silty clay with kankars. (Cl)			UDS-1	1.00-1.45
		3 3 5 (8)	SPT-1	1.45-1.90
2.20m				
			DS-2	2.50
		12 16 19 (35)	SPT-2	3.00-3.45
Dense, brownish grey, silty sand with boulder pieces. (SM)				
			*UDS-2	4.00-4.12
		14 19 23 (42)	SPT-3	4.20-4.65
Very dense, brownish grey, silty sand with boulder pieces. (SM)				
5.10m		29 43 38 (>100) 5.0 cm Pentn.	SPT-4	5.10-5.45
5.45m				

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975 | Created by : Chandrani | Created on : 03/10/2017 | Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MWBH-16 | Co-ordinates E=1682 N=13909

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 04/09/17
Completion Date : 04/09/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 76.044 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				
			DS-1	0.50
Medium dense, greyish brown, silty sand with clay binder. Obs. gravels & kankars. (SM)		4 6 9 — 15	SPT-1	1.20-1.65
			*UDS-1	2.10-2.55
2.70m		12 19 25 — 44	SPT-2	2.70-3.15
Dense, greyish brown, silty sand with clay binder. Obs. gravels & kankars. (SM)			DS-2	3.60
4.20m		16 21 31 — 52	SPT-3	4.20-4.65
Very dense, greyish brown, silty sand with clay binder. Obs. gravels & kankars. (SM)				
N.B. - '*' means sample could not be recovered.		29 43 38 — >100 (7.0 cm Pentn.)	SPT-4	5.00-5.37
5.37m				

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 03/10/2017	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. MWBH-17

Co-ordinates E=938 N=14355

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 : 05/09/17
Completion Date : 05/09/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 77.180 M.
Water Struck At :
Standing Water Level : 1.60 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Filled up soil consists of greyish brown, silty sand with clay binder.			DS-1	0.70
			*UDS-1	1.00-1.45
1.50m		3 4 4 (8)	SPT-1	1.60-2.05
			DS-2	2.60
Stiff / very stiff, yellowish brown, silty clay with kankars & boulders. (Cl)		5 5 9 (14)	SPT-2	3.20-3.65
			DS-3	4.10
		5 8 11 (19)	SPT-3	4.30-4.75
5.05m				
N.B. - '*' means sample could not be recovered.		4 6 9 (15)	SPT-4	5.05-5.50

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975 | Created by : Chandrani | Created on : 03/10/2017 | Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MWBH-18

Co-ordinates E=699 N=14642

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	7
Vane (V)		Disturbed (DS)	6
		Water Sample (WS)	0

Commencement Date : 05/09/17
Completion Date : 05/09/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 76.026 M.
Water Struck At :
Standing Water Level : 3.60 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
			DS-1	0.60
			UDS-1	1.00-1.45
		5 7 9 (16)	SPT-1	1.45-1.90
Very stiff, greyish yellow, silty clay / clayey silt with sand mixture. Obs. kankars. (Cl)			DS-2	2.50
		9 13 (22)	SPT-2	3.05-3.50
			*UDS-2	4.00-4.15
4.50m		9 12 23 (35)	SPT-3	4.50-4.95
Hard, greyish yellow, silty clay / clayey silt with sand mixture. Obs. kankars. (Cl)		6	DS-3	5.50
5.80m				
		21 29 50 (>100) 5.0 cm Penetn.	SPT-4	6.00-6.35
			DS-4	7.00
Very dense, greyish brown, silty sand with gravels & clay binder. Obs. pocket of clayey silt at SPT-05. (SM)		26 38 36 (>100) 4.0 cm Penetn.	SPT-5	7.50-7.84
			DS-5	8.50
		38 62 (>100) 13.0 cm Penetn.	SPT-6	9.00-9.28
			DS-6	9.70
N.B. - '*' means sample could not be recovered.		26 39 35 (>100) 3.0 cm Penetn.	SPT-7	10.00-10.33
10.33m				

BH-18/Sheet-1

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 03/10/2017	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO. MWBH-19

Co-ordinates E=673 N=14685

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	7
Vane (V)		Disturbed (DS)	5
		Water Sample (WS)	0

Commencement Date : 06/09/17
Completion Date : 06/09/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 76.114 M.
Water Struck At :
Standing Water Level : 4.30 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
			DS-1	0.70
		6 8 13 — 21	SPT-1	1.00-1.45
			*UDS-1	2.00-2.45
		9 9 16 — 25	SPT-2	2.60-3.05
Very stiff to hard, brownish yellow, silty clay with traces of calcareous nodules. Obs. sand mixture. (Cl)			DS-2	3.60
		11 15 19 — 34	SPT-3	4.15-4.60
			*UDS-2	5.15-5.27
		10 11 15 — 26	SPT-4	5.80-6.25
7.00m			DS-3	7.00
		33 67 — >100 (10.0 cm Penetn.)	SPT-5	7.50-7.75
Very dense, greyish yellow, silty sand with kankars. Obs. clay binders. (SM)			DS-4	8.50
		21 39 40 — >100 (4.0 cm Penetn.)	SPT-6	9.00-9.34
			DS-5	9.80
N.B. - '*' means sample could not be recovered.		45 55 — >100 (13.0 cm Penetn.)	SPT-7	10.00-10.28
10.28m				

