	OWNER & CONSULTANT:	**NTPC LIMITED**
	EPC CONTRACTOR:	**BHARAT HEAVY ELECTRICALS LIMITED, POWER SECTOR.**

TELANGANA SUPER THERMAL POWER PROJECT
STAGE-II (3X800MW) BTG PACKAGE

TECHNICAL SPECIFICATIONS
FOR
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

DOCUMENT NO: PE-TS-546-600-C102

PREAMBLE

This document/specification consists of the following sections:

Section A: Brief Scope of Work

Section B: Project Information

Section C: This section indicates the technical requirements specific to the contract not covered in section-D.

Section D: This section comprises of technical specification.

Note:

1. Specifications relevant to the scope work is applicable.
2. In case of any conflict between section -C and section-D, Section-C of the specification prevails.

SECTION - C
SPECIFIC TECHNICAL REQUIREMENTS

SUB-SECTION–IID

CIVIL WORKS

1.00.00 **SCOPE OF CIVIL, STRUCTURAL & ARCHITECTURAL WORKS OF BTG PACKAGE**

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

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

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

1. Topographical Survey.
2. Geo-technical Investigation (additional data wherever required beyond details as provided).

3. Site clearance including cutting of trees of girth less than 30 centimeters. Cutting of trees of girth more than 30cm shall be done by the Owner after finalization of GLP. However, removal and disposal of roots of trees of all girths (including trees of girth less than 30cm or more) and other vegetation is in Bidder's scope.

4. Removal of below ground facilities/sub structures (Existing facilities/structures shall be dismantled and removed upto ground level by employer) all complete which have interference with the new facilities envisaged for Stage-II.

   Dismantling of all underground facilities including paving /flooring and projection of structures above ground level etc., if any, is in the scope of bidder. Existing foundation/underground structures interfering with new foundations/structures are to be removed by the bidder. All existing foundations/below ground facilities interfering with new facilities are to be dismantled upto minimum 10m or technical/system requirement, whichever is greater, from the extreme outline of the new underground foundation/ structure. No drawing for substructure are available. Bidder may assess the same as per actual site conditions without any additional time and cost implication to owner.

   Dismantled material such as reinforcement, structural steel, concrete, masonry waste, other demolition waste, etc., arising from civil structures shall be the property of the bidder. The bidder has to take care of this aspect while bidding. Bidder shall be responsible for safe disposal of all such materials outside the plant boundary in environmentally friendly manner meeting all statutory requirements. The liability for any payment w.r.t. removal /disposal of dismantled material including the applicable taxes/duties shall be that of the Bidder.

   The area will be handed over in as is and where is basis.

5. Infrastructure Works

   a. Rigid pavements Roads as shown in Road layout tender drawing including approach road /heavy duty paving/heavy duty passage to buildings/ facilities in the package, including construction of priority roads at onset of project works and maintenance of the roads during the entire construction period. Laying of 40mm bitumen mastic wearing course over roads after completion of construction activities i.e at the time of handover as specified in Cl 5.10.00 of part-B sub-section D-1-5.

   b. RCC Storm water drainage in BTG area (including facilities/structures) and RCC drains along roads in Bidder's Scope including connection upto terminal point as shown in GLP/Layout of drain. Drains shall be constructed simultaneously with roads.

   c. DELETED

   d. Complete site levelling of BTG block area and any other area as shown in drawing titled 'Site Levelling Plan'.

e. Retaining walls/slope protection work under site levelling work.

f. DELETED

g. DELETED

h. DELETED

i. DELETED

j. Civil works for Water Supply for BTG area.

k. DELETED

l. Zero liquid discharge and associated facilities for BTG area

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

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

6. Foundations for all buildings/ area/ systems including machine foundations for BTG area.

7. All Civil, Structural, Architectural works including underground facilities like drainage, sewerage, trenches, earthing mat/ grounding for entire area under Bidder's scope covering the following:

a. Boiler and ESP supporting structures and foundations.

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

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

d. ESP control room building.

e. Mill reject silo and associated trenches.

f. DELETED

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

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

i. DELETED

j. Interconnecting galleries between Mill Bunker Buildings

k. Area Paving and miscellaneous foundations in entire area enclosed within the peripheral roads of the entire BTG area from edge of drain along peripheral road beyond Air Cooled Condenser upto heavy duty passage beyond ESP area bound by peripheral roads in orthogonal directions, including heavy duty passages, sump pits, drains, culverts, cable slits, fire water trench, including, rail/ road/ drain crossing of fire water trench & pipes etc. (as shown in GLP)

Amdt_1 - 5m RCC paving shall be provided all around the facilities / buildings / structures, in addition to plinth protection, for facilities / buildings / structures not inside the extent of above mentioned paving.

l. ~~Bunker MCC including RIO room.~~ Clar_3 - Deleted

m. Main Power House building.

n. Air Conditioned Offices of 350 sqm to be provided in MPH building above Control Room.

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

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

q. DELETED

r. DELETED

s. DELETED

t. DELETED

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

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

w. VFD Room in transformer Yard area, for CEP

8. DELETED.

9. DELETED.

10. DELETED

11. DELETED

12. DELETED

13. DELETED

14. DELETED

15. DELETED

16. DELETED

17. DELETED

18. DELETED

19. DELETED

20. DELETED

21. DELETED

Amdt_1 - x. Rail track inside Main Powerhouse building in Unloading bays of all units including supply & fixing of Rails.

Fuel Oil - LDO tank dyke area, FOPH, Tanker unloading platform, Oil water separator pit. Modification of existing railway unloading trench. Culvert for road crossing, pipe pedestals for Fuel oil pipes etc.

22. Civil works for Outdoor transformer foundations.

23. DELETED

24. Earthing mats & risers for all buildings under the bidder's scope.

25. Sheds for Construction workers and O&M Workers, including food serving kiosk and bio Toilet Blocks for ladies and gents to cater to the workers working in each work area. The sheds should be easily accessible to workers by foot. Minimum 02 numbers of shed in different areas shall be provided. Drinking water facility and maintenance of toilet and shed shall be the responsibility of the bidder till COD of all the units. The sheds shall be constructed at start of the project construction and are permanent in nature.

26. DELETED

27. Civil Works associated with fire detection and fire protection system as per Tender Drawing.

28. Civil works associated with air conditioning & ventilation system in BTG area.

29. Civil, Structural works for pipe /cable /duct supporting structures, trestles and foundations, trenches, culverts, duct banks, pedestals, hume pipe & culverts, buried pipes, racks, culverts across rail/road tracks for pipes/ drains/ cables/ sewers and any other facility and thrust blocks etc. associated with all systems covered under the scope.

30. DELETED

31. DELETED

32. All Civil Works associated with Air Cooled Condenser including pylon supports etc. as per system requirement.

33. DELETED

34. Providing foundations and support structures for elevators mentioned elsewhere in the specifications.

35. All civil, structural and architectural works including extension of cantilever related to interface locations at terminal points for Pipe Cable Racks/Trestles/Galleries/ Connecting walkways, etc, as required during detailed engineering

36. Any other miscellaneous building or facility.

1.00.01 Steel structures for following facilities as mentioned below shall be fabricated in factory, transported, and erected at site.

1. Technological Structures such as Boiler, ESP, Mill Bunker Building and Bunker support Structure.
2. Main Power House Building including Control Tower.

For balance structures bidder has the option to fabricate at factory or at site meeting all the quality and inspection requirements as defined elsewhere in the technical specifications.

All structures shall have bolted field connections.

For coal bunkers, hoppers to prevent coal dust/flue gas leakages, the applicable field joints shall necessarily be welded.

No additional land than what is mentioned in technical specifications, shall be provided by Owner for site fabrication. Bidder has to make all necessary arrangements of land, electricity, water, security, etc. on its own. No claim, whatsoever, regarding time extension and financial implication for site fabrication shall be entertained at any point of time.

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

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

1.00.02 **CORROSION PROTECTION**

The plant lies in the corrosive category C3 as per ISO 12944-2. Protection measures shall be provided for the mentioned corrosivity category with very high durability as specified in Part-B of Technical Specifications

1.00.03 Supply of earth for filling, disposal of surplus earth/ debris/rock including arranging the borrow pit/disposal site and making payment of Seigniorage, royalty, levies, taxes and any other applicable charges etc. shall be in bidder's scope.

1.00.04 **PROOF CHECKING**

THE SCOPE OF WORK OF THE SUCCESSFUL BIDDER INCLUDES: -

(a) To interact, discuss with Owner / Proof Checking (PC) agency for the modalities, schedule, and design parameters, loading to be considered in line with the Owner's specifications.

(b) To submit the drawings and design calculations as per the project schedule sequentially as per the sequence below.

(c) Incorporate all the comments/observations/suggestions furnished by the Owner/ PC on the drawings and design documents.

(d) After review of the drawings and design documents by PC the same shall be submitted to the Owner for consent. In case of further observation by Owner the same is also to be incorporated.

Sequence of submission of documents: -

1) Design basis which will include all design philosophy, seismic and wind criteria as per specification, foundation type along with bearing capacity as per Geotechnical Report, materials of construction, loading details, finishing schedule etc.
2) Architectural details/General Arrangement drawings for buildings, facilities, equipment including the elevations and cross sections.
3) Design calculation along with the STAAD/ANSYS/SAP 2000 models and/or computer work sheets or any other software model as mutually agreed with Owner.
4) Foundation drawings.
5) Superstructure drawings sequentially as per construction sequence or material projection, as applicable.

2.00.00 WORKER & STAFF COLONY AND CONSTRUCTION FACILITIES

2.01.00 WORKER & STAFF COLONY

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

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

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

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

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

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

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

2.02.00 CONSTRUCTION FACILITIES

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

1. Construction Water

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

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

   Charges for construction water shall be decided by NTPC based on the cost to NTPC, which shall be intimated during the execution stage.

2. Construction Power

   Scope of supply of construction power is specified in SECTION – VI, PART-B, SUB SECTION B-18 of Technical specification.

3. Construction of following temporary facilities of bidder

   a) Construction office,

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

   c) Workshops for maintenance of construction plant and equipment.

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

   e) Safety Control room

4. Amdt_1 - Providing all necessary Firefighting devices/equipment etc. as mentioned elsewhere in the Tender document.

   ~~during the project execution stage~~ in project areas including laydown/pre-assembly yard area.

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

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

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

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

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

10. Use of ash and ash based products.

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

Fly ash is available within plant boundary. Bidder to collect and transport the same meeting environmental norms/ local regulations at his own cost as per operation schedule for fly ash collection.

A token amount of Rs 1 per Metric Tonne shall be charged.

11. Repair & Maintenance Facilities by the Bidder:

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

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

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

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

2.03.00 **DEVELOPMENT OF LAYDOWN AREA** Amdt_1 - 40 acres

Areas marked in GLP totalling ~~50 Acres~~ (approx.) are identified as laydown/preassembly area. Also, development, fencing/boundary wall, security, etc. in the laydown area is in Bidder's scope. Fencing of the laydown areas is in bidder's scope. Any additional laydown area requirement shall be in Bidder's scope including area development, fencing/boundary wall, security etc.

2.03.01 The contractor shall develop the following facilities in the laydown area

a. Site clearance including cutting of trees as specified elsewhere in the specifications.

b. Bidder shall construct and maintain approach road from plant area to laydown area and road network in the interior of laydown area. Further bidder to ensure measures to avoid noise and dust pollution to habitants during the contract period.

c. Security of material shall be responsibility of the EPC Contractor, including gate control.

d. RCC/Brick drains in the entire laydown area and along roads shall be planned so as to ensure proper disposal of rainwater. RCC drain with culvert to be mandatorily provided at crossings wherever vehicular /material movement is envisaged.

e. Levelling, compaction backfilling, for purpose of laydown area surface preparation

f. Hard crusting of Laydown area, fabrication, and pre-assembly yard area has to be carried out as per specifications mentioned elsewhere. The extent of hard crusting shall be decided by the contractor based on their requirement. Material and equipment storage shall be as per guidelines covered elsewhere.

SUB-SECTION–III

TERMINAL POINTS & EXCLUSIONS

1.00.00 TERMINAL POINTS

The following terminal points are to be read in conjunction with the tender drawings, scope of supply and technical specifications of various systems.

1.01.00 Mechanical

1.01.01 Auxiliary Steam System

The stub/Tee-off connections with Isolating valve and blank flange required on the auxiliary steam Unit/Station header for future connections and Interconnection as indicated in the tender drg.

1.01.02 Plant Water System

For all Terminal Points related to plant water systems, Bidder to refer the Doc.No. 9592-999-POM- A - 037 titled “Plant Water Scheme & TP details” and Doc.No. 9592-999-POM-F-006 titled “Pipe & Trestle Layout “jointly.

1.01.03 Compressed Air Systems

For Compressed Air System terminal points, Bidder to refer the Doc. No.9592-999-POM-A-037 titled “Plant Water Scheme & TP details” and Doc.No. 9592-999-POM-F-006 titled “Pipe & Trestle Layout “.

1.01.04 Fire Detection and Protection system

One pipe (per unit) connection of 300 NB size with an isolation valve at a terminal pressure of about 6 kg/sq.cm (g) near D-row, near Boiler center line at about 4 meters above local grade level for further interconnection by Bidder to meet the fire water requirement of Air pre-heater and coal mills.

1.01.05 Fuel Oil Pressurization System

Terminal Point for Fuel oil firing system is identified at TP-A as shown in Pipe & Cable Trestle Layout drawing (9592-999-POM-F-006), to be read in conjunction with clause 2.18.00, Sub Section-IIA-01, Part-A Section-VI.

1.01.06 ID Fan Outlet Duct

1. Two nos. of transition ducts of minimum 3 m length at ID fan common outlet duct for future interconnection to employer's FGD system.
2. Common outlet duct from ID fans, extending (as bypass to FGD system) up to future outlet duct of employer's FGD system at chimney inlet.

For details, please also refer tender P&ID - XXXX-001-POM-A-018a & 18b

1.01.07 **Auxiliary Cooling Water (ECW) System**

Employer shall terminate one secondary circuit cold water (from the discharge of Employer's Auxiliary cooling water pumps at the downstream of Employer's self-cleaning filters) at a suitable location near A-row for cooling of primary DM cooling water of ECW system of SG & TG auxiliaries in PHEs. The secondary cooling water flow shall be maximum 3600 m3/h/unit at maximum 36 DegC. Bidder shall terminate the secondary circuit hot water (from the discharge of PHEs of SG /TG auxiliaries) at suitable location near A row to enable Employer to interconnect the same at discharge header. The temperature rise of return hot secondary cooling water circuit shall be limited to 7 deg C across the Bidder's cooling system and the pressure drop across the secondary circuit shall be limited to 15 mWC between the terminal points.

1.01.08 **Condensate Polishing Plant**

The DM water used for resin transfer operations from the Regeneration building to the Condensate Polisher vessels shall be collected in service vessel area in a tank of 1.5 times the capacity of DM water required for transferring the resin or 50 m3 (whichever is higher) and the same shall be pumped to Aux CT basin for recycle/reuse. However, DM water used for resin transfer operations from the Condensate Polisher vessels to the Regeneration building shall be collected in an N-pit in the regeneration area. For location of terminal points, please refer plant water scheme.

1.02.00 **ELECTRICAL**

a) Terminal point for Construction power – 2nos., of 11kV feeder shall be made available to the bidder from employer's existing 11KV Construction power switchgear of Telangana STPP-I.

b) Insert Plate On ACC Column for supporting 400 KV insulator string/Lattice structure gantry beam between ACC columns for Generator Transformer stringing.

c) Terminal points as indicated in Tender SLD.

1.03.00 **CONTROL & INSTRUMENTATION**

a) For hardwired signals which are being connected to the Contractor's system from Employer's system/equipment, terminal points shall be the TBs of Contractor's Marshalling cabinets.
b) For soft signals from Contractor's system to Employer's PI (ERP) system, terminal points shall be the network port of Employer's IT LAN switch in main plant TG building.

c) For other soft signals which are being connected to the Contractor's system from Employer's system/equipment, terminal points shall be the network port of Station LAN.

1.03.04 CIVIL

Terminal Points as marked in GLP and other tender drawings.

1.03.05 FOR OTHER SYSTEM: NIL

2.00.00 EXCLUSIONS

2.01.00 MECHANICAL

a) Complete Fire Detection and Protection System (FDPS) excluding inert gas fire extinguishing system under the scope of Bidder. However, civil works pertaining to FDPS shall be in the scope of Bidder as specified elsewhere in the specification.

b) Air conditioning and Ventilation system of Water system Control Building, Switchyard Control Building and other buildings not covered in the scope of Bidder.

c) Instrument & Service Air Compressors, Air Drying Plants, Air Receivers, etc.

d) Supply of coal, fuel oil, limestone and Biomass.

e) Coal Handling Plant

All the equipment & accessories, conveyors, short supports, stringers, deck plates, head and tail end frames, operating and maintenance platforms, guides for the vertical gravity take-up VGTU, intermediate platforms (including support beams) / handrails in the VGTU structure along with access platforms, complete technological structures, bolts, anchor fasteners, embedments, inserts, templates, chute work, flap gates and actuators, ventilation, service water, potable water and dust suppression system, monorails, electric hosts, manual hoists, chain pulley blocks, downcomers, dust and debris chutes, internal & external illumination, cabling, cable trays & cable tray supporting system, equipment earthing and lightning protection system and all associated electrical works of Coal Handling Plant for the transfer points and galleries and tripper floors of mill bunker buildings.

f) Ash Handling Plant

The scope of ash handling plant contractor shall start from the following terminal point of the Steam Generator Contractor:

a) Boiler bottom seal plates and drip mesh
b) Air heater ash hopper outlet flange
c) Economizer and economizer bypass (if applicable) hopper outlet flanges
d) Duct hopper outlet flanges

2.02.00 ELECTRICAL

a) Power, Auxiliary, Indoor Transformers.
b) HT Switchgear
c) EHV & HT Cables
d) DG sets
e) Station Lighting
f) Switchyard and SAS

2.03.00 CIVIL

a) Green Belt and afforestation
b) Sewerage Treatment Plant. However, laying sewer pipelines to nearest STP is included in scope of work.
c) Rainwater Harvesting, however, all the buildings and site development shall be designed to take care of rainwater harvesting & ground water recharging.
d) Landscaping, however, layout provision shall be kept.
e) Area paving in ESP to Chimney area beyond heavy duty passage between ESP and Chimney.

2.04.00 CONTROL & INSTRUMENTATION

a) For BOP Systems (CHP, AHP, WATER System etc.)
b) CCTV System for O&M
c) PA system for O&M
d) FOPH
e) Compressed Air System.
f) FGD System

NTPC Limited

(A Government of India Enterprise)

BULK TENDER FOR MAIN PLANT PACKAGE FOR GADARWARA STPP STAGE-II (2x800 MW) TELANGANA STPP STAGE-II (3x800 MW) NABINAGAR STPP STAGE-II (3x800 MW)

TECHNICAL SPECIFICATION

FOR

MAIN PLANT (BULK BTG) PACKAGE

PART – B

(BOOK 4 OF 5 – CIVIL)

SECTION – VI

BID DOC. NO.: CS-8014/9592/0371-001A-2

PART – B (CIVIL) (BOOK 4 OF 5)	
D – 1	CIVIL WORKS

CONTENTS

D-1-1

1.00.00 **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.

Detailed 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 / NTPC Ltd. 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

2.00.00 SCOPE OF WORK

The scope of work for the 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.

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3.00.00 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 Requirements Chapter.
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.
3.07.00	"As-built" drawings in AutoCad & PDF format shall be prepared and submitted to owner by the Contractor after completion of construction / erection, incorporating changes, if any. Final executed quantities of RCC and structural Steel shall be incorporated in the As-Built drawing.

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4.00.00 GENERAL LAYOUT PLAN

4.01.00 The preliminary layout plan proposed for the project is shown in the drawing 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 15m with respect to center line of double lane road and 12 meter with respect to center line of single lane road.

c) The entire construction activity shall take into account the commissioning of the unit 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 has 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.

4.02.00 CONSTRUCTION STORES

Construction Stores (as per Scope defined in Part-A) shall be constructed. These will be pre-engineered Buildings with hall for storage of materials. These stores shall be used by the contractor for the storage of material in construction phase, and after completion of work shall be handed over to owner in good condition for use by the owner in O&M stage.

Pre-engineered buildings shall be of structural steel construction with metal roofing and wall cladding of approved profile, shall be designed, manufactured, supplied and erected by the PEB agency of the Contractor (hereinafter called as PEB agency or the agency). Pre-engineered building shall be complete with painting, metal facia, metal gutter, rain water down comers, sun-shades, openings, etc., along with associated structural steel, cladding and roofing work insulation, Trims & Flashings, foundations, Rolling shutters, doors, windows ramps, masonry, plastering, plumbing etc.

Pre-engineered buildings complete including Architectural and Structural design, detailed Engineering, preparation of drawings and documents, obtaining Engineer's approval, procurement of raw materials, factory fabrication, supply, transportation, unloading, stocking of fabricated structures at stock yard at Employer's premises (if required) for pre-engineered buildings as described in tender drawings including structural steel works required for super structure with beam and column system structural members required for fixing of door/window/ ventilator /fan/rolling shutter etc. (all secondary structural members shall be rolled sections as per relevant IS codes), supply & erection of steel door/windows/ventilators/rolling shutters (rolling shutter with geared arrangement) including providing & fixing glass panes with putty and glazing clips in steel doors, windows, ventilators, supplying & fixing of roof sheeting/ side cladding complete with fasteners/washers/gaskets, foundations, embedment of foundation bolts using templates, anchor bolts, with all accessories like flames, wall flashings, ridge caps, gable, cover, eaves gutter, rain water down comer, floor preparation and ironite flooring, sun shades etc. including surface preparation and painting, all complete as per drawings, codes standards & relevant IS standards, transporting, assembly at site, erecting in position at all elevations, alignment complete the work as per approved construction drawings, codes, standards, and instructions of the Engineer.

4.03.00 Site Levelling and Slope Protection Work

4.03.01 Complete levelling of area as shown in Tender drawing Titled 'Site Levelling Plan' shall be done by the Bidder.

Bidder shall carry out the topographical survey before he commences detailed design and site leveling. This survey shall cover area 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 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 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 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.

Materials of any kind obtained from excavation on the Site shall remain the property of the Employer and shall be disposed of as the Project Manager may direct.

In case of in-plant excavation and backfilling the excavated material can be used for backfilling if it meets the technical requirements. However, any royalty or statutory charges involved as per local laws have to be borne by the vendor.

Excavated material (like rock, boulders, sand, moorum, etc.), which meets the technical requirements of construction material, can be used by the vendor on directions of EIC, subject to payment of requisite charges as decided by NTPC. Any royalty or statutory charges involved as per local laws have to be borne by the vendor.

If the excavated material is to be disposed outside plant boundary, as stipulated in the technical specifications, all clearances and permissions has to be obtained by the vendor. No extra charges for the same, including statutory charges and taxes, would be payable by NTPC to the vendor. NTPC would only extend support for obtaining the clearances and permissions.

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 titled "Topographical Survey". 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. f) 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 1Vertical: 2 Horizontal) with Rip-Rap. For slope steeper than 1:2 encountered anywhere, slope protection shall be provided at slope with gabion wall/RCC retaining wall as per the requirement.
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.

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5.00.00 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. However, if landscaping is excluded from the scope of works, area for landscaping is to be kept.

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.

The total floor Area shall be area enclosed under the outside walls, including the wall thickness, of the building but excluding the following:

- Lift shaft, Open staircase, Rainwater downcomer incasements, Sunshades, any floor/ roof projection, terrace area, any other shaft (Electrical/ HVAC, Plumbing), Atrium, porch, balconies, patios and same area multiplied by number of floors.

The total floor area shall be maximum of floor area mentioned in technical specifications or Floor area as per tender drawings.

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

a) Mill Bunker Building

b) Conveyor galleries and trestles in Main plant area

c) Machine Foundations in Main plant area

d) Boiler Structure

e) DELETED

f) ESP Structure

g) ESP Control Room buildings

h) Pipe & Cable Gallery

i) Main Power House

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 may 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 and 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 ~~CPVC~~ UPVC pipes and shall be located at every column location.

