2X800 MW DVC KODERMA STPP STAGE-II

TECHNICAL SPECIFICATION
FOR
INDUCED DRAFT COOLING TOWER

BOOK 2 OF 2

(CIVIL SPECIFICATION)

SPECIFICATION No. PE-TS-519-165-W001
REV NO. 00

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA, INDIA

INDEX

SCOPE OF WORKS

SCOPE OF THIS PACKAGE COVERS THE FOLLOWING:

1	Complete civil works including excavation, shoring, dewatering, backfilling, concrete work including casing, sidewalls, top deck, recovery stacks at tower fans outlet, foundations (including Piling, if required), cold water basins, sludge pit for each basin section, staircase at both ends of cooling tower, all other staircases / ladders as required, doors and their frames, walkways, platforms, hand railing, water-proofing, finishing and all other incidental civil works including earth work for grading, removal of surplus soil to a space decided by the engineer, shuttering, steelworks for reinforcement etc
2	The scope of the work for cooling tower shall include preparation of detailed design and construction drawings, submission of design basis report, calculation of BOQ against drawing submitted, complete all as required to give satisfactory performance and as stipulated in various clauses in this document/ specification.
3	Bidder shall also submit all drawings in AutoCAD format along with PDF files. All excel sheets depicting all formulae used in calculations, structural analysis files and other files used in detail design shall also be submitted in executable form along with design documents. Overall quantities for cooling tower as a whole shall also be prepared and submitted.
4	In case, STAAD.Pro software is not used for carrying out structural analysis of Tower, a licensed version of the used software shall then be installed in BHEL computer (to enable review of document) along with submission of all the related design and calculation files.
5	Bidder has the freedom of proposing both RCC as well as FRP cooling towers. In case FRP cooling tower is selected, official copies of Indian standards (IS) pertaining to analysis and design of FRP towers used in design shall be submitted to BHEL.
6	The specification covers general requirements of materials, design and testing of RCC/ FRP works, structural works and finishing work etc. involved in the design of Reinforced Concrete/ FRP Induced Draft Cooling Tower. This document is not exhaustive. Relevant codes and standard practices to be followed by bidder where ever required, not conflicting with the provisions of this specification, for delivering performance as per the satisfaction of owner.
7	Various plant facilities are envisaged around IDCT area which may or may not have interface with IDCT system. Bidder is required to establish that the conceptualised IDCT is in sync with these facilities. These facilities include but not limited to storm water drainage system, sewerage discharge, effluent discharge, foundations of nearby structures etc. Bidder drawings shall be prepared so as the other facilities are not affected.
8	Any other design, drawing etc. if required for completion of the system but not mentioned above shall also be included in the scope of bidder.

CIVIL TECHNICAL REQUIREMENTS

1	The cooling tower shall be capable of cooling the rated quantity of water through the specified thermal range at the design wet bulb temperature and it shall conform to the other design parameters as stipulated in mechanical section of this document.
2	Bidder shall submit detail design calculation and construction drawings to BHEL for obtaining approval from DVC prior to commencement of work at site.
3	All the material specification and design criteria mentioned here shall be read in conjunction with the customer specification.
4	**CODES AND STANDARDS:**
4.1	**MATERIALS:**
4.1.1	IS: 432 Mild steel and medium tensile steel bars. (parts1&2) and hard drawn steel wire for concrete reinforcement.
4.1.2	IS: 1785 Plain hard drawn steel wire for pre-stressed (parts 1 & 2) concrete.
4.1.3	IS: 1786 High strength deformed steel bars and wires for concrete reinforcement.
4.1.4	IS: 2062 Steel for general structural purposes.
4.1.5	IS: 3589 Seamless or electrically welded steel pipes for water, gas & sewage (168.3mm- 2032mm).
4.1.6	IS: 8112 43 Grade Ordinary Portland cement.
4.1.7	IS: 12330 Sulphate resisting Portland cement.
4.2	**CODES OF PRACTICE**
4.2.1	IS: 456 Code of practice for plain and reinforced concrete.
4.2.2	IS: 800 Code of practice for general construction in steel.
4.2.3	IS: 875 Code of practice (part 1 to 5) for design loads other than earthquake for building and structures.
4.2.4	IS: 1080 Code of practice for design and construction of simple spread foundations.
4.2.5	IS: 1343 Code of practice for pre-stressed concrete
4.2.6	IS: 1893 Criteria for earthquake resistant design of structures.
4.2.7	IS: 2309 Code of practice for the protection of buildings and allied structures against lightning.
4.2.8	IS: 2629 recommended practice for hot dip galvanizing on iron and steel.
4.2.9	IS: 2950 Code for practice for design and (part 1) construction of raft foundation.
4.2.10	IS: 3043 Code of practice for earthing.
4.2.11	IS: 3370 Code of practice for concrete structures (part 1 to 4) for storage of liquids.
4.2.12	IS: 12200 Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams.

4.2.13	BS: 8007 B.S. Code of Practice for design of concrete structures for retaining aqueous liquid.
4.2.14	IS 13920 : 1993 Ductile detailing of reinforced concrete structures subjected to seismic forces — code of practice.
4.2.15	IS: 1904 Code of practice for design and construction of foundations in soil: General
4.2.16	IS: 2950 (PART-1) Code of practice for design and construction of raft foundations - design.
4.3	**CODES FOR STOP-LOGS AND TRASH RACK:**
4.3.1	IS: 4622 Recommendations for fixed - wheel gates structural design.
4.3.2	IS: 5620 Recommendations for structural design criteria for low head slide gates.
4.3.3	IS: 11388 Recommendations for design of trash rack for intakes.
4.3.4	IS: 11855 General requirements for rubber seals for hydraulic gates.
4.4	**CODES AND STANDARDS FOR FRP COMPONENTS**
4.4.1	The design of FRP components of cooling tower shall comply with the requirements stipulated below mentioned standards. The cooling tower and its components shall be designed to withstand the most onerous loading case / combination resulting from the various loading cases / combinations stipulated in CTI ESG 152.
4.4.2	All material properties, stresses and their reduction factors, deflection criteria, material service factors, connection details and their tolerances etc., as applicable as per CTI codes CTI STD- 131, CTI STD -137, CTI ESG-152, shall be so considered such that the cooling tower and its components withstand the severest temperatures in the place of installation and application and serve a reasonably long life not less than CTI indicated life expectancy.
4.4.3	Following is the list of few codes/ standards to be followed for FRP cooling tower design:
4.4.3.1	CTI STD – 131 : Fiberglass-Reinforced Plastic Panels
4.4.3.2	CTI STD – 137 : Fiberglass Pultruded Structural Products for Use in Cooling Towers
4.4.3.3	CTI ESG – 152 : Structural Design of FRP Components
4.4.3.4	CTI STD – 203 : Industrial Cooling Tower Standard
4.4.3.5	ASCE 7 -10 : Minimum design loads of buildings and other structures. (as per CTI ESG – 152)
4.5	The applicability of the provisions for conformity to the various codes and standards stipulated shall be in the following order:
4.5.1	Bureau of Indian Standards.
4.5.2	British Standards Institution.
4.6	Wherever the above standards are in conflict with the stipulations of this specification, the technical specification shall govern.
5	**FOUNDATION OF COOLING TOWER**

5.1	For all major foundations, the minimum founding depth and the minimum size of foundation shall be as per foundation system specified elsewhere in the specification and geotechnical data.
5.2	For open foundations, the total permissible settlement shall be as per the criteria furnished under the foundation system specified elsewhere in this specification.
5.3	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.
5.4	No major foundation shall rest on filled up soil. Loose soil if any below foundation is to be removed and replaced with PCC (1:4:8)
5.5	Owner had carried out geo-technical investigation in the proposed cooling tower site. The sub-strata details encountered at some bore holes in the cooling tower area are enclosed under Geo-technical investigation & foundation system chapter.
5.6	The geotechnical data attached shall be solely for the purpose of guidance to the bidder. BHEL/owner does not take any responsibility about the accuracy and applicability of the geo-technical data furnished herewith.
5.7	The onus of correct assessment/ interpretation and understanding of the existing sub-strata conditions is on the bidder. Any variation in the data between the one furnished and to that found during execution of the work at site shall not constitute a valid reason in affecting the terms & conditions of this bid and the bidder shall note that nothing extra will be payable on this account.
5.8	The bidder shall fully satisfy himself about the nature of sub-strata expected to be encountered including the type of foundation, ground water table and construction methodology to be adopted etc prior to the submission of the bid.
5.9	Detailed geo-technical Investigation report shall be made available to the successful bidder during contract engineering stage.
5.10	If the bidder desires to carry out additional geo-technical investigation he/she may do so with prior information/ permission of BHEL/owner at no extra cost to BHEL/owner. No extension in time schedule shall be permitted on this account.
5.11	The bidder shall obtain approval on the agency for conducting geo-technical investigation work, field and laboratory testing schedule proposed by the bidder etc from BHEL/owner before undertaking the geo-technical investigation work.
5.12	However, the net safe bearing capacity (SBC) of shallow foundation to be adopted for the design of foundations during detailed engineering shall be limited to the values mentioned elsewhere in the specification and any value of net SBC higher than the one indicated shall not be accepted. However, bidder shall note that the net safe bearing capacity and foundation depth to be adopted for design during detailed engineering stage shall be got approved by BHEL/owner.

6	**CONSTRUCTION JOINTS:** The number of construction joints shall be kept as low as possible consistent with reasonable precautions against shrinkage. Concreting shall be carried out continuously up to construction joints.
7	**FRP STRUCTURE:** Design criteria for FRP cooling tower shall be as specified elsewhere in the mechanical specification. However, design has to be strictly carried out as per relevant codes and standards.
8	**LOADING:** For consideration of loads on structures and load combinations IS: 875 (Part -1 to 5) Code of Practice for design loads (other than Earthquake) for Buildings and Structures shall be followed. Site specific seismic data and wind data shall be followed for design of cooling towers.
9	**LIVE LOADS:** The following live loads (minimum) shall be adopted for the design of buildings and structures Associated with Cooling Towers:
9.1	Roof / Fan deck 500 Kg / Sq. M.
9.2	RCC Floors 500 Kg / Sq. M.
9.3	Stair, landings 500 Kg / Sq. M.
9.4	Chequered & Grating floor 400 Kg / Sq. M.
9.5	Basin, sump and duct Earth pressure; water pressure as applicable and additional surcharge load of 2.0 T/Sq. M.
9.6	Covers for H.W. channels / H.W. distribution basin 300 Kg / Sq. M.
9.7	Walkways inside cooling towers 300 Kg / Sq. M.
9.8	Underground pipes and ducts Earth pressure and surcharge load of 2.0 T / Sq. M.
10	**MISCELLANEOUS WORK:**
10.1	Concrete structures, floors and foundation coming in direct contact with acid/alkalis/other Corrosive chemicals shall be provided with lining/treatment.
10.2	Concrete structures, floors and foundations indirectly affected by acid/acidic fumes shall be treated with appropriate acid proof treatment in line with customer specification.
10.3	All concrete surfaces subject tow water/water spray/moist air except exterior surface shall be applied with high build heavy duty polyurethane coating having formulation of 100 % solids, solvent free over proper cleaned and complete dried surface.Thickness of polyurethane coating shall be 2.0mm.
10.4	Exterior surface of cooling tower shall be coated with one coat of High performance moisture compatible corrosion resistant coating system minimum of 150 micron as per Annexure-G followed by finish coat of two pack aliphatic isocyanate cured acrylic finish paint with gloss retention and minimum 70 micron DFT.

10.5	For all underground structures and water retaining structures special care shall be taken to water-proof them and water proofing shall conform to provision of relevant IS standards or as per the specifications of approved manufacturer. Water-tightness shall be ensured by provision of PVC water bars of approved type with all necessary fittings and clippings to keep it in position during concreting. Water proofing compound as admixtures must be used in concrete.
10.6	Internal surface of all water retaining structures shall be plastered in line with requirement mentioned in customer specification.
10.7	Any surface treatment required for RCC structure not covered here shall be provided as mentioned elsewhere in the customer specification.
10.8	BHEL has developed a Technical specification for excavation, construction, erection etc of RCC & Steel structures.Bidder shall comply with this specification during execution.
10.9	Latest amendment shall supercedes previous one on same subject matter.
10.10	Backfilling/Filling upto finished ground level shall be done by bidder.

DAMODAR VALLEY CORPORATION

KODERMA THERMAL POWER STATION
PHASE-II (2x800 MW)

TECHNICAL SPECIFICATION

FOR

EPC PACKAGE

PART –B

(BOOK 4 OF 5 – CIVIL WORKS)

SECTION - VI

BIDDING DOCUMENT NO.: DVC/C&M/Engineering/KTPS(2X800 MW)/EPC/IPHB

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

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

5.01.00 **Architectural Concepts &Design:**

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

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

c) All buildings and structures shall be architecturally treated in such a way that completes the 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 considering 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 shall be designed to take care of rainwater harvesting & ground water recharging. Development of rainwater harvesting scheme for the project and obtaining approval of the scheme from Central Ground water board is in bidder's scope

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

paneling for housing LVS.

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

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

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

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

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

Passages shall be provided inside the FGD area connecting to the outer periphery road to have access to the various facilities/buildings. These passage areas shall be provided with heavy duty paving for movement of heavy vehicles. The top surface of the passages shall be finished with 50 mm thick metallic hardener topping. Heavy duty paving shall also be provided for the areas in the equipment lay down area, unloading & maintenance area, storage area with 50 mm thick metallic hardener topping.

Lightly loaded areas such where no heavy traffic movement is envisaged shall be provided with Normal Duty paving. However, corridors below pipe/cable trestle gallery where no traffic movement is envisaged and in the area over the buried fire water pipes shall be provided with interlocking concrete blocks of minimum M35 grade and minimum 80 mm thickness underlain by 20mm thick layer of sand followed by 200mm thick 63 mm and down aggregate with interstices filled with selected moorum/ non-expansive soil.

All facility/buildings shall be provided with 750 mm wide plinth protection all around. It consists of 50 mm thick P.C.C. M-20 grade with 12 mm maximum size aggregate over 200 mm thick stone soling using 40 mm nominal size rammed, consolidated and grouted with fine sand.

An area of minimum 7.5m width all around the tank foundations and other facilities/buildings shall be paved. This paving shall be beyond the extent of plinth protection. Further, heavy duty paving shall be provided for passages connecting the outer periphery road to have access to the various facilities/buildings.