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975 | Created by : Chandrani | Created on : 03/10/2017 | Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MWBH-20 | Co-ordinates E=243 N=15448

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 : 06/09/17
Completion Date : 06/09/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 81.805 M.
Water Struck At :
Standing Water Level : 3.70 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
			DS-1	0.80
			*UDS-1	1.10-1.25
		5 7 11 = 18	SPT-1	1.40-1.85
Medium dense, yellowish brown, clayey silty sand with moorum & kankars. (SM)				
			DS-2	2.30
		9 16 29 = 45	SPT-2	3.00-3.45
			DS-3	3.80
04.00m.		11 23 34 = 57	SPT-3	4.00-4.45
Very dense, yellowish brown, silty sand with clay binder, kankars & moorum. (SM)				
		36 43 21 = >100 (5.0 cm Pentn.)	SPT-4	5.00-5.35
N.B. - '*' means sample could not be recovered. 5.35m.				

BH-20/Sheet-1

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975 | Created by : Chandrani | Created on : 03/10/2017 | Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MWBH-21 | Co-ordinates E=(-)121 N=16056

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 : 05/09/17
Completion Date : 05/09/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 79.795 M.
Water Struck At :
Standing Water Level : 1.10 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
			DS-1	0.50
		1 1 2 (3)	SPT-1	1.00-1.45
			UDS-1	2.00-2.45
Loose, yellowish brown, silty sand with clay binders. Obs. pocket of clayey silt at UDS-01. (SM)		2 2 2 (4)	SPT-2	2.45-2.90
			DS-2	3.40
		3 3 4 (7)	SPT-3	4.00-4.45
4.60m			DS-3	4.60
Very dense, yellowish brown, silty sand with clay binders. (SM)		38 62 (>100) 10.0 cm Pentn.	SPT-4	5.00-5.25
5.25m				

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW). CETEST

Job No : 3975 | Created by : Chandrani | Created on : 03/10/2017 | Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MWBH-22

Co-ordinates E=(-)628 N=16787

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 : 06/09/17
Completion Date : 06/09/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 79.255 M.
Water Struck At :
Standing Water Level : 2.30 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
			DS-1	0.50
			*UDS-1	1.00-1.45
		3 5 6 (11)	SPT-1	1.60-2.05
Medium dense to dense, yellowish brown, silty sand with moorum & kankars. (SM)				
			DS-2	2.60
		6 13 18 (31)	SPT-2	3.05-3.50
			DS-3	4.10
4.20m		24 31 45 (>100) 5.0 cm Penth.	SPT-3	4.20-4.55
Very dense, yellowish brown, silty sand with moorum & kankars. (SM)				
5.05m		29 36 35 (>100) 3.0 cm Penth.	SPT-4	5.05-5.38

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 03/10/2017	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO. MWBH-23

Co-ordinates E=(-)1367 N=17011

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 07/09/17
Completion Date : 07/09/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 79.570 M.
Water Struck At :
Standing Water Level : 2.45 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
			DS-1	0.70
Very stiff, yellowish brown, clayey silt with sand mixture / clayey silty sand. Obs. moorum & kankar. (Cl)		6 7 9 — 16	SPT-1	1.00-1.45
			*UDS-1	2.00-2.12
2.50m		11 16 19 — 35	SPT-2	2.50-2.95
			DS-2	3.50
Hard, yellowish brown, clayey silt with sand mixture / clayey silty sand. Obs. moorum & kankar. (Cl)		26 58 36 — >100 (3.0 cm Penetn.)	SPT-3	4.00-4.33
Very dense, yellowish brown, silty sand. (SM)		36 64 — >100 (10.0 cm Penetn.)	SPT-4	5.00-5.25
2.50m - 5.25m				

N.B. - '*' means sample could not be recovered.

Project : Preliminary G. I. Work for Talcher Thermal Power Project-III (2x660 MW).			CETEST
Job No : 3975	Created by : Chandrani	Created on : 03/10/2017	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO. MWBH-24

Co-ordinates E=(-)1883 N=17480

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 07/09/17
Completion Date : 07/09/17
Bore Hole Diameter : 150 mm.
Level Of Ground : 7.165 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	0.80
		1 2 2 (4)	SPT-1	1.00-1.45
Medium, reddish brown, clayey silt with sand mixture. Obs. kankars. (Cl)			*UDS-1	2.00-2.45
		2 2 3 (5)	SPT-2	2.55-3.00
			DS-2	3.50
4.10m		3 4 7 (11)	SPT-3	4.10-4.55
Stiff, reddish brown, silty clay / clayey silt with sand mixture. (Cl)				
5.05m		4 6 9 (15)	SPT-4	5.05-5.50
N.B. - '*' means sample could not be recovered.				