5.02.02 **Conveyor Galleries and Trestles in Main Plant area**

Troughed belt conveyors in Main plant area shall be housed 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. 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 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.

The maximum span of conveyor gallery shall be limited to 25 meters 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. Minimum grade of steel & thickness of tubular/hollow sections shall be Y_{st} 240 MPa & 4.0mm respectively. The steel structures using tubular sections shall be designed as per limit state method as per IS 800:2007. The properties and fabrication of tubular sections shall be as per IS:806 – "Code of Practice for use of steel tubes in general building construction." and EN 1993-1-8:2005.

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 of 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 degrees, chequered plate steps with nosing and toe guard shall be provided. Seal plates under the conveyor galleries shall be provided in such a way that complete gallery bottom shall form a leak proof floor. The floor of conveyor gallery all along the gallery length, shall be provided with minimum 12 gauge thick seal plates and other drainage arrangements as specified elsewhere.

Conveyor gallery shall have permanently color 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 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.

Conveyor gallery supporting trestles located between transfer points / buildings 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 P. T. F. E. Bearings to allow both rotation & longitudinal movements. End of conveyor gallery which will be supported over transfer point, 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 point structure and vice - versa.

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. Trestle columns base shall be kept 1.2m below the finished floor level of ground floor of main power house.

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.

Fan and Mill foundations:

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, 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 may 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.

For Boiler Elevator Machine Room, refer clause no 9.14.00.

5.02.05 DELETED

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 (penthouse)/ 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 Room building**

i. Salient Features

This 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 this 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 premium smooth Acrylic Paint over Texture Coat.

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 galvanized 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 up to a depth lower than the pit top surface such that the column base plate & stiffeners are concealed below the pit raft level. Auxiliary columns in main power house shall be 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. ~~CPVC~~ upvc 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 around the 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 over that 50 mm thick mineral wool insulation 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.

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 **30 mm thick** Hermetically sealed double glass of Fire resistant of min 14mm thick clear, toughened, interlayered 120 minute fire rated for both integrity & radiation control and 6 mm thick toughened tinted glass with **10 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 glass wall with motorized curtain 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 with air lock lobby.

Control room interiors shall be designed and executed by the 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.

Air-Conditioned Office (Including minimum 5 cabins for Senior level executives) with Pantry, Conference room, Toilet block (Ladies and gents toilet separately) shall be provided in MPH building in addition to other facilities specified. This area shall have access to natural light on three sides minimum. It shall have air lock lobby at entrance with auto sliding doors. Minimum area of this office shall be as specified in Part-A/IID. This area shall be positioned over the CR with good aesthetic view and noise reduction and dust isolation. The noise reduction and dust isolation shall be done with AAC Panel, Mineral wool insulation, Aluminium composite panels, Fire rated Glass, and Air Lock lobby.

5.02.10 DELETED

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 overground liquid retaining structures appropriate load cases shall be considered.
5.02.11.01.04	All liquid retaining and conveying structures shall be designed as per 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) shall be 200mm. Effluent drains (depth more than 500mm), 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 For areas other than paved area, 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.

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5.07.00 SEWERAGE SYSTEM:

Complete sewerage system upto nearest Sewage Treatment Plant (STP in the Owner's scope) for the bidder's facilities is in bidder's scope.

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 BTG area is in bidder's scope. Storm water drain shall be designed taking into account the finished ground levels of the plant & surrounding area, drainage pattern, intensity of rainfall, etc. with a return period of 50 years**.** 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). The runoff coefficient of paved and unpaved area shall be 0.9 and 0.6 respectively.

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 (if applicable)

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**

5.09.01 RAIL TRACK CUM ROAD INSIDE MPH - Rail track cum road shall consist of minimum 500mm thick RCC M25 base slab over an under bed as specified below. The under bed for base slab shall consist of 75mm thick 1:4:8 PCC on stone soling of 230mm compacted thick with 63 mm and down aggregate with interstices filled with well graded selected sand/ moorum/ nonexpansive soil on compacted and dressed sub - grade. Reinforcement for the slab shall consist of minimum 16mm diameter bars @ 200 mm c/c at bottom of the slab in both directions and minimum 12mm diameter bars @ 200 mm c/c at middle and top in both directions. The rails shall be 52 kg/m Industrial Use (IU) as per Indian Railway Specification IRS T-12. Rail track cum road shall be provided with three rails and shall have minimum 5.0M width.

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 with 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.

Turning Circle radius adequate for 16 Wheel Truck shall be provided at all relevant points including approach (Entry/Exit) and access road for Truck movement at loading/unloading/weighment facilities of Limestone, Gypsum, Ash, Biomass for efficient and safe movement of truck.

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 either Conventional Cement Concrete or Geopolymer 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 Conventional Cement Concrete or 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 in Chapter 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**

The single lane roads shall be (5.75 meter wide) with 3.75 meter wide concrete pavement and 1.0 meter wide flat shoulders on both sides of the road as given in tender drawing "Details of Road".

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”.

5.10.04 **INTERMEDIATE ROAD:**

The intermediate lane roads shall be (8 meter wide) with 5.5 meter wide concrete pavement and 1.25 meter wide raised shoulders on both sides of the road as given in tender drawing Details of Road.

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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, 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 ACC area, Main Plant Building area, Boiler area and ESP 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 pedestal. 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	DELETED
5.15.00	DELETED
5.16.00	DELETED
5.17.00	DELETED
5.18.00	DELETED
5.19.00	DELETED
5.20.00	DELETED
5.21.00	DELETED
5.22.00	DELETED
5.23.00	**COAL (IN SG AREA) HANDLING SYSTEM**
5.23.01	DELETED
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 as per limit state method as per IS 800:2007. The properties and fabrication of tubular sections shall be 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 8.5m 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

$$1.6 \times \frac{Rated\ capacity\ of\ Conveyor\ System}{Conveyor\ belt\ speed} \times F$$

per unit length of each moving conveyor shall be:

Where, F = 1100/800 for coal

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(except main plant block) 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. Encasement of the pedestal shall be done upto 75 mm(minimum) above the top of the stiffener plate.

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 sides. 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.
5.23.05	DELETED
5.23.06	DELETED
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) and sheeting shall be provided all

around the periphery of pump houses

5.23.09 DELETED

5.23.10 DELETED

5.23.11 DELETED

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 275 mm. Stringers shall be of rolled steel channel (minimum ISMC 250) and tread shall be of electro forged steel gratings. Stairs shall be provided with 32 mm dia nominal bore medium duty M. S. pipe hand rail.

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

Treads and landing shall be suitable for the prescribed loading. The maximum width of openings in gratings shall not exceed 40 mm. The minimum size of main bars shall be 40 x 5 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/Track hopper, 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 Track hopper/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 as per limit state method as per IS 800:2007. The properties and fabrication of tubular sections shall be as per IS:806 – “Code of Practice for use of steel tubes in general building construction.” and EN 1993-1-8:2005.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 DELETED

5.23.16 DELETED

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 lime conveyor galleries, the down comer shall be provided at every trestle location. In case of Control rooms and MCC buildings, Pump houses, etc water coming from down comers shall discharge into peripheral drains which will lead the water / coal slurry into contractor's RCC drain/ ZLD Pit. In case of all coal conveyor galleries, the down comer shall be provided at every trestle location. Each downcomer shall lead the water / coal slurry to RCC pit (of 2 Cu.M capacity) to allow settling of coal. For coal transfer point in main plant block, minimum four no of downcomer shall be provided which 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 shall be pumped to coal settling pond. In all cases, Plant effluents shall not be discharged into storm water drains. Suitable kick plates/Curb beams shall be provided around the floor openings, stair case landings, in the transfer points, crusher house and other buildings.
5.23.18	DELETED
5.23.19	**Roof Details** Roof slabs for CHP 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 mummty, 600mm high parapet wall shall be provided. Parapet wall shall have suitable coping. External face of parapet wall of the buildings provided with metal cladding shall also be finished with metal cladding of design and colour as per approved architectural drawings. Junction of roof and parapet shall be provided with 150 x 150 mm size concrete fillet. Drain level shall be provided with 45 x 45 cm size khurras having minimum thickness of 30 mm of M-15 concrete over PVC sheet of 1 m x 1m x 400 micron and finished with 12 mm 1 : 3 cement : sand plaster. Roofs of all M. C. C./control rooms, crusher house and TP(if applicable), penthouse etc., shall have roof water proofing treatment. Roof water proofing treatment shall be as mentioned else where in specification.

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

5.23.20 Floors and Grade level details

5.23.20.1 DELETED

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

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

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

Toe guard of size 100 x 6 mm shall be provided at various openings provided in floors e.g. around stair case openings, chute openings and other similar cutouts. For conveyor walkways, angle runner to act as toe guard shall be provided.

All along the periphery of RCC floors (where no brick masonry walls are provided) 100 mm thick 300 mm high RCC wall and 900 mm high steel hand rails all around over this RCC wall shall be provided.

The grade slab shall consists of 230 mm thick rubble soling (63 mm downgraded hard stone aggregate as per IRC specification, watering and compaction to minimum of 90% Standard Proctor density, including filling the interstices of stone aggregates with sand), over well compacted earth, overlaid by 50 mm thick P. C. C. M-7.5 and 150 mm thick RCC of grade M-25 with minimum 8 mm dia bars placed at 200 mm C / C in either direction respectively. There will be minimum 50 mm thick metallic hardener finish over the RCC slab.

All buildings (including, 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 100 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 HGTU, VGTU etc 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.

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 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 DELETED

5.23.26 DELETED

5.23.27 Miscellaneous

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.

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.

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	DELETED
5.23.29	DELETED
5.24.00	DELETED
5.25.00	DELETED
5.26.00	DELETED
5.27.00	DELETED
5.28.00	DELETED
5.29.00	DELETED
5.30.00	DELETED
5.31.00	DELETED
5.32.00	**SHEDS FOR CONSTRUCTION WORKERS AND O&M WORKERS** Sheds for Construction workers and O&M Workers shall be permanent structure with truss roof provided with insulated sheeting with common rest room, cooking area, Food serving kiosk, drinking water facility, toilet and bathing area along with covered verandah for easy approach to facilities. The sheds should be well ventilated. The sheds to be scattered as per work locations and suitably located. External finishes shall be Premium smooth Exterior Paint with silicone additives over Texture Coat. Bidder to refer Tender Drawing titled 'Sheds for Construction workers and O&M Workers'.
5.33.00	DELETED
5.34.00	**BIO TOILET**

Bio-Toilet shall be provided in all the Construction and O&M worker's sheds. 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.

In addition to this permanent sample collection provision(tap/alternate arrangement) to be made before reaching of treated effluent to soak pit. This is to ascertain the quality of effluent at all periods of time and this would also help in the seeding requirement of bacteria.

5.35.00 DELETED

5.36.00 WORKER'S ACCOMODATION BUILDINGS

Accommodation for Workers & staff colony in adequate numbers as required for the project peak demand shall be made in the form of temporary structures which shall be removed after completion of the project. It shall have facilities for drinking water & sanitation, approach

road, dust suppression, drainage, sewage treatment plant, solid waste collection & disposal, fuel for cooking, medical healthcare, creches, Occupational Health Center etc.

The Occupational health centre with creche facility shall be a single storied Temporary structure building of minimum area of 300 sqm. meeting the statutory requirements.

5.37.00 DELETED

5.38.00 AIR COOLED CONDENSER SUPPORTING STRUCTURE

The bidder shall have the option to design the Air Cooled condenser (ACC) supporting structure either with structural steel framed superstructure adequately braced in vertical planes in both the orthogonal directions or with RCC pylon structure. The general arrangement and details of structural steel columns, beams, bracings or RCC structure shall be as per the bidders ACC structure design and detailed engineering scheme.

In case of steel supporting structure, the bottom level of base plates of columns shall be 1.20 M below the finished floor level of ground floor of Main Power House. The RCC pedestals supporting the column base plates shall be extended to provide RCC encasement to the structural steel columns up to at least 350 mm above the top of the paving RCC slab.

In case Bidder adopts RCC pylon for Air cooled condenser structures, casting of the same shall be done using slipform shuttering. For construction of RCC pylons, bidder should engage an agency who has experience in construction of RCC shell-like structures like chimney/ silo/ pylon using slipform equipment.

Area Paving:
Passages shall be provided inside the ACC block connecting to the outer periphery road to have access to the various facilities/ structures/ 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. All other areas inside the entire ACC area enclosed between peripheral roads encompassing the ACC area shall be provided with normal duty paving without metallic hardener topping.

Sectional details of heavy duty paving and normal duty paving shall be as specified in the “Area Paving” chapter of this specification.

Design Concept:

ACC supporting super-structure shall be designed by the Bidder based on limit state method for (i) structural steel as per IS 800 & for (ii) RCC pylons as per IS 4998 & CICIND model code and RCC foundations as per IS : 456.

The maximum Horizontal Deflection for the ACC supporting structure shall not exceed Height/500.

Layout aspects, additional loads and design criteria as described in relevant sections of Mechanical & Electrical chapters of Technical Specification shall also be considered on ACC supporting super-structure and foundations.

5.39.00 **HARD CRUSTING**

Hard crusting in preassembly area and any other areas shall be done with 63mm to 45mm graded stone aggregate, watering and compacting each layer (not exceeding 200mm in thickness) to minimum of 85% of original volume of stone stack including filling the interstices of stone aggregate with moorum/locally available non-expansive soil. The minimum compacted thickness of stone aggregate layer shall be 200mm. The compacted subgrade below stone aggregate shall be 85% of standard proctor density.

5.40.00 **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.

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6.00.00 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 230 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 shall be considered)	0.50
	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, Bio mass, ,Limestone and Gypsum 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/lime/biomass 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. iv) Bio mass 1000 kg. / Cu. M. For sizing calculation v) Lime stone 1400 kg. / Cu. M. vi) Gypsum 1100 kg. / Cu. M. vii) Coal 800 kg. / Cu. M. viii) Bio mass 600 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)
J)	Railway Supporting Structures, Rail Culverts	As per Railway 'Bridge Rules'
K)	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.

L) 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. In Limit state design, the partial safety factor for temperature load in load combinations shall be taken same as specified for dead load (DL) in Table 4 of IS 800: 2007 for steel structures and in Table 18 of IS 456 for concrete structures.

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. In Limit state design, the partial safety factor for differential settlement load in load combinations shall be taken same as specified for dead load (DL) in Table 4 of IS 800: 2007 for steel structures and in Table 18 of IS 456 for concrete structures.

6.02.09 **Additional Loads**

Following Minimum additional Loads shall be considered in the design of Main Power House, CCR and Trestles.

(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

(i) Other loads as defined in Mechanical/ Electrical input drawings

(I) Loads for solar installations over roof to be taken not less than 1 KN/sqm in addition to live loads, dust loads etc as mentioned elsewhere. Roof slab to be design for local effect due to wind load at support location for installations

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 limit states for different load combinations shall be taken as per relevant

IS and IRS codes.

g) Wherever pipe cable trestle is routed through filled up area, soil overburden weight to be accounted from natural ground level to finished grade level in foundation design as in other structures.

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 unfavourable 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 limit states.

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

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

p) Foundations shall be designed for all the load combinations for which Structure has been designed, in addition to the load combinations mentioned in respective codal provisions.

6.03.03 Design of steel structures shall be done as per provisions of IS:800: 2007 (Limit state design) and other relevant IS standards including National Building Code(2016).

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

	1.6 x (rated capacity of conveyor system) / Conveyor speed x 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 handling structures:** 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:800:2007-"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 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 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, 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 foundations of transfer points, & 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 **as per IS 3370 (Part 2) with limiting crack width to 0.1mm**
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	10 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 requirements.

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 or 6mm flats. 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.

6.03.09 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 Main Power House, ESP Control Building, 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 DELETED

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.

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

a) Total 10 hours biomass blended coal requirement of the boiler for BMCR duty with worst coal firing, equally distributed over the number of bunkers (i.e. the coal mills) required in service for this duty condition as specified elsewhere.

b) Total 10 hours biomass blended coal requirement of the boiler for BMCR duty with design coal firing, equally distributed over the number of bunkers (i.e. the coal mills)

required in service for this duty condition as specified elsewhere.

c) Total 10 hours biomass blended coal requirement of the boiler for TMCR duty with worst coal firing, equally distributed over the number of bunkers (i.e. the coal mills) required to be in service for this duty condition as specified elsewhere.

6.03.15 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.

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 TG, Mills, Fans & BFPs**

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

Analysis for the foundation

For the foundations of the all equipment, detailed 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 IS 1893. 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 IS 456.

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.

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

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

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

6.03.26 **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

6.03.26.1 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.

6.03.26.2 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) Connections to be designed as per IS 800.

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

c) 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.

d) 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.

e) 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 DELETED

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 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, ~~Transfo~~

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) DELETED

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. 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 system as mention below in this specification for the Corrosivity category mentioned in Part A-IID-Civil Works

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 considerations in ISO 12944 Part 3. Where steel is fully accessible for cleaning and repainting and where it is feasible to follow design criteria given in ISO 12944 part 3, minimum thicknesses of structural members shall be as follows:

Structural Sections	Minimum thickness	Minimum Flange thickness	Minimum Web thickness
Plates	6		
Built up Sections		6	6
Angle sections	6		
ISMB /ISMC		6	4.5
NPB/ WPB		6	4.5
RHS/SHS/ Tubular Sections	4		
All dimensions in mm			

Where steel surfaces are inaccessible for cleaning and repainting (such as back to back sections, lap joints etc.) 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 minimum thickness specified above, whichever is more). The minimum thickness consideration shall apply for both web and flange.

However minimum gusset plate thicknesses shall be followed as mentioned else where in the specification and minimum angle section to be used is ISA 50x50x6. Ends of tubular sections to be effectively sealed at both ends. Also tubular handrail thicknesses will be as governed by mentioned clauses in the spec.

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)**

Following painting system corresponding to corrosion category as mentioned in Part A IID Civil Works of this specifications shall be adopted for the project.

CORROSSIVITY CATEGORY(as per ISO 12944-2)	PRIMER COAT	INERMEDIATE COAT	FINAL COAT
C3	All steel surfaces shall be provided with two	Primer coat shall be followed with the application of	Intermediate coat shall be followed with the application

	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.	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 (from the application of primer coat) by airless spray technique.	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 ∆E) 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	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	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

	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.	24 hours (from the application of primer coat) by airless spray technique.	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 Chequered plate to receive same corrosion protection measures as structural steel unless specified other wise.

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.,

D-1-7/ 7.00.00 FOUNDATION SYSTEM AND GEOTECHNICAL DATA

7.01.00 Soil Data

Owner has carried out detailed geotechnical investigation at the project site. Bore logs data, Pile capacities and Bearing capacity for design of foundations for the respective projects are given at Appendix-III & Annexure - C of this specification. The detailed geotechnical investigation report comprising of Boreholes, Laboratory tests, Chemical analysis, etc for the sub-strata prevailing at site would be made available for the Bidder's study at the Owner's office, if required. The onus of correct assessment / interpretation and understanding of the existing subsoil condition / data lies with the Bidder. **In case, bidder feels that the available data is inadequate, he may carry out his own geotechnical investigation. Further, if any change in layout or for any area not covered in the provided geotechnical data, the bidder has to carry out geotechnical investigation in the area at no cost to Owner.** Geotechnical investigation work shall got executed by the Contractor through the agencies as mentioned in Clause No. 7.06.00. However, no time extension shall be given on account of soil investigation carried out by the Bidder. The geotechnical investigation report shall be prepared with detailed recommendations regarding type of foundation and allowable bearing pressure for various structures/ facilities and other soil parameters. Net allowable bearing pressure shall be limited to Table-1 of Appendix-III. The report shall be submitted for Owner's approval prior to commencement of design of foundation.

Bidder may refer enclosed topographical survey drawing and general layout plan along with borelogs for variation in existing ground level (EGL) / natural ground level (NGL) and finished ground level (FGL). Wherever ash/coal deposit/brick-bats etc. is found the same shall be treated as filled up soil.

7.01.01 The furnished borelog details are specific to the co-ordinates where the boreholes have been carried out and are provided for bidder's information only. Soil profile in the proposed area may vary with respect to the borelogs enclosed for bidder's information. Bidder has to consider all such variations in his estimation, over the extent of the work to be carried out. The Bidder should note that nothing extra whatsoever on account of variation between soil data collected by Owner and that found by the Bidder during geotechnical investigation by him or during execution of works, shall be Payable.

7.01.02 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) Natural sand/ sand manufactured from other than natural sources as specified elsewhere in the technical specification 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 foundation 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) In case of soil, minimum founding level shall be 1.0m below Finished ground level (FGL) or, 1.0m below Natural ground level (NGL) whichever is lower.
In case of rock, minimum founding level shall be 1.0m below Finished ground level (FGL) or, 0.5m embedment in rock whichever is lower.
For meeting the bearing capacity and /or functional requirement lower depth to be adopted based on requirement.

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 M7.5 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 minimum embedment as per Annexure-C into the rock, shall be removed and built up through PCC M10 upto the designed bottom level of the foundation. The founding level for all the open foundations shall be kept at same level for 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.

7.02.03 **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. Two stage flushing of pile bore shall be ensured by airlift technique duly approved by the Employer.
If required, temporary or permanent MS liner may be provided for piling.

ii) The allowable load capacity of the pile in different modes (vertical compression, Lateral and pullout) shall be least of below three i.e.
   a) design value based on borelog along with lab test data furnished in Annexure-C,
   AND
   b) pile capacity achieved in pile load tests
   AND
   c) the values furnished in table at Appendix-III:

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 with test load of one and half times the allowable pile capacity. Piles for routine load tests shall be approved by the Employer.

xi) In case, routine pile load test shows that the pile has not achieved the desired capacity or pile(s) have been rejected due to any other reason, then the Contractor shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required.

xii) Testing of piles and interpretation of pile load test results shall be carried out as per IS:2911 (Part-4). Contractor shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory / institute prior to their use. Settlement / movement of the pile top shall be made by Linear Variable Differential Transducers (LVDT) having a least count of 0.01mm.

xiii) The test load on initial and routine test piles shall be applied by means of reaction from anchor piles / rock anchors alone or kentledge with concrete blocks alone or combination of anchor piles / rock anchors and kentledge with concrete blocks.

xiv) Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the routine load test and not intended to replace the use of static load test. This test is limited to assess the imperfection of the pile shaft and shall be undertaken by an independent specialist agency to be approved by Engineering department of Owner. The test equipment shall be of TNO or PDI make or equivalent. The process shall confirm to ASTM.

xv) High Strain Dynamic Load Test may be carried out for routine vertical load test of working piles. However, at least three numbers of static routine vertical load tests shall be carried out on pile on which high strain dynamic load test has already been carried out for establishing the correlation between the two tests. In case of discrepancy if any between dynamic and static vertical load tests, then additional static routine vertical load tests shall be conducted as decided by the Engineer and the results of static routine vertical load shall prevail. Number of routine vertical pile load tests as per clause 7.02.03 (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 or pure bending, whichever is governing, 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.

7.03.00 Excavation, Filling and Dewatering

7.03.01 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.

7.03.02 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.

7.03.03 **Backfilling in Power House and Boiler Area**

Backfilling around foundations, trenches, sumps, pits, plinths, etc. shall be carried out with natural sand/ sand manufactured from other than natural sources as specified elsewhere in the technical specification in layers not exceeding 300 mm compacted thickness and each layer shall be compacted to minimum 80% of relative density. **Controlled Low Strength Material (CLSM) as specified elsewhere in technical specification may also be used for backfilling in Power House and Boiler area.**

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 sand 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.

7.03.04 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.

7.03.05 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.

7.03.06 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.

7.04.00 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.

7.04.01 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).

7.04.02

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/design/pattern and get the same approved from Engineer before carrying out the blasting operation. The services of such specialized blasting experts shall be available throughout the period in which the blasting work is undertaken at site. While carrying out the detailed blasting design, the proximity of existing facilities, structures/sub-structures shall be taken into account. All blasting shall be done as per the approved blasting scheme/design /pattern & all blasting operations shall be done under the supervision & guidance of the representative of the blasting expert. All controlled blasting shall be done by using time delay detonators (i.e. excel type).