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

GRADE SLAB OF BUILDINGS AT GROUND FLOOR

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

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

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

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

5.13.00 **AREA PAVING**

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

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

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

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

	Ground floor area in the ESP envelope shall be provided with normal duty paving with neat cement punning. Wherever paving is envisaged to be provided, RCC paving shall be provided. However, corridors below trestle where no traffic movement is envisaged and in the area over the buried fire water pipes shall be provided with interlocking concrete blocks of minimum M35 grade and minimum 80 mm thickness underlain by 20mm thick layer of sand followed by 200mm thick 63 mm and down aggregate with interstices filled with selected moorum/ non-expansive soil. All other areas inside the Main plant block shall be provided with normal duty paving without metallic hardener topping. Suitable open RCC drains shall be provided to dispose off storm water drain. Separate open RCC drains shall be provided to dispose off floor wash and plant effluents into RCC sump pits. Separate RCC sump pits shall be provided for different types of effluents. The paving shall be provided with slope of 1:500 to dispose the surface water/wash water to the nearest drain. All drains/pits shall be provided with Heavy duty electro forged GI grating cover. Sewer lines (Cast Iron), interconnected by sewer manholes (RCC) at regular intervals (not exceeding 30 metercentre to centre) shall be provided to dispose off sewage from main plant block. For the purpose of area paving, Main plant block is defined as the entire area enclosed between peripheral roads encompassing the Transformer yard area, Main Plant Building area, *Service Building area,* Boiler area, ESP area, Chimney area & FGD area.
5.13.01	**Ground Floor Slab of Buildings** In all buildings including main plant building, the ground floor slab shall consist of minimum 150mm thick RCC M25 grade base slab over an under bed as specified below. The under bed for ground floor slab shall consist of 75mm thick 1:4:8 PCC on stone soling of 200mm compacted thick with 63 mm and down aggregate with interstices filled with well graded selected sand/ moorum/ non-expansive soil on compacted and dressed sub - grade. Reinforcement for the slab shall consist of minimum 8mm diameter bars @ 200 mm c/c at top & bottom of the slab in both directions. However, at passages, unloading & maintenance bays, stone soiling of minimum 400mm thick and minimum 10mm diameter bars @ 200 mm c/c at top and bottom in both directions shall be provided. Further, top surface of ground floor slabs shall be finished with 50mm thick metallic hardener topping.
5.13.02	**Civil Works for Fire Detection & Protection System in Ground Floor/ Paving** Fire water pipes shall be provided with either RCC trench/buried underground/on pedastal. Fire water trenches shall be open RCC type trench with removable RCC cover. RCC valve pit alongside trenches and RCC fire trenches crossing drains shall also be provided as per requirement. Interlocking concrete block paving shall be provided over the buried fire water pipes as specified elsewhere in the specification. At road/ drain crossings, NP3 class hume pipe encased in RCC shall be provided as per requirement at a depth of minimum 1m from FGL for routing of fire water pipes. In case of rail crossings, NP4 class hume pipe encased in RCC shall be used instead of NP3 class hume pipe. Each of the outdoor deluge valve and accessories shall be provided with housing comprising of Brick wall and RCC roof.
5.14.00	**VOID**
5.15.00	**VOID**

5.17.00 **Induced Draft Cooling Towers**

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

5.17.01 Cooling Tower Basin

The basin of the cooling tower for collection of cold water shall be made of Reinforced Cement Concrete (RCC M - 30 grade as per IS: 456). The floor of the basin shall be sloped to minimum 1 in 80 towards the sludge drains. The required slope shall be achieved by screed concrete of grade M-15 as per IS:456 having minimum thickness at edge as 25 mm. Drainage arrangement of basin shall be as specified elsewhere in the Technical Specifications. If the cooling tower basin and sludge sump is below ground level, FRP hand railing shall be provided all around the cooling tower basin and sludge sump pit. The bottom 500 mm of hand railing shall also have FRP/PVC wire mesh with opening size of 50mm grid to avoid ingress of leaves, vegetation, and debris into the basin. The basin shall be tested for water tightness as per IS:3370.

Bottom of the lowest level beam shall be at least at free board level. In case, the beams are provided into the water, the same shall be designed for un-cracked section as per IS:3370.

The outlet channel shall be covered on top with removable precast concrete slabs for about 5m length from cooling tower basin and the entire length of cold water outlet channel shall be provided with 32 NB (Medium) G.I pipes. Hot water duct around cooling towers, if placed below ground shall be encased with min. 500mm thick PCC (M20 grade).

a) Foundation of Cooling Tower

The foundation of the Cooling Tower shall be as detailed out elsewhere in the specifications.

b) Super Structure of Cooling Tower (applicable in case of RCC cooling tower)

Columns, beams and other structures like tie beams, slabs etc. shall be of reinforced cement concrete of grade M-30 (minimum) as per IS : 456. Uniform concrete grade shall be used for the entire cast-in-situ reinforced concrete superstructure.

The fan deck slab shall be properly sloped so that rain water does not accumulate over the deck slab. The slope shall be 1 : 120 (min.). The slope shall be provided with screed concrete of grade M-15 (minimum) as per IS : 456.. Fan Deck slab and all other over ground platforms shall be provided with FRP handrailing. Suitable arrangement for drainage of rain water to be provided. However, there is no specific requirement of Rain Water down comers.

c) Cells, Distribution System and Stack (applicable in case of RCC cooling tower)

Cooling tower cells shall consist of RCC columns, beams and walls. The spacing of columns shall be minimum 4000 mm c/c. Inclined bracings shall not be provided between the columns. Hot water distribution channel shall also be of RCC. Cell division partition walls shall be of precast solid concrete blocks with provision of pilasters for walls, if required. The peripheral wall shall be Cast-in-Situ RCC wall and shall have two layers of reinforcement on either faces in both directions with minimum dia of reinforcement bars as 8 mm and maximum spacing as 150 mm c/c. Minimum thickness of Cast-in-Situ RCC peripheral walls shall be 200 mm.

Hot water channel shall be covered with suitably designed precast / cast - in - situ concrete slab. Wherever flow control valves are located over hot water basin, these shall be placed over precast concrete covers / concrete slab and designed for specified load. The minimum thickness of RCC fan stack shall be 150 mm. The fanstack shall have two layers of

reinforcement on either faces in both directions with minimum dia of reinforcement bars as 8mm and maximum spacing as 200mm c/c.

d) Stairs

RCC staircase for approach to fan deck for each cooling tower shall be provided. The stairs shall have 1000 mm clear width and FRP hand railing. The riser shall be maximum 175 mm & treads 250 mm (minimum). Edge protection angle (min 35X35X6, made of aluminum) shall be provided to the treads with the lugs.

e) Steel Structures

All mild steel parts of structures used in cooling towers shall be hot dip galvanized or seal spray zinc coated as per BS:5493 (for a very long period of maintenance of more than 20 years). The minimum coating for galvanization shall be 610 gm/sq.m and shall comply with relevant IS Codes. Galvanizing shall be checked and tested in accordance with IS: 2629. All welding shall be done before galvanizing. Any site joints required to be carried out after galvanizing shall be either flanged or screwed joints. Nails, nuts, bolts and all components coming in direct contact with water shall be of stainless steel of SS 316.

f) Water proofing of structures and construction joints

For water proofing of underground structures including basin slab and hot water distribution channel, water proofing cum plasticizer compound shall be mixed with the concrete. In addition Chemical injection treatment shall be provided for the construction joints of all underground structures.

g) Expansion Joints

PVC sealing strips shall be used for all expansion joints where water is retained. The minimum thickness of PVC sealing strip will be 6 mm (minimum) and minimum width 225 mm. The expansion joint shall be as per IS: 3370. At expansion joints, joints filler material with sealing compound on both sides shall be provided throughout the length of the joint.

h) Grade of concrete

All RCC associated with induced draught cooling towers including switchgear and control room, unless specified otherwise, shall be design mix (controlled) concrete of grade M 30 of IS: 456. Water - cement ratio shall not exceed 0.45.

Minimum 75 mm thick PCC of grade M-7.5 as per IS: 456 shall be provided as mud mat below foundation unless specified otherwise. The PCC shall extend 75 mm beyond the outer edge of structural concrete.

For water retaining structure minimum 100 mm thick PCC of grade M-10 as per IS:456 shall be provided as mud mat below the bottom slab / raft. The PCC shall extend 100 mm beyond the outer edge of the structural concrete.

i) Form-Work

Plywood Form-work shall be used for basin, basin walls, outlet channel and super structures.

j) Doors (applicable in case of RCC cooling tower)

FRP door shall be provided in each fan stack at fan deck level. Door height & width as per requirement for equipment movement (clear) shall be provided. However, door size shall be minimum 2100 mm high (clear) & 1200 mm wide (clear). Door shall have locking facility.

k) Coating

All concrete surfaces in direct contact with water/ water spray/moist air shall be applied with Moisture Compatible Corrosion Resistant Coating System or its equivalent as specified in Annexure-G. All concrete surfaces subject to water/ water spray/moist air upto and including Fan Deck slab level including basin slab, inner faces of peripheral walls, all faces of cell partition wall, all faces of columns, all faces of beams (both cast in situ and precast), bottom surface of fandeck slab for counter flow tower and both surface of fandeck slab for cross flow tower, inner face of fanstack, all faces of hot water basin (for cross flow tower), etc as applicable shall receive the said coating after cleaning and drying of the concrete surface. The detailed specification of the coating system on concrete surfaces is given in Annexure-G.

External surfaces of Cooling tower peripheral walls and fanstack shall be painted with two or more coats of waterproof cement paint of approved shade, make and color.

l) Paving

Paving shall be provided for a minimum clear width of 5.0 m from the outer face of the HW pipes all around the cooling tower basin. Paving shall also be provided in between the hot water pipes and space available between HW pipes and CT basin wall spray catcher. The minimum total width of paving around CT basin shall be atleast 8.5 m from outer edge of the spray catcher or basin wall. Paving shall consist of reinforced concrete base slab laid over 75 mm thick PCC of grade M-10 as per IS:456 sub-base and 200 mm thick stone soling. The sub-base shall be laid on the compacted and suitably prepared sub-grade. The degree of compaction of sub-grade shall be as specified elsewhere in the specification. The thickness of the RCC base slab of grade M - 25 shall be suitably designed considering a superimposed load intensity of 5T / Sq.m. However the minimum thickness of base slab shall be not less than 150 mm having double layered reinforcement in both directions both top and bottom. The maximum spacing of the reinforcement bars shall be 150mm c/c and minimum dia of reinforcement bars shall be 8mm.

RCC peripheral drain of minimum cross sectional dimensions 300mm X 300mm to dispose storm water shall be provided around area paving and shall be connected to nearest Owner's storm water drain.

RCC paving all around cooling towers shall be connected to the existing road so as to provide approach to both cooling towers and switchgear & control room building as indicated in tender drawing. The clear width of this approach road shall be 5.5M and top of approach road shall be 350 mm above FGL.

m) Walkways

Permanent walkways at least 1000mm clear width shall be provided at hot water distribution level and at drift eliminator level for counter flow type cooling towers. The clear working height available above these walkways shall be at least 2.0 meters. The walkway and its supporting structure shall be of RCC M - 30 grade. Suitable RCC guards rails 300 mm high shall also be provided on both sides of these walkways. Over the guard rails FRP hand railing shall be provided. The vertical post of handrail shall be 700 mm high and at an interval of 1500mm c/c. There shall be two levels of horizontal pipes for hand railing spaced equally in vertical plane.

Permanent walkways at least 1000 mm clear width shall also be provided for access to fan and around gear box with FRP gratings of clear opening size not more than 50 MM x 50 mm and grating thickness of 50 mm on RCC supports at fan deck Level.

05.17.02 **Design Criteria**

R.C.C. Structures

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

1. Water filled inside upto the designed level and no earth outside.
2. Earth pressure plus 2.0 T / M^2 surcharge (Vertical direction) plus ground water table at Finished Graded ground Level (FGL) outside and no water inside.

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

Wherever, the foundation raft of cooling tower is same as CW basin slab, the foundation shall be designed by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2): 2009 (all faces). However, if the cooling tower foundation is not the same as the CW basin slab and a separate foundation for the cooling tower is provided below the CW basin slab due to founding level requirements, the basin slab shall be designed as a structural slab resting on grid of beams taking support from columns or as a flat slab taking support from columns. Arrangement with providing walls between the columns and the periphery to support the structural basin slab is not permitted. The CW basin slab (both faces, including beams at CW basin slab level) shall be designed as structural slab by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2): 2009 and the structures below CW basin slab shall be designed as per IS:456 (2000). However, the size of the column below CW basin slab upto foundation shall be maintained same as the size of the columns just above CW basin slab.

(c) The design of staircase, switchgear building, control room/RIO room, transformer and trestle foundation, storm water drain shall be as per IS: 456 (2000).

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

(e) Fan deck shall also be designed for rolling loads due to movement of equipment during Installation / maintenance operation.

Minimum Clear cover for all RCC structures/elements of cooling towers to meet durability requirements shall conform to severe exposure condition as per IS: 456 (2000).

Fan Supporting Structures (applicable in case of RCC cooling tower)

Static Analysis & Design

The following load conditions and load combinations shall be considered for the design of the Fan

supporting structures.

(a) Machine Load

(b) Load case (a) + unbalance load for the balance of the fan corresponding to G16 as per ISO 1940-1: 2003

(c) Load case (a) + unbalance load corresponding to one blade failure load condition.

The strength design of the Fan supporting structure shall be done for worst loading combinations as stated above.

Dynamic Analysis

(a) Free vibration analysis

A free vibration analysis of the fan supporting structure including the intermediate supporting structure for motor, gear box and pillow block (if applicable) shall be carried out to calculate the natural frequency of the fan supporting structure and its fundamental natural frequency shall be at least + 20% away from the operating speed of the fan and motor.

(b) Forced vibration analysis

Forced response analysis shall be carried out on the fan supporting structure including the intermediate structure supporting the motor, gear box and pillow block to calculate the vibration amplitudes for the following unbalance condition: -

1. For unbalance load corresponding to G16 as per ISO 1940-1: 2003
2. For unbalance load corresponding to one blade failure condition.

The amplitude derived shall be within the permissible values as specified by the fan manufacturer or IS: 2974 (Part - IV), whichever is more stringent.

Mid Bearing Supporting Structure

The intermediate supporting structure for motor, gear box and pillow block if provided shall be so arranged that it does not cause any torsional moments on the beams / pedestals on which the intermediate support rests. The intermediate supporting structure shall be orthogonal to the grid of beams on which it rests. The motor shall be supported on a base frame. The concrete block supporting the fan/gear reducer shall be connected to immediate lower level of beam column junctions by means of at least four diagonal columns.

Fan Stack

The fan stack shall be made of RCC with minimum 150 mm thickness. With reinforcement provided on both faces in either direction. Design of the fan stack shall be made on the basis of relevant stipulations of IS : 11504 for Natural Draught Cooling Towers. The fanstack shall have two layers of reinforcement on either surfaces in both directions with minimum dia of reinforcement bars as 10mm and maximum spacing as 150mm c/c.

Steel Structure

These structures shall be designed, fabricated and erected as per IS: 800 (latest revision).

All mild steel parts or structural steel works used in the cooling towers shall be hot dip - galvanised as per IS: 4759 with 610gm/sq.m. coating or seal spray zinc coated as per BS:5493 (for a very long period of maintenance of more than 20 years). Nails and all components coming in direct contact with water shall be of stainless steel of SS 316 or equivalent.

For all steel structures, other than hot water pipes, sludge pipes and hot water distribution pipes, which are outside cooling tower painting shall be as specified in corrosion protection clause. However, for

painting of hot water pipes, sludge pipes and hot water distribution pipes, relevant clause for painting specified elsewhere in the technical specification shall be referred.

The minimum cement content as specified in subsequent clauses of this specification shall be applicable for all structures of cooling towers.

Test for water tightness

The water tightness of C.W. basin, outlet channel, CW channel and all other water retaining structures shall be tested for water tightness as per the provisions of IS : 3370.

5.17.03 **Stoplog gates and Trash racks for Cooling Tower**

Stoplog gate and trash rack/screen shall be provided in the outlet channel of each cooling tower. The design criteria and material specification for Stoplog gates and Trash racks shallbe as specified for Circulating Water Pump House.

5.18.01.07 **VOID**.

5.18.01.08 **Stop-logs and Trash Racks for CWPH, RWPH**

5.18.01.08.01 **Stop-log gates**

Clear size of the stop logs shall be equal to the clear opening size of water inlet opening below breast wall. Number of segments of the stop log shall be decided to match the capacity of the electrically operated monorail hoist provided to handle it. Structural design of stop log shall conform to IS: 5620 and IS: 4622. Maximum water level for designing the stop logs shall be taken as maximum water level of the forebay. Top and bottom unit of stop log gates shall be designed for their respective water head, whereas the remaining interchangeable units shall be designed for the water head corresponding to the lower most interchangeable unit. The stop logs shall be operated under balanced water head and they are not to be designed for operating under flowing water. Filling valves shall be provided in the stop logs to balance the water pressure before lifting the stop log. These stop logs are used only during maintenance / inspection of pumps. The stop logs shall be operated by means of an electrically operated hoist. Suitable lifting beam shall be provided to operate the stop logs.

5.18.01.08.02 **Trash Racks**

Bar screen trash rack is to be provided at inlet of the sump of the pump house in order to prevent ingress of timber & other floating particles which could damage the Pumps.

Each bay of pump sump shall be provided with Type - 1 trash rack (removable section rack), conforming to IS: 11388. Centre to centre spacing of trash rack bars shall be 100mm (max). The trash racks shall be provided with number of interchangeable segments, to facilitate easier handling by means of a lifting beam and electrically operated hoist. Trash rack bars shall be designed for a differential water head of 2.0m. and other structural members shall be designed for a differential water head of 1.0m. Minimum thickness of trash rack bars shall be 10mm. Suitable size of horizontal members and end members shall be provided as per design requirements, for efficient operation of trash rack.

All trash racks should be capable of being lowered in the associated stop log groove to enable drawal of clean water while a particular trash rack is raised for cleaning purpose.

Suitable arrangement for storing all the stop logs and stand by trash rack shall be provided by the Bidder, to keep them in good working condition.

5.18.01.08.03 **Lifting Beams**

Separate lifting beams (automatic) shall be designed & fabricated with guide shoes, hooks, links and counter weights etc. complete for automatic operation to engage and disengage the stop logs and trash racks in the required position.

5.18.01.08.04 **Leakage Tests of Stop logs**

Leakage tests shall be carried out with the stop logs lowered onto the sill. Before observation for leakage, the stop log shall be raised and lowered about one meter several times in order to dislodge

any debris that might have lodged in the side and bottom seals, The leakage shall then be measured and it should not be more than 5 litres / minute / meter of length of seal under maximum head.

5.18.01.08.05 **Material Specifications of Stop logs & Trash racks**

All material used in the fabrication of stop log or trash rack shall be of high grade, free from defects and imperfections and shall be of the highest standard commercial quality suitable for the intended use. Radiographic examination or magnetic particle testing or other comparable tests shall be carried out for determining the soundness of steel castings and shall be conducted by the Bidder, if asked for by the Employer.

5.18.01.08.06 **Materials for the various components of Stop logs**

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

5.18.01.08.07 Materials for various components of Trash Rack:

Sl. No.	Component Parts	Recommended	Reference Materials
1.	Trash rack and 1st stage embedded parts	Structural steel	IS 2062
2.	2nd stage embedment	Stainless steel	SS 316L or IS 1570 (Part–5)

3.	Slide Block	Structural steel with bronze padding	IS 2062 & IS 305
4.	Track base	Stainless steel	SS 316L or IS 1570 (Part–5)
5.	Track	Stainless steel	SS 316L or IS 1570 (Part–5)
6.	Guides	Corrosion resistant steel.	IS 6603

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

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

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

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

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

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

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

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

D-1-6 DESIGN CRITERIA

6.01.01 **General**

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

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

6.01.03

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

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

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

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

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

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

6.02.00 **Loading**

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

6.02.01 **Dead loads**

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

6.02.02 **Imposed loads**

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

addition to imposed loads.

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

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

shall be considered)

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

D) Coal, 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 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)
	H) Railway Supporting Structures, Rail Culverts	As per Railway 'Bridge Rules'

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

Notes:

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

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

6.02.03 **Equipment, piping and associated loads**

Equipment loads shall be considered over and above the imposed loads. Equipment loads shall be considered as given by equipment supplier.

6.02.04 **Crane load**

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

6.02.05 **Seismic load**

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

6.02.06 **Wind load**

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

6.02.07 **Temperature Load**

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

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

6.02.08 **Differential Settlement Loads**

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

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

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

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

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

6.02.09 **Additional Loads**

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

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

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

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

(d) Dry Fly Ash Piping Loads.

(e) Ash Water Piping Loads.

(f) Supply Air and Instrument Air Piping.

(g) Service Water Piping

(h) Loads associated with Coal Handling Plant equipment

(i) Loads for Solar installations over roof to be taken not less than 1KN/sqm. Roof slab to be designed 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 stresses for different load combinations shall be taken as per relevant IS and IRS codes.

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

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

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

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

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

l) The Structures shall be Designed for most 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 Stresses.

No reduction in equipment loads, piping loads, ash loads and loads due to other permanent facilities shall be considered for calculation of seismic weight of the building/structure and for load combinations thereof.

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

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

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

6.03.03 Design of steel structures shall be done as per provisions of IS:800: 2007 (Limit state design) and other relevant IS standards including National Building Code (2016). For design of coal/lime stone/biomass bins and loading hopper IS:9178 (part I to III) shall be followed.

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

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

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

6.03.06 For calculation of coal/lime stone/biomass 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/lime stone/biomass load per unit length of each moving conveyor shall be

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

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

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

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

6.03.08.01	All liquid retaining structures shall be designed for following load conditions. Underground structures: a. Water filled inside up to design level and no earth outside. b. Earth pressure with surcharge of 2.0 T/m2 and ground water table up to FGL outside and no water inside. c. Stability against uplift shall be checked for completed structure and under construction stage with no water inside and ground water table up to FGL, with a minimum factor of safety of 1.20 against uplift. Installation of pressure relief valves shall not be permitted in the base slab of any liquid retaining / conveying structure. d. The structure shall also be checked for normal working condition with water filled inside up to design level and earth pressure outside with no effect of surcharge and ground water table. For design of over - ground liquid retaining structures appropriate load cases shall be considered.
6.03.08.02	All liquid retaining structures shall be designed by working stress method as given in clause 4.5 of IS 3370(Part2).
6.03.08.03	In the wall of liquid retaining structures with cylindrical shape such as clarifiers, vertical reinforcement shall be checked assuming the walls were fully fixed at the base, and the horizontal reinforcement shall be provided to resist horizontal (hoop) tension assuming hinged condition at the junction of the base slab & wall.
6.03.08.04	Wherever sandwich slabs are provided in liquid retaining structures to take care of stability against uplift, only well graded sand of approved quality shall be used as fill material. The sand compaction shall be done with plate / disc compactors in such a manner that the bottom slab is not structurally damaged.

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

6.03.08.06 Coefficient of active earth pressure shall be considered for design of free standing retaining walls and coefficient of earth pressure at rest shall be considered for design of top propped retaining walls.

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

6.03.08.08 Factor of safety against overturning and sliding

The structure shall be checked for minimum factor of safety of 1.5 against overturning conditions (ratio of stabilizing moment to overturning moment) and 1.4 against sliding conditions as per IS: 456.

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

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

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

Sl. No.	Structural Element	Main Reinforcement	Distribution Reinforcement / Stirrups/ ties/ Anchor Bars
a)	Foundation	12 mm	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 requirement.

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

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

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

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

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

CLAUSE NO.	TECHNICAL REQUIREMENTS
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 ESP Control Building, Compressor House, and all other steel buildings envisaged in this specification	Height /325
3.	Vertical Metal Sheeting in Cladding	Span/250

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

Note: Along wind forces on slender and wind sensitive structures and structural elements shall also be computed, for dynamic effects, using the Gust Factor or Gust Effectiveness Factor Method as defined in the standard. The structures shall be designed for the higher of the forces obtained from Gust Factor method and the Peak Wind Speed method.

Analysis for dynamic effects of wind must be undertaken for any structure which has a height to minimum lateral dimension ratio greater than “5” and/or if the fundamental frequency of the structure is less than 1 Hz.

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

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

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

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

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

For electric overhead cranes :

1) upto 50 Tonne capacity : span/750

2) over 50 Tonne capacity : span/1000

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

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

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

6.04.00 **CORROSION PROTECTION**

6.04.01 **General**

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

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

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

(c) All steel structures shall be designed by following basic design 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 goverened 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 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	Primer coat shall be followed with the application of Intermediate coat of two component polyamide cured epoxy with MIO Content (containing lamellar MIO minimum 30% on pigment, solid by volume minimum 80% ±2%) of minimum 100 micron DFT. This coat shall be applied in shop after an interval of minimum 24 hours (from the application	Intermediate coat shall be followed with the application of finish coat of two-pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% ±2%) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0

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

Notes:

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

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

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

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

6.04.05 **Gratings**

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

6.04.06 **Hand Railings and Ladders**

All Mild steel (MS) handrails and ladders in outdoor locations and in pump valve pits shall be galvanised at the rate of 610 gm/sqm as per IS 4736. All other MS handrails shall be painted as specified in clause 6.04.03 above. However, Stainless steel handrails shall be provided as specified in General Architectural Specification clause 9.00.00.

6.04.07 **Sea Worthiness**

All Steel Sections and fabricated Structures, which are required to be transported on sea, shall be provided with anti-corrosive Paint before shipment to take care of sea worthiness.

6.04.08 DELETED

6.04.09 **For reinforced concrete work.**

i) The protection for concrete sub-structure shall be provided based on aggressiveness of the soil, chemical analysis of soil/sub-soil water and presence of harmful chemicals/salts.

ii) The protection to super structure shall depend on exposure condition and degree of atmospheric corrosion.

This shall require use of dense and durable concrete, control of water cement ratio,

increase in clear cover, use of special type of cement and reinforcement, etc., coating of concrete surface, etc.,

Bidder shall furnish the details of corrosion protection measures.

CLAUSE NO.	TECHNICAL REQUIREMENTS
7.00.00	**FOUNDATION SYSTEM AND GEOTECHNICAL DATA**
7.01.00	**Soil Data** Owner has carried out geotechnical investigation of stage-I area. No borelogs are available in the proposed stage-II area. Available bore logs of the vicinity of stage-II area along with laboratory test results are enclosed at Annexure-C for Bidder's reference. The geotechnical investigation report of this area will be made available for the Bidder's study at the Owner's consultant office, if required. The onus of correct assessment / interpretation and understanding of the existing subsoil condition / data lies with the Bidder. If bidder feels furnished data is inadequate, he may carry out his own geotechnical investigation at site before bidding for his Information at no extra cost and time to owner. Such data collected by bidder is only for the purpose of bidding and it shall not be a part of technical documents related to this package. However, final design shall be based upon the detailed geotechnical investigation, which is to be conducted by successful bidder as per the clause 7.08.00 after placement of award. The Bidder should note that nothing extra whatsoever on account of variation between the foundation system assumed by bidder before bidding and that finalized based on the detailed geotechnical investigation after award, shall be payable. No time extension in the bidding time will be given to bidder for carrying out geotechnical investigation. **Bidder may refer enclosed topographical survey drawing and general layout plan along with borelogs for variation in existing/ natural ground level (NGL) and finished ground level (FGL).** Wherever ash/coal deposit/brick-bats etc. is found the same shall be treated as filled up soil.
7.01.01	Successful bidder shall carryout his own detailed soil investigation for facilities under this package and shall be as per the scheme approved by owner**.** The scheme for geotechnical investigation shall be as given at Clause 7.08.00 and shall be approved by owner before execution. Geotechnical investigation work shall got executed by the Contractor through the agencies as mentioned in Clause No. 7.07.03. However, no time extension shall be given on account of soil investigation carried out by the Bidder. The geotechnical investigation report shall be prepared with detailed recommendations regarding type of foundation and allowable bearing pressure for various structures/ facilities and other soil parameters. The report shall be submitted for Owner's approval prior to commencement of design of foundation.
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 natural sand/ sand manufactured from other than natural sources as specified elsewhere in the technical specification. Sand for filling shall be clean and well graded conforming to IS 383 with grading Zone I to III. c) Sand shall be spread in layers not exceeding 30cm compacted thickness over the area. Each layer shall be uniformly compacted by mechanical means like plate vibrators, small vibratory rollers, etc to achieve a relative density of not less than 80%.

d) Other requirements of tank foundations shall be as per IS 803 and as specified elsewhere in the specifications.