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.

e) The Contractor shall install and operate equipment (such as duly calibrated triaxial seismograph) for continuous monitoring and control of blast induced vibrations, noise level/ air pressure, dust, silica and noxious gases during all blasting operations.

f) The monitoring of vibrations shall be done at a minimum of 3 locations and more as per requirement of site considering the critical nearby structures. The vibration shall be controlled considering the nearby habitats, structures, sub-structures etc. and vibration shall not be transmitted to the adjoining areas. Any method/ steps necessary for the same and in line with the recommendations of the specialized agency is in the scope of the Bidder.

g) To restrict Flyrocks proper muffling mats and/or wire mesh and/or any other means required and necessary shall be used. The same shall be ensured by the Bidder as per recommendations of specialized blasting experts and Engineer.

h) The over breaking of rock strata beyond the required levels shall not be done. The founding strata shall not be impacted due to blasting and the last 150-300mm of rock strata shall be broken by mechanical means like chiselling /rock breaker etc.

7.05.00

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. **For deep excavation in sheet piling / contiguous pile / secant pile / diaphragm walls etc may be required depending upon the proximity to the existing facilities. The excavation design & scheme shall be developed by a specialized agency.**

7.06.00 **Geotechnical investigation work shall be got executed by the Contractor through the following 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
5. Secon Private Limited, Banglore
6. Soil Engineering Consultants, New Delhi
7. CEG Test House and Research Centre Private Limited, Jaipur
8. Geomarine Consultants Pvt Ltd., Chennai
9. Soiltech India Private Limited, Pune

Appendix-III (GADARWARA St-II)

SOIL DATA AND FOUNDATION SYSTEM

Owner has carried out detailed geotechnical investigation in the proposed area. Logs of boreholes of proposed area are enclosed as Annexure C GADARWARA ST-II

a) The minimum founding level and the corresponding net allowable bearing pressure shall be as given in Table – 1 below.

Table-1
Net Allowable Bearing Pressure

Founding Depth/ Stratum	Net Allowable Bearing Pressure T/m2		
	Isolated / Strip Foundation		Rafts (width > 6m)
	Settlement (40mm)		Settlement (75mm)
	Width upto 3.0m	width >3 to 6m	
1.0m below NGL	12	10	12
2.0m below NGL	15	12	15
3.0m below NGL	19	17	19
4.0m below NGL	22	20	22
5.0m below NGL	28	25	30
More than 10.0m below NGL	35	35	35

For Finished ground level (FGL), refer General layout plan (GLP)

To determine the Natural Ground Level (NGL), tender drawings titled “TOPOGRAPHICAL SURVEY” shall be referred. Further the above, tender drawings shall also be referred in conjunction with borelog data attached at Annexure C GADARWARA ST-II to this specification.

As per the topographical survey drawing, there are many nallahs passing through the ESP control room unit#4, some portion of ESP Unit#4 in plant area in Gadarwara St-II area. Depth of nallah is varying from 4m to 8m below FGL. For location of nallahs topographical survey drawing may be referred.

The NGL for any particular structure/facility shall be the lowest of all the NGLs mentioned in the extent of the building/facility.

The NGL of any point shall be the lowest of the levels at (a) TOPOGRAPHICAL SURVEY and (b) Borelog data attached at Annexure to this chapter.

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 M7.5.

The net allowable bearing pressure higher than above mentioned values shall not be permitted. At intermediate levels the bearing capacity shall be same as the net allowable bearing pressure corresponding to the immediate shallower level mentioned above.

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 powerhouse, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	25 mm
Isolated & Strip (other than Main powerhouse, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	40 mm
Raft (other than Main powerhouse, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	75 mm

In case the total permissible settlement is to be restricted to less than as above specified from functional requirements, then the net allowable bearing pressure shall be reduced after review in consultation with Engineer.

b) **Pile limiting capacities:**

The allowable load capacity of the pile in different modes (vertical compression, Lateral and pullout) shall be least of below three i.e.

i) design value based on borelog along with lab test data furnished in Annexure-C,

AND

ii) pile capacity achieved in pile load tests

AND

iii) the values furnished in following table

Dia. (mm)	Cut off Level	Minimum Pile length below COL (m)	Vertical compression capacity (T)	Uplift capacity (T)	Lateral capacity (T)
600	3.0m below FGL	27 for non nala area	120	50	7.0
		27 for nala area	110	40	3.0
760	3.0m below FGL	28 for non nala area	200	80	14.0
		28 for nala area	180	75	5.0
1000	3.0m below FGL	29 for non nala area	350	130	20.0
		29 for nala area	325	100	8.0

c) Special Requirements:

i) Chemicals in ground water and subsoil, as observed during investigation are:

Chemical	Sulphates	Chlorides	pH
Ground Water	310-380 mg/l	40-75 mg/l	7.2-7.6
Sub-soil	0.10-0.11 %	0.02-0.04 %	6.7-7.4

APPENDIX-III (TELANGANA ST-II)

SOIL DATA AND FOUNDATION SYSTEM

Owner has carried out detailed geotechnical investigation in the proposed area. Logs of boreholes of proposed area are enclosed as Annexure C TELANGANA ST-II.

a) The minimum founding level and the corresponding net allowable bearing pressure shall be as given in Table – 1 below.

Table – 1

Founding Depth/ Stratum	Net Allowable Bearing Pressure T/m2		
	Isolated and combined footings including raft for 25mm permissible settlement in case of soil and 12mm in case of rocky strata	Isolated and combined footings for 40mm permissible settlement in case of soil and 12mm in case of rocky strata	Rafts (width > 6m) for 75mm permissible settlement in case of soil and 12mm in case of rocky strata
	Width upto 6.0m		
In case of Soil			
1.0m below NGL	-	10	12
2.0m below NGL	-	14	18
3.0m below NGL	20	22	22
3.5m below NGL	25	25	25
4.0m or more than 4.0m below NGL	30	30	30
In case of rocky strata			
Minimum 0.50m Embedment in rock	35	35	35
Minimum 1.0m Embedment in rock	40	40	40
Minimum 1.5m Embedment in rock	45	45	45
Minimum 2.5m or more than 2.5m embedment into rock	50	50	50

For Finished ground level (FGL) refer General layout plan (GLP)

To determine the Natural Ground Level (NGL) the tender drawings titled TOPOGRAPHICAL SURVEY shall be referred. Further the above, tender drawings shall also be referred in conjunction with borelog data attached at Annexure to this chapter.

The NGL for any particular structure/facility shall be the lowest of all the NGLs mentioned in the extent of the building/facility.

The NGL of any point shall be the lowest of the levels at (a) TOPOGRAPHICAL SURVEY and (b) Borelog data attached at Annexure C TELANGANA ST-II to this specification.

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 M7.5.

The net allowable bearing pressure higher than above mentioned values shall not be permitted. At intermediate levels the bearing capacity shall be same as the net allowable bearing pressure corresponding to the immediate shallower level mentioned above.

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 powerhouse, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	25 mm
Isolated & Strip (other than Main powerhouse, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	40 mm
Raft (other than Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	75 mm
Foundations in Weathered rock / rock	12 mm

In case the total permissible settlement is to be restricted to less than as above specified from functional requirements, then the net allowable bearing pressure shall be reduced after review in consultation with Engineer.

b) Pile limiting capacities: NA

c) Special Requirements:

i) Chemicals in ground water and subsoil, as observed during investigation are:

Chemical	Sulphates	Chlorides	pH
Ground Water	120 mg/l	34-80 mg/l	7.5-7.78
Sub-soil	0.04-0.05%	0.006-0.018 %	7.76-9.58

APPENDIX-III (NABANAGAR ST-II)

SOIL DATA AND FOUNDATION SYSTEM

Owner has carried out detailed geotechnical investigation in the proposed area. Logs of boreholes of proposed area are enclosed as Annexure C NABINAGAR ST-II.

a) The minimum founding level and the corresponding net allowable bearing pressure shall be as given in Table – 1 below.

Table-1

Net Allowable Bearing Pressure

Structure	Df below FGL (m)	Net Allowable Bearing Capacity (t/sqm)		
		S=25mm	S=40mm	S=75mm
		Width upto 6m		Width>6m
TG, Main powerhouse, Boiler, ID Fan, Booster fan	2.0	6	8	12
	3.0	7	10	14
	4.0	8	11	15
	5.0	9	13	17
	>=6.0	10	15	19

Structure	Founding Depth/ Stratum	Net Allowable Bearing Pressure (t/sqm)		
		Isolated / Strip Foundation S=40mm		Rafts (width > 6m) S=75mm
		Width upto 3.0m	width >3 to 6m	
ESP, ESP Control room	2.0m below FGL	13	10	13
	3.0m below FGL	16	11	15
	4.0m below FGL	18	12	16
	5.0m below FGL	22	14	18
	6.0m below FGL	25	17	20
	>=7.0 below FGL	28	20	25
ACC, CPU Reg., Pipe rack, Cable trestle,	1.0m below NGL	08	06	08
	1.5m below NGL	12	08	12
	3.0m below NGL	14	10	14
	4.0 m below NGL	17	12	18
	>=5.0m below NGL	20	16	20
Any Other structures not specified above	1.0m below NGL	08	06	08
	1.5m below NGL	10	08	10
	2.0m below NGL	12	09	12
	3.0m below NGL	13	10	13
	4.0 m below NGL	15	12	17
	>=5.0m below NGL	18	16	20

For Finished ground level (FGL) refer General layout plan (GLP)

To determine the Natural Ground Level (NGL), tender drawings titled "TOPOGRAPHICAL SURVEY" shall be referred. Further the above, tender drawings shall also be referred in conjunction with borelog data attached at Annexure C NABINAGAR ST-II to this specification.

The NGL for any particular structure/facility shall be the lowest of all the NGLs mentioned in the extent of the building/facility.

The NGL of any point shall be the lowest of the levels at (a) TOPOGRAPHICAL SURVEY and (b) Borelog data attached at Annexure to this chapter.

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 M7.5.

The net allowable bearing pressure higher than above mentioned values shall not be permitted. At intermediate levels the bearing capacity shall be same as the net allowable bearing pressure corresponding to the immediate shallower level mentioned above.

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 powerhouse, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	25 mm
Isolated & Strip (other than Main powerhouse, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	40 mm
Raft (other than Main powerhouse, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	75 mm

In case the total permissible settlement is to be restricted to less than as above specified from functional requirements, then the net allowable bearing pressure shall be reduced after review in consultation with Engineer.

b) **Pile limiting capacities:**

The allowable load capacity of the pile in different modes (vertical compression, Lateral and pullout) shall be least of below three i.e.

i) design value based on borelog along with lab test data furnished in Annexure-C,

AND

ii) pile capacity achieved in pile load tests

AND

iii) the values furnished in following table

Dia. (mm)	Cut off Level	Minimum Pile length below COL (m)	Vertical compression capacity (T)	Uplift capacity (T)	Lateral capacity (T)
600	3.0m below FGL	22	110	50	9.0
		24	120	60	9.0
		26	130	70	9.0
760	3.0m below FGL	22	180	70	12.0
		25	210	90	12.0
		27	250	110	12.0
760	4.0m to 5.0m below FGL	22	200	70	12.5
		24	210	90	12.5
		27	250	110	12.5
760	7.0m or more than 7.0m below FGL	18	180	70	14.0
		21	210	90	14.0
		25	250	110	14.0
1000	3.0m below FGL	22	325	90	16.0
		25	400	120	16.0
		27	450	150	16.0
1000	4.0m to 5.0m below FGL	22	350	110	16.5
		24	400	150	16.5
		26	440	180	16.5
1000	7.0m or more than 7.0m below FGL	19	340	100	18.5
		23	400	150	18.5
		25	450	180	18.5

c) Special Requirements:

i) Chemicals in ground water and subsoil, as observed during investigation are:

Chemical	Sulphates	Chlorides	pH
Ground Water	<60 mg/l	17-25 mg/l	7.70-8.24
Sub-soil	<0.06 %	0.010-0.014 %	7.70-8.15

D-1-8

8.00.00 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.

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.

Construction / 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.

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 MS lugs of 8mm diameter and 150mm long @ 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 cover slabs / 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 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. However, if landscaping is excluded from the scope of works, area for landscaping is to be kept.
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-20) 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 confirming to IS:15658, 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.

8.01.02.31 All opening in floors/roofs/cladding for routing of pipes/cables/ducts shall be suitably sealed by the contractors after completion of erection works.

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 structures, foundations, machine foundations and some of other important structural members shall be as follows::

Sl No	Description	Minimum grade of concrete
i)	Foundations & Pedestals; Column Encasements; Tank Foundations (of over-ground steel tanks); Paving/ Ground floor slabs/ Grade slabs/ Floor & Roof Slabs; Drains/ Trenches/ Sump pits/ Box Culverts; Foundations, sub-structures & super-structures of all buildings UNO; Transformer foundations; RCC encasement of CW/ACW Pipes & other pipes; Thrust blocks etc	M25
ii)	ID, FD, PA fan & Mill foundations (block foundations); Water retaining structures/ Pits; CW & CEP Pits; ACC; Pre-cast drains; Pre-cast slabs	M30
iii)	BFP foundations (in case of springs supported) / (in case of block foundation);	M35 / M30
iv)	TG Raft/ Substructure Railway load bearing structures; All spring supported machine foundations except TG	M35
v)	TG top Deck	M50
vi)	PCC mat Below foundations	M7.5
vii)	PCC encasement of Pylon supports; Plinth protection	M20
viii)	Road (Geopolymer concrete) DLC / PQC	M10/ M35

d) Concrete design mix of M50 grade concrete for TG top deck 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/G as per ASTM C494 or IS 9103) in the concrete mix.

Dosage & mixing methodology of this chemical admixture including addition of viscosity modifying agent, if any, shall be as per recommendation of institute from where design mix has been done.

vi) Fly ash shall be not be used as replacement of total cementitious materials.

e) Higher grade of concrete than specified above may be used at the discretion of the Bidder.

f) 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.

g) For thin concrete sections such as roof slab over profiled metal deck sheets, 12mm and down coarse aggregates shall be used for coarse aggregates.

h) 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.

i) 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

Admixtures in concrete for promoting workability, retarding setting, reduction in permeability, facilitating pumping of concrete, etc., shall be used as per the approved mix design after approval from the Engineer. Admixtures shall conform to clause 5.5 of IS: 456. These shall be free from injurious amount of chloride, etc. Addition of admixtures should not reduce the specified strength or durability of concrete and should not have detrimental effect on reinforcement.

The admixtures shall conform to IS: 9103 or ASTM C-494 and shall be proven performance record make and from a reputed manufacturer. Calcium chloride as accelerating admixture is not permitted to be used.

Admixtures shall either be naphthalene based or any other material approved by the Engineer. Ligno-sulphonate based materials shall not be used. Admixtures shall be used in liquid form only, quantity of which shall be as per manufacturer's recommendation and approved mix design.

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 IS 516 Part-5, Sec-I. 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 Fans, Mills etc, 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 as per the criteria specified in metal deck roof material clause in Architectural Design and concept chapter and design criteria chapter. These profiled metal deck sheets shall be fixed to the structural steel secondary beams/ Purlins using Headed shear anchor studs.

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 minimum vertical clearance of 8.5m shall be maintained between Rail top level and bottom of structure. However, a minimum vertical clearance of 6.8m shall be maintained between Rail top level and bottom of structure in case of Ash silo.

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 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 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.

For coal bunkers, hoppers and chimney flue liners, to prevent coal dust/flue gas leakages, the applicable field joints shall necessarily be welded.

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**

i) All fillet welds shall be checked for size and visual defects.

ii) Macroetch examination on production test coupons for main fillet weld with minimum
one joint per built up beam, column, and crane girder, etc.

iii) 25% weld length of tension members of crane girder shall be subjected to dye-penetration test.

iv) On all other welds, dye-penetration test on 5% of weld length with minimum 300mm at each location shall be carried out.

b) **Butt Welds**

i) 100% visual examination.

ii) Dye penetration test on all butt welds after back gouging shall be carried out.

iii) Mechanical testing of production test coupons - minimum one joint/built up beam, column and crane girder. The engineer may reduce the frequency of the test, after getting consistently satisfactory results of initial 10 tests.

iv) 100% radiography test on butt welds of tension flange (bottom flange) of crane girder and bunker supporting girders. All other butt welds shall be subjected to radiography test on 10% of weld length of each welder.

c) **Dimensional Tolerance and Acceptance Criteria of Welds**

i) Every first and further every 10th set of identical structure shall be checked for control assembly at shop before erection.

ii) All structures, components/members shall be checked for dimensional tolerance during fabrication and erection as per IS:7215 and IS:12843 respectively

iii) Dry film thickness after painting shall be checked by using elchometer.

iv) Acceptance criteria of NDTs on welds shall be as per AWS D-1.1(Dynamically loaded structures - Tension welds).

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, relevant standards shall be observed.

For the bolts supplied in dull-black condition, exposed portion of bolts, nuts etc shall be painted immediately after bolting in line with touchup painting cl 6.04.03. For bolts supplied in Galvanized or Aluminum/ Zinc-spray coated condition, this painting need not be done.

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.

j) 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.

8.09.00 **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 at a token amount of Rs 1 per Metric Tonne 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.

8.10.00 **Controlled Low Strength Material (CLSM):**

a) Controlled Low Strength Material (CLSM) may be used for backfilling in foundation as an alternate to compacted sand fill. The compressive strength of CLSM should not be less than 0.5 MPa at 28 days.

A typical raw material combination for production of low strength flowable fills is as follows:

Sl No	Raw Material	Typical proportion by weight
1	Pond Ash	90% to 95%
2	Cement	*5% to 10%
3	Water	**W/C ratio b/w 3 to 4

* Minimum cement content should be minimum 5% by weight of Pond Ash and Cement
**Prior to usage, W/C of mix needs to be checked to get flowable mix

b) Procedure: Proportioning and blending materials: The dry materials Cement and Pond ash are to be weighed according to formulations presented above. All the dry materials added into mixer sequentially. The blending of these dry materials allowed for 1-2 minutes prior to the addition of water. After thorough mixing, water is to be added and allowed the mix for another 2 minutes to achieve flowable mix.

c) Flowability: The minimum flowability value should be 200mm as per relevant ASTM standards. Hardening time of flowable fill in the field is measured using Kelly Ball apparatus as per ASTM standards, in general, the hardening time of flowable fills is less than 5 h for low flowability mixes.

d) Pumpability: Flowable fills are usually pumped and placed at the site using the conventional concrete pumping equipment.

e) Permeability: Permeability of most excavatable CLSM is similar to compacted granular fills. It is in the range of 10-4 cm/sec to 10-5 cm/sec. 11 CLSM mixtures of higher strength and high fines content can achieve permeability as low as 10-7 cm/ sec.

f) Shrinkage: Shrinkage and shrinkage cracks do not affect the performance of CLSM. The linear shrinkage of CLSM is about 0.02%.

g) Hardening time is referred to as the approximate time required for the flowable fill to change from the initial plastic state to hardened state with an appropriate strength to handle the weight of a person in the field. Hardening time of flowable fill in the field is measured using Kelly Ball apparatus as per ASTM standards. The procedure involves raising and dropping the Kelly ball to the flowable fill specimen of 400 x 400 x 150 mm and measuring the indentations produced on the upper surface of the fill. Hardening time is represented as the time taken for the fill material to obtain an indentation diameter of less than 76 mm on the surface of the fill. The laboratory determination of hardening time is generally done by visual identification. In general, the hardening time of flowable fills is less than 5 h for low flowability mixes. The hardening time depends on the fineness of the ash used in the mix. Usually, coarse grained flowable fill mixes

are found to harden within less time when compared to that of finer ash based flowable fills.

h) Quality control: The American Society for Testing and Materials (ASTM) has introduced five standard test methods for testing freshly mixed controlled low strength material (CLSM). The standard methods are as follows:

1. ASTM D 6103 - Standard Test Method for flow Consistency of Controlled Low Strength Material (CLSM)
2. ASTM D 6023 - Standard Test Method for Unit Weight, Yield, Cement Content and Air Content (Gravimetric) of Controlled Low Strength Material (CLSM)
3. ASTM D 6024 - Standard Test Method for the Ball Drop on Controlled Low Strength Material (CLSM) to determine suitability for load application
4. ASTM D 5971 - Standard Practice for Sampling Freshly Mixed Controlled Low-Strength Material
5. ASTM D 4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

8.11.00 **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.

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9.00.00 **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) (Wall thickness 3.65 mm minimum) conforming to IS: 1161 and shall be finished with suitable paint. All rungs and ladders shall be finished with suitable paint. 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. /galvanising as per cl 6.04.03

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 shall be provided with SS Handrailing. Height of the handrail shall be1000 mm /1200mm in accordance with the preceding para. For SS handrail 32NB/50NB/60NB (polished) stainless steel pipe with wall thickness 2.0mm (minimum) shall be provided. The spacing of vertical posts shall not be more than 1200mm. Two number of horizontal rails shall be provided including the top member. SS Toe guard, knee guard (100 mm wide and 6mm thick) shall be provided above the floor level. The SS railing in service building shall have Glazed railing system with laminated Toughened glass panels.

b) All stairs shall have a maximum riser height of 150mm and a minimum tread width of 300 mm. Minimum clear width of stair shall be 1500 mm unless specified otherwise. The width of staircase shall meet the National Building Code requirements.

c) All buildings having metal cladding shall be provided with 1 meter high 1 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 /1200 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, firefighting, etc., shall be provided for each floor. All the drains shall be suitably covered with grating or precast RCC panels.

e) RCC steps / staircase shall be provided for main entrance of all RCC construction buildings.

f) RCC Parapet, of 900 mm high from Finished floor level of roof for accessible roof and of 600 mm high from Finished floor level of roof for Non accessible roof, Parapet, Sunshades of 450mm over window, 600mm over door and 900mm over

rolling shutters, architectural facia, projections, etc., shall be provided with drip course in cement sand mortar 1:3. Minimum 600mm wide roof projection shall be provided at terrace level in all buildings.

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 firefighting 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 service building.

i) All electrical conduits in buildings for lighting, Air-conditioning, other services shall be of concealed type. Conduits shall be laid in RCC structures at the time of casting.

j) Wherever the area of building at any floor is more than 500 sq.m. Minimum two no of staircase shall be provided. Number of staircases shall also be governed by Electrical Safety Rules.

k) For MPH and Boiler structure, 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

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.

Chlorinated Polyvinyl Chloride (CPVC) pipes, confirming to IS 15778, having thermal stability for hot & cold water supply including all CPVC plain & brass threaded fittings shall be used for internal piping works for service water and potable water supply. For installation of CPVC pipes guidelins as stipulated in Clause No. 18.9 , CPWD specifications shall be followed.

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 (decorative type)

a) One number wall mounted coloured glazed vitreous China European water closet and dual flushing valve system, water faucet, health faucet, toilet paper holder as per IS:2556.

b) One number colour glazed ceramic oval shaped wash basin 450x 550 mm (approx.) mounted under the counter with18mm 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/SS Studs 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 on Ground floor of Main Power House Building, on Ground floor of Gate Complex with CISF Building and at Each Floor of Service Building.

f) Janitor Space & space for drinking water cooler.

g) Electric operated hand dryer with photo voltaic control.

h) In addition to the facilities stipulated elsewhere Bathroom with rotating type chromium plated shower including all fitting and fixtures shall also be provided in toilet at ground and operating floor of Main Power House Building.

9.03.03 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 coupling , CP bottle 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 minimum 500 liters capacity, complete with float valve, overflow drainage pipe arrangement, CPVC concealed water supply pipe of minimum 12 mm diameter, CPVC 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).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 Control Room floor of ESP control room building and One number of pantry shall be provided in Buildings having Control room. One number of pantry shall be proved at each floor of service Building.

9.03.04 a) Laboratory sink shall be of white vitreous china of size 600x400x200 mm conforming to IS: 2556 (Part-5)with single 15 mm C.P. brass pillar taps with elbow operated levers ISI Marked.

b) In addition, adequate number of portable toilet units with adequate plumbing and sanitary arrangement, shall be provided during construction stage for workers.

c) Adequate number of toilet units with necessary plumbing and sanitary arrangement, shall be provided for workers (O&M workers).