7.02.00 **Foundation System**

The requirements for the foundation system to be adopted are as given in subsequent clauses. Depending upon the depth of competent strata/stratum, type of structures, functional requirement of facility, extent of cutting / filling, suitable open 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) foundation 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 and Table 1a. 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, 0.6m below rock level 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 (1:4:8) up to designed foundation level.

e) Wherever the intended bearing stratum is weathered rock, but the actual strata encountered during excavation consists of both overburden soil and weathered rock at founding level, under such cases, the overburden upto the weathered rock level including 0.6 m into the weathered rock shall be removed and built up through PCC (1:3:6) upto the designed founding level. Thus, maintaining the same founding level for all the footings of a structure.

f) The last layer of about 300 mm before reaching the founding level shall be excavated carefully by such equipment so that soil / rock at the required level will be left in its natural condition.

g) During detailed engineering, the Allowable Bearing Pressure shall be adopted after approval of geotechnical investigation report. However, the maximum allowable bearing pressure shall be lower of the two values i.e. as per approved geotechnical report and as per the values furnished in Table-1.

Table-1

Founding Depth/ Stratum	Net Allowable Bearing Pressure T/m2		
	Isolated and combined footings including raft for 25mm permissible settlement in case of soil and 12mm in case of rocky strata	Isolated and combined footings for 40mm permissible settlement in case of soil and 12mm in case of rocky strata	Rafts (width > 6m) for 75mm permissible settlement in case of soil and 12mm in case of rocky strata
	Width upto 6.0m		
In case of Soil			
1.0m below NGL	10	12	12
2.0m below NGL	16	18	20
3.0m below NGL	20	22	25
4.0m or more than 4.0m below NGL	25	28	30
In case of rocky strata			
Minimum 0.60m Embedment in rock	30	30	30
Minimum 1.0m Embedment in rock	35	35	35

Minimum 2.0m Embedment in rock	40	40	40
Minimum 3.0m Embedment in rock	45	45	45
Minimum 3.5m Embedment in rock	50	50	50
4.5m or more than 4.5m embedment into weathered rock Embedment in rock	55	55	55

To determine the Natural Ground Level (NGL), tender drawings titled "TOPGRAPHICAL SURVEY" shall be referred. Further the above tender drawings shall also be referred in conjunction with borelog data carried out during .
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) TOPGRAPHICAL SURVEY and (b) Borelog data.
In case any loose/soft pockets is encountered at founding level, the same shall be removed completely upto the hard strata and filled up with PCC (1:4:8).

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

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

7.03.00 Special Requirements

7.03.01 Details of treatment for foundations / underground structures required to counteract soil / water chemical environment shall be as per detailed geotechnical investigation to be carried out by contractor. Contractor shall carry out chemical analysis during detailed geotechnical investigation and required treatment shall be provided accordingly.

7.04.00 Excavation, Filling and Dewatering

7.04.01 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.

7.04.02 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.
7.04.03	**Backfilling in Power House & 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. **Backfilling in other area** Backfilling around foundations, pipes, trenches, sumps, pits, plinths, etc. shall be carried out with approved material in layers not exceeding 300 mm compacted thickness (higher thickness of layers upto 500mm with heavy mechanical compacting equipment) and each layer shall be compacted to 90% of standard proctor density for cohesive soils and to 80% of relative density for non cohesive soils. Rock pieces having size less than 150 mm and interstices filled with soil may be used for backfilling around foundation, plinths etc. and shall be compacted to minimum of 85% of original stack of material after filling the interstices.
7.04.04	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.
7.04.05	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.
7.04.06	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.
7.05.00	**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.
7.05.01	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).
7.05.02	a) Contractor shall engage an agency expert in blasting such as, NIRM (National Institute of Rock Mechanics), CMPDIL, Central Institute of Mining and Fuel Research Dhanbad, Dept. of Mining of Govt. Institutions etc. to design detailed blasting scheme and get the same approved from Engineer before carrying out the blasting operation. All blasting shall be done as per the approved blasting scheme & initial blasting operations shall be done under the supervision & guidance of the representative of the blasting expert. b) All the statutory laws, (Explosives Act etc.) rules, regulations, Indian Standards, etc. pertaining to the acquisition, transport, storage, handling and use of explosives, etc. shall be strictly followed. c) The Contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives as per explosives act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive Materials. d) The Contractor shall be responsible and liable for any accident and injury / damage which may occur to any person or property of the project or public on account of any

operations connected with the storage, transportation, handling or use of explosive and blasting operations.

7.06.00 Sheeting & Shoring

The contractor shall ascertain for himself the nature of materials to be excavated and difficulties, if any, likely to be encountered in excavation while executing the work. Sheet piling, sheeting and shoring, bracing and maintaining suitable slopes, drainage, etc. shall be provided and installed by the Contractor, to the satisfaction of the Engineer.

7.07.00 Geotechnical Investigation

The Contractor shall carry out detailed geotechnical investigation in the areas under his scope for establishing the sub-surface conditions and to decide type of foundations for the structures envisaged, construction methods, any special requirements/treatment called for remedial measures for sub-soil/ foundations etc. in view of soft sub-soils, aggressive sub-soils and water, expansive/swelling soils etc. prior to commencement of detailed design/drawings. The Contractor shall obtain the approval for the field testing scheme proposed by him from the Owner before undertaking the geotechnical investigation work.

7.07.01.00 **Scheme of geotechnical Investigation**

7.07.02.01 Field test shall include but not be limited to the following:

Boreholes, Standard Penetration Test (SPT), Dynamic Cone Penetration Test (DCPT), collection of disturbed samples (DS) and undisturbed soil samples (UDS), Trial Pits (TP), Plate Load Tests (PLT), Electrical Resistivity Test (ERT), In situ field permeability tests, collection of water samples, etc.

7.07.02.02 The diameter of borehole shall be minimum 150 mm in soil and 76 mm in rock. The diameter of UDS sampler shall be 100 mm minimum. Core drilling in rock shall be done by using hydraulically feed rotary drill & double tube core barrel with diamond bit.

7.07.02.03 The minimum tests are indicated in Clause No. 7.08.00. Adequate number of tests shall be conducted up to sufficient depth for complete determination of subsoil conditions. The depth of boreholes shall be as specified in Appendix A. SPT shall be carried out in all types of soil deposits and in all rock formations with core recovery up to 20%, met within a borehole. This test shall be conducted at every 3.0 m interval or at change of strata, up to the final depth. SPT 'N' of 100 and above shall be referred as refusal. UDS shall be collected at every 3.0 m interval or at change of strata up to depth of borehole. UDS may be replaced by additional SPT, if SPT'N' value in the strata is above 50.

7.07.02.04 Laboratory tests shall be done as per relevant IS codes. The laboratory tests, not be limited to the following shall be conducted on disturbed and undisturbed soil samples, rock samples & water samples collected during field investigations in sufficient numbers.

Laboratory Tests on Soil Samples

Laboratory tests shall be carried out on disturbed and undisturbed soil samples for Grain Size Analysis, Hydrometer Analysis, Atterberg Limits, Triaxial Shear Tests (UU), Natural Moisture Content, Specific Gravity and Bulk Unit Weight, Consolidation Tests, Unconfined Compression Test, Free swell Index, Shrinkage Limit, Swell Pressure Test, Chemical Analysis test on soil and water samples to determine the carbonates, sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel.

Laboratory Tests on Rock Samples

Moisture content, porosity & density, Specific Gravity, Hardness, Soundness, Slake durability index, Unconfined compression test (Both at saturated and in-situ water content), Point load

strength index and deformability test (Both at saturated and in-situ water content) shall be carried out on rock samples.

7.07.02.05 Geotechnical investigation (field & laboratory) shall be carried out in accordance with the provisions of relevant Indian Standards.

On completion of all field & laboratory work, geotechnical investigation report shall be submitted for Owner's review/approval. The Geotechnical investigation report shall contain geological information of the region, procedure adopted for investigation, field & laboratory observations/ data/ records, analysis of results & recommendations on type of foundation for different type of structures envisaged for all areas of work with supporting calculations. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, etc.

Recommendations on foundation system and the net allowable bearing pressures and pile capacity shall be based on the conservative values of geotechnical investigation data.

7.07.03 **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

7.08.00 Geotechnical Investigation Scheme

a) **Boreholes (Minimum)**

S.No	Structure	Spacing/Number of borehole	Depth of borehole	Remarks
1	Main Plant structures (Transformer Yard, Main power house, Boiler, ESP, Chimney, Mills, Fans etc)	About 40-50 m along the rows of main power house columns. Minimum 3 boreholes under each Boiler, Mill & Bunker, ESP structure and 3 boreholes under	Depth of boreholes shall be 20 to 25m.	Depth of boreholes shall be as mentioned in column "Depth of Borehole" or 5m

		Chimney, Minimum 2 boreholes under each TG, ESP Control Room, TPs. 4 boreholes in Transformer yard		continuous in rock with RQD > 50% whichever is earlier.
2	Switchgear room, control room and transformer foundation	Minimum 4 no of boreholes	10 to 15 m	
3	Biomass	Minimum 8 boreholes	10 to 15 m	
4	FGD and DeNox systems	Minimum 20 boreholes	15 to 20 m	
5	Coal Handling Plant structures	Minimum one borehole under each TP and two under each crusher and one borehole under each structure. Minimum 10 no of under each stockpile area	15 to 20 m	
6	Ash Handling & AWRS Structures	Minimum 8 boreholes	10 to 15 m	
7	Service building, FOPH and Other Off-site Structure / Facility	Minimum Two boreholes under each area / facility	10 to 15 m	
8	Water treatment plant structures	Minimum 8 no of borehole	10 to 15 m	
9	Switchyard Structures	Minimum 8 no of borehole	10 to 15 m	
10	Cooling Towers	Minimum 4 no of borehole in each CT	10 to 15 m	

11	**Wagon Tippler**	**Minimum 3 no of borehole**	**25 to 30m**	
12	**CW Pump House**	**Minimum 1 no under each structure/ facility**	**15 to 20 m**	
13	**Trach Hopper**	**Minimum 4 no under each structure/ facility**	**20 to 25 m**	
14	**Settling tank, dewatering bins area**	**Minimum 5 nos**	**10 to 15 m**	
15	**Conveyors**	**1 no @ 200m c/c**	**10 to 15 m**	
16	**Other structure/ facility**	**Minimum 1 no under each structure/ facility**	**10 to 15 m**	

b) Other Field Tests (Minimum)

1	Plate Load Test (PLT)	1 no each in ESP, transformer yard area, Ash handling, switchyard and other area, where open foundations are feasible.	Test Depth from 2 to 3 m	
2	Cyclic Plate Load Test (CPLT)	1 no in each TG, Mill, FGD and ID fans	Test Depth from 2 to 3 m	
3	Trial Pit (TP)	About 10 Nos.	Depth upto 3 m	
4	In Situ Permeability Test In Boreholes	In minimum 8 Nos. of boreholes	Tests shall be conducted at depths of 1.0m, 3.0m, 5.0m, 8.0m and 12.0m.	
5	ERT	2 Nos. each in Transformer yard, TG, Boiler, Chimney, Ash handling area, ESP Control Room, coal handling area, ash handling area 1 No near each Pump House		

		other than mentioned above		
6	CROSS HOLE	1No. in each TG, 1No. in each Mill & bunker and 2 Nos in ID Fan, 1 no in each FGD	Depths covering from 1.0 m to 20.0 m	
7	PMT	40 no of tests in main power house area covering power house to chimney, TPs.	Depths covering from 1.0 m to 20.0 m	

- Depth and location of Boreholes and other field tests (PLT, CPLT, CROSS HOLE TEST, PMT, TP, ERT, field permeability tests etc.) shall be approved by Owner before execution of geotechnical investigation work.

- Investigation in any other building / structure / facilities / trestles which are not mentioned above shall also be carried out, if required, by the bidder for the facilities under his scope.

CLAUSE NO.	TECHNICAL REQUIREMENTS
D-1-8	**GENERAL SPECIFICATION**
8.01.00	**GENERAL REQUIREMENTS**
8.01.01	**JOINTS IN CONCRETE STRUCTURES**
	Construction Joints
	All horizontal construction joints shall be provided with a groove (shear key) for transfer of shear force.
	For construction joint in concrete wall, the maximum height of any lift should not exceed 2 meters. However, the time interval between the successive lifts should be as small as possible and the wall should be built to its full height in the least possible time.
	Expansion joints for all underground structures shall be made watertight by using ribbed PVC water stops with central bulb or of kicker type. The thickness and width of PVC water stops shall be as per the requirement of design. However, the minimum thickness and width shall be 6mm and 225mm respectively.
	Expansions Joints
	In case of expansion joints, preformed bitumen impregnated fibre board conforming to IS 1838 shall be used as joint filler. The joints shall be sealed with bitumen sealing compound conforming to IS 1834, however in case of liquid retaining/carrying structures, two parts polysulphide sealant conforming to IS 12118 or silicon sealing compound shall be used.
	IS 3414 shall be followed for details of joints in buildings. 3 mm thick stainless steel strip in matt or buff finish shall be provided over building expansion joints.
8.01.02	**Miscellaneous General Requirements**
8.01.02.1	All steel sections and fabricated structures, which are required to be transported on sea, shall be provided with anti-corrosive paint before shipment to take care of sea worthiness.
8.01.02.2	Monorails, monorail girders and fixtures shall be provided, wherever required to facilitate erection / maintenance of equipment.
8.01.02.3	Wherever possible all floor openings shall be provided with 100 mm thick 150 mm high RCC kerb all around.
8.01.02.4	Angles 75 x 75 x 6 mm (minimum) with 8mm diameter and 150mm long MS lugs @ 150 c/c shall be provided for edge protection all around cut outs/openings in floor slabs. Angles 50 x 50 x 6mm with effective anchor lugs shall be provided for edges of concrete drains supporting grating/covers, edges of RCC cable / pipe trenches supporting covers/chequered plates/ grating, edges of manholes supporting covers, supporting edges of precast RCC covers and any other place where breakage of corners of concrete is expected.
8.01.02.5	Floor of switchgear room shall be provided with embedded M.S. channel suitable for easy movement of breaker panels.
8.01.02.6	Anti-termite constructional measures and chemical treatment measures shall be given to all vulnerable areas susceptible to termite including column pits, wall trenches, foundations of buildings, filling below the floors, etc., as per IS 6313 and other relevant Indian Standards.
8.01.02.7	All cable & pipe routing shall be done as per system requirement and as stipulated elsewhere in the specification and shall run above ground on elevated trestles or other supporting structures except in some localized area (as approved by Employer) where the same can run in trenches. In case, pipes are to be routed on RCC pedestals, the height should not be less than 500mm above formation level/paving level. All trenches shall be of RCC with removable RCC covers.