9.03.05

For common toilets at each floor of Service building, toilet cubicles shall be provided. Restroom Cubicle (of following standard dimension which includes 600mm door size width) self-supporting 12mm thick compact laminates made out of, urea free, thermosetting phenolic resins treated Kraft papers as core material and Amino plastic resin treated decor papers on the finish surface, conforming to latest and applicable IS: 2046-1995, EN 438:2016 and NEMA LD3-2005 quality standards with Antivirus, Antibacterial and Antifungal properties (conforming to ISO 21702:2019, JIS Z2801:2010 and ASTM G21-2015 standards respectively) to fulfil the applicable requirements of indoor air quality certifications for Greenguard-Gold standards.

This also includes providing and fixing in position necessary hardware made out of Stainless steel (Grade 316) as per manufacturer's specifications & Architects instructions like (1) Door Knob, (2) Spring Loaded Hinges (3) Slide Bolt with Occupancy indicators, (4) Coat hook (5) U-Channels, (6) Adjustable foot (Mid Panel Mounted or Divider Setback Leg) (7) Top rail with T and L Corner connector (8) Rubber noise deafening tape, (9) Screws & wall Plugs.

The top fitting should consist brushed finish round top rail which will get fixed with pilasters with panel tube holder, 'L' corner bend (connected with top rail) will be used on the corner of cubicle in absence of brick wall and 'T' Connector in T junctions, Wall Bracket fixing is used only on the wall which will hold the top rail.

All screws also will of 316 Grade in stainless steel. All pilasters are supported by Metal Leg [Straight Leg made out either only SS Brush finish or With SS with black powder coated / Set Back Leg with Zinc casted black powder coated] . The base of the stainless-steel bottom will be anchored to the floor with a clearance height upto 150mm. A Toilet Cubicle shall have approximate dimension of 2025mm Height x 1000mm Width x 1500mm Depth. All the necessary fittings shall be provided to make the system complete. Matching urinal partitions shall also be provided in the toilet where cubicles are provided.

9.04.00 **Flooring**

Floor finishes of approved shade and colour 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 50/70 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. Water proofing treatment in sunken portion of WCs, bathroom, kitchen, pantry etc., shall be done in two (2) coats by applying cement slurry mixed with water proofing cement compound (confirming to IS 2645). The First layer shall be of slurry of cement @ 0.488 kg/sqm mixed with water proofing cement compound @ 0.253 kg/ sqm. This layer shall be allowed to air cure for 4 hours. The Second layer shall be of slurry of cement @ 0.242 kg/sqm mixed with water proofing cement compound @ 0.126 kg/sqm. This layer will be allowed to air cure for 4 hours followed with water curing. The water proofing shall be done for the entire sunken area.
9.04.03	Metallic Hardener Topping shall be 12 mm thick. Metallic Hardening Compound shall be of approved quality consisting of uniformly graded iron particles, free from non-ferrous metal particles, oil, grease sand, soluble alkaline compounds. The ratio of Metallic hardener and Cement shall be 1:4. This mix shall be mixed with 6mm nominal stone in Ratio of 1mix : 2 stone. The mixture so obtained shall be laid in 12 mm thickness, on cement concrete floor within 2 to 4 hours of its laying. For laying, the top surface pf underbed shall be roughened with brushes while the concrete is still green and the forms/strips shall be kept projecting up 12 mm over the concrete surface, to receive the metallic hardening compound topping. The topping shall be laid true to provide a uniform and even surface. It shall be firmly pressed into the bottom concrete to have good bond with it. After the initial set has started, the surface shall be finished smooth and true to slope with steel floats.
9.04.04	Heavy duty cement concrete tiles 300 mm x 300 mm shall be provided 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 shall be as follows - a) 450x450mm in white colour b) 300x450mm in DIGITAL series c) 300x600mm in DIGITAL series
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 bitumastic 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 bitumastic end sealing. Battery Room in all buildings shall be provided with acid/ alkali resistant tiles on flooring & dado 1200mm high.
9.04.07	(i) Digitally glazed vitrified & Matt Finish Digitally glazed Vitrified tiles 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) Digitally glazed vitrified Tile, Size of tile 600mm x 600mm / 605mm x 605mm
b) Digitally glazed vitrified Tile, Size of tile 800mm x 800mm
c) Digitally glazed vitrified Tile, Size of tile 1200mm x 1200mm

and

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 hardener 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 VOID

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 pre-polished, 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 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. Engineered wooden flooring (15mm thick) shall be provided in VIP area, conference rooms of Service Building and MPH Building.

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 framework 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 **Over-Deck Insulation**

Roof insulation with 40 mm thick impervious sprayed, closed cell free Rigid Polyurethane foam over deck insulation conforming to IS: 12432 Part-III (density of foam being 40-50 Kg/Cum), over a coat of Polyurethane primer applied @ 6-8 sqm per litre, laid over 400 G Polythene sheet over PUF spray and provided with a wearing course of 40 mm cement screed 1:2:4 (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) in chequered rough finish, in panels of 2.5m X2.5m and embedded with 24G wire netting and sealing the joints with polymerized mastic, shall be provided on the roof of Service Building above the waterproofing.

9.06.03 For efficient disposal of rainwater, the runoff 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 watertight 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 unplasticised PVC (upvc rain water pipes conforming to IS 13592 , Type A with joints with seal ring confirming to IS 5382 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 dry 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 dry 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.

The elastomeric membrane mentioned above in (a) and (b) for waterproofing shall be of two component, instant setting, 100% solids spray applied hybrid polyurea polyurethane liquid applied elastomeric seamless waterproofing membrane meeting the requirements of LAM as per ASTM C836 and having excellent tensile strength of 15MPa (As per ASTM D412), elongation more than 450% (as per ASTM D 412), tear strength of 60 Kn/m (As per ASTM D1004/ASTM D624), adhesion to concrete of 2MPa (as per ASTM D 4541), abrasion resistance of 60mg loss (1 Kg,CS 10 Wheels,1000 cycles - As per ASTM D4060), Shore A Hardness of 85 (As per ASTM D2240), resistance to hydrostatic pressure head of

	7 Bar (As per ASTM D 5385/ DIN 16726), puncture resistance of 1000N (As per ASTM E154), water vapour permeability of 25 mg/m2/day (As per ASTM E96), Impact resistance of 17 N.m (As per ASTM D2794), Low temperature crack bridging ability up to 3.2mm (As per ASTM C 1305), dynamic crack bridging ability class B 3.2 (as per EN 1062-7 Method B- B3.2) with no crack observed in the coating after 20000 sinusoidal cycles, resistance to root (As per CEN TS/14416) and fire resistance of class B (As per EN 13501-1).The coating shall be applied with a total consumption of 1.6 Kg/Sqm to achieve a total system DFT of 1.5mm, thereby satisfy the requirements of LAM as per ASTM C898 and shall be applied on the entire horizontal surface extending upto 300mm above the FFL on the vertical surface as per the methodology. The application system includes base preparation of cleaning, brushing and removal of flacky materials, grouting the porous area with cementitious grout, proper coving between slab and wall junctions and priming the surface with two component solvent free epoxy primer which is applied with a consumption of 200 grams per Sqm, followed by spray application of hybrid polyurea waterproofing coating. Protective geo textile fabric of minimum 150GSM over the entire membrane with proper overlaps shall be applied.
9.06.06	Roof of all buildings shall be provided with access/approach through staircase or ladder. Roof where equipment and Solar PV is mounted shall be provided with access through staircase.
9.06.07	RCC parapet wall of minimum 900 mm height (From finish floor level of roof) with coping for all accessible roofs and 600 mm height for all non-accessible roofs (From finish floor level of roof) 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.
9.06.10	**White glazed tile** Above the Over deck insulation, White glazed tile (min. 5mm thick) for roofing over under bed of cement mortar/ concrete, topped with spreading the white cement slurry at an average rate of 2.5 kg/sq m (unless noted otherwise), jointing and joint filling with white cement slurry, laid to plumb and water level in desired pattern, casted in panels, wherever required, shall be provided on the roof of Service Building.
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. Vertical R.C.C studs shall be provided along AAC Block masonry openings for fixing window and door frames. For control room, control equipment room in MPH Building, **where dry wall construction shall be used,** walls shall be of factory made composite modular light weight aerated concrete panels, (minimum 2 hours of fire rating) consisting of 2 fiber reinforced cement sheets (minimum 4 mm thick) on either side of light weight concrete core, having minimum compressive strength of 35 Kg / Cm2 and the density in the range of 700-900 Kg. / cu.m. of the thickness and fire rating as specified below, to provide external wall and internal partition at all levels, capable of sustaining wind pressure of 3.00 M height (H) within limiting deflection of span/250, fixed in position in tongue and groove jointing system by screwing the panels to top and bottom U channels, (channels minimum 1.25 mm thick and galvanised to grade 180 (minimum) as per IS : 277), fixing U profiled top and bottom channels to concrete / primary steel members which are placed at the maximum vertical spacing of 4.5m with the help of galvanised steel expansion fasteners, filling the joints from both faces with silicon acrylic paste and making the same water tight by covering with fibre glass tape (minimum 50 mm wide and minimum 0.5 mm thick) or by any other suitable material, so as to ensure that the entire construction done with the light weight aerated concrete panels are weather proof and panel surfaces are flush for painting, creating opening for doors / windows /ventilators / ducts / pipes/fans/AC etc. and finishing the opening face with the same U profiled galvanized steel channel which is used at the top and bottom. The Outer wall of control room, control equipment room in MPH Building shall be made of aerated concrete panels over that 50 mm thick mineral wool insulation and metal sheeting on outside
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** Sheeting Procurement takes considerable time therefore advance supply of the sheeting material shall be ensured to meet site requirements and the project schedule.

9.08.01 **Material**

a) Wall Cladding & Roofing Material

Troughed permanently colour coated sheet of approved shade and colour shall be

i) either of steel with minimum 0.6mm bare metal thickness (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade Y250 as per IS 15961 / 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 Y350 as per IS15961/ 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 Y550 as per IS 15961/ 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) paint or Super Polyester paint or SDP paint (Super Durable Polyster with no TGIC Triglycidyl Isocynurate) . The silicon content in the SMP paint to be 30 to 50%. The paint to be, 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/SDP systems shall be of industrial finish of product type 4 of AS/NZ2728.

Also, the heavy metal content (Lead, Cadmium, Chromium etc) to be within environmental norms so that the sheet is also suitable for rainwater harvesting.

9.08.03 **Design Criteria**

For wall cladding insulated / uninsulated and conveyor gallery sides and roof, permanently colour coated sheet of troughed profile shall be used. However alternative profile meeting the strength, deflection and other functional requirements such as section modulus and moment of inertia shall be provided.

Sheet shall be of profile, sectional properties, colour and shade as per specifications.

For profiled metal decking sheets (to be used for RCC floor slab or roof slab) the sectional modulus and moment of inertia of troughed profile per meter width shall be so as to limit the deflection of sheets to span/250 under total super imposed loading (DL +LL) comprising the self-weight of metal deck sheet, dead weight of green concrete and an additional construction load 100kg per sq.m for two span condition. The section modulus and moment of inertia of troughed profile shall be computed as per the provisions of IS 801 for satisfying the deflection and strength requirements.

For metal deck sheets used for roofing (with or without RCC) and side cladding, the sectional modulus and moment of inertia of troughed profile per metre width shall be such that the deflection of sheets is limited to span/250 under design wind pressure for two span condition. The sectional modulus and moment of inertia of troughed profile shall be computed as per the provisions of IS 801 for satisfying the deflection and strength requirements. No increase in allowable stress is permissible under wind load condition.

9.08.04 **Fasteners**

Side cladding/roofing/decking sheets shall be fixed to the runner/purlins using self-drilling special coated fasteners confirming to corrosion resistant class 3 of AS3566 and tested for 1000 hours salt spray test. Spacing of Self-drilling fasteners in transverse direction (along runners/purlin) shall be equal to the pitch of trough or 250(+/-100) mm, whichever is lesser and in longitudinal direction at every runner/purlin location.

Shear anchor studs shall also be provided through metal deck, which are to be used as permanent shuttering, at regular interval on all top flange / flange plate of structural beams as specified in Clause no. 8.03.00.

Alternatively, J/U type hooks shall be used in roofing which shall be provided in transverse direction (along runners/purlin) at a spacing equal to the pitch of trough or 250(+/-100) mm, whichever is lesser and in longitudinal direction at every runner/purlin location.

9.08.05 **Miscellaneous Details**

To minimize the number of joints, the length of the sheet shall preferably be not less than 4.5m, cut pieces shall not be used, unless specifically approved by the Engineer. However, the actual length shall be such so as to suit the purlin / runner spacing.

Lap between the sheets shall be at least 150mm in the longitudinal direction and at least one crest wide in the transverse direction which shall be properly anchored / fixed with fasteners.

Z spacers if required shall be made of at least 2 mm thick galvanised steel sheet of grade 350 as per IS 277

Sealant used for cladding shall be butyl based, two parts poly sulphide or equivalent approved, non stainless material and be flexible enough not to interface with fit of the sheets

. Filler blocks as a trough filler shall be used to seal cavities formed between the profiled sheet and the support or flashing. The filler blocks shall be manufactured from black synthetic rubber or any other material approved by the Engineer.

For insulation of cladding and other areas, mineral wool conforming to IS 8183 shall be used. The density shall be 32 or 48 kg. /cu.m for glass or rock wool respectively. The nominal thickness of insulation shall be 50mm.

All flashings, trim closures, caps etc. required for the metal cladding system shall be made out of plain sheets having same material and any weather/moisture sealants with appropriate material and coating specification as mentioned above for the outer face of the metal cladding. Overlap shall be min. 150 mm or as specified by manufacturer.

The contractor shall prepare working drawings of sheeting system including end and side laps, flashing, fixing details etc. before starting sheeting work at site.

9.08.06 **Pre-Fabricated Insulated Metal Sandwich Panels**

For buildings where Pre-Fabricated (Factory made) Insulated Metal Sandwich Panels shall be used for Roofing, the sandwich panels shall comprise top sheet as troughed permanently colour coated sheet & bottom sheet as plain permanently colour coated with 50mm thick insulation sandwiched between the two sheets. Each sheet shall be

i) either of steel with minimum 0.6mm bare metal thickness (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade Y250 as per IS15961/ 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 Y350 as per IS15961/ 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 Y550 as per IS15961/ 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. The insulation shall be of Polyurethane type. The polyurethane shall be Chlorofluorocarbon (CFC) free and self-extinguishing and shall conform to IS 12436: 1988. It shall have Modular Density 40 +/- 2 Kg/m3 and Thermal Conductivity @ 10 Deg.C 0.017 - 0.020 W/M 0k, Water absorption (% by vol) 3.1, Critical Oxygen Index 23 and Compressive Strength 1.2 Kg/sq.cm.

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/flame 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,**
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 / other equivalent approved sahde).
	The final, finished coating shall be fungus resistant, UV resistant, water repellent, 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 and High Pressure Laminates (HPL)** 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 (70:30 ratio) PVDF / 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.

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.

High Pressure Laminates (HPL) :

8mm thick Suede Finish exterior grade High Pressure Laminate (HPL) made up of 1300mmx 3050mm in size and manufactured under EN438- 2&3:2005 standard. HPL should made with GLE Technology & Double Layer UV Protection process under high pressure, thermosetting Phenolic resign treated Exclusive & Certified Exterior Grade Decorative paper (UV Resistant) on both side with high grade Kraft paper in between. Both the decorative and Kraft paper to be made of Virgin Pulp. HPL should be resistance to water immersion characterstic with permissible increase on thickness and mass <0.60% and have density >1.35G/cm3, UV resistance on Grey scale measurement will be measured ≥ 4, with flame retardant fulfilled the criteria of under EN13501-1:2007 with classification of BS1D0 standard property, Moisture resistant, Impact resistant, termite resistant, Scratch resistant, Weather and climatic shock resistant high pressure thermosetting resin treated balanced compact laminates HPL. The manufacturer shall provide 10 years warranty certification on manufacturing and moisture related defects. HPL shall have Green Guard Gold certification where the VOC emission level is less than 0.22 PPM. Anti-bacterial and Anti-Fungal property under JIS Z2801:2000. HPL will be installed on Aluminum tubes at 500 mm c/c distance with special L Brackets. Aluminum box size will be 25mmx50mmx1.8 mm. Boards will be fixed on the Aluminum Channels with colour match rivets (Manufacturer approved Rivets) through 8mm drill hole in Boards and 5mm dia drill holes in Aluminum Box. Rivets will be installed by automatic Rivet Guns Shade designed of clad should be finalized under direction of Engineer –in charge.

9.10.11 DELETED

9.10.12 DELETED

9.10.13 **Exterior Painting on Wall (Premium Acrylic Smooth Exterior Paint with Silicone Additives over Texture Coat)**

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.

Textured base coat

Exterior wall Texture-New work (Two or more coats applied @ 6.5kg/10 sqm over and including priming coat of exterior primer applied @ 2.20 kg/10 sqm). High Quality Exterior Acrylic Modified resin and special quality Silica Quartz with Trowel Texture.

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& Structural Glazing:

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 sections shall confirm to IS 733 & IS 1285 and 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 be as per IS 3614 Part-II. Fire rating of the doors shall be of minimum 2 hours of integrity and 30 minutes of insulation. 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. The sliding door (except in MPH) shall have 10mm thick toughened tinted glass in suitable Aluminium frame. At the entrance of all common control rooms in MPH G.I. framed with fire resistant glass, sliding doors shall be provided. The other doors in common control rooms in MPH shall be G.I. framed with fire resistant glass as per fire zoning. Fire Resistant Glazed Door System (Swing / Sliding) shall be of uniform GI profile 50X50 mm with 14mm EI 20 GLASS for Interior Application. Fire Resistant Glazed Door System shall have 120 minutes of integrity and radiation control (EW 120) with symmetrical (Bi-Directional) fire protection. The frames shall be cold rolled

	profiles as per EN standard EN 10327/ Indian Standard IS 513 . The door frames are cold rolled from 1.5 mm steel sheet to form a profile of 50 mm x 50 mm on all sides. The door shutter shall have the top rail, side rail and bottom rail dimensions of 50 mm x 50 mm. The overall door opening shall be as per tested evidence and tested as per EN 1634-1/ ISO 834-1 / ISO 3009 /(Indian Standard) IS 16947:2018 in an accredited laboratory. The glass must be minimum 14mm clear (MADE IN INDIA)120 min fire rated for Integrity, Radiation control (EW 120) and partially insulation (EI 20) Non Wired Toughened Interlayered glass with a light transmission of 86% and a sound reduction of 38 dB and manufactured in UL & TUV audited Facility and including UL-EU Certification and compliant to class 1(B)1 category of Impact Resistance as per EN 12600. The glass shall be tested and certified for no formation of bubbles or yellowing after 5000 hours of exposure to UV radiation by TUV Rheinland as per EN 12543-4.The base glass and finished glass must made in India. The shutters shall be fixed to the frame using Weld-on hinges of dimensions 179mm X 20mm. The profiles shall have groves to incorporate Fire Resistant gaskets. The glass shall be held in its place with the help of 1.5 mm cold rolled steel beading and ceramic tape with cross section of 4 x 15 mm as per the test evidence. Beading shall be clipped on using Stainless Steel self-tapping screws fixed at a distance of 70 mm from the edges and 150 mm c/c henceforth. The glass panes are to be supported on non-combustible 6 mm Calcium Silicate setting blocks. The door shall be fitted with offset pull handle and door closer. The inactive leaf (in case of double leaf only)shall be fixed to the frame using a tower bolt at meeting edge at top or as per the tested evidence. The doors shall be manufactured in a TUV audited facility. The maximum glazing size shall be as per the test certification. The profile has to be fixed to the supporting construction by means of M10 or bigger steel bolts at every 150 mm from the edges and every 500 mm (approx.) c/c. The doors shall offer C4 level of wind resistance when tested as per EN12211 and shall provide class 4 level of air permeability as per EN 1026. The door shall also be subjected to durability tests as per EN 12400 for C5 classification (200,000 cycles). The doors shall also be tested for class 5 of impact resistance when tested as per EN 13049. The doors & partition shall also be tested for class 4 level of Mechanical strength when tested as per EN13115. The door shall have water tightness level of 8A when tested as per EN 1027. The sliding door system shall be connected to the surrounding construction by means of interlocking labyrinths lined with intumescent tapes as per the test evidence and connected to the sliding mechanism at the top. The sliding mechanism shall be as mentioned in the tested evidence or Assessment and shall have steel rollers. The glass should be held in its place with the help of 1.5 mm cold rolled steel beading and ceramic tape with cross section of 4 x 15 mm as per the test evidence. Beading shall be clipped on using Stainless Steel self-tapping screws fixed at a distance of 70 mm from the edges and 150 mm c/c henceforth. The glass panes are to be supported on non-combustible 6 mm Calcium Silicate setting blocks. The sliding mechanism shall be fixed to adequate supporting construction (MS channel / Reinforced concrete) to ensure proper support for the door.
9.11.12	Minimum area of windows in building on each floor level shall be 10% of floor area.

9.11.13 **Structural Glazing & supporting Structure:**

Structural Glazing supporting Structure:

Structure shall be of Aluminium extruded tubular and other aluminium sections as per the architectural drawings and approved shop drawings , the aluminium quality as per grade 6063 T5 or T6 as per BS 1474,including super durable powder coating of 60-80 microns conforming to AAMA 2604 of required colour and shade as approved by the Engineer-in-Charge.

Design & Analysis of Structural Glazing:

Designing, fabricating, testing, protection, installing and fixing in position semi (grid) unitized system of structural glazing (with open joints) for linear as well as curvilinear portions of the building for all
heights and all levels, including:

(a) Structural analysis & design and preparation of shop drawings for the specified design loads conforming to IS 875 part III (the system must passed the proof test at 1.5 times design wind pressure without any failure), including functional design of the aluminum sections for fixing glazing panels of various thicknesses, aluminium cleats, sleeves and splice plates etc. gaskets, screws, toggles, nuts, bolts, clamps etc., structural and weather silicone sealants, flashings, fire stop (barrier)- cum-smoke seals, microwave cured EPDM gaskets for water tightness, pressure equalisation& drainage and protection against fire hazard including:

(b) Fabricating and supplying serrated M.S. hot dip galvanised / Aluminium alloy of 6005 T5 brackets of required sizes, sections and profiles etc. to accommodate 3 Dimentional movement for achieving perfect verticality and fixing structural glazing system rigidly to the RCC/ masonry/structural steel framework
of building structure using stainless steel anchor fasteners/ bolts, nylon seperator to prevent bimetallic contacts with nuts and washers etc. of stainless steel grade 316, of the required capacity and in required numbers.

(c) Fixing and filling, two part pump filled, structural silicone sealant and one part weather silicone sealant compatible with the structural silicone sealant of required bite size in a clean and controlled factory / work shop environment, including double sided spacer tape, setting blocks and backer rod, all of approved grade, brand and manufacture, as per the approved sealant design, within and all around the perimeter for holding glass.

(d) Fixing in position flashings of solid aluminium sheet 1 mm thick and of sizes, shapes and profiles, as required as per the site conditions, to seal the gap between the building structure and all its interfaces with curtain glazing to make it watertight.

(e) Making provision for drainage of moisture/ water that enters the curtain glazing system to make it watertight, by incorporating principles of pressure equalization, providing suitable gutter profiles at bottom (if required), making necessary holes of required sizes and of required numbers etc. complete.

This item includes cost of all inputs of designing, labour for fabricating and installation of aluminium grid, installation of glazed units, T&P, scaffolding and other incidental charges including wastages etc., enabling temporary structures and services, cranes or cradles etc. as described above and as
specified. The item includes the cost of getting all the structural and functional design including shop drawings checked by a structural designer, dully approved by Engineer-in-charge. The item also includes the cost of all mock ups at site, cost of all samples of the individual components for testing in an approved laboratory, field tests on the assembled working structural glazing as specified, cleaning and protection till the handing over of the building for occupation. In the end, the Contractor shall provide a water tight structural glazing having all the performance characteristics etc. all complete as required, asper the Architectural drawings, as per item description, as specified, as per the approved shop drawings and as directed by the Engineer- in-Charge.

The NIT approving authority will decide the necessity of testing on the basis of cost of the work, cost of the test and importance of the work. Performance Testing of Structural glazing system Tests to be conducted in the NABL accredited lab or any other accreditation body which operates in accordance with ISO/ IEC 17011 and accredits labs as per ISO/IEC 17025

1. Performance Laboratory Test for Air Leakage Test (-50pa to - 300pa) & (+50pa to +300pa) as per ASTM E-283-04 testing method for a range of testing limit 1 to 200 mVhr
2. Static Water Penetration Test. (50pa to 1500pa) as per ASTME- 331-09 testing method for a range up to 2000 ml.
3. Dynamic Water Penetration (50pa to 1500pa) as per AAMA 501.01- 05 testing method for a range upto2000 ml.
4. Structural Performance Deflection and deformation by static air pressure test (1.5 times design wind pressure without any failure) as per ASTME-330-10 testing method for a range upto 50 mm
5. Seismic Movement Test (upto 30 mm) as per AAMA 501.4-09 testing method for Qualitative test, Tests to be conducted on site.
6. Onsite Test for Water Leakage for a pressure range 50 kpa to 240 kpa (35psi) upto 2000 ml

IGU Panels:
Fixing, assembling and supplying vision glass panels (IGUs) comprising of hermetically-sealed 6-12- 6 mm insulated glass (double glazed) vision panel / openable panels units of size and shape as required and specified, comprising of an outer heat strengthened float glass 6mm thick, of approved colour and shade with reflective soft coating on surface # 2 of approved colour and shade, an inner Heat strengthned clear float glass 6mm thick, spacer tube 12mm wide, dessicants, including primary seal and secondary seal (structural silicone sealant) etc. all complete for the required performances, as per the Architectural
drawings, as per the approved shop drawings, as specified and as directed by the Engineer-in-Charge. The IGUs shall be assembled in the factory/ workshop of the glass processor.

(i) Coloured tinted float glass 6mm thick substrate with reflective soft coating on face # 2, + 12mm Airgap + 6mm Heat Strengthened clear Glass of approved make having properties as visible Light transmittance (VLT) of 25 to 35 %, Light reflection internal 10 to 15%, light reflection external 10 to 20 %, shading coefficient (0.25- 0.28) and U value of 3.0 to 3.3 W/

	m2 degree K etc. The properties of performance glass shall be decided by technical sanctioning authority as per the site requirement. Shadow Box: Fabricating and supplying shadow box of required size and shape, for fixing in the spandrel portion of the structural glazing, in linear as well as curvilinear portions of the building by providing semi -rigid, inorganic, non-combustible fibre glass wool insulation 50 mm thick, conforming to IS: 8183 and BS: 3958 Part 5. The insulation layer shall have facing (factory bonded on surface # 1 of the fibre glass insulation layer), of black non-woven fibre glass tissue of nominal thickness 0.5 mm and nominal mass not less than 60 gm /sqm, made of randomly oriented glass fibres distributed in a binder by a wet-lay process including fixing 1.5 mm thick solid aluminum sheet backing using, 6 mm thick cement board including SS rivets, nuts, bolts, washers etc complete.
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 should be free from distortion and thermal stress
9.12.06	For internal glazed partition, 8mm thick clear toughened glass shall be provided. Internal Glazed partition in in MPH shall be fully glazed fire rated fixed partition with 120 minutes of integrity and radiation control (EW 120) with symmetrical (Bi-Directional) fire protection. The frames shall be cold rolled profiles As per EN standard EN 10327/Indian Standard (IS 513) . The frames are cold rolled from 1.5 mm steel sheet to form a profile of 50 mm x 50 mm on all sides. He system shall be tested as per EN 1364-1/(Indian Standards) IS 16945:2018 in an accredited laboratory. The glass shall be Contraflam Lite 14mm (MADE IN INDIA)clear 120 min fire rated for Integrity, Radiation control (EW 120) and partially insulation (EI 20) Non Wired Toughened Interlayered glass with a light transmission of 86% and a sound reduction of 38 Db and manufactured in UL & TUV audited Facility and including UL-EU Certification and compliant to class 1(B)1 category of Impact Resistance as per EN 12600. The glass shall be tested and certified for no formation of bubbles or yellowing after 5000 hours of exposure to UV

	radiation by TUV Rheinland as per EN 12543-4 The glass shall provide bi-directional (Symmetrical) fire protection. The base glass and processed glass must be made in INDIA. The glass shall be held in its place with the help of 1.5 mm cold rolled steel beading and ceramic tape with cross section of 4 x 15 mm as per the test evidence. Beading shall be clipped on using Stainless Steel self-tapping screws fixed at a distance of 70 mm from the edges and 150 mm c/c henceforth. The glass panes are to be supported on non-combustible 5 mm Calcium Silicate setting blocks. The maximum glazing size shall be as per the test certification. The profile has to be fixed to the supporting construction by means of M10 or bigger steel bolts at every 150 mm from the edges and every 500 mm (137pprox..) c/c. The Partitions shall offer C4 level of wind resistance when tested as per EN12211 and shall provide class 4 level of air permeability as per EN 1026. The Partitions shall also be tested for class 5 of impact resistance when tested as per EN 13049. The Partitions shall also be tested for class 4 level of Mechanical strength when tested as per EN13115. The Partitions shall have water tightness level of 8A when tested as per EN 1027.
9.12.07	11.5 mm thick laminated glass consisting of 5 mm thick heat reflective toughened glass (cool-lite / Azure/ equivalent) on outer face and 5 mm thick toughened glass on inner face having 1.52mm PVB layer in between to be used for Structural glazing. 11.5 mm Laminated glass with 6mm heat strengthened glass + 1.52mm PVB layer + 6 mm heat strengthened glass of approved make to be used in railings wherever shown in drawings.
9.12.08	6 mm thick Lacquered glass of desired colour, shade and design.
9.13.00	**False ceiling**
9.13.01	False ceiling of 12.5 mm thick tapered/square edge glass fibre reinforced gypsum board conforming to IS : 2095 having fine texture finish, including providing and fixing of frame work at all levels, for all kind of work, consisting of light weight galvanised steel member (minimum 0.8 mm thick and galvanised as per IS: 277) having maximum grid size of 1200 mm x 600 mm for supporting panels of specified size, suspended from RCC structural steel or catwalkway grid above, with 4 mm (minimum) galvanised wires (rods), with special height adjustment clips, providing angle section of minimum 25 mm width along the perimeter of ceiling, supporting grid system (minimum 0.8 mm thick and galvanised as per IS: 277), expansion fasteners for suspension arrangement from RCC, providing openings for AC ducts, return air grills, light fixtures, etc., all complete. (concealed grid and finished flat seamless and curve shape (dome etc.), finished smooth(seamless) along with the galvanised light gauge steel supporting system laid in profile to suit the profile of dome).
9.13.02	False ceiling of 12 mm thk calcium silicate board 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).
9.13.03	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.
9.13.04	Batten ceiling: Batten ceiling made up of extruded aluminum / metal of minimum 0.6mm thickness with powder coated finish (min. 40 microns) /wooden finish (minimum 0.11mm). The ceiling must have superior acoustics and must adhere to the highest health and safety standards. The battens shall have possibility of curvilinear arrangement. The batten ceiling shall be Greenguard, tested/certified from UL/Intertek. The product shall meet technical requirements of ASTM E84. Batten ceiling of 1"x1" made up of extruded aluminum with "click-on system". Sublimation/Heat transfer method should not be used for better scratch resistance. Die-casted click on joinery shall not be used.
9.13.05	**Designer membrane ceiling**: The ceiling shall have demountable translucent stretch ceiling membrane with harpoon, corners ready to install. It shall not get discoloured & sag. All joints shall be provided with appropriate interface trims to be able to demount the ceiling to access the lights. The ceiling shall be installed using ceiling aluminium suspension system, complete as per manufacturer's installation guidelines and as per approved shop drawings in line with the design intent and approval by Engineer In-charge. LED strips shall be installed using custom aluminium extrusions to ensure longevity of the installation. The ceiling shall have following features and properties: - Durable: The systems shall resist shocks and shall not crack with movement or under stretch conditions. Safe: The membranes and profiles shall have passed the stringent fire and safety tests. The membrane shall have been classified as non-toxic upon burning. The Flexible membrane shall be b-s1-d0 / ASTM E-84 class A tested/certified. Green: Membranes shall be 100% recyclable. There shall not be any welding defect on Membranes.
9.13.06	Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures, A.C. ducts etc.
9.13.07	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.
9.13.08	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.
9.13.09	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. Elevator Mahine room in all buildings except Boiler & ACC shall be made as per option a) as stated below, however in Boiler & ACC Elevator machine room shall be made 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, Balance area including passage, Cable vault, Equipment Area, ESP SWGR/ ACP Room/ UAF Room, Switchgear room, MCC Room	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)
	b) SWAS Room, UPS Battery charger room	Matt Finished Vitrified ceramic tiles.	Aluminium composite panel cladding on walls and columns upto false ceiling level	Aluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design
	c) Deaerator floor	Cement concrete with Metallic hardener topping.		-
	d) 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)

TABLE –A

INTERIOR FINISHING SCHEDULE

S. NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
	e) General circulation and movement areas	20 mm thick heavy duty anti skid full body vitrified tile		Acrylic distemper (except metal deck area).
	f) Control room area including control room	Matt Finish Vitrified ceramic tiles flooring	Partition in fire rated glass with fire rated frames with 2 hr fire rating & Metal Batten panel cladding for columns and walls	Metal Batten panel ceiling in combination with demountable translucent stretch ceiling membrane or as per approved design.
	g) 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	Alluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design
	h) 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	Aluminium 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
	i) Record room	ceramic tiles	Acrylic distemper.	Alluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design
	j) 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
	k) Toilet area	ceramic tiles	Digitally glazed ceramic wall tiles up to False Ceiling Height	Calcium Silicate False Ceiling
	l) 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

TABLE –A

INTERIOR FINISHING SCHEDULE

S. NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
	m) 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
	n) 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
	o) Lift and Staircase Lobby	18mm thick polished granite stone as pattern.	18mm thick polished granite & glass mosaic tile cladding up to False Ceiling Height	Aluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design
	p) Passages and general circulation areas.	Deleted	Deleted	Deleted

TABLE –A

INTERIOR FINISHING SCHEDULE

S. NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
	q) 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
	r)Oil canal, oil room, oil purification Tank and other areas where oil spillage is likely to occur.	75 mm thick A.R. Brick	12 mm thick A.R. Tile	As above except oil canal.
	s)Pathways including roof area.	22mm thick concrete chequered tiles.	-	-
2.	DELETED			
3.	ESP control building			
	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 tiles.	Aluminium composite panel cladding on walls and columns	Mineral fiber Board False Ceiling
	c) Control Room	Digitally glazed Vitrified tiles.	Aluminium composite panel cladding on walls and columns in ESP Control Room Building	Aluminium false ceiling in combination with GRG plaster board border in column depth or as per approved design
	d) MCC Room, AHU/ AC Plant room/ Cable vault	Cement concrete with Metallic hardener topping	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)

TABLE –A

INTERIOR FINISHING SCHEDULE

S. NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
	g) Toilets	ceramic tiles.	Designer ceramic wall tiles dado up to false ceiling level.	Calcium silicate false ceiling.
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.	**DELETED**			
6.	DELETED			
7.	**DELETED**			
8.	**DELETED**			
9.	**DELETED**			
10.	**DELETED**			
11.	**Sheds for Construction workers and O&M Workers**			

TABLE –A

INTERIOR FINISHING SCHEDULE

S. NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
	Rest room	Cement concrete with Metallic hardener topping. Matt Finished Vitrified Ceramic Tiles	Acrylic distemper	Metal roof
	Toilets	Ceramic tiles.	Digitally glazed ceramic wall tiles dado up to false ceiling level.	Metal roof
12.	Miscellaneous Switchgear room, control room/ Any other Building.			
	a) Operating/Maintenance areas/ MCC room /Switchgear Room	Cement concrete with Metallic hardener topping	Acrylic distemper	Acrylic distemper (except metal deck area)
	b) Control room/RIO Room /PLC /Office area.	Matt Finished Vitrified Ceramic Tiles	Acrylic emulsion paint.	Mineral fiber board false ceiling.

TABLE –A

INTERIOR FINISHING SCHEDULE

S. NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
	c) 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)
	d) Toilet/Pantry area	ceramic tiles.	Digitally glazed ceramic wall tiles dado up to 2200 mm	Acrylic distemper
	e) RCC Stair case	18 mm thick Marble Stone with grooves	18 mm thick Marble Stone	Acrylic distemper
13.	**DELETED**			
14.	**DELETED**			
15.	**DELETED**			
16.	**Rest Room for O&M Workers**			
	a) Rest room	Cement concrete with Metallic hardener topping.	Acrylic distemper	Metal roof
	b) Toilets	ceramic tiles.	Digitally glazed ceramic wall tiles	Metal roof

TABLE –A

INTERIOR FINISHING SCHEDULE

S. NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
			dado up to 2100 high, Acrylic Distemper paint above	
18.	**Car Parking**			
	a) Covered Parking	Concrete Blocks	Acrylic distemper	Acrylic distemper
19.	**Parking Shed**	Concrete Blocks		
20.	**DELETED**			
21	**DELETED**			
22.	**Coal Handling Plant Buildings**			
	a) Non-Air-conditioned space.	Cement concrete with Metallic hardener topping	Acrylic distemper over wall putty	Acrylic distemper
	b) R.C.C Staircase	18 mm thick granite flooring	1200 high Glass mosaic tiles and	Acrylic distemper

TABLE –A

INTERIOR FINISHING SCHEDULE

S. NO.	DESCRIPTION OF AREA	FLOOR FINISH	WALL FINISH	CEILING FINISH
			Acrylic Emulsion paint over wall putty above	
	c) Toilet area	Heavy Duty Dust pressed ceramic tiles.	Designer ceramic wall tiles dado up to false ceiling level.	Calcium silicate false ceiling
	d) Battery room	Acid, Alkali resistant tile	Acid/Alkali resistant tile and chemical resistant paint above dado.	Chemical resistant paint.
	e) Entrance/ Reception	18 mm thick Granite Stone	Acrylic emulsion paint and Glass Mosaic tiles cladding	Acrylic distemper
	f) Passages	18 mm thick Granite Stone	Acrylic emulsion paint	Acrylic distemper
	g) Air-Conditioned Space	Vitrified Ceramic Tiles	Acrylic emulsion paint	GI clip in metal false ceiling

Note :

1. All wall 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. All electrical conduits in building for Lighting, HVAC and services shall be concealed type. The laying work of electrical conduits shall be done before finishing works.
8. All Plumbing pipes shall be of concealed type. The laying work of plumbing pipes shall be done before finishing works.

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.	As per corrosion protection clause in design criteria chapter	

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

10.00.00 **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) Chimney shell
b) TG foundation top deck/ Substructure
c) Spring supported decks of all machine foundations

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, it is established in the report, 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 10 degree Celsius to 65 degree 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/Fe550D 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 conforming to IS: 13757, or Fly ash lime bricks conforming to IS: 12894 or Fly ash Cement Brick confirming to IS 16720 shall be used. 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 **Autoclave Aerated Concrete (AAC) block**

Providing and laying of **Autoclave Aerated Concrete (AAC) block masonry** using blocks having dimensions of 625mm x 250mm. thickness ranging from 100 mm to 300 mm conforming to IS:2185 (Part-III), for dimension and tolerance, with minimum compressive strength of 30 kg/ sq.cm. 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 (1000 mm/ 125 mm thk.) the jointing reinforcement i.e 1 number of 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 instruction laid down in IS:6041-1985, IS-1905) (Reinforcement bars shall be measured & paid separately under relevant items).

AAC blocks shall have the following physical properties:

Density (oven dry) - 550-650kg/ cum.
Compressive Strength - Min. 30 kg/ sq. cm.
Thermal Conductivity - 0.162W/mk (avg)
Resistant to fire - 2-6 hrs depending upon thickness
Dry shrinkage - 0.02% (avg)
Design gross density - 800 kg/cum (approx)

D-1-11

11.00.00 **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/ 12.00.00 ANNEXURES

12.00.00(A) ANNEXURE (A)

(a) List of Codes and Standards

All applicable standards, references, specifications, codes of practice, etc., shall be the latest edition including all applicable official amendments and revisions. A complete set of all these documents shall be available at site with Bidder. List of some of the applicable Standards, in original Codes and references is as following:

Where provisions are not covered in Indian Standards, reference shall be made to ACI, AISC, EN, CICIND and other International Standards.

LIST OF CODES AND STANDARDS

Excavation and Filling

IS :2720	Methods of test for soils(relevant parts)
IS:4701	Code of practice for earth work on canals.
IS:9759	Guide lines for dewatering during construction.
IS:10379	Code of practice for field control of moisture and compaction of soils for embankment and sub-grade.

Properties, Storage and Handling of Common Building Materials

IS:269	Specification for ordinary Portland cement.
IS:383	Coarse and fine aggregates from natural sources for concrete.
IS:432	Specification for mild steel and medium tensile steel bars and
(Part 1&2)	hard drawn steel wires for concrete reinforcement.
IS:455	Portland slag cement.
IS:702	Industrial bitumen.
IS:712	Specification for building limes.
IS:1077	Common burnt clay buidling bricks.
IS:1161	Steel tubes for structural purposes.
IS:1239	Mild steel tubes, tubulars and other wronght steel fillting - MS tubes.
IS:1363	Hexagon head bolts, screws and nuts of productions
(Part 1-3)	grade - C.
IS:1364	Hexagon head bolts, screws and nuts of productions
(Part 1-5)	grade-A & B.
IS:1367 (Part 1-18)	Technical supply condition for threaded fasteners.
IS:1489 (Part-I)	Portland-pozzolana cement. Fly ash based
IS:1542	Sand for Plaster.

IS:1566	Hard drawn steel wire fabric for concrete reinforcement.
IS:1786	High strength deformed steel bars & wires for concrete reinforcement.
IS:2062	Hot Rolled Low, Medium and High Tensile Structural Steel
IS:2116	Sand for masonry mortars.
IS : 2185 (Part 1)	Hollow & solid concrete blocks.
(Part 2)	Hollow & solid light weight concrete blocks.
IS:2386 (Part I-VIII)	Testing of aggregates for concrete.
IS:3812	Specification for fly ash for use as pozzolona and admixture.
IS:4082	Recommendation on stacking and storage of construction materiel and components at site
IS:8500	Structural steel-Microalloyed (Medium and high strength qualities).
IS:12894	Specification for fly ash lime bricks.
IS:13757	Burnt clay fly ash building bricks.

Cast in-situ Concrete and Allied Works

IS:280	Mild steel wire for general engineering purpose.
IS:456	Code of practice for plain and reinforcement concrete.
IS:457	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
IS:516	Method of test for strength of concrete.
IS:1199	Methods of sampling and analysis of concrete.
IS:1791	General requirement for batch type concrete mixers.
IS:1834	Hot applied sealing compound for joints in concrete.
IS:1838	Preformed fillers for expansion joints in concrete pavement and structures.
IS:2438	Specification for roller pan mixers.
IS:2502	Code of practice for bending and fixing of bars for concrete reinforcement.
IS:2505	Concrete vibrators - immersion type.
IS:2506	General requirements for screed board concrete vibrators.

IS:2722	Specification for Portable Swing weigh batchers for concrete (single and double bucket type).
IS:2750	Steel scaffoldings
IS:2751	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.
IS:3150	Hexagonal wire netting for general purposes.
IS:3366	Specification for pan vibrators.
IS:3370 (Part 1-4)	Code of practice for concrete structures for the storage of liquids.
IS:3558	Code of practice for use of immersion vibrators for consolidating concrete.
IS:4014 (Part-1&2)	Code of practice for steel tubular scaffolding.
IS:4326	Code of practice for earth quake resistant design and construction of buildings.
IS:4656	Form vibrators for concrete.
IS:4925	Concrete batching and mixing plant.
IS:4990	Plywood for concrete shuttering work.
IS:4995	Criteria for design of reinforced concrete bins for storage of granular and powdery materials
IS:5256	Code of practice for sealing expansion joints in concrete lining on canals.
IS:5525	Recommendations for detailing of reinforcement in reinforced concrete works.
IS:6461	Glossary of terms relating to cement concrete.
IS:6494	Code of practice for water proofing of underground reservoir and swimming pools.
IS:6509	Code of practice for installation of joints in concrete pavements.
IS:7861 (Part -1&2)	Code of practice for extreme weather concreting.
IS:9012	Recommended practice for shotcreting.
IS:9103	Admixtures for concrete.
IS:9417	Recommendations for welding cold worked bars for reinforced concrete construction.
IS:10262	Recommended guidelines for concrete mix design.

IS:11384	Code of practice for composite construction in structural steel and concrete.
IS:12118	Two parts polysulphide based sealants.
IS:12200	Code of practice for provision of water stops at transverse construction joints in masonry and concrete dams.
IS:13311	Non destructive testing of concrete - methods of test.
(Part 1)	Ultrasonic pulse velocity.
(Part 2)	Rebound hammer.
IS:17452	Use of Alkali Activated Concrete for Precast Products-Guidelines
SP-16	Design codes for reinforced concrete to IS:456-1978.
SP-23	Hand book of concrete mixes.
SP-24	Explanatory handbook on Indian standards code for plain and reinforced concrete. (IS : 456)
SP-34	Hand book on concrete reinforcement and detailing.
ACI-318	American Concrete Institute code for structural concrete.

Precast Concrete Works

SP:7	National Building Code - Structural Design
(Part 6/Sec.7)	Prefabrication and system building and mixed / composite construction.
IS:10297	Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units.
IS:10505	Code of practice for construction of floors and roofs using pre-cast reinforced concrete waffle units.
IS:15658	Pre-cast concrete block for paving.
IS 15916	Building Design and Erection using Pre fabricated concrete

Masonry & Allied Works

IS:1905	Code of practice for structural use of unreinforced masonry.
IS: 2185	Part-1 Concrete Masonry Units - Specification Part 1 Hollow and Solid Concrete Blocks Part-3 Specification for concrete masonry units: Part 2 Hollow and solid light weight concrete blocks
IS:2212	Code of practice for brick work.
IS:2250	Code of practice for preparation and use of masonry mortars.

	IS:2572	Code of practice for construction of hollow concrete block masonry.
	SP:20	Hand book on masonry design and construction.
	Sheeting Works	
	IS:277	Galvanised steel sheets (Plan & corrugated).
	IS:513	Cold-rolled low carbon steel sheets & strips.
	IS:730	Hook bolts for corrugated sheet roofing.
	IS:801	Code of practice for use of cold formed light gauge steel structural members in general building construction.
	IS:2527	Code of practice for fixing rain water gutters and down pipe for roof drainage.
	IS:7178	Technical supply condition for tapping screw.
	IS:8183	Bonded mineral wool.
	IS:8869	Washers for corrugated sheet roofing.
	IS:12093	Code of practice for laying and fixing of sloped roof covering using plain and corrugated galvanised steel sheets.
	IS:12436	Preformed rigid Polyurethane (PUR) and isocyanurate (PIR) foams for thermal insulation.
	IS:12866	Plastic translucent sheets made from thermosetting polyester resin (glass fibre reinforced).
	IS:14246	Continuously pre-painted galvanised steel sheets and coils.
	BS:5950	Code of practice for design of light gauge profiled
	(Part-6)	steel sheeting
	Fabrication and Erection of Structural Steel Works	
	IS:800	Code of practice for General Construction of steel.
	IS:813	Scheme for symbols for welding.
	IS:814	Covered electrodes for manual metal arc welding of carbon & carbon manganese steel.
	IS:816	Code of practice for use of metal arc welding for general construction in mild steel.
	IS:817	Code of practice for training and testing of metal arc welders.