	All cable trenches located inside buildings shall have minimum 6mm thick (o/p) chequered plate covers.
	Cable trenches, where allowed, located outside the buildings shall project at least 200mm above the finished formation level unless noted otherwise elsewhere in this specification so that no storm water shall enter the trench. The bottom of the trench shall be provided with a longitudinal slope of 1:500.The downstream end of trenches shall be connected through pipe drains to the nearby RCC manholes (to convey water from trenches) of storm water drainage system, but avoiding back flow of storm water. In general, the precast covers shall not be more than 300 mm in width and shall not weigh more than 65 kg. Lifting hooks shall be provided in the precast covers.
	All cable trenches, wherever required, shall be provided with suitable insert plates for fixing support angles of cable trays.
	In Main plant area wherever fire water pipe trenches are envisaged, these trenches shall be of RCC and provided with precast RCC cover flush with finished level of paving in that area.
	R. C. C. cable slits shall be filled with sand after erection of cables, up to top level and covered with 75mm thick PCC cover of minimum M15 grade.
8.01.02.8	All steel platforms above grade shall be provided with 100 x 6 thick kick plates at edge of platform.
8.01.02.9	Duct banks consisting of PVC conduits conforming to IS 4985 for cables shall be provided with proper sealing arrangement consisting of fire retardant sealing compound.
8.01.02.10	Independent network of lines for sewerage and drainage shall be provided. Plant effluent shall not be mixed with either storm water or sewage.
8.01.02.11	The sub-grade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor density at Optimum moisture content (OMC.)
8.01.02.12	Detailed scheme for dewatering shall be prepared, wherever required, before starting of deep excavation work. IS 9758 shall be followed as general guidance for dewatering.
8.01.02.13	Structural steel column base plates and bolts, gussets, etc., shall not project above the floor level unless and noted otherwise. These shall be encased by concrete cover up to floor level with concrete grade M 25.
8.01.02.14	Non-shrink flow able grout shall be used for under-pinning work below base plate of columns. Nominal thickness of grout shall be 50 mm. Non-shrink cum plasticizer admixture shall be added in the grout. Crushing strength of the grout shall generally be one grade higher than that of the base concrete. Minimum grade of grout shall be M-30.
	Grouting of all pockets, blockouts, sleeves and the openings around the embedment, inserts, bolts etc. and under pinning below the base / sole plate shall be with non - shrink flow able grout. Grade of grout shall be one grade higher than concrete. However minimum grade of grout shall be M - 30.
	However, for equipment foundations, high strength (minimum characteristic compressive strength of 60 N/sq.mm at 28 days) ready mixed non-shrink, chloride free, cement based, free flowing, non-metallic grout as recommended by equipment manufacturer shall be used.
8.01.02.15	All the buildings and site development including landscaping shall be designed to take care of rain water harvesting & ground water recharging. Development of rain water harvesting scheme for the buildings, structures, facilities in Bidder's scope and obtaining approval of the scheme from Central Ground Water board is in Bidder's scope.
8.01.02.16	As required suitable steel frames shall be provided around openings in the roof and external walls for mounting exhaust fans.

CLAUSE NO.	TECHNICAL REQUIREMENTS
8.01.02.17	750mm wide x 100 mm thick plinth protection in PCC (M-15) shall be provided around all buildings, pits / sumps, clarifiers, tanks, etc.
8.01.02.18	All masonry walls shall be provided with Damp Proof Course at plinth level.
8.01.02.19	All monorail openings in the walls shall be provided with double plate flush steel door shutters with suitable access platform and ladder as required.
8.01.02.20	Hand rail (of minimum 1m height), size and material to be adopted shall be as per general architectural specification.
8.01.02.21	In all buildings, suitable arrangement for draining out water collected from equipment blow downs, leakages, floor washings, firefighting etc. shall be provided for each floor with suitable floor drains.
8.01.02.22	Unless specified all sand filling shall be compacted to minimum 80% of the relative density and backfilled earth shall be compacted to minimum 90% of the Standard proctor density at OMC.
8.01.02.23	All buildings shall be provided with peripheral drains by the side of plinth protection for catering to the rain water from roofs and storm water from adjacent area. Plinth protection drains shall be provided all around the building and to be connected with nearest storm water drain. Minimum size of plinth protection drain will be 300mmx300mm.
8.01.02.24	Minimum 2.0m wide walkway with plain cement concrete (nominal mix M15 grade) paving 150 mm thick laid over 75 mm thick bed of dry aggregate shall be provided connecting all buildings and facilities. The top of walkway shall be minimum 200mm above FGL, unless specified otherwise.
8.01.02.25	For all buildings, finished floor level (FFL) shall be minimum 500mm above finished ground level (FGL).
8.01.02.26	40mm Diameter MS rods as earthing mat, placed at a distance of 1.0m away and at depths between 0.60m and 1.00m shall be supplied and laid all around the periphery of buildings, structures, and outdoor equipment, as per approved drawings. Riser of 40mm Dia. MS rods and connecting to the above Earthing mat shall also be supplied and laid in position by the Contractor, as per the approved drawings. Raiser shall be laid up to a height of 300 mm above the local Ground level, at each of the columns of the buildings on the outside of the buildings, and minimum 2 (two) numbers for each structures and equipment. The contractor shall also supply and lay necessary number of 3.0 m deep 40 mm diameter MS rods Earthing electrodes and connect electrodes to the Earthing mat, as per the approved drawings and supplying and laying of 40 mm Dia. MS rods for connecting the Contractor's earthing mat with the Employer's earthing mat separately.
8.01.02.27	Hume pipes of required class shall be as per IS: 458. Hume pipe made of Geopolymer concrete may also be used. Details of ingredients for Geopolymer concrete is as per details specified elsewhere.
8.01.02.28	Coefficient of active earth pressure shall be considered for design of free standing retaining walls and coefficient of earth pressure at rest shall be considered for design of top propped retaining walls.
8.01.02.29	Interlocking concrete block 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 openings in floors / roofs / Walls / Cladding for routing of Pipes / cables / Ductsshall be suitably sealed by the contractor 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 machine foundations and some of other important structural members shall be as follows:

Sl No	Description	Minimum grade of concrete
i)	ID, FD, PA fan & Mill foundations (block foundations)	M-30
ii)	TG top Deck	M50
iii)	TG Raft/ Substructure	M35
iv)	Complete wagon tippler, reclaim hopper, Stacker and Reclaimer foundations, Crusher Deck foundation and other railway load bearing structures.	M35
v)	BFP foundations (in case of springs supported) / (in case of block foundation)	M35 / M30
vi)	Rail load Bearing Structures	M35

Concrete design mix of M50 grade concrete for TG top deck and substructure shall be carried out as per IS 10262 satisfying following conditions /Specification:

i) OPC 43 grade cement shall be used to design M50 grade of concrete mix. However, in case the mix design using OPC 43 grade cement fails to achieve the target strength of M50 grade concrete, OPC 53 grade cement may be used provided adequate precautions for higher heat of hydration and quality assurance measures are in place.

ii) The concrete slump shall be in the range of 150-180mm at pouring point.

iii) Maximum cement content (OPC) shall be limited as stipulated in IS 456.

iv) Free water-cement ratio shall be as per clause 5.1 of IS 10262.

v) PCE type superplasticizers shall be used as high range water reducing admixtures (Type F as per ASTM C494 or equivalent) in the concrete mix. Dosage & mixing methodology of this chemical admixture shall be as per manufacturer's recommendation.

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

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

e) Unless otherwise specified, 20mm and down aggregates shall be used for all structural concrete works. However, 40mm and down aggregates may also be used under special conditions for mass concreting in foundation.

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

g) Minimum 75mm thick lean concrete M-7.5 shall be provided below all other underground structures, foundations, trenches, etc., to provide a base for construction.

h) All structural(reinforced) concrete production shall be done at automated batching plant of suitable capacity, conforming to IS:4925., situated within the area allocated to the contractor. Batching plant shall also have provision to mix fly ash (by weight). The batching plant shall have facility of digitised recording of the materials added along with quantity of concrete produced in each batch and printout of the same. Batch-wise report for each shift shall be submitted to the Engineer.

8.02.02 **Reinforcement Couplers**

Reinforcement couplers (mechanical splicing systems with upset parallel threaded couplers) may be used in reinforced concrete works, subject to following conditions:

a. Couplers shall meet the performance requirements of IS 16172 for class H.
   i. It shall have minimum tensile strength corresponding to Fe550D which is 600 N/mm2 and failure shall take place outside the length of splice as per clause no 9.2.1 of IS 16172.
   ii. Percentage elongation at maximum force in the reinforcing bar outside the length of mechanical splice shall be minimum 3 % before the failure of test piece as per clause no. 9.2.2 of IS:16172.
   iii. Slip test value shall not exceed 0.10 mm. as per clause no 9.3 of IS 16172.
   iv. Cyclic tensile test corresponding to Fe550D reinforcement bar as per clause no 9.4 of IS 16172.
   v. Low cycle fatigue test as per clause no 9.5.1 of IS 16172.

vi. High Cycle Fatigue test as per clause no 9.5.2 of IS 16172.

b. The manufacturer shall mark the coupler in such a way that all finished reinforcement couplers can be traced to the original cast from which they were made along with date of manufacture.

c. Sampling and other requirements of IS 16172 shall be complied with.

d. Each lot shall be supplied with manufacturer's test certificate (MTC) indicating values of tests in line with IS 16172.

e. The minimum clear cover requirements are to be ensured for reinforcement couplers also.

f. The couplers shall be used only at the locations where joint is required as per standard lapping purpose and couplers shall not be used for joining of several cut pieces of reinforcement in a single bar. As a general guideline, the length of the bars in which coupler is to be provided should not be less than 4m.

Vendors for the reinforcement couplers shall be subject to the approval of Engineer-In-Charge

8.02.03 Special requirements for concreting of major equipment foundations shall be as given below.

a) **Temperature Control of Concrete**

All the machine foundations such as Mills & Fans, top decks of TG & BFPs, the temperature of fresh concrete shall not exceed 25 deg C when placed. For maintaining the temperature of 25 deg C, crushed ice shall be used in mixing water.

b) **Admixture**

Plasticizer /super plasticizer admixture shall generally be added to the concrete for promoting workability. In addition, plasticizer/super plasticizer-cum-retarder shall be added to retard the setting time for mass concreting work as required. In case of pumping, suitable pumping additive shall also be added to avoid segregation and increase flowability. The slump shall generally be in the range given below:

Top decks of TG & BFP	-	150 mm to 180 mm
Block foundations	-	100 mm to 150 mm
TG Column	-	100 mm to 150 mm

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 IS13311 (Part-1). In case of any defect, the Bidder shall rectify the defects suitably using cement/epoxy grout, etc.

Wherever block type foundations are provided for machine foundations such as BFPs, UPV testing of foundation concrete is not required.

8.02.04 **Anchor Fasteners**

Anchor Fasteners for use in concrete shall conform to the following:

a. The safe tensile load carrying capacity of the anchors shall be arrived by providing the minimum factor of safety of 2.5 on the characteristic load of the anchor. Minimum size of the anchors shall be M8.

b. All anchors shall be from established and approved makes/ manufacturers.

c. Anchors shall be fixed in position as recommended by the manufacturer and as approved by the engineer.

d. Anchor fastener can be of mechanical type based on working principles such as keying, friction, combined friction- keying or chemical bonding type.

1) Mechanical type: The anchors shall be cold formed stud type torque controlled mechanical expansion fasteners having 3-way expansion sleeve of SS 316 grade with nut and washer and galvanized to minimum 5 microns. For coastal/ corrosive environments, the anchors shall be of Stainless Steel (min grade SS 304) or HCR (High Corrosion Resistance). The anchors shall conform to a minimum grade of 5.8 as per IS: 1367.

2) Chemical type: The anchor shall be adhesive type consisting of slow curing chemical adhesive with a proportion of resin and hardener as per manufacturer's recommendation in a soft foil pack, threaded rod of carbon steel conforming to a minimum grade of 5.8 as per IS: 1367 and minimum galvanization of 5 microns with associated nut and washer. The chemical shall be dispensed through mechanical dispenser and shall be self-curing type.

e. Capacity of the anchors shall be established after considering the effect of concrete grade, embedded depth, concrete thickness, anchor spacing and edge distance from the concrete.

f. The selection for particular type of the anchors shall be made after considering the concrete grade, available embedment depth, load to be transferred, space available for installing anchors.

8.03.00 **FORMWORK**

Formwork for building RCC Slabs/ Beams & Columns shall be of 2 different types.

Type 1 Formwork: (For RCC slab of Structural Steel Framed Buildings Only)

Troughed colour coated metal deck sheets shall be used as permanent shuttering having minimum thickness of 0.80mm. These profiled metal deck sheets shall be fixed to the structural steel secondary beams/ Purlins using Headed shear anchor studs. The detailed material property requirement of metal deck sheet is specified elsewhere in this specification.

The shear anchor studs for fixing metal deck sheet to floor structural beams shall conform to Type-B studs specified in AWS D1.1/D1.1M or equivalent as shear connector of 19mm diameter and 100mm length manufactured from cold drawn round steel bars conforming to the requirement of ASTM A 29, of grade designation 1010 through 1020, of standard quality with either semi-killed or killed, welded by Drawn Arc Stud Welding through metal deck sheet.

The shear anchor studs for fixing metal deck sheet to roof structural purlins shall conform to Type-B studs specified in AWS D1.1/D1.1M or equivalent as shear connector of 16mm diameter and 65mm length manufactured from cold drawn round steel bars conforming to the requirement of ASTM A 29, of grade designation 1010 through 1020, of standard quality with either semi-killed or killed, welded by Drawn Arc Stud Welding through metal deck sheet.

Type 2 Formwork: (For RCC Buildings)

Plywood with film face formwork shall be used for floor & roof slabs, Columns & Beams of all RCC buildings.

8.04.00 **CULVERTS /RACKS ACROSS RAIL TRACKS**

Design of bridges/ culverts or any other structure crossing the Railway tracks shall be as per Railways/ RDSO guidelines/specifications for Dedicated Freight Corridor (DFC) 32.5 T loads. The Bidder shall obtain necessary approvals from Railways before start of construction work. Construction of these structures is to be done as per Railways guidelines. Any statutory and codal charges payable to Railways/ RDSO for approval & execution of the above crossings shall be borne by the Bidder. Engagement of approved Railway Consultant for the above work by the bidder would be at his own cost.

The levels/clearances of the above crossings are to be finalized by the bidder as per Railway standards and shall be subject to approval of Owner/Owner's Consultant.

However, for design of the above crossings above rail track, the following minimum clearance from Rail track shall be maintained:

A. Horizontal clearance: A minimum clearance of 3.5m shall be maintained between centre line of the Railway track to face of the crossing structure.

B. Vertical clearance: A minimum vertical clearance of 8.5m shall be maintained between Rail top level and bottom of structure.However, a minimum vertical clearance of 6.5m shall be maintained between Rail top level and bottom of structure in case of FA 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 (Sandtax Matt or equivalent) of approved colour and shade. Toe wall shall be provided with weep holes at appropriate spacing.

8.05.02 **Gate along Fencing**

All gates shall be of structural steel of minimum 3.75 metre width for single lane access road and 8.00 m width for double lane access roads. The height of gate shall be same as that of the fence unless noted otherwise. Each gate shall have provision for wicket gate of size 1.0 m x 2.1 m.

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

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

8.06.00 **GRATING**

All gratings shall be electroforged types. Minimum thickness of the grating shall be 40 mm. The opening size shall not be more than 30mmx100mm. The minimum thickness of the main bearing bar shall be 5 mm or as per design requirement whichever is higher. All gratings shall be hot dip galvanised at the rate of 610 g. per sq.m. after surface preparation by means of shot blasting or cleaned by acid pickling.

8.07.00 **FABRICATION & ERECTION OF STEEL STRUCTURES**

The fabrication shall be done as per fabrication drawing which would clearly indicate various details of joints to be welded, type of weld, length and size of weld.

All steel structures shall be fabricated in factory, transported and erected at site. All factory fabricated structures shall have bolted field connections.

Coal bunkers, Lime storage silo and biomass silo with hoppers and chimney flue liners can either be fabricated at factory in segments, transported and welded at site before erection or fabricated at site. For coal bunkers, hoppers and chimney flue liners, to prevent coal dust/flue gas leakages, the applicable field joints shall necessarily be welded.

Note: Steel structures shall mean Plant and Non-Plant building structures, boiler & ESP support structures, CHP structures, AHP structures, chimney flue liners support platforms & stairs, pipe and cable support structures.

Site welding can be permitted in special cases where final inputs are not available before release of fabrication drawings.

Before dispatching the fabricated structural members to site, it shall be ensured that all parts in the assembly fit accurately together by carrying out pre-assembly of fabricated structural members having bolted field joints, in the factory.

All steelwork before and after manufacturing shall be smooth, straight and free of deformations, cracks, twists and burrs. All steelwork shall be cut and fabricated to a tolerance of ± 1.5 mm in its length and location of matching bolt holes for field connections.

8.07.01 **Welding**

a) Welding of Structural steel shall be done by an electric arc process and shall conform generally to relevant acceptable standards viz. IS:816, IS:9595, IS:814, IS:2014, IS:4354 and Indian Standard Hand Book for metal arc welding, and other standards, codes of practice internationally accepted. For welding of any particular type of joint, Bidder shall give appropriate tests as described in any of the Indian Standards - IS: 817, IS: 7307 and international standards as relevant.

b) Submerged arc-welding shall be used for welding longitudinal fillet welds (connecting flange with web) and longitudinal / transverse butt joints for fabrication of columns, framing beams and crane girders and all other built-up members, unless manual arc welding is specifically approved by the Engineer. Necessary jigs and fixtures and rotation of structures shall be so arranged that vertically down-hand position of welding becomes possible. 'Open-Arc-Welding' process employing coated electrodes shall be employed for fabrication of other welded connections and field welding.

c) Wherever welding is done for assembling the components of structures, the job shall so positioned that down hand welding is possible.

d) Any structural joint shall be welded only by those welders who are qualified for all welding procedures and positions in such type of joint that is welded.

e) All records for entire welding operations such as welders identification marks, the joints welded by the each welder, the welding procedures adopted, welding machine employed, pre and post heating done and any non-destructive test done and stress relieving /heat treatment performed on such joints shall be accessible to the Engineer for scrutiny.

f) In a fabrication of plated columns/beams and built up members all shop splices in each component part shall be done before such component part is welded to other parts of the member. Wherever weld reinforcement interferes with proper fitting between components to be assembled by welding, these welds shall be ground flush prior to assembly.

g) The members to be joined by fillet welding shall be brought and held as close together as possible and in no event shall be separated locally by more than 3mm. If the local separation is 1.5mm or greater, the fillet weld size shall be increased by the amount of separation.

Edge preparation for welding as per weld joint detail shall be prepared either by machines or by automatic gas cutting. All edges cut by flame shall be ground before they are welded.

8.07.01.1 **Electrodes**

a) The electrodes used for welding shall be of suitable type and size depending upon specification of the parent materials, the method of welding, the position of welding and quality of welds desired e.g. normal penetration welds or deep penetration welds. However, only low Hydrogen electrodes shall be used for plate thickness above 20 mm.

b) All low hydrogen electrodes shall be baked and stored before use as per manufacturer recommendation. The electrodes shall be rebaked at 250°C - 300°C for one hour and later on cooled in the same oven to 100°C. It shall be transferred to a holding oven maintained at 60°C - 70°C. The electrodes shall be drawn from this oven for use.

c) Where coated electrodes are used they shall meet the requirements of IS: 814 and relevant ASME-Sec. Covering shall be heavy to withstand normal conditions of handling and storage.

d) Only those electrodes which give radiographic quality welds shall be used for welds which are subjected to radiographic testing

e) Where bare electrodes are used, these shall correspond to specification of the parent material. The type of flux-wire combination for submerged arc welding shall conform to the requirements of F-60 Class of AWSA-5-17-69 and IS: 3613. The electrodes shall be stored properly and the flux shall be baked before use in an oven in accordance with the manufacturer's requirements as stipulated.

f) 308L and 309L electrodes / fillers shall be used for welding of stainless steel to stainless steel and stainless steel to mild steel respectively.

g) Specific approval of the Engineer shall be taken by Bidder for the various electrodes proposed to be used on the work before any welding is started.

8.07.01.2 **Preheating inter-pass Temperature and Post Weld Heat Treatment**.

a) Mild steel plates conforming to IS: 2062 and thicker than 20mm, may require preheating of the parent plate prior to welding as mentioned in Table-I.

However, higher preheat and inter-pass temperatures required due to joint restraint etc. and will be followed as per approved welding procedure. In welding materials of unequal thickness, the thicker part shall be taken for this purpose.

b) Base metal shall be preheated, notwithstanding provisions of IS: 9595, to the temperature given in Table-1 prior to welding or tack welding. Preheating shall bring the surface of the base metal to the specified preheat temperature and this temperature shall be maintained as minimum temperature while welding is in progress.

TABLE – 1

MINIMUM PREHEAT and INTER PASS TEMPERATURE FOR WELDING

Thickness of thicker part at point of Welding	**Welding using Low hydrogen electrodes or Submerged arc welding**
Upto and including 20mm	None
Over 20mm and upto and including 40m	$20^{o}C$
Over 40mm and upto and including 63mm	$66^{o}C$
Over 63mm	$110^{o}C$

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 600ºC and rate of application shall be 200ºC 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 the relevant standards shall be observed.

8.07.04 **Erection of Structures**

All erection work shall be done with the help of cranes, use of derrick is not envisaged.

Erection Marks

a) Erection marks in accordance with fabrication drawing shall be clearly painted on the fabricated steelwork. Each piece shall be marked in at least on two places. Each piece shall also have its weight marked thereon.

c) The centre lines of all columns, elevations and girder bearings shall be marked on the

sections to ensure proper alignment and assembly of the pieces at site.

Erection Scheme

a) The Erection Scheme for the erection of all major structures shall be furnished. The erectability of the structure shall be checked by the Bidder before commencement of fabrication work to avoid future modification. The erection scheme shall indicate the approximate weight of the structural members, position of lifting hook, crane boom length, crane capacity at different boom length and at different boom inclination, etc.,

b) The erection scheme shall also give details of the method of handling, transport, hoisting, including false work/staging, temporary, bracing, guying, temporary strengthening, etc., It will also give the complete details of the number and capacity of the various erection equipment that will be used such as cranes, winches, etc., along with disposition at the time of erection of columns, trusses, etc.

c) The erection of columns, trusses, trestles, portals, etc., shall be carried out in one single piece as far as practicable. No column shall be fabricated and erected in more than 3 pieces. Galleries shall generally be erected as box i.e. the bottom chord and bracings, top chord and bracings, side vertical posts and bracings, end portals and roof-trusses shall be completely welded prior to erection and if required temporary strengthening during erection shall be made. The inside sheeting runners and roof sheeting purlins may be erected individually. When erection joints are provided in columns, their location shall generally be just above a floor level.

8.08.00 STEEL HELICAL SPRINGS AND VISCOUS DAMPERS UNITS

8.08.01 General Requirement

This part of the specification covers the requirement for the manufacturing, testing, supply, transport to site, pre-stressing erection, supervision of erection by the vendor, release of pre-stress, alignment, commissioning, etc. of Steel helical springs and viscous dampers units.

The Steel helical springs and viscous dampers units supplied should be of proven make.

8.08.02 Codes and Standards

Some of the relevant applicable Indian standards and codes, etc, applicable to this section of the specification are listed below:

DIN : 4024 Machine foundations; Flexible supporting structures for machine with rotating masses.

DIN : EN 13906-1 Cylindrical helical springs made from round wire and bar: calculation & design.

DIN : 2096 Helical compression springs out of round wire and rod; quality requirements for hot formed compression springs.

ISO : 10816 /IS:14817 Criteria for assessing mechanical vibrations of machine.

ISO : 1940/IS: 11723 Criteria for assessing the state of balance of rotating rigid bodies.

8.08.03 Design & Supply of Material

i) **Supply**

Steel helical springs and viscous dampers and associated auxiliaries shall consist of:

(a) Steel helical springs units (fully pre-stressable) and viscous dampers units along with viscous liquid including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads, etc.

(b) Frames for pre-stressing of spring elements.

(c) Suitable hydraulic jack system including electric pumps, high pressure tubes etc. required for the erection, alignment etc., of the spring units. One set of extra hydraulic jacks, and hand operated pumps shall also be provided.

(d) Any other items which may be required for the pre-stressing, erection, release of pre-stress, alignment, and commissioning of the Steel helical springs and viscous dampers.

ii) **Design**

The spring units should have stiffness in both vertical and horizontal directions with the horizontal stiffness not less than 50% of vertical stiffness. However, for projects in high seismic zones, the minimum stiffness in horizontal direction shall be reviewed based on the design requirement and in no case it shall be less than 15% of vertical stiffness.

The stiffness should be such that the vertical natural frequency of any spring unit at its rated load carrying capacity is between 2 Hz to 4 Hz. The damper units or spring-cum-damper units should be of viscous type offering velocity proportional damping. The damper units should be suitable for temperatures ranging from 0 to 50°C. The damping resistance of individual damper units should be such that the designed damping can be provided using reasonable number of Units.

The Steel helical spring units and viscous damper units and their housings shall be designed for a minimum operating life of 30 years. Steel helical spring units shall conform to infinite life fatigue load calculations as per DIN EN 13906-1.

8.08.04 **Manufacturing & Testing**

Complete manufacturing and testing of the Steel helical springs and viscous dampers shall be done at the manufacturing shop of the approved sub vendor / supplier. For this purpose the contractor / sub vendor shall submit the detailed quality plan for approval of engineer and take up the manufacturing / testing after approval of such quality plan. The quality plan shall include

(a) Manufacturing schedule and quality check exercised during manufacturing.

(b) Detail of test to be carried out at the manufacturing shop with their schedule.

(c) Special requirements, if any, regarding concreting of top deck.

(d) Complete step-by-step procedure covering the installation and commissioning of the spring system.

(e) Manuals for erection, commissioning, testing and maintenance of the Steel helical springs and viscous dampers.

(f) A checklist for confirming the readiness of the civil fronts for erection of Steel helical springs and viscous dampers.

(g) Checklist for equipment required at each stage of erection.

(h) Bill of materials and data sheet of various elements such as spring units, viscous dampers, with their rating, stiffness etc. included in the supply.

(i) Bill of material and data sheet for frames for pre stressing, hydraulic jack including electric pump, high pressure tubes, hand operated pump etc., with their rating and umbers.

(j) Any other details which may be necessary to facilitate design and construction of the foundations / structures.

8.08.05 The springs shall conform to codes DIN EN 13906-1 and DIN 2096. The quality assurance and inspection procedure shall be finalized on the basis of the above codes and the quality plans be drawn accordingly.

8.08.06 **Transportation**

Steel helical springs and viscous dampers shall be suitably protected, coated, covered, boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection.

8.08.07 **Erection and Commissioning**

Complete erection and commissioning of the Steel helical springs and viscous dampers including pre-stressing of elements, placing of elements in position, checking clearances on the shuttering of the RCC top deck, releasing of pre-stress in spring elements, making final adjustments and alignments etc. shall be carried out by a specialist supervisor of vendor.

The contractor shall guarantee the performance of the Steel helical springs and viscous dampers for 24 months from the date of commissioning of each machine which shall be termed as Guarantee Period".

8.08.08 **Supervision**

The supervision of installation of Steel helical springs and viscous dampers including pre-stressing, placing, releasing and alignment of spring units shall be done by a specialist supervisor of sub vendor / supplier, trained for this purpose.

8.08.09.1 **Realignment of Spring System**

If any realignment of the Steel helical springs and viscous dampers is required to be done for aligning the shaft or for any other reasons during the first one year of operation from the date of commissioning of the machine, the same shall be done by the contractor.

8.08.09.2 **Acceptance Criteria**

Stiffness values shall be checked. The permissible deviations shall be as per DIN 2096.

Following acceptance criteria shall be followed:

General workmanship is being good as recommended by the manufacturer and approved by Equipment supplier.

Tolerances are within the specified limit.

Manufacturer's test certificate (MTC) shall be in compliance with the applicable codes / standards.

Bought out material is from the approved manufacturer / vendor.

Bought out material is matching with the approved sample.

CLAUSE NO.	TECHNICAL REQUIREMENTS
D-1-9	**Architectural Concepts and Design**
9.01.00	For Architectural Concepts and Design refer to 5.01.00 in this specification.
9.02.00	**General Architectural Specifications**
9.02.01	**General**

a) Minimum 1000 mm high (from floor/ roof level) hand railing shall be provided around all floor/roof openings, projections/balconies, walkways, platforms, steel stairs, etc., wherever the height of the building is more than 12m, railing heightshall be 1.2m. All handrails and ladder pipes (except at operating floors) shall be 32 mm nominal bore MS pipes (medium class) conforming to IS: 1161 and shall be galvanised as per IS: 4736 and finished with suitable paint. All rungs and ladders shall also be galvanised. Minimum weight of galvanising shall be 610 g/sqm. The spacing of vertical posts shall be maximum 1500mm. Two number of horizontal rails shall be provided including the top member. In addition, toe guard/ kick plate of min size 100x6th shall be provided above the floor level.