	IS:1024	Welding in bridges and substructured subject to dynamic.
	IS:1181	Qualifying tests for Metal Arc welders (engaged in welding structures other than pipes).
	IS:1182	Recommended practice for Radiographic examination of fusion welded butt joints in steel plates
	IS:1608	Mechanical testing of metals - tensile testing
	IS:1852	Rolling and Cutting Tolerances for Hot rolled steel products.
	IS:2016	Specification for Plain washers.
	IS:2595	Code of practice for Radiographic testing
	IS:2629	Hot dip galvanising of iron and steel
	IS:3502	Steel chequred plate.
	IS:3613	Acceptance tests for wire flux combination for submerged arc welding.
	IS:3658	Code of practice for liquid penetrant flaw detection.
	IS:3664	Code of practice for ultra sonic pulse echo testing contact and immersion method
	IS:3757	High strength structural bolts.
	IS:4000	High strength bolts in steel structure - code of practice.
	IS:4353	Sub merged arc welding of mild steel and low alloy steel Recommendation
	IS:4759	Hot dip zinc coating on structural steel and other allied products.
	IS:5334	Code of practice for magnetic particle flaw detection of welds.
	IS:5369	General requirements for plain washers and lock washer
	IS : 6623	High strength structural nuts.
	IS:6649	Hardened and tampered washers for high strength structural bolts & nuts.
	IS:6911	Stainless steel plate, sheet and strip.
	IS:7205	Safety code for erection of structural steel.
	IS:7215	Tolerances for fabrication of structural steel.
	IS:7307	Approved test for welding procedures
	(Part - I)	Fusion welding of steel.
	IS:7310	Approval test for welders working to approval welding procedure.

(Part-I)	Fusion welding of steel
IS:9178 (Part-1to 3)	Criteria for design of steel bins for storage of bulk material.
IS:9595	Recommendations for metal arc welding of carbon & carbon manganese steel.
IS:12843	Tolerances for erection of steel structures.
SP:6 (Part 1 to 7)	ISI Hand book for structural Engineers.

Plastering and Allied Works

IS:1661	Code of practice for application of cement and cement lime plaster finishes.
IS:2402	Code of practice for external rendered finishes.
IS:2547 (Parts 1&2)	Gypsum building plaster.

Acid and Alkali Resistant Lining

IS:158	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali & heat resisting.
IS:412	Expanded metal steel sheets for general purpose.
IS:4441	Code of practice for use of silica type chemical resistant mortars.
IS:4443	Code of practice for use of resin type chemical resistant mortars.
IS:4456 (Part I & II)	Method of Test for chemical resistant tiles.
IS:4457	Ceramic unglazed vitreous acid resisting tiles.
IS:4832	Specification for chemical resistant mortars.
(Part - 1)	Silicate type
(Part - 2)	Resin type
(Part - 3)	Sulfur type
IS:4860	Acid resistant bricks.
IS:9510	Bitumastic acid resisting grade.

Water Supply, Drainage and Sanitation

	IS:458	Precast concrete pipes (with & without reinforcement).
	IS:554	Pipe threads where pressure tight joints are made on the threads – dimensions, tolerances and designation.
	IS:651	Salt glazed stoneware pipes and fittings.
	IS:774	Flushing cisterns for water closets and urinals.
	IS:775	Cast iron brackets and supports for wash basins and sinks.
	IS:778	Copper alloy gate, globe and check valves for water works purposes.
	IS:781	Cast copper alloy screw down bib taps & stop valves for water services.
	IS:782	Caulking lead.
	IS:783	Code of practice for laying of concrete pipes.
	IS:1172	Code of basic requirements of water supply, drainage and sanitation.
	IS:1230	Cast iron rain water pipes and fittings.
	IS:1239 (Part 1&2)	Mild Steel tubes, tubulars and other wrought steel fittings
	IS:1536	Centrifugally cast (Spun) iron pressure pipes for water.
	IS:1537	Vertically cast iron pressure pipes for water, gas and sewage.
	IS:1538	Cast iron fittings for pressure pipe for water, gas and sewage.
	IS:1703	Copper alloy float valve for water supply fitting.
	IS:1726	Cast iron manhole covers and frames.
	IS:1729	Cast iron / Ductile iron drainage pipes and pipe/fittings for over ground non pressure pipeline socket and spigot series.
	IS:1742	Code of practice for building drainage.
	IS:2064	Selection, installation and maintenance of sanitary appliances.
	IS:2065	Code of practice for water supply in buildings.
	IS:2326	Automatic flushing cisterns for urinals.
	IS:2548	Plastic seats and covers for water closets.
	IS:2556	Vitreous sanitary appliances (vitreous china).

	IS:3114	Code of practice for laying of cast iron pipes.
	IS:3311	Waste plug and its accessories for sinks and wash basins.
	IS:3438	Silvered glass mirrors for general purposes.
	IS:3486	Cast iron spigot and socket drain pipes.
	IS:3589	steel pipe for water and sewage (168.3 to 2540mm outside diameter)
	IS:3989	Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
	IS:4111 (Part 1 to 5)	Code of practice for ancillary structure in sewerage system.
	IS:4127	Code of practice for laying of glazed stone ware pipes.
	IS : 4733	Methods of sampling and testing sewage effluents.
	IS:4764	Tolerance limits for sewage effluents discharged into inland surface waters.
	IS:1068	Electroplated coating of nickel plus chromium and copper plus nickel plus chromium.
	IS:5329	Code of practice for sanitary pipe work above ground for buildings.
	IS:5382	Rubber sealing rings for gas mains, water mains and sewers.
	IS:5822	Code of practice for laying of electrically welded steel pipes for water supply.
	IS:5961	Specification for cast iron grating for drainage purpose.
	IS:7740	Code of practice for construction and maintenance of road gullies.
	IS:8931	Copper alloy fancy single taps combination tap assembly and stop valves for water services.
	IS:9762	Polyethylene floats for float valves.
	IS:10592	Industrial emergency showers, eye and face fountains and combination units.
	IS:12592	Specification for precast concrete manhole covers and frames.
	IS:12701	Rotational moulded polyethylene water storage tanks.
	IS:13983	Stainless steel sinks for domestic purposes.
	SP:35	Hand book on water supply and drainage with special emphasis on plumbing.
	CPH&EEO	Manual on sewage and sewage treatment
	Publication	- as updated.

Doors Windows and Allied Works

	IS:204	Tower Bolts.
	(Part 1)	Ferrous metals
	(Part 2)	Non - ferrous metals
	IS:208	Door Handles.
	IS:281	Mild steel sliding door bolts for use with padlocks.
	IS:362	Parliament Hinges.
	IS:419	Putty, for use on window frames.
	IS:451	Technical supply conditions for wood screws
	IS:733	Wrought aluminium and aluminium alloy bars, rods and sections for general engineering purposes.
	IS:1003 (Part I)	Timber panelled and glazed shutters (doors shutters).
	IS:1003	Timber panelled and glazed shutters
	(Part-1)	door shutters.
	IS:1038	Steel doors, windows and ventilators.
	IS:1081	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.
	IS:1285	Wrought aluminium and aluminium alloy extruded round tube & hollow section (for general engineering purposes).
	IS:1341	Steel butt hinges.
	IS:1361	Steel windows for Industrial buildings.
	IS:1823	Floor door stoppers.
	IS:1868	Anodic coatings on Aluminium and its alloys.
	IS:2202	Wooden flush door shutters (solid core type) particle
	(Part-2)	board face panels and hard board face panels.
	IS:2209	Mortice locks (vertical type)
	IS:2553	Safety glass.
	(Part-1)	General purposes

IS:2835	Flat transparent sheet glass.
IS:3548	Code of practice for glazing in buildings.
IS:3564	Door closers (Hydraulically regulated)
IS:3614	Specification for fire check doors :
(Part-1)	plate, metal covered and rolling type.
(Part-2)	Resistance test and performance criteria.
IS:4351	Specification for steel door frames.
IS:5187	Flush bolts.
IS:5437	Figured, rolled and wired glass.
IS:6248	Specification for metal rolling shutters and rolling grills.
IS:6315	Specification for floor springs (Hydraulically regulated) for heavy doors.
IS:7196	Hold fast.
IS:7452	Hot rolled steel sections for doors, windows and ventilators.
IS:10019	Mild steel stays and fasteners.
IS:10451	Steel sliding shutters (top hung type)
IS:12823	Prelaminated particle boards.

Roof Water Proofing and Allied Works

IS:3067	code of practice for general design details and preparatory work for damp proofing and water proofing of buildings.
ASTM	Standard specification for high solid content cold
C836-89a	liquid applied elastomeric water proofing membrane for use with separate wearing course.
ASTM	Standard guide for high solid content cold
C898-89	liquid applied elastomeric water proofing membrane for use with separate wearing course.

Floor Finishes and Allied Works

IS:5318	Code of practice for laying of flexible PVC sheet and tile flooring.

	IS:8042	White portland cement.
	IS:13755	Dust pressed ceramic tiles with water absorption of 3%, E 6% (Group B11a).
	IS:13801	Chequered cement concrete tiles.
	Painting and Allied Works	
	IS:162	Ready mixed paint, brushing fire resisting, silicate type for use on wood, colour as required.
	IS:428	Distemper, oil, emulsion, colour as required.
	IS:1477	Code of practice for painting of terrous metals in buildings.
	(Part -1)	Pretreatment.
	(Part -2)	Painting.
	IS:1650	Specification for colours for building and decorative materials.
	IS:2074	Ready mixed paint, air drying, red oxide-zinc chrome, priming.
	IS:2338	Code of practice for finishing of wood and wood based materials.
	(Part -1)	Operations and Workmanship.
	(Part -2)	Schedule.
	IS:2395	Code of pratice for painting concrete, masonry and plaster surfaces.
	(Part-1)	Operations and Workmanship.
	(Part -2)	Schedule.
	IS:2524	Code of practice for painting of nonferrous metals in buildings.
	(Part -1)	Pretreatment
	(Part -2)	Painting.
	IS:2932	Enamel, synthetic, exterior, (a) under coating and (b) finishing.
	IS:2933	Enamel exterior, (a) under coating, (b) finishing.
	IS:4759	Hot dip zinc coatings on structural steel and other allied products.
	IS:5410	Specification for cement paint.
	IS:15489	Plastic emulsion paint.
	IS:6278	Code of practice for white washing and Colour washing.

	IS:10403	Glossary of term related to building finish.
	IS:12027	Silicone based water repellent
	IS:13238	Epoxy based zinc phosphate primer (2 pack)
	IS:13239	Epoxy surfacer (2 pack)
	IS:13467	Chlorinated rubber for paints
	IS:14209	Epoxy enamel, two component glossy.
	BS:5493	Code of practice for protective coating of iron and steel structures against corrosion.
	Piling and Foundation	
	IS:1080	Code of practice for design and construction of shallow foundations on soils.
	IS:1904	Code of practice for design and construction of foundation in Soils : General Requirements.
	IS:2314	Steel sheet piling sections.
	IS:2911	Code of practice for design and construction of pile foundations. (Relevant Parts)
	IS:2950	Code of practice for designs and construction of Raft foundation.
	(Part-1)	Design
	IS:2974 (Part-1 to 5)	Code of practice for design and construction of machine foundation.
	IS:4091	Code of practice for design and construction foundations for transmission line towers and poles.
	IS:6403	Code of practice for determination of Bearing capacity of Shallow foundations.
	IS:8009	Code of practice for calculation of settlement of foundation.
	(Part -1)	Shallow foundations.
	(Part -2)	Deep foundations.
	IS:12070	Code of practice for design and construction of shallow foundations on rocks.
	ISO 10816	Criteria for assessing mechanical vibrations of machines.
	ISO 1940	Criteria for assessing the st of balance of rotating rigid bodies.

DIN : EN 13906-1	Helical compression spring made of round wire and rod : calculation and design of compression .
DIN:2096	Helical compression spring out of round wire and rod : Quality requirements for hot formed compression spring.
DIN:4024	Flexible supporting structures for machine with rotating machines.
Roads	
IRC:5 (Section-1)	Standard specifications and Code of practice for road bridges, General Features of Design.
IRC:14	Recommended practice for 2cm thick bitumen and tar carpets.
IRC:15	Standard specifications and code of practice for construction of concrete roads.
IRC:16	Specification for priming of base course with bituminous primers.
IRC:19	Standard specifications and Code of practice for water bound macadam.
IRC:21 (Section-III)	Standard specifications and Code of practice for road bridges. Cement concrete (plain and reinforced).
IRC:34	Recommendations for road construction in water logged areas.
IRC:36	Recommended practice for the construction of earth embankments for road works.
IRC:37	Guidelines for the Design of flexible pavements.
IRC:56	Recommended practice for treatment of embankment slopes for erosion control.
IRC:58	Guidelines for the design of rigid pavements for highways.
IRC:73	Geometric Design standards for rural (non-urban) highways.
IRC : 86	Geometric Design standards for urban roads in plains.
IRC:SP:13	Guidelines for the design of small bridges & culverts.
IRC - Publication	Ministry of Surface Transport (Road wing), specifications for road and bridge works.
IS:73	Paving bitumen.
Loading	
IS:875 (Relevant parts)	Code of practice for design loads (other than earthquake) for buildings and structures.
IS:1893	Criteria for earthquake resistant design of structures.

IS:4091	Code of practice for design and construction of foundation for transmission line towers and poles.
IRC:6 (Section-II)	Standard specifications & Code of practice for road bridges. loads and stresses
Safety	
IS:1641	Code of practice for fire safety of buildings - General principles of fire grading and classification.
IS:1642	Code of practice for fire safety of buildings - Details of construction.
IS:3696 (Part-1&2)	Safety code for scaffolds and ladders.
IS:3764	Excavation work - code of safety.
IS:4081	Safety code for blasting and related drilling operations.
IS:4130	Demolition of buildings - code of safety.
IS:5121	Safety code for piling and other deep foundations.
IS:5916	Safety code for construction involving use of hot bituminous materials.
IS:7205	Safety code for erection of structural steel work.
IS:7293	Safety code for working with construction machinery.
IS:7969	Safety code for handling and storage of building materials.
Indian Explosives Act 1940)	(As updated)
Architectural Design of Buildings	
SP:7	National Building Code of India
SP:41	Hand book on functional requirements of buildings (other than industrial buildings)
ECBC	Energy Conservation Building Code
GRIHA	Green Rating For Integrated Habitat Assessment.
Tall Structures, Chimneys	
IS:4998	Criteria for design of reinforced chimneys
IS:6533	Code of practice for design and construction of steel chimneys
ICAO	International Civil Aviation Organisation (ICAO)
DGCA	Instruction of Director General of Civil Aviation , India

ACI:307	Specification for the design and construction of reinforced concrete chimneys
BS:4076	Specification for steel chimneys
CICIND	Model Code for concrete chimneys Model code for steel chimneys
ASCE Code	Design and construction of steel chimney liners prepared by Task committee on steel chimney liners. Fossil power committee, Power division published by ASCE - 1975.
IS:1554	PVC insulated (heavy duty) electric cables
IS:2606	Alloy lead anodes for chromium plating
IS:3043	Code of Practice for Earthing
IS:9537	Conduits for electrical installations. The Indian Electricity Rules The Indian Electricity Act The Indian Electricity (Supply) Act The Indian Factories Act
IS:2309	Practice for protection of buildings and allied structures against lightning

Miscellaneous

IS:802 (Relevant parts)	Code of practice for use of structural steel in overhead trans-mission line towers.
IS:803	Code of practice for design, fabrication and erection of vertical mild steel cylindrically welded in storage tanks.
IS:10430	Criteria for design of lined canals and guidance for selection of type of lining.
IS:11592	Code of practice for selection and design of belt conveyors.
IS:12867	PVC handrails covers.
IS 11504	Criteria for structural design of reinforced concrete natural draught cooling towers
BS:4485 (IV)	British Standard : Code of design for water cooling towers
CIRIA Publication	Design and construction of buried thin-wall pipes.
IS 4671	Expanded polystyrene for thermal insulation purposes.
IS:18299	Structural Design And Proof Checking Consultancy Services For Structures

12.00.00(B)

ANNEXURE (B)

CONSTRUCTION METHODOLOGY

Construction and erection activities shall be fully mechanized from the start of the work.

All excavation and backfilling work shall be done using excavators, loaders, dumpers, dozers, poclains, excavator mounted rock breakers, rollers, sprinklers, water tankers, etc. Manual excavation can be done only on isolated places with specific approval of engineer.

For controlled rock blasting specialized agency, equipped with sensors to assess the impact of the blast on the adjoining existing structures, shall be employed.

Dewatering shall be done using the combination of electrical and standby diesel pumps.

Pile installation equipment suitable for flushing with air lift technique shall be used for construction of bored piles.

For concreting, weigh batching plants, transit mixers, concrete pumps, hoists, etc. shall be used.

Procurement of metal deck sheet to be used as shuttering material, shall be done well in advance so that concreting works shall not get delayed as this material is a long lead item

All fabrication and erection activities of structural steel shall be carried out using automatic submerged arc welding machines, cutting machines, gantry cranes, crawler mounted heavy cranes and other equipment like heavy plate bending machines, shearing machines, lathe, milling machines, etc. Use of derricks shall not be permitted. Special enclosures, for blast cleaning of steel structure surface preparation, shall be used.

All handling of materials shall be with cranes. Heavy trailers shall be used for transportation.

Mechanized modular units of scaffolding and shuttering shall be used.

Grouting shall be carried out using hydraulically controlled grouting equipment.

Roadwork shall be done using pavers, rollers and premix plant.

All finishing items shall be installed using appropriate modern mechanical tools. Manual punching etc. shall not be permitted.

Heavy duty hoists for lifting of construction materials shall be deployed. Compressors for cleaning of foundations and other surfaces shall be used.

Field laboratory shall be provided with all modern equipment for survey, testing of soil, aggregates, concrete, welding, etc. For testing of steel works, ultrasonic testing machines, radiographic testing machines, dye penetration test equipment, destruction testing equipment, etc. shall be deployed.

All persons working at site shall be provided with necessary safety equipment and all safety aspects shall be duly considered for each construction/ erection activity. Moreover, only the persons who are trained in the respective trade shall be employed for executing that particular work.

ANNEXURE-C

TELANGANA ST-II

Coordinate & Local

N-2074518, E-339859.1

1723 3447

BNT-05

DBH-01

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project : NTPC	Started on : 20/02/2024
Method of Boring : Hydraulic Drilling.	Completed on : - 20-02-24
Location : Ramgundam	Chainage : -
BH-No. DBH-01	Water Table : - 1.95 mt
Depth of Termination : - 10.00 mt	Reference Level : 149.065
Casing : - 9.50 mt	

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
0.0	Yellowish Brown fine to very fine grained ~~silty~~ sandy clay and gravels. (Filled up) 0.0 m to 0.70m		0.0	DS	-	-	-	-	-		
1.5	grayish Light Brown fine to very fine grained silty sandy with Silty ash		1.5	SP	4	4	5	9			
3.00	← DO → (3.00 to 3.50) mt		3.00	DS	←						
4.5	Ratish Brownish fine to very fine grained ~~silty~~ sandy clay with soft rock. (4.50 to 4.70) mt		4.5	SPT	30	50/6cm	-	50+ (R)			
6.00	Reddish brown coarsed fine to grained sand stone rock (4.70 to 6.00) mt		6.00	SPT	50/4cm	>	>	100/(R)	10.6%		
	— DO — (6.00 to 7.50) mt										
7.50			7.50	Rock					57.33%	29.33%	
9.00	—— DO ——		9.00	Rock					38.66%	30%	
10.00	—— DO ——		10.00	Rock					70%	59%	

Signature of Site Engineer

Amit Kumar Sahani 20/02/24

Signature of Client

K.C.T. Consultancy Services®

Project : TELANGANA STPP ST-II

Bore Hole No. : DBH-02

Location : Switchyard

Depth of Termination : 10.0M

Co-ordinates: N 1599, E 3200

Reduced Level: 147.5 m

Depth of Water Table : Encountered at 1.60 m depth during investigation

Date of Start: 18-02-2024

Date of Completion: 19-02-2024

Diameter of Bore: 150mm and Nx size

Bit Used: Soil Suface Bit and NX Size

BORE LOG DATA SHEET

Method of Boring	Depth m	Casing	Notation	Soil Description	Depth of Sample m	Drill Run From m	Drill Run To m	Type of Sample	SPT N Value/Penetration of S.S.S N_1	N_2	N_3	N	Core Recovery (%)	RQD (%)	Remarks
Rotary drilling method	0.00	Used		Dark reddish brown, fine to medium grained, clayey sand with gravels and fractured rock fragments **0.00 to 0.30m**	0.00	0.00	1.50	DS	-	-	-	-	-	-	
	0.50														
	1.00			Dark grey, fine to very fine grained, silty clays of low plasticity mixed with ash and with occasional gravels (CL) **0.30 to 2.80m**	1.50	1.50	3.00	SPT	3	5	6	11	-	-	
	1.50														
	2.00														
	2.50														
	3.00				3.00	3.00	4.50	SPT	5	8	8	16	-	-	
	3.50														
	4.00			Light brownish to brownish, fine to medium grained, clayey sand with little gravels and occasional rock fragments **2.80 to 6.30m**											
	4.50				4.50	4.50	4.70	SPT	6	9	11	20	-	-	
	5.00														
	5.50														
	6.00				6.00	4.70	6.00	UDS	-	-	-	-	-	-	
	6.50														
	7.00	Not used													
	7.50				7.50	6.00	7.50	CORE	-	-	-	-	73.33	55.33	
	8.00														
	8.50			Slightly weathered, weak, light yellowish white, fine to very fine grained, massive rock											
	9.00				9.00	7.50	9.00	CORE	-	-	-	-	96.66	87.33	
	9.50														
	10.00				10.00	9.00	10.00	CORE	-	-	-	-	91.00	83.00	

6.30 to 10.00m

K.C.T. Consultancy Services®

Project : TELANGANA STPP ST-II

Bore Hole No. : DBH-03

Location : Switchyard

Depth of Termination : 10.0M

Co-ordinates: N 1599, E 3400

Reduced Level: 147.5 m

Depth of Water Table : Encountered at 1.30 m depth during investigation

Date of Start: 20-02-2024

Date of Completion: 20-02-2024

Diameter of Bore: 150mm and Nx size

Bit Used: Soil Suface Bit and NX Size

BORE LOG DATA SHEET

Method of Boring	Depth m	Casing	Notation	Soil Description	Depth of Sample m	Drill Run From m	Drill Run To m	Type of Sample	SPT N Value/Penetration of S.S.S N_1	N_2	N_3	N	Core Recovery (%)	RQD (%)	Remarks
Rotary drilling method	0.00	Used		Brownish pink, fine to medium grained, clayey sand with little gravels and fractured rock fragments **0.00 to 0.30m**	0.00	0.00	1.50	DS	-	-	-	-	-	-	
	0.50														
	1.00 ▼			Dark brownish grey, fine to medium grained, silty clayey sand with little gravels and mixed with ash **0.30 to 2.70m**											
	1.50				1.50	1.50	3.00	SPT	3	4	6	10	-	-	
	2.00														
	2.50			Brownish, fine to very fine grained, sandy clays of intermediate plasticity (CI) **2.70 to 3.60m**											
	3.00				3.00	3.00	4.50	UDS	-	-	-	-	-	-	
	3.50			Mixture of dark brownish, red, fine to medium grained, clayey sand with highly weathered, fractured and disintegrated, reddish brown, fine to medium grained, fractured rock fragments **3.60 to 4.70m**											
	4.00														
	4.50	Not used			4.50	4.50	4.70	SPT	12	50 11 cm	-	>100	-	-	
	5.00														
	5.50														
	6.00			Highly weathered, very weak, brownish red, fine to medium grained, rock with closely spaced discontinuties **4.70 to 8.50m**	6.00	4.70	6.00	CORE	-	-	-	-	22.84	-	
	6.50				6.00	6.00	6.09	SPT	70/9 cm	-	-	>100			
	7.00														
	7.50				7.50	6.09	7.50	CORE	-	-	-	-	66.00	-	
	8.00														
	8.50														
	9.00			Slightly weathered, weak, dark brownish red, fine to medium grained, rock with closely spacied discontinuties	9.00	7.50	9.00	CORE	-	-	-	-	98.00	9.33	
	9.50														
	10.00				10.00	9.00	10.00	CORE	-	-	-	-	81.00	13.00	