For handrailing at operating floors of Main Power House including RCC stairs (for one flight above and below operating floor level), passages, around all floor openings shall be Stainless Steel (SS) pipes shall be used.All floors of Service building 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 shall be provided. The spacing of vertical posts shall not be more than 1500mm. Two number of horizontal rails shall be provided including the top member. SS Toe guard, knee guard and kick plate 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 180mm and a minimum tread width of 275 mm. Minimum clear width of stair shall be 1200 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 brick wall at ground floor level. All buildings having metal cladding shall be provided with a 150 mm high RCC toe kerb (on upper floor) at the edge of the floor along the metal cladding. 1000 /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, fire fighting, 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) Parapet, Chajjas 450mm over window and 600mm door heads, 900mm over rolling shutters, architectural facia, projections, etc., shall be provided with drip course in cement sand mortar 1:3.

g) All fire exits shall be painted with fire resistant paint P.O red/signal red colour shade which shall not be used anywhere except to indicate emergency or safety measure. Fire safety norms shall be followed as per National Building Codes and fire safety requirements for providing fire exits, escape stairs and fire fighting equipment. In detailing of all buildings, fire safety requirements conforming to IS: 1641 and IS:1642 shall be followed.

h) Ramps & Lifts for Physically challenged persons shall be provided for barrier free access to 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.

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 CPVCplain & brass threaded fittingsshall 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 (decorativetype).(Jaquar / Hindware/ equivalent)

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

b) One number colour glazed ceramic oval shaped wash basin 450x 550 mm (2pprox..) 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 and minimum 12 mm thick plywood backing or mounted with SS Studs, one number stainless towel rail 600 x 20 mm, one number liquid soap dispenser. (Jaquar / Hindware/ Asai/ Saingobain /equivalent)

e) One toilet with required facilities shall be provided for physically challenged persons as per National Building Code requirements

f) Janitor Space & space for drinking water cooler.

g) Electric operated hand dryer with photo voltaic control.

h) The pantry shall consist of one number stainless steel pantry sink, as per IS : 13983, of size 610 x 510 mm, bowl depth 200 mm with drain board of at least 450 mm length withcoupling , 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, GI concealed water supply pipe of minimum 12 mm diameter of medium class, cast iron sanitary pipe (with lead joints) of minimum 75 mm diameter, floor trap with Stainless

Steel grating, inlet and outlet connections for supply and drainage, with all bends, tees, junctions, sockets, etc., as are necessary for the commissioning and efficient functioning of the pantry (all sanitary fittings shall be heavy duty chrome plated brass, unless noted otherwise)

One number of pantry shall be provided on Control Room floor of ESP control room building and One number of pantry shall be provided in Buildings having Control Room .

i) 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.

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

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

9.04.00 **Flooring**

Floor finishes of approved shade and colour 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.

CLAUSE NO.	TECHNICAL REQUIREMENTS
9.04.03	Metallic hardener topping -with ordinary grey cement shall be- 12 mm thick (insitu) or finishing the concrete / mortar surfaces topping shall be furnished with neat cement slurry (with ordinary grey cement)
9.04.04	Heavy duty cement concrete tiles 300 mm x 300 mm shall be providedusing 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 of Kajaria/ Nitco/ Somany/ RAK/ Johnson or equivalent b) 300x450mm in DIGITAL series of Kajaria/ Nitco/ Somany/ RAK / Johnson or equivalent c) 300x600mm in DIGITAL series of Kajaria/ Nitco/ Somany/ RAK / Johnsonor equivalent
9.04.06	12mm/20mm / 38mm / 75 mm/ 115mm thick acid resistant tile on horizontal and vertical surfaces, at all levels for all type of works shall include one coat of bitumen primer followed by 12 mm thick bituminastic layer, 20mm / 38mm/ 75 mm / 115mm thick A.R. tiles, 6 mm thick under-bed by potassium silicate mortar conforming to IS:4832 (Part-I), pointing of joints of tiles with acid/alkali resistant epoxy/furane mortar conforming to IS:4832 (Part-I), up to a depth of 20 mm and bituminastic end sealing. Battery Room in all buildings shall be provided with acid/ alkali resistant tiles on flooring & dado 1200mm high.
9.04.07	(i) 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) Double charged Size of tile 600x600/605x605 of Premium Series Kajaria/ Royale Series Somany/ Johnson or equivalent b) Double charged ,Size of tile 800x800 of Polished and Kajaria/ Somany/ Polished and Johnson / RAK or equivalent ii) Anti-Skid Full Body Vitrified Tiles Antiskid, full body Vitrified Tiles of size 600X600X20 mm (KAJARIA/ RAK/ NITCO/ JOHNSON) thick as specified below of approved make, shade, colour and pattern, over under bed of cement mortar / PCC shall be provided in TG Hall flooring at operating level. Full body Vitrified Tiles shall be laid on properly laid leveled floor, with joints 3 to5 mm wide & 8 to10 mm deep & shall be filled with approved Epoxy Grout mix of 0.70 kg of organic coated filler of desired shade (0.10 kg of hardner and 0.20 kg of resin per kg). Full body Vitrified Tiles shall have water absorption less than 0.5%, Modulus of Rupture more than 38N/mm2, Breaking strength more than 7500 N, Mohs scale more than 6, Abrasion resistance less than 144 mm3 and coefficient of friction more than 0.4. Vitrified Tiles shall generally conform to IS: 15622
9.04.08	For pathway, chequered and designed concrete tiles minimum 22 mm thick, 200x200 mm size conforming to IS: 13801 of approved shade and colour shall be used. 1000 wide pathways shall be provided for maintenance on rooftops of all buildings.
9.04.09	**Epoxy Flooring**

	Epoxy Flooring shall be provided with surface preparation of concrete substrate with Captive Shot Blasting Machine OR Light Grinding to form the required anchor profile on the floor substrate followed by application of epoxy resin based moisture barrier underlay of 2 mm thickness including filling of saw cut joints with epoxy cementitious resin based moisture barrier underlay as per manufacturer specification. Application of self smoothing epoxy floor topping of epoxy based resin of 2 mm thickness over epoxy resin based moisture barrier underlay including application of solvent free epoxy resin based two component primer. It shall include application of PU Sealant at Expansion and Isolation Joint respectively including surface preparation of the joint, fixing of backup strip and application of sealant.
9.04.10	
9.04.11	Mirror polished (6 layers of polish) Granite stone (slab) - 18 mm thick (minimum) / Flame finish/ (making top surface rough by burning)/ honed finish granite stone (slab) - 18 mm thick (minimum) shall be provided.
9.04.12	Decorative/designer prepolished, plain and pigmented, high wearing resistance concrete tiles of 20mm thickness (minimum) in various non-standard interlocking patterns.
9.04.13	Skirting in general shall be 150 mm high. Dado in toilets & pantries, shall be upto false ceiling level from finished floor level. Skirting and Dado shall match with the floor finish.
9.04.14	Interlocking concrete blocks shall be of various sizes and thickness having M35 grade of concrete and pigmented to specified colours, in different pattern (in different textures chequered or other patterns in indentation for guiding band/s for visually impaired persons) including the preparation of sub base with 20mm thick sand and filling of joints with sand.
9.04.15	Matt finish (with grooves) Porcelain tiles (for guiding band/s for visually impaired persons in service building) shall be with 3mm groove joints as per approved pattern pointed neatly with 3x4mm stainless epoxy grout SP- 100 of Laticrete or approved equivalent in approved colour to match colour of tile. 24 mm x 24 mm x 3.8 mm thick (minimum) glass mosaic tiles in decorative murals and pattern. Engineered wooden flooring (15mm thick)) of Mikasa/ Century/ Pergo / Equivalent shall be provided in VIP area, conference rooms.
9.04.16	**Rubber Flooring** Rubber flooring shall conform to IS 809. The minimum thickness shall be 4 mm with sheet size of 602mm x 602mm. Rubber flooring shall consist of 100% virgin elastomer reinforcing agents, resins, curing agents, anti-oxidants and pigments. It shall have excellent abrasion resistance and shall have class-I fire rating. It shall be acid & alkali resistant and shall be of anti static grade. In general, BS code shall apply for their technical characteristics.
9.05.00	**Epoxy Resin Floor Finish** Self-smoothing, seamless epoxy resin floor finish shall be provided on horizontal and vertical surfaces including preparation of surface, application of epoxy based primer coat, of approved colour, quality and make to give minimum thickness of 300 micron (in two coats)
9.06.00	**Roof**
9.06.01	Except for the roofs subjected to heavy loads, roof of all buildings having structural steel frame work shall consist of permanently colour coated (on exposed face) troughed metal sheet decking of approved profile as specified in clause 9.08.00. Silicon modified polyester paint having DFT of minimum 20 microns shall be used for permanent coating. The sheeting shall

	be fixed by means of concealed fixing system or any other compatible method approved by the Engineer. RCC slab of minimum 40 mm clear thickness in excess of trough depth shall be provided over the metal decking. Water proofing cum plasticiser compound shall be added to concrete over the metal decking. Bidder shall demonstrate that the roof is leak proof by carrying out the water-retaining test by maintaining the minimum water depth of 50mm over the roof surface for a period of 48 hours. Water Proofing Treatment as given below for RCC roof slabs shall be provided to ensure that the roof is watertight.
9.06.02	DELETED
9.06.03	For efficient disposal of rainwater, the run off gradient for the roof shall not be less than 1:100 and the roof shall be provided with RCC water gutter, wherever required. Gutter shall be made water tight using suitable watertight treatment. This gradient can be provided either in structure or subsequently by screed concrete 1:2:4 (using 12.5 mm coarse aggregate) and/or cement mortar (1:4). However, minimum 25 mm thick cement mortar (1:4) shall be provided on top to achieve smooth surface.
9.06.04	Unplasticised PVC 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 green stage. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar underbed layer also. b) For roofs having no structural slope: Screed concrete mix (1:2:4) grading having minimum 25mm thickness at the lowest point of the slope shall be laid over R.C.C. slab and shall be laid as per the slope specified elsewhere in the specification. Top surface of grading underbed shall be finished with 15mm thick cement plaster (1:4). Over the finished surface elastomeric membrane shall be laid and top of the elastomeric membrane shall be finished with 20 mm thick cement: sand (1:4) mortar with chicken wire mesh and pressed precast concrete tiles of 20 mm thickness where applicable shall be laid over mortar at green stage. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar underbed layer also
9.06.06	Roof of all buildings shall be provided with access/approach through staircase or ladder. Roof where equipment are mounted shall be provided with access through staircase.

CLAUSE NO.	TECHNICAL REQUIREMENTS
9.06.07	RCC parapet wall of minimum 1000 mm height (above top of slab) with coping for all accessible roofs and 600 mm height for all non-accessible roofs shall be provided. Alternatively, parapet wall comprising structural steel post, runner and sheeting may be provided for buildings with metal sheet cladding.
9.06.08	Fillets at junction of roof and vertical walls shall be provided with cast-in-situ cement concrete (1:1.5:3) nominal mix followed by 12mm thick 1:4 cement sand plaster.
9.06.09	Pathways for handling of materials and movement of personals shall be provided with 22mm thick chequered cement concrete tiles as per IS:13801 for a width of 1000mm.
9.07.00	**Walls**
9.07.01	All walls shall be non-load bearing infill panel walls.
9.07.02	For initial height up to 1 metre in buildings one brick thick masonry wall shall be provided wherever metal cladding is specified.
9.07.03	All internal walls shall be with one brick thick in cement mortar (1:6). However, internal partition walls for toilets shall be with half brick masonry thick with cement mortar (1:4).
9.07.04	For ESP Control Room Building, wall shall be of Autoclaved Aerated Concrete Block. Autoclaved Aerated Concrete (AAC) block masonry shall be with blocks having dimensions of 625 mm x 250 mm. thickness ranging from 100 mm to 300 mm conforming to I.S. :2185(part III).The jointing cement sand mortar in the composition of 1: 6 (Cement: sand) shall be used with suitable plasticizer(optional). Sand having modulus of fineness 1.1 shall be used. Thehorizontal 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. For control room , control equipment room in MPH Building , 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.
9.07.05	Toilet Block in ESP Control Room Building shall be of Brick Masonry
9.07.06	50 mm thick DPC in Cement concrete (1:1.5:3) with water proofing compound followed by two layers of bitumen coating 85/25 grade as per IS: 702 @ 1.7 kg./sq.m. shall be provided at plinth level before starting the masonry work.

9.07.07 Enclosure of the elevator shall have 2hours fire rating and it shall be sealed from outside to ensure dust free environment.

9.08.00 **COLOUR COATED AND OTHER SHEETING WORK**

9.08.01 Material

a) Wall Cladding & Roofing Material

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

i) either of steel with minimum 0.6mm bare metal thickness (i.e. excluding the thickness of galvanizing/aluminium-zinc coating and painting) of grade 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
Alternativelyaluminium 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.

Alternativelyaluminium 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 TriglycidylIsocynurate) . 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 Panelsshall 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.

	Alternativelyaluminium 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 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 shade).
	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.

9.10.12 **ExteriorPainting on Wall (Premium Acrylic Smooth Exterior Paint with Silicone Additives)**

The paint shall be (premium acrylic smooth exterior paint with silicone additives) of approved brand and manufacture. This paint shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty containers shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

Preparation of Surface

For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Engineer in charge after inspection before painting is commenced.

Application of Base Coat

Base coat shall be of water proofing cement paint.

Preparation of Mix for Base Coat

Cement Paint shall be mixed in such quantities as can be used up within an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish. Cement Paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of cement Paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the cement Paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. In all cases the manufacturer's instructions shall be followed meticulously.

The lids of cement Paint drums shall be kept tightly closed when not in use, as by exposure to atmosphere the cement Paint rapidly becomes air set due to its hygroscopic qualities. In case of cement Paint brought in gunny bags, once the bag is opened, the contents should be consumed in full on the day of its opening. If the same is not likely to be consumed in full, the balance quantity should be transferred and preserved in an airtight container to avoid its exposure to atmosphere.

Application of Base Coat

The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so that the direct heat of the sun on the surface is avoided. The method of application of cement Paint shall be as per manufacturer's specification. The completed surface shall be watered after the day's work. The second coat shall be applied after the first coat has been set for at least 24 hours. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted.

For new work, the surface shall be treated with three or more coats of water proof cement Paint as found necessary to get a uniform shade.