8.50 to 10.00m

Shifted co-ordinate
→ E - 2074309
N - 339624

E - 3253
N - 1951

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project : NTPC	Started on : 09/4/24
Method of Boring : Hydraulic	Completed on : 09/4/24
Location : Ramagundam	Chainage :
BH-No. DBH-05	Water Table : 1.80M
Depth of Termination : 10.00M	Reference Level : 144.66
Casing : ~~8.00~~ 7.90M	

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
0.00	Brownish fine to fine grained silty sandy filled up soil with grave.		0.00	DS							
1.50	—— DO but grayish mix yellowish sandy with fly ash.		1.50	SPT	3	3	5	8			
3.00	—— DO (Brownish clayey) ——		3.00	UDS	—	—	—	—			
4.50	—— DO ——		4.50	SPT	3	4	6	10			
6.00	—— DO (6.00 to 6.10M) ——		6.00	UDS	—	—	—	—			
7.50	—— DO but Whitish grey sandy (6.10 to 7.60M)		7.50	SPT	5	7	11	18			
9.00	~~formation~~ DO Rock ~~for~~ sandy stone.		9.00	UDS / SPT	13	16	25	41			N/R
10.00	Redish brown fine to fine coarse grained silty fractured soft Rock (7.60 to 10.00M)		10.00	Rock	—	—	—	—			

Signature of Site Engineer Navin Kr. Singh

Signature of Client

Machine NO- BRT-02

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project : NTPC	Started on : 21/02/2024
Method of Boring : HYDRULIC DRILLING	Completed on : 21/02/2024
Location : RAMAGUNDAM	Chainage : -
BH-No. DBH 07	Water Table : 3.80M.
Depth of Termination : 10 M	Reference Level : 145.065
Casing : 3 M	N-2074258E-339462

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
0.0	Reddish Brown fine to coarse grained silty sandy CLAY with gravel and some ~~soft~~ boulder		0.0	DS	—	—	—	—			
1.5	← DO → (0.0m to 2.10m)		1.5	SPT	5	7	12	19			
3.0	Blackish Brown fine to fine grained silty CLAY with some gravel.		3.0	UDS	—	-	-	-			
4.5	← DO → (2.10m to 5.30m)		4.5	SPT	4	5	6	11			
6.0	Brownish fine to fine grained silty SAND with some gravel		6.0	UDS	—	-	-	-			
7.5	← DO →		7.5	SPT / DS	15	27	35	62			N/R
9.0	← DO →		9.0	SPT	40	50/7cm	-	7/00			
10.0	← DO → (5.30m to 10.30m)		10.0	SPT / DS	50/10cm	-	-	7/00			N/R

Signature of Site Engineer S Mondal

Signature of Client

Machine No:- KCT01

DBH:-08

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project :- NTPC	Started on :- 21/02/24
Method of Boring :- Hydraulic Drilling	Completed on :- 23/02/24
Location :- Ramagundam, Telangana	Chainage :
BH-No. :- 08	Water Table :- 1.20 Mt
Depth of Termination :- 10.00 mt	Reference Level :- 147.116
Casing :- 6.00 mt	E :- 3400 N :- 1399

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R.%	RQD	Remark
0.0	Redish Brown, fine to coarse grained, silty clay with sand & gravels ← filled up soil → (0.0mt to 0.20m)			DS	–	–	–	–	–		
1.50	whitish grey, fine to coarse grained, sand with Balder & gravels, (0.20mt to 2.40mt)		1.50	Rock / SPT	50 / 3cm	–	–	>100 (R)	–	–	NR / SPT
3.00	Redish grey fine to fine grained, silty sand with clay & gravels, (2.40mt to 3.80mt)		3.00	SPT	12	16	18	34	–	–	
4.50	Redish Brown, fine to very fine grained silty sand with clay & gravels (3.80mt to 5.30mt)		4.50	SPT	60 / 8cm	–	–	>100 (R)			
6.00	Redish Brown, fine to coarse grained, sand stone with Soft Rock		6.00	ROCK	–	–	–	–	72.55%	14.28%	

Signature of Site Engineer

23/02/24

Signature of Client

Medicine NO:-KCT01

DBH:-08

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project :- NTPC
Method of Boring :- Hydraulic Drilling
Location :- Ramagundam, Telangana
BH-No. - 08
Depth of Termination :- 10.00mt
Casing :- 6.00 mt

Started on :- 21/02/24
Completed on :- 23/02/24
Chainage :
Water Table :- 1.20 m
Reference Level :- 147.116

E:-3400, N:-1399

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
7.50	—— DO ——		7.50	Rock	—	—	—	—	99%	33.3%	
9.00	—— DO ——		9.00	Rock	—	—	—	—	58.66%	54%	
10.00	—— DO ——		10.00	Rock	—	—	—	—	99%	91%	

Signature of Site Engineer

Signature of Client

23/02/24

K.C.T. Consultancy Services®

Project : TELANGANA STPP ST-II

Bore Hole No. : DBH-9

Location : Switchyard

Depth of Termination : 10.0M

Co-ordinates: E 3544, N 1445

Reduced Level: 144.635 M

Depth of Water Table : Encountered at 1.90m depth during investigation

Date of Start: 27-03-2024

Date of Completion: 27-03-2024

Diameter of Bore: 150mm and Nx size

Bit Used: Soil Suface Bit and NX Size

BORE LOG DATA SHEET

Method of Boring	Depth m	Casing	Notation	Soil Description	Depth of Sample m	Drill Run From m	Drill Run To m	Type of Sample	SPT N Value/Penetration of S.S.S N_1	N_2	N_3	N	Core Recovery (%)	RQD (%)	Remarks
Rotary drilling method	0.00	Used		Dark blackish, fine to medium grained, clayey sand with little gravels (SC) **0.00 to 0.40m**	0.00	0.00	1.50	DS	-	-	-	-	-	-	
	0.50														
	1.00			Yellowish brown, fine to medium grained, silty sand with little plastic fines and little gravels (SM) **0.40 to 3.10m**	1.50	1.50	3.00	SPT	4	6	7	13	-	-	
	1.50 ▼														
	2.00														
	2.50														
	3.00	Not used			3.00	3.00	3.10	SPT	51/4 CM	-	-	>100	-	-	
	3.50														
	4.00			Yellowish brown, fine to medium grained, clayey sand with much gravels (SC) **3.10 to 6.00m**											
	4.50				4.50	3.10	4.50	CORE	-	-	-	-	10.71	-	
	5.00														
	5.50														
	6.00			Highly weathered, weak, dark reddish, fine to medium grained, fractured rock **6.00 to 7.50m**	6.00	4.50	6.00	CORE	-	-	-	-	78.00	-	
	6.50														
	7.00														
	7.50			Moderately weathered, weak, Dark reddish, fine to medium grained, fractured rock **7.50 to 9.00m**	7.50	6.00	7.50	CORE	-	-	-	-	50.00	-	
	8.00														
	8.50														
	9.00			Highly weathered, moderately weak, dark reddish, fine to medium grained, fractured rock	9.00	7.50	9.00	CORE	-	-	-	-	34.00	-	
	9.50														
	10.00				10.00	9.00	10.00	CORE	-	-	-	-	38.00	-	

9.00 to 10.00m

For KCT Consultancy Services.,

(Dr. K K Thaker)

Fig. No.
( )

K.C.T. Consultancy Services®

Project : TELANGANA STPP ST-II

Bore Hole No. : DBH-10

Location : Switchyard

Depth of Termination : 10.0 m

Co-ordinates: E 3530, N 1317

Reduced Level: 147.5 m

Depth of Water Table : Encountered at 1.40 m depth during investigation

Date of Start: 19-02-2024

Date of Completion: 19-02-2024

Diameter of Bore: 150mm and Nx size

Bit Used: Soil Suface Bit and NX Size

BORE LOG DATA SHEET

Method of Boring	Depth m	Casing	Notation	Soil Description	Depth of Sample m	Drill Run From m	Drill Run To m	Type of Sample	SPT N Value/Penetration of S.S.S N_1	N_2	N_3	N	Core Recovery (%)	RQD (%)	Remarks
Rotary drilling method	0.00	Used		Dark brownish, fine to medium grained, filled up clayey sand with debris **0.00 to 0.40m**	0.00	0.00	1.50	DS	-	-	-	-	-	-	
	0.50														
	1.00			Reddish brown, fine to medium grained, silty clayey sand with much gravels (SM-SC) **0.40 to 3.60m**	1.50	1.50	3.00	SPT	8	12	14	26	-	-	
	1.50														
	2.00														
	2.50														
	3.00	Not used			3.00	3.00	3.45	UDS	-	-	-	-	-	-	
	3.50														
	4.00			Highly weathered, weak, reddish brown, fine to medium grained, rock with close spacing of discontinuties **3.60 to 5.50m**	4.50	3.45	4.50	CORE	-	-	-	-	40.00	13.33	
	4.50														
	5.00														
	5.50														
	6.00			Moderately weathered, weak, reddish brwon, fine to medium grained, rock with moderately wide spacing of discontinuties **5.50 to 8.50m**	6.00	4.50	6.00	CORE	-	-	-	-	51.33	38.66	
	6.50														
	7.00														
	7.50				7.50	6.00	7.50	CORE	-	-	-	-	36.66	22.66	
	8.00														
	8.50														
	9.00			Slightly weathered, weak, dark brownish red, fine to medium grained, massive rock	9.00	7.50	9.00	CORE	-	-	-	-	68.66	55.33	
	9.50														
	10.00				10.00	9.00	10.00	CORE	-	-	-	-	65.00	65.00	

8.50 to 10.00m

For KCT Consultancy Services.,

(Dr. K K Thaker)

Fig. No.
( )

K.C.T. Consultancy Services®

Project : TELANGANA STPP ST-II

Bore Hole No. : DBH-11

Location : Switchyard

Depth of Termination : 10.0M

Co-ordinates: E 3202, N 1201

Reduced Level: 147.5 m

Depth of Water Table : Encountered at 1.60 m depth during investigation

Date of Start: 21-02-2024

Date of Completion: 21-02-2024

Diameter of Bore: 150mm and Nx size

Bit Used: Soil Suface Bit and NX Size

BORE LOG DATA SHEET

Method of Boring	Depth m	Casing	Notation	Soil Description	Depth of Sample m	Drill Run From m	Drill Run To m	Type of Sample	SPT N Value/Penetration of S.S.S N_1	N_2	N_3	N	Core Recovery (%)	RQD (%)	Remarks
Rotary drilling method	0.00	Used		Reddish yellow, fine to very fine grained, filled up clayey sand with rock fragments **0.00 to 0.30m**	0.00	0.00	1.50	DS	-	-	-	-	-	-	
	0.50			Reddish yellow, fine to very fine grained, clayey sand with rock fragments **0.30 to 2.70m**	1.50	1.50	3.00	SPT	11	7	10	17	-	-	
	1.00														
	1.50														
	2.00														
	2.50														
	3.00	Not used		Boulderous formation of highly weathered, moderately weak, reddish yellow, fine to very fine grained, pebble, cobble boulder size fragments of rock with reddish brown, fine to very fine grained, clayey sand **2.70 to 5.40m**	3.00	3.00	4.50	SPT	60/7 cm	-	-	>100	-	-	
	3.50														
	4.00														
	4.50				4.50	4.50	6.00	SPT	50/9 cm	-	-	>100	-	-	
	5.00														
	5.50														
	6.00			Highly weathered, weak, brownish red, fine to medium grained, fractured rock **5.40 to 7.30m**	6.00	6.00	6.07	SPT	50/7 cm	-	-	>100	-	-	
	6.50														
	7.00														
	7.50				7.50	6.00	7.50	CORE	-	-	-	-	92.00	56.00	
	8.00														
	8.50			Slightly weathered, moderately weak, brownish red, fine to very fine grained, massive rock											
	9.00				9.00	7.50	9.00	CORE	-	-	-	-	86.00	85.00	
	9.50														
	10.00				10.00	9.00	10.00	CORE	-	-	-	-	99.00	99.00	

7.30 to 10.0m

For KCT Consultancy Services.,

(Dr. K K Thaker)

Fig. No.
( )

UTM Cordinate

X = 339679.1

Y = 2074068.92

K.C.T-02

DBH:-12

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project :- NTPC	Started on :- 27/03/24
Method of Boring :- Hydraulic Drilling	Completed on :- 27/03/24
Location :- Ramagundam, Telangana	Chainage :
BH-No. - 12	Water Table :
Depth of Termination :- 10.00m	Reference Level : 147.322
Casing : 3.00 m	

E - 3425 , N - 1240

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
	Redish Brown, fine to fine grained, Silty Sand with gravels & clay etc.										
0.0	← filledup soil →		0.0	DS	-	-	-	-			
1.50	Brownish grey, fine to fine grained Silty Sand with clay & clay Ash. (0.0m to 1.90m)		1.50	SPT	5	6	6	12			
3.00	Brownish, fine to fine grained, silty Sand with clay & gravels		3.00	UDS / SPT	4	5	7	12	-	-	NR / UDS
4.50	← DO → (1.90m to 4.90m)		4.50	SPT	10	50 / 7cm	-	>100 (R)			
6.00	Redish Brown, fine to coarse grained, Soft sand stone with Soft rock		6.00	Rock	-	-	-	-	69.0%	66.36%	
7.50	← DO. →		7.50	Rock	-	-	-	-	19.33%	13.33%	
9.00	← DO →		9.00	Rock	-	-	-	-	94.00%	86.66%	
10.00	← DO →		10.00	Rock	-	-	-	-	99.00%	99.00%	

filledup Soil

Signature of Site Engineer

27/03/24

Signature of Client

K.C.T. Consultancy Services®

Project : TELANGANA STPP ST-II

Bore Hole No. : DBH-13

Location : Switchyard

Depth of Termination : 10.0M

Co-ordinates: E 3171, N 1081

Reduced Level: 147.5 m

Depth of Water Table : Encountered at 3.40 m depth during investigation

Date of Start: 21-02-2024

Date of Completion: 21-02-2024

Diameter of Bore: 150mm and Nx size

Bit Used: Soil Suface Bit and NX Size

BORE LOG DATA SHEET

Method of Boring	Depth m	Casing	Notation	Soil Description	Depth of Sample m	Drill Run From m	Drill Run To m	Type of Sample	SPT N Value/Penetration of S.S.S N_1	N_2	N_3	N	Core Recovery (%)	RQD (%)	Remarks
Rotary drilling method	0.00	Used		Light reddish brown, fine to medium grained, filled up clayey sand with occasional gravels **0.00 to 0.50m**	0.00	0.00	1.50	DS	-	-	-	-	-	-	
	0.50			Yellowish brown, fine to very fine grained, clayey sand with occasional gravels (SC) **0.50 to 1.95m**											
	1.00														
	1.50				1.50	1.50	3.00	SPT	3	4	4	8	-	-	
	2.00			Light brownish, fine to very fine grained, sandy clays of intermediate plasticity with much gravels and rock fragments **1.95 to 3.50m**											
	2.50														
	3.00				3.00	3.00	4.50	UDS	-	-	-	-	-	-	
	3.50														
	4.00														
	4.50			Reddish brown, fine to very fine grained, clayey sand (SC) **3.50 to 6.40m**	4.50	4.50	6.00	SPT	4	6	11	17	-	-	
	5.00														
	5.50														
	6.00				6.00	6.00	6.40	UDS	-	-	-	-	-	-	
	6.50	Not used													
	7.00			Slightly weathered, moderately weak, dark brownish red, fine to medium grained, rock with close spacing of discontinuties **6.40 to 9.10m**											
	7.50				7.50	6.40	7.50	CORE	-	-	-	-	73.63	9.09	
	8.00														
	8.50														
	9.00			Slightly weathered, moderately weak, dark brownish red, fine to medium grained, massive rock	9.00	7.50	9.00	CORE	-	-	-	-	51.33	7.33	
	9.50														
	10.00				10.00	9.00	10.00	CORE	-	-	-	-	68.00	68.00	

9.10 to 10.00m

For KCT Consultancy Services.,

(Dr. K K Thaker)

Fig. No.
( )

E - 2977
N - 15724

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project : NTPC
Method of Boring : Hydraulic Machine
Location : Ramagundam
BH-No : DBH- 14
Depth of Termination : 15.00 M
Casing : 4.80 M

Started on : 20/3/24
Completed on : 21/3/24
Chainage :
Water Table : 1.70M
Reference Level : 195.774

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
0.00	Brownish fine to fine grained silty sandy filldup with gravel (0.00 to 1.5		0.00	DS							
1.50	Greyish Mix White fine to fine grained silty sandy) with little grave		1.50	SPT	2	2	3	5			
3.00	—— DO ——		3.00	UDS / SPT	3	4	7	11			N/R UDS taken SPT
4.50	—— DO —— (0.30 to 4.70M)		4.50	SPT	3	6	9	15			
6.00	Redish brown fine to fine Corse grained silty fractured soft Rock.		6.00	Rock	-	-	-	-			
7.50	—— DO ——		7.50	Rock	-	-	-	-			
9.00	—— DO ——		9.00	Rock	-	-	-	-			
10.50	—— DO ——		10.50	Rock	-	-	-	-			
12.00	—— DO ——		12.00	Rock	-	-	-	-			
13.50	—— DO ——		13.50	Rock	-	-	-	-			
15.00	—— DO ——		15.00	Rock	-	-	-	-			

Signature of Site Engineer Navin Kr. Singh
Signature of Client

Drawing → N-2074467
E-339328

BH-05

Actual → N-2074461
E-339328

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project : NTPC	Started on : 6/3/24
Method of Boring : HYDRULIC DRILLING	Completed on : 7/3/24
Location : RAMAGUNDAM	Chainage : ~~0.550~~
BH-No. DBH-15	Water Table : ~~145.550~~ 1.50 m
Depth of Termination : 15M	Reference Level : 145.550
Casing : 4.5M	

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
0.0	Redish Brown fine to medium grained silty CLAY with grave. (0.0m to 0.40m)		0.0	DS	–	–	–	–			
1.5	Greyish fine to medium grained FLY ASH		1.5	SPT	1	2	2	4			
3.0	← DO → (0.0m to 3.40m filled up)		3.0	UDS	–	–	–	–			
4.5	Redish Brown fine to medium grained SAND (3.40m to 4.70m)		4.5	SPT	50/10cm	–	–	7/10cm			
6.0	Redish Brown fine to medium grained SAND STONE		6.0	Rock	–	–	–	–	37%	10%	
7.5	← DO →		7.5	Rock	–	–	–	–	42%	24%	
9.0	← DO →		9.0	Rock	–	–	–	–	55%	46%	
10.5	← DO →		10.5	Rock	–	–	–	–	63%	43%	
12.0	← DO →		12.0	Rock	–	–	–	–	92%	76%	
13.5	← DO →		13.5	Rock	–	–	–	–	96%	96%	
15.0	← DO → (4.70m to 15.00m)		15.0	Rock	–	–	–	–	99%	99%	

Signature of Site Engineer S. Mandal

Signature of Client

E-9022
N-1506

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project : NTPC	Started on : 04/9/24
Method of Boring : Hydraulic Machine	Completed on : 04/13/24
Location : Ramagundam	Chainage :
BH-No. - DBH-16	Water Table : 1.65M
Depth of Termination : 15.00M	Reference Level : 145.154
Casing : 5.90M	

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R.%	RQD	Remark
0.00	Brownish mix yellow fine to fine filldup silty clay with gravels. (0.00 to 0.40M)		0.00	DS	–	–	–	–			
1.50	Greyish fine to fine silty sandy grained (0.40 to 1.60M)		1.50	SPT	12	10	13	23			
3.00	Reddish brown fine to fine silty clay with gravels (1.60 to 3.70M)		3.00	UDS / SPT	16	33	51/2cm	>100			
4.50	Reddish Brown fine to fine coarse grained silty fractured Soft Rock		4.50	Rock	–	–	–	–	58.75	32.50	
6.00	—— DO ——		6.00	Rock	–	–	–	–	32.46	18	
7.50	—— DO ——		7.50	Rock	–	–	–	–	19	–	
9.00	—— DO ——		9.00	Rock	–	–	–	–	85.33	72	
10.50	—— DO ——		10.50	Rock	–	–	–	–	50.66	–	
12.00	—— DO ——		12.00	Rock	–	–	–	–	80.66	9.33	
13.50	—— DO ——		13.9	Rock	–	–	–	–	68.66	–	
15.00	—— DO —— (3.70 to 15.00M)		15.00	Rock	–	–	–	–	60.66	–	

Signature of Site Engineer Navinkr. Singh.

Signature of Client

E-2938
N-1450

N-2074428
E-339299

PS-01

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project : NTPC	Started on : 4/3/24
Method of Boring : HYDRULIC DRILLING	Completed on : 5/3/24
Location : RAMAGUNDAM	Chainage :
BH-No. DBH-17	Water Table : 1.30m
Depth of Termination : 15m	Reference Level : 145.700
Casing : 3m	

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
0.0	Brownish fine to medium grained silty CLAY with some gravel. (0.0m to 0.50m)		0.0	DS	–	–	–	–			
1.5	Redish Brown fine to medium grained silty ~~SAND~~ CLAY with gravel. (0.50m to 2.30m)		1.5	SPT	2	3	4	7			
3.0	Redish Brown fine to medium grained silty SAND with some Rock		3.0	SPT	50/8cm	–	–	7/100			
4.5	← DO → (2.30m to 4.60m)		4.5	~~ROCK~~ SPT	50/5cm	–	–	7/100			
6.0	Redish Brown fine to fine grained SAND STONE		6.0	Rock	–	–	–	–	94%	72%	
7.5	← DO →		7.5	ROCK	–	–	–	–	87%	27%	
9.0	← DO →		9.0	ROCK	–	–	–	–	95%	0%	
10.5	← DO →		10.5	ROCK	–	–	–	–	92%	7%	
12	← DO →		12.0	ROCK	–	–	–	–	98%	94%	
13.5	← DO →		13.5	ROCK	–	–	–	–	96%	96%	
15	← DO → (4.60m to 15.00m)		15.0	ROCK	–	–	–	–	98%	98%	

Signature of Site Engineer S. Mandal

Signature of Client

E - 3000
N - 1457

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project : NTPC	Started on : 02/3/24
Method of Boring : Hydraulic Machine	Completed on : 02/3/24
Location : Ramagundam	Chainage :
BH-No. : -DBH-18	Water Table : 1.86M
Depth of Termination : 15.00M	Reference Level : 145.362
Casing : 3.00M	

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
0.00	BrownishRed fine to fine grained silty sandy clay with gravels. ~~(0.00 to 1.50)~~		0.00	DS	–	–	–	–			
1.50	DO (0.00 to 1.60M)		1.50	SPT	16	25	32	57			
3.00	Reddish Brown Mix White fine to fine silty sandy clay with gravels.		3.00	UDS/DS	31	51/5cm	>	>100			NIR UDS
4.50	DO (1.60 to 4.50M)		4.50	SPT	36	51/4cm	>	>100			
6.00	Reddish brown fine to fine carse grained silty fractured soft Rock.		6.00	Rock	–	–	–	–	67.33	50.66	
7.50	DO		7.50	Rock	–	–	–	–	68.66	68.66	
9.00	DO		9.00	Rock	–	–	–	–	90	69.33	
10.50	DO		10.50	Rock	–	–	–	–	57.33	26.66	
12.00	DO		12.00	Rock	–	–	–	–	94	90	
13.50	DO		13.50	Rock	–	–	–	–	89.33	17.33	
15.00	DO (4.50 to 15.00M)		15.00	Rock	–	–	–	–	90.66	78	

Signature of Site Engineer: Navin Kr. Singh   Signature of Client

New Shifted Co-ordinate
E - 339361
N - 2079374

E - 3027
N - 1425

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project : NTPC	Started on : 05/3/12
Method of Boring : Hydraulic	Completed on : 06/3/12
Location : Ramagundam	Chainage :
BH-No. - DBH-19	Water Table : 1.90M
Depth of Termination : 15.00 M	Reference Level : 145.17
Casing : 2.50M	

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
0.00	Greyish fine to fine grained Silty some clay with gravel — Filled up (0.00 to 0.40M)		0.00	DS	—	—	—	—			
1.50	Reddish brown fine to fine grained silty clay with gravels (0.40 to 2.60M)		1.50	SPT	33	51/3cm	>	>100			
3.00	Reddish brown fine to fine Coarse grained silty fractured soft Rock		3.00	Rock / SPT	51/3cm	>	>	>	37.5	-	NIR SPT
4.50	—— DO ——		4.50	Rock	—	—	—	—	58	-	
6.00	—— DO ——		6.00	Rock	—	—	—	—	72	-	
7.50	—— DO ——		7.50	Rock	—	—	—	—	70	-	
9.00	—— DO ——		9.00	Rock	—	—	—	—	50	-	
10.50	—— DO ——		10.50	Rock	—	—	—	—	68	~~46~~	
12.00	—— DO ——		12.00	Rock	—	—	—	—	~~62.8~~	~~16.7~~	
13.50	—— DO ——		13.50	Rock	—	—	—	—	79.66	17.33	
15.00	—— DO —— (2.60 to 15.00M)		15.00	Rock	—	—	—	—	90.66	73.33	

Signature of Site Engineer: Vanit Kr. Singh.

Signature of Client

DBH-20
BNT-01

Cordinate :- N— 1396
E— 2973

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project :- NTPC	Started on : 01-03-24
Method of Boring :- Hydraulic Drilling	Completed on : 01/3/24
Location :- Ramagundam	Chainage :
BH-No. DBH-20	Water Table : 1.80M
Depth of Termination :- 12.00M	Reference Level : 146.231
Casing : 2.60M	

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R.%	RQD	Remark
0.00	Reddish brown fine to grained clayey sand filled up		0.00	DS	—	—	—	—	—	—	
0.80	(0.00 to 0.80) mts										
1.50	Reddish brown fine to grained with gravels.		1.50	SPT	21	33	41	74			
3.00	—— DO —— (0.80 to 3.00M)		3.00	UDS / SPT	25	51/8CM	>	>100			
4.50	Reddish Brown fine to fine corse grained Silty Soft Rock		4.50	Rock	—	—	—	—	81.33	54	
6.00	—— DO ——		6.00	Rock	—	—	—	—	63.33	13.33	
7.50	—— DO ——		7.50	Rock	—	—	—	—	50	6.66	
9.00	—— DO ——		9.00	Rock	—	—	—	—	90	86.66	
10.50	—— DO ——		10.50	Rock	—	—	—	—	100	88	
12.00	—— DO —— (3.10 to 12.00M)		12.00	Rock	—	—	—	—	94.66	92.66	

Signature of Site Engineer Varun Kr. singh

Signature of Client

E-3019
N-1376

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project : NTPC
Method of Boring : Hydraulic Machine
Location : Ramagundam
BH-No. BBH-21
Depth of Termination : 15.00M
Casing : 2.50M

Started on : 28/2/24
Completed on : 28/2/24
Chainage :
Water Table : 1.45M
Reference Level : 146.577

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
0.00	Brownish fine to fine grained silty sandy clay with gravel. (0.00 to 0.30M)		0.00	DS	—	—	—	—			
1.50	Reddish Brown fine to fine grained silty clay with much gravel. (0.30 to 1.70M)		1.50	SPT	25	51/3CM	>	>100			
3.00	Reddish brown fine to fine coarse grained silty fractured soft ROCK (1.70m to 3.00)		3.00	ROCK SPT	51/3CM	>	>	>100			N/R SPT
4.50	DO (Soft ROCK)		4.50	ROCK	—	—	—	-	17.33	-	
6.00	DO		6.00	ROCK	—	—	—	—	90.66	88.66	
7.50	DO		7.50	ROCK	—	—	—	—	22.66	11.33	
9.00	DO		9.00	ROCK SPT	51/3CM	>	>	>100	28	-	N/R SPT
10.50	DO		10.50	ROCK	—	—	—	—	28	-	
12.00	DO		12.00	ROCK	—	—	—	—	64	-	
13.50	DO		13.50	ROCK	—	—	—	—	72	-	
15.00	DO (1.70 to 15.00M)		15.00	ROCK	—	—	—	—	72	-	

Signature of Site Engineer Vaibhav KV. Singh.

Signature of Client

BNT-06

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project : NTPC	Started on : 27/02/24
Method of Bonng : Hydrolic	Completed on : 27/02/24
Location : Ramagundam (Telangana)	Chainage :
BH-No. DBH-22	Water Table : 1.30 mts
Depth of Termination : 10.00 mts	Reference Level : 145.816
Casing : 1.50 mts	Co-ordinates : E:- 2936 N:- 1363

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
0.00	Brownish fine to fine grained silty sand with some gravel (0.00m to 0.60m)		0.00m	DS	—	—	—	—			
1.50	Reddish Brown fine to coarse grained sand stone soft Rock		1.50	Rock	—	—	—	—	92.22	24.4	
3.00	—— DO ——		3.00m	Rock	—	—	—	—	52%	21.33	
4.50	—— DO ——		4.50	Rock	—	—	—	—	72.66	0.00	
6.00	—— DO ——		6.00m	Rock	—	—	—	—	97.33	0.00	
7.50	—— DO ——		7.50m	Rock	—	—	—	—	30.66	0.00	
9.00	—— DO ——		9.00m	Rock	—	—	—	—	16.66	0.00	
10.00	—— DO ——		10.00	Rock	—	—	—	—	30%	20%	

Signature of Site Engineer

Signature of Client

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project: NTPC	Started on: 28/02/24
Method of Boring: Hydrolic	Completed on: 28/02/24
Location: Ramagundam (Telangana)	Chainage:
BH-No. DBH-23	Water Table: 1.30 mtl
Depth of Termination: 10.00 mtr	Reference Level: 146.280
Casing: ϕ	Co-ordinates: E1-2919 N:- 1335

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
0.00	Brownish grey fine to fine silty clay filled up soil (0.00m to 0.40m)		0.00	DS	—	—	—	—			
1.50	Reddish Brown fine to very fine grained silty clay with some gravel (0.40m to 1.60m)		1.50m	SPT	50/13cm	>	>	R			
3.00	Reddish Brown fine to coarse grained silt sand stone soft Rock		3.00m	Rock	—	—	—	—	87.85	87.85	
4.50	—— DO ——		4.50m	Rock	—	—	—	—	50.66	13.33	
6.00	—— DO ——		6.00m	Rock	—	—	—	—	42.66	23.33	
7.50	—— DO ——		7.50m	Rock	—	—	—	—	24%	9.33	
9.00	—— DO ——		9.00m	Rock	—	—	—	—	51.33	42.66	
10.00	—— DO ——		10.00	Rock	—	—	—	—	95%	90%	

Signature of Site Engineer

Signature of Client

BNT-04

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project : NTPC	Started on : 28/02/24
Method of Boring : Hydrolic	Completed on : 29/02/24
Location : Ramagundam (Telagana)	Chainage :
BH-No. DBH-24	Water Table : 1.40 mtr
Depth of Termination : 10.00 mtr	Reference Level : 146.096
Casing : 1.50 mtr	Co-ordinates : E:- 2892 N:- 1315

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
0.00	Brownish fine to very fine silty clay with some gravel filled up soil (0.00m to 0.40m)		0.00m	DS	—	—	—	—			
1.50	Brownish fine to fine silty sand (0.40m to 1.60m)		1.50	SPT / DS	50 / 6cm	>	>	R			
3.00	Reddish Brown fine to coarse grained silt sand stone soft Rock		3.00	Rock	—	—	—	—	14.28	0.00	
4.50	—— Do ——		4.50	Rock	—	—	—	—	34.66	0.00	
6.00	—— Do ——		6.00m	Rock	—	—	—	—	81.33	0.00	
7.50	—— Do ——		7.50m	Rock	—	—	—	—	80.66	0.00	
9.00	—— Do ——		9.00m	Rock	—	—	—	—	48%	0.00	
10.00	—— Do ——		10.00m	Rock	—	—	—	—	24%	0.40	

Signature of Site Engineer

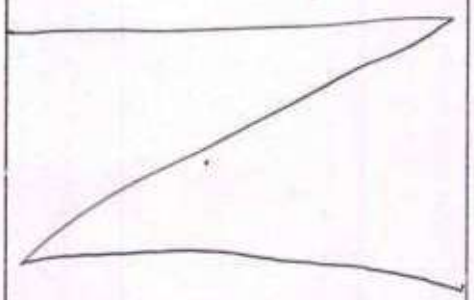
Signature of Client

BNT-06

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project: NTPC	Started on: 26/02/24
Method of Boring: Hydrolic	Completed on: 27/02/24
Location: Ramagundam (Telangana)	Chainage:
Bh No. DBH-25	Water Table: 1.25 mts
Depth of Termination: 15.00 mts	Reference Level: 145.850
Casing: 1.50 mts	Co-ordinates: E-2956 N:- 1322

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
0.00	Brownish fine to coarse grained sandy ~~clay~~ silt with some gravel (0.00m to 0.70m)		0.00m	DS	—	—	—	—			
1.50	Reddish Brown fine to coarse grained sand stone soft Rock		1.50m	Rock	—	—	—	—	58.75	0.00	
3.00	DO		3.00m	Rock	—	—	—	—	96%	34.66	
4.50	DO		4.50m	Rock	—	—	—	—	46%	20.66	
6.00	DO		6.00m	Rock	—	—	—	—	~~94.66~~	~~38.33~~	
7.50	DO		7.50m	Rock	—	—	—	—	95.33	~~38.66~~	
9.00	DO		9.00m	Rock	—	—	—	—	~~68.66~~	~~14.66~~	20.66
10.50	DO		10.50m	Rock	—	—	—	—	~~58.33~~ 83.33	~~15.33~~ 14.66	
12.00	DO		12.00m	Rock	—	—	—	—	~~83.33~~ 53.33	15.33	
13.50	DO		13.50m	Rock	—	—	—	—	90%	20%	
15.00	DO		15.00m	Rock	—	—	—	—	52.66	34%	



Signature of Site Engineer

Signature of Client

BH-26
BNT-01

Cordinate N – 1314
E – 3029

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project :- NTPC
Method of Boring :- Hydraulic Drilling
Location :- Ramagundam
BH-No. - 26
Depth of Termination :- 15.00 mt
Casing :- 3.00 mt

Started on : 27-02-24
Completed on - 27-02-24
Chainage : -
Water Table : 1.50 mt
Reference Level : 146.031

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R.%	RQD	Remark
0.00 ↓ 0.50	Brownish red light fine grained clayey sand with o.g. filled up (0.00 to 0.50) mt		0.00	DS							
↓ 1.50	Reddish brown light Coarsed to fine grained clayey sand (0.50 to 1.50) mt		1.50	SPT	14	25	31	56			N.R SPT
↓ 4.00	Reddish brown light Coarsed to fine grained clayey sand with soft rock (1.50 to 4.00) mt		3.00	UDS SPT	17	27	50/7cm	>100			N.R UDS
↓ 4.50	Reddish brown light Coarsed to fine grained sand stone and fracture rock (4.00 to 4.50) mt		4.50	Rock	-	-	-	-	38.00		
6.00	Do		6.00	Rock SPT	38	50/7cm	>	100			
7.50	Do		7.50	Rock	-	-	-	-	36.00		
9.00	Do		9.00	Rock	-	-	-	-	56.66		
10.50	Do		10.50	Rock	-	-	-	-	64.00		

Signature of Site Engineer

Signature of Client

DBH-26
BNT-01

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project : - NTPC	Started on :- 27-02-24
Method of Boring : Hydraulic Drilling	Completed on :- 27-2-24
Location : - Ramagundam	Chainage :
BH-No. - 26	Water Table : 1.50 mt
Depth of Termination : - 15.00 mt	Reference Level : 146.031
Casing : - 3.00 mt	

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
10.50 ↓ 12.00	Redish brown light coarsed to fine grained Sand Stone and fracture rock (10.50 to 12.00)		12.00	Rock/SPT	50/5cm	>	>	100	22.00		
13.50	—— Do ——		13.50	Rock	–	–	–	–	48.00		
15.00	—— Do ——		15.00	Rock/SPT	50/4cm	>	>	100	13.33		N.R/SPT

Signature of Site Engineer — Signature of Client

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project : NTPC	Started on : 27/02/24
Method of Boring : Hydrolic	Completed on : 28/02/24
Location : Ramagendam (Telangana)	Chainage :
BH-No. DBH-27	Water Table : 1.05 mts
Depth of Termination : 10.00 mts	Reference Level : 146.223
Casing : 1.50 mts	Co-ordinates : E1-2880 N1-1275

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
0.00	greyish Brown fine to very fine grained silty sand with clay and some gravel filled up soil (0.00 mts to 0.30 m)		0.00 m	DS	–	–	–	–			
1.80	Reddish Brown fine to coarse grained sand stone soft stone (0.30 mts to 1.60 m)		1.50	SPT	50/05cm	–	–	R			
3.00	Reddish Brown fine to coarse grained sand stone soft Rock		3.00 m	Rock	–	–	–	–	13.57	0.00	
4.50	——— DO ———		4.50 m	Rock	–	–	–	–	36%	7.3	
6.00	——— DO ———		6.00 m	Rock	–	–	–	–	53.33	19.33	
7.50	——— DO ———		7.50 m	Rock	–	–	–	–	26.66	13.33	
9.00	——— DO ———		9.00 m	Rock	–	–	–	–	54%	54%	
10.00	——— DO ———		10.00 m	Rock	–	–	–	–	39%	34%	

Signature of Site Engineer

Signature of Client

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project : NTPC	Started on : 27/02/24
Method of Boring : Hydrolic	Completed on : 27/02/24
Location : Ramagundam (Telangana)	Chainage :
BH-No. : DBH-28	Water Table : 1.40 mts
Depth of Termination : 10.00 mts	Reference Level : 145.815
Casing : 1.50 mts	Co-ordinates : E:- 2933 N:- 1252

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
0.00	Brownish fine to fine grained silty sand with gravel (0.00 to 1.20 m)		0.00m	DS	—	—	—	—			
1.50	Reddish Brown fine to coarse grained sand stone soft Rock		1.50m	Rock	—	—	—	—	93.33	0.00	
3.00	——— DO ———		3.00m	Rock	—	—	—	—	12.66	0.00	
4.50	——— DO ———		4.50m	Rock	—	—	—	—	76.66	76.66	
6.00	——— DO ———		6.00m	Rock	—	—	—	—	55.33	37.33	
7.50	——— DO ———		7.50	Rock	—	—	—	—	29.66	21.33	
9.00	——— DO ———		9.00	Rock	—	—	—	—	86.66	86.66	
10.00	——— DO ———		10.00	Rock	—	—	—	—	55%.	15.33	

Signature of Site Engineer

Signature of Client

E-2998
N-1244

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project : NTPC	Started on : 26/12/24
Method of Boring : Hydraulic Machine	Completed on : 26/12/24
Location : Ramagundam	Chainage :
BH-No. - DBH-29	Water Table : 1.45M
Depth of Termination : 15.00M	Reference Level : 146.068
Casing : 2.50M	

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
0.00	Brownish fine to fine silty Sandy clay with gravel. (0.00 to 1.00M)		0.00	DS	—	—	—	—			
1.50	Reddish Brown fine to fine silty soft Rock		1.50	Rock	—	—	—	—			
3.00	—— DO ——		3.00	Rock	—	—	—	—			
4.50	—— DO ——		4.50	Rock	—	—	—	—			
6.00	—— DO ——		6.00	Rock	—	—	—	—			
7.50	—— DO ——		7.50	Rock	—	—	—	—			
9.00	—— DO ——		9.00	Rock	—	—	—	—			
10.50	—— DO ——		10.50	Rock	—	—	—	—			
12.00	—— DO ——		12.00	Rock	—	—	—	—			
13.50	—— DO but Soft Rock — (some clay)		13.80	Rock / SPT / DS	51/4cm	>	>	>100			N1 RSPT
15.00	—— DO ——		15.00	Rock	—	—	—	—			

Signature of Site Engineer: Vinay Kr. Singh.

Signature of Client

DBH30

BRT-5

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project : NTPC	Started on : 14/02/2024
Method of Boring : Hydraulic Drilling	Completed on : 19/3/2024
Location : Ramagundam	Chainage :
BH-No. DBH30	Water Table : 2.30 M (12/3/24)
Depth of Termination : 9.00m	Reference Level : 145.529
Casing : 1.50M	E-2857, N-1225

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
0.0	Redish Brown fine to very fine grained Sand and ~~Soil~~ soft Rock. with clay. (0.0m TO 0.80m)		0.0	DS	—	—	—	—	—	—	—
			1.50	Rock	—	—	—	—	67.14	0.0	
1.50	Redish Brown fine to Coresed grained sandstone Rock.										
3.0	← DO →		3.00	Rock	—	—	—	—	66.66	47.37	
4.5	← DO →		4.50	Rock	—	—	—	—	70.00	70.00	
6.0	← DO →		6.00	Rock	—	—	—	—	82.66	72.0	
7.50	← DO →		7.50	Rock	—	—	—	—	89.33	86.66	
9.0	← DO →		9.00	Rock	—	—	—	—	87.33	74.0	

Signature of Site Engineer

Signature of Client

Bhoomi

Water table
⇒ 18/3/24 ⇒ 1.30 M
19/3/24 ⇒ 2.10 M

K.C.T. Consultancy Services®

Project : TELANGANA STPP ST-II

Bore Hole No. : DBH-31 — **Date of Start:** 22-02-2024

Location : ACC U#3 — **Date of Completion:** 23-02-2024

Depth of Termination : 10.0M — **Diameter of Bore:** 150mm and Nx size

Co-ordinates: E 2917, N 1234 — **Bit Used:** Soil Suface Bit and NX Size

Reduced Level: 145.5 m

Depth of Water Table : Encountered at 1.50 m depth during investigation

BORE LOG DATA SHEET

Method of Boring	Depth m	Casing	Notation	Soil Description	Depth of Sample m	Drill Run From m	Drill Run To m	Type of Sample	SPT N Value/Penetration of S.S.S N_1	N_2	N_3	N	Core Recovery (%)	RQD (%)	Remarks
Rotary drilling method	0.00	Used		Reddish brown, fine to medium grained, clayey sand with gravels and fragments of rock **0.00 to 0.90m**	0.00	0.00	0.90	DS	-	-	-	-	-	-	
	0.50														
	1.00														
	1.50				1.50	0.90	1.50	CORE	-	-	-	-	25.00	-	
	2.00			Highly weathered, weak, dark brownish red, fine to medium grained, fractured rock **0.90 to 4.30m**											
	2.50														
	3.00	Not used			3.00	1.50	3.00	CORE	-	-	-	-	33.30	-	
	3.50														
	4.00														
	4.50				4.50	3.00	4.50	CORE	-	-	-	-	34.66	18.66	
	5.00														
	5.50			Highly weathered, weak, dark brownish red, fine to medium grained, rock with moderately close spacing of discontinuties **4.30 to 7.40m**											
	6.00				6.00	4.50	6.00	CORE	-	-	-	-	20.00	8.00	
	6.50														
	7.00														
	7.50			Slightly weathered, weak, dark brownish red, fine to medium grained, massive rock **7.40 to 8.50m**	7.50	6.00	7.50	CORE	-	-	-	-	95.33	89.33	
	8.00														
	8.50														
	9.00			Slightly weathered, moderately weak, dark brownish red, fine to medium grained, massive rock	9.00	7.50	9.00	CORE	-	-	-	-	96.66	90.66	
	9.50														
	10.00				10.00	9.00	10.00	CORE	-	-	-	-	98.00	98.00	
				8.50 to 10.00m											

For KCT Consultancy Services.,

(Dr. K K Thaker)

Fig. No.
( )

K.C.T. Consultancy Services®

Project : TELANGANA STPP ST-II

Bore Hole No. : DBH-32 **Date of Start:** 23-02-2024

Location : ACC U#3 **Date of Completion:** 24-02-2024

Depth of Termination : 10.0M **Diameter of Bore:** 150mm and Nx size

Co-ordinates: E 2961, N 1210 **Bit Used:** Soil Suface Bit and NX Size

Reduced Level: 145.5 m

Depth of Water Table : Encountered at 1.60 m depth during investigation

BORE LOG DATA SHEET

Method of Boring	Depth m	Casing	Notation	Soil Description	Depth of Sample m	Drill Run From m	Drill Run To m	Type of Sample	SPT N Value/Penetration of S.S.S N_1	N_2	N_3	N	Core Recovery (%)	RQD (%)	Remarks
Rotary drilling method	0.00	Used		Light brownish, fine to medium grained, filled up clayey sand with gravels **0.00 to 0.30m**	0.00	0.00	1.50	DS	-	-	-	-	-	-	
	0.50			Dark brownish red, fine to very fine grained, silty clayey sand and highly weathered, completely fractured and disintegrated, dark brownish, red, fine to very fine grained, fractured rock fragments **0.30 to 1.50m**											
	1.00														
	1.50				1.50	1.50	1.60	SPT	50/6 cm	-	-	>100	-	-	
	2.00			Highly weathered, moderately weak, dark brownish red, fine to very fine grained, rock with close spacing of discontinuties **1.50 to 4.30m**											
	2.50														
	3.00				3.00	1.60	3.00	CORE	-	-	-	-	51.42	8.57	
	3.50														
	4.00														
	4.50			Moderately weathered, moderately weak, dark brownish red, fine to very fine grained, rock with moderately close spacing discontinuties **4.30 to 6.30m**	4.50	3.00	4.50	CORE	-	-	-	-	76.66	26.66	
	5.00														
	5.50														
	6.00	Not used			6.00	4.50	6.00	CORE	-	-	-	-	63.33	16.66	
	6.50														
	7.00														
	7.50			Slightly weathered, moderately weak, dark brownish red, fine to medium grained, massive rock	7.50	6.00	7.50	CORE	-	-	-	-	98.00	76.00	
	8.00														
	8.50														
	9.00				9.00	7.50	9.00	CORE	-	-	-	-	82.66	72.00	
	9.50														
	10.00				10.00	9.00	10.00	CORE	-	-	-	-	75.50	62.00	
6.30 to 10.00m															

For KCT Consultancy Services.,

(Dr. K K Thaker)

Fig. No.
( )

Machine no - BNT-04

DBH-33

K.C.T CONSULTANCY SERVICES, AHMEDABAD

Project : NTPC	Started on : 21-02-2024
Method of Boring : Hydraulic Drilling.	Completed on : 22-02-2024
Location : Ramagundam	Chainage :
BH-No. DBH-33	Water Table : 1.10mtz
Depth of Termination :	Reference Level : 145.733
Casing : 3.0m	coordinates - E-2887 N-1196

Depth in m	Description	Drill Run Time	Depth of Sample in m	Types of Sample	N1	N2	N3	N Value	C.R. %	RQD	Remark
0.0	Redish Brown fine to very fine grained size. sandy clay with Boldars and gravels. (Filledup) 0.0m to 0.40m		0.0	DS	—	—	—	—	—	—	—
1.5	Brownim grey fine to very fine grained ~~silty~~ Sandy clay with gravels and soft Rock (0.40m to 1.90m)		1.50	SPT	62	38/4cm	—	>100 (R)	—	—	—
3.00	Redish Brown fine to Coresed grained Sandstone Rock		3.00	Rock/SPT	50/3cm	—	—	>100 (R)			N/R SPT
4.50	← DO →		4.5	Rock	—	—	—	—			
6.0	← DO →		6.00	Rock	—	—	—	—			
7.50	← DO →		7.50	Rock	—	—	—	—			
9.00	← DO →		9.00	Rock/SPT	50/3cm	—	—	>100 (R)			N/R SPT
10.5	← DO →		10.5	Rock	—	—	—	—			
12.0	← DO → 1.90m to 12.80m		12.50	Rock/SPT	50/3cm	—	—	0/100 (R)			N/R SPT
13.5	← DO → soft sandstone with sandy clay 12.80 to 13.60m		13.5	Rock/SPT	50/11cm	—	—	>100 (R)			—
15.0	← DO →		150	Rock	—	—	—	—			

Signature of Site Engineer

Signature of Client