Precaution

Water proof cement Paint shall not be applied on surfaces already treated with white wash, colour wash, distemper dry or oil bound, varnishes, Paints etc. It shall not be applied on gypsums, wood and metal surfaces. If water proofing cement is required to be applied on existing surface, previously treated with white wash, colour wash etc., the surface shall be thoroughly cleaned by scrapping off all the white wash, colour wash etc. completely. Thereafter, a coat of cement primer shall be applied followed by two or more coat of water proof cement.

Application of exterior paint

	Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of paint with potable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer's instructions & directions of the Engineer-in-charge shall be followed meticulously. The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust. Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks.
9.11.00	**Doors, Windows& 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 generally be as per IS 3614 (Part 2). Fire rating of the doors shall be of minimum 2 hours. These doors shall be double cover plated type with mineral wool insulation.

CLAUSE NO.	TECHNICAL REQUIREMENTS
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 Kerafix 2000 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 of Dorma (TS 73V, TS 83V, TS93V), Geze (TS 2000NV) or equivalent. 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 Kerafix 2000 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.

Fire Rated Door (swing / sliding) shall be of Makes- Saint Gobain, Acodor, IGI, Matrix.

9.11.12 Minimum area of windows in building on each floor level shall be 10% of floor area.

9.11.13 S**tructural 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 approvedlaboratory, 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 to be used should be from the manufacturers of glass like Saint Gobain (India) or Asahi (India) or equivalent. The glass should be free from distortion and thermal stress
9.12.06	For internal glazed partition, 8mm thick clear toughened glass shall be provided.Internal Glazed partition in in MPH shall be Vetrotech Saint-Gobain / equivalent 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 Standars) 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 Kerafix 2000 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 (approx.) 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. Partitions shall be of Makes - SaintGobain,Acodor , IGI , Matrix ,Tata Pravesh.
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 ineer face having 1.52mm PVB layer in between.
9.12.08	6 mm thick Lacquered glass (SAINT GOBAIN /ASAHI or similar approved brand) 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).
9.13.03	False ceiling of 12 mm thk calcium silicate board of 'HILUX' or equivalent with suspension system as per manufacturers details including supporting grid system, expansion fasteners for suspension arrangement from RCC, providing openings for AC ducts, return air grills, light fixtures, etc., all complete. (With concealed grid and finished flat seamless).
9.13.05	ALUMINIUM FALSE CEILING : Aluminiumfalse 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 providinggood acoustic properties. False ceiling shall have coil coatingof thickness 25micron (minimum)andit shall be installed with T-Grid (of profile 24

	mm) insame or contrasting colours or with 6 mmrecess joints. The whole system shall be leveladjusting arrangement and shall besuspended as per manufacturer guidelines.
9.13.08	Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures, A.C. ducts etc.
9.13.09	Suitable M.S. channel (Minimum MC75 with maximum spacing of 1.2 m C/C both ways) grid shall be provided above the false ceiling level for movement of personnel and to facilitate maintenance of lighting fixtures, AC ducts etc.
9.13.10	Underdeck insulation shall be provided on the ceiling (underside of roof slab) and underside of floor slab of air-conditioned area depending upon the functional requirements. This underdeck insulation shall consist of 50mm thick mineral wool insulation with 0.05 mm thick aluminium foil & 0.6 mm x 25mm mesh wire netting and shall be fixed to the ceiling with 2 mm wire ties.
9.13.11	Suitable cut-outs shall be provided in false ceiling to facilitate fixing of lighting fixtures, AC grills, smoke detectors, etc.
9.14.00	**Elevator Machine Room** Elevator machine room shall be as per NBC requirements in either way. a) Floor of the elevator machine room shall be of RCC and wall shall be of one brick thick masonry wall. It shall be provided with fire door and other requirements as per NBC and elevator norms. b) Floor of Machine Room shall be provided with profiled metal decking sheet. Trough shall be filled with Insulating Material (glass wool or rock wool) and thereafter finished with Minimum 50 mm thick wooden flooring, consisting of 37 mm thick hardwood planks, finished with 11mm thick laminated wooden flooring (of 'pergo' or equivalent) with plank size 193x1195mm (material class shall be 34 as per EN13329), over 2 mm expanded polystyrene foam and polythene sheet under laying. Roof and Side enclosure of Machine Room shall be provided with Prefabricated Insulated Metal Sandwich panels. Composition of Insulated Metal Sandwich Panels shall be as described in Clause 9.08.00 of Part-B (Civil) of Technical Specification. Doors of Machine Room shall be Double Plate Steel flush doors of thickness 45 mm with steel sheets of 18 gauge with necessary stiffeners. Space between two sheets shall be filled with mineral wool insulation. Frame of doors shall be pressed steel sheets of 16 gauge. All necessary fittings for the doors shall be provided by the Bidder. Rubber sealing, for making the Doors airtight shall also be provided. Windows/ventilators shall be of standard extruded anodised Aluminium Sections of minimum 2 mm thickness with 24 mm hermitically sealed double glazing consisting of two 6 mm thick toughened glass separated by 12 mm. gap. Technical requirements of prefabricated insulated metal sandwich panels/decking sheets shall be same as given elsewhere in this specification.
9.15.00	**Interior Design** A comprehensive interior design scheme shall be conceived with the intention of projecting a definite theme and aesthetic appearance to inside working environment. It shall take into account the multidisciplinary engineering activities involving power plant technology, and architectural & civil engineering for a smooth control hierarchy and man machine interface. All the design aspects such as flooring, false ceiling, furniture, colour scheme equipment design & layout, illumination, fire fighting, acoustics and ergonomics requirements shall be detailed out so as to present an overall unified aesthetic spatial appearance.

The areas to be undertaken for this interior design process shall be control room complex including common control room, computer room, conference rooms and office areas in the buildings and the following aspects shall be reviewed and evaluated for design. Furniture to be supplied by Bidder for the control room complex and other control rooms shall be as specified under C&I specification.

a) Layout, keeping in view the man-machine interface and suitable ergonomic practices.

b) Integration of civil engineering with architecture and interior design.

c) Illumination levels, noise levels, electromagnetic interference levels, taking into account the equipment and furniture.

d) Comfort and safety requirements such as air conditioning, fire fighting, fire escapes, etc.

e) Microprocessors based control system to control the functional requirements.

The above design philosophy put into practice shall be detailed out through presentation drawings, perspective views, scale models, detail drawings, etc.

9.16.00 **Stainless Steel Hand railing**

Providing and fixing knockdown railing system comprising of SS 304 Grade Stainless Railing of 50mm diameter handrail fixed on 50 mm SS round baluster placed at maximum 1000 c/c along with five numbers 19 mm diameter midrail connected at side of baluster by special brackets, both the end of mid rail should be bush inserted for jointing and to give extra strength (joints should not be welded and invisible). The balustrade should be fixed onto floor with casted plate of minimum 6mm thickness. Base plate shall be concealed with suitable SS 304 cover cap so that the mounting height fasteners are not visible after installation. Only high strength anchor fasteners would be used for fixing of baluster, as giving extra strength, rust proof and more durable. Onsite welding is strictly not allowed. Wherever welding is required, it should be Tig welding process with same grade 304/316 at factory only so that floor stone and other things would not be damaged and for safety purpose also. Baluster and handrail connector should be screwed tightened and not to be welded on site. Wall thickness of all pipes shall be taken as 2 mm. Along with all visible components developed in high grade SS and whenever required, joints to be filled with bushings for extra strength. Railing Height to be taken @ 1000/ 1200 mm from floor level.

9.17.00 **Finishing Schedule**

Interior and Exterior Finishes shall be as given in Tables-A&B respectively attached at the end of these specification.

2. The colour and pattern of finish shall be as per approved details.
3. All materials shall be of reputed and established brand approved by Engineer-in-charge.
4. Wherever alternative materials are specified, the final selection rests with Engineer-in-charge.
5. This finishing schedule shall also be applicable to similar functional areas for all other buildings and facilities.
6. All the finishing materials shall be applied/provided as per manufacturer specification and guidelines under the supervision & guidelines of manufacturer.
7. Requirement given above are suggestive and minimum. Bidder is welcome to suggest alternative scheme conforming to design functional requirement subject to approval of the Engineer-in-charge.

TABLE –B

EXTERIOR FINISHES SCHEDULE

Sl.No.	DESCRIPTION OF AREA	WALL AND PROJECTIONS	SOFFIT OF PROJECTIONS
1.	Auxiliary building in steel framed structure.	Premium Acrylic Smooth exterior paint with silicon additives over Texture coat over plastered surface/ Aluminium Composite Panel Approved colour/ colour combination of colour coated metal cladding	Premium Acrylic Smooth exterior paint with silicon additives over Texture Coat 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 Texture coat over plastered surface	Premium Acrylic Smooth exterior paint with silicon additives over Texture coat over plastered surface
3.	Steel Structure, trestles, etc.	High performance Paint of approved specification and shade.	
4	Service building	GRC Tiles, GRC Customized screens, Aluminium Composite Panels, High Preesure Laminates and Structural Glazing	Premium Acrylic Smooth exterior paint with silicone additives over Texture coat over plastered surface
NOTE : 1. The colour and pattern of finish shall be as finalized by Engineer. 2. All materials shall be of reputed and established brand approved by Engineer.			

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.

CLAUSE NO.	TECHNICAL REQUIREMENTS
D-1-10	**MATERIAL SPECIFICATION**
10.01.00	**Cement**

Fly ash based portland pozzolana cement conforming to IS: 1489 (Part-1) shall be used for all areas other than for the critical structures identified below. Other properties shall be as per IS code.

Ordinary Portland Cement (OPC) shall necessarily be used for the following structures.

a) Ordinary Portland Cement (OPC) shall necessarily be used for RCC for Chimney shell.
b) TG foundation top deck
c) Spring supported decks of all machine foundations such as TDBFP/MDBFP

The grade of cement shall be Grade 43 for OPC conforming to IS: 269.

In place of fly ash based portland pozzolana cement, OPC mixed with Fly Ash can be used. Batching plant shall have facility for mixing fly ash. Fly ash shall conform to IS: 3812(Part I). Percentage of fly ash to be mixed in concrete shall be based on trial mix. Mix design shall be done with varying percentage of fly ash mix with cement

10.02.00 **Aggregates**

a) **Coarse Aggregate**

Coarse aggregate for concrete shall be crushed stones chemically inert, hard, strong, durable against weathering of limited porosity and free from deleterious materials. It shall be properly graded. It shall meet the requirements of IS: 383.

However, use of aggregate manufactured from other than natural sources (Listed in Annexure-A of IS 383) and Bottom Ash from Thermal Power Plants shall be permitted only in Lean Concrete of Grade M7.5 and M10 (for % of utilization refer Table-1 of IS 383).

b) **Fine Aggregate**

Fine aggregate shall be hard, durable, clean and free from adherent coatings of organic matter and clay balls or pellets. Fine aggregate in concrete shall conform to IS: 383. Bidder can use either natural sand or crushed sand, confirming to IS:383, based on availability.

For plaster, it shall conform to IS: 1542 and for masonry work to IS: 2116.

However, use of aggregate manufactured from other than natural sources (as Listed in Annexure-A of IS 383) and Bottom Ash from Thermal Power Plants conforming to IS:383 shall be permitted only in Lean Concrete of Grade M7.5 and M10 (for % of utilization refer Table-1 of IS 383).

c) Petrographic examination of aggregate shall be carried out by the contractor at National Council for Cement and Building Materials (NCB), Ballabgarh, or any other approved laboratory to ascertain the structure and rock type including presence of strained quartz and other reactive minerals for machine foundations, etc. In case, the coarse aggregate sample is of composite nature, the proportions (by weight) of different rock types in the composite sample and petrographic evaluation of each rock should also be ascertained. While determining the rock type, special emphasis should be given on identification of known reactive rocks like chalcedony, opal etc. The procedure laid down in IS 2430 for sampling of aggregates may be followed.

The laboratory shall determine potential reactivity of the aggregate, which may lead to reaction of silica in aggregate with the alkalis of cement and / or potential of some aggregates like limestone to cause residual expansion due to repeated temperature cycle. If the same is established, the contractor shall further carry out alkali aggregates

reactivity test as per IS 2386 (Pt.VII) and / or repeated temperature cycle test to establish the suitability of the aggregates for the concrete work. The test results, with the final recommendations of the laboratory, as to a suitability of the aggregate, for use in the concrete work for various structures and suggested measures, in case of results are not satisfactory, shall be submitted to the Engineer for his review, in a report form.

In case in the report, it is established, that the aggregates contain reactive silica, which would react with alkalis of the cement, the contractor shall change the source of supply of the aggregate or use low alkali cement as per recommendation or take measures as recommended in the report as instructed by Engineer. In case aggregates indicate residual expansion, under repeated temperature cycle test (from 10o Celsius to 65o Celsius and for 60 temperature cycles) the material shall not be used for concreting of TGs', BFPs' and other equipment foundations which are likely to be subjected to repeated temperature cycle. The contractor shall use aggregates free from residual expansion under repeated temperatures cycle test.

10.03.00 **Reinforcement Steel**

Reinforcement steel shall be of high strength deformed TMT steel bars of grade Fe-415/Fe-500/Fe 500D and shall conform to IS 1786 and IS 13920. However, minimum elongation shall be 14.5%.

Relevant clause of IS 13920 are quoted below for clarity:

Quote

5.3.1 Steel reinforcement shall comply with all of the following:
a) Elongation shall be at least 14.5 percent,
b) Ratio of ultimate stress to 0.2 percent proof stress shall not exceed 1.25,
c) Ratio of ultimate stress to 0.2 percent proof stress shall be at least 1.15, and
d) Steel shall be only of strength grades with minimum 0.2 percent proof stress of 415 MPa, 500 MPa or 550 MPa, in addition to other requirements of IS 1786.'

5.3.2 The actual 0.2 percent proof stress of steel bars based on tensile test must not exceed their characteristic 0.2 percent proof stress by more than 20 percent

Unquote

Mild steel and medium tensile steel bars shall conform to Grade A of IS:432-Part 1 and hard drawn steel wire shall confirm to IS:432-Part II. Welded wire fabric shall conform to IS 1566.

10.04.00 **Structural Steel**

Structural Steel (including embedded Steel) shall be straight, sound, free from twists, cracks, flaw, laminations and all other defects. Structural steel shall comprise of mild steel, medium strength steel and high tensile steel as specified below.

10.04.01 **Mild Steel**

a) Rolled sections shall be of grade designation E250, Quality A/BR, Semi-killed/ killed conforming to IS 2062. All steel plates shall be of Grade designation E250, Quality BR (fully killed), conforming to IS 2062 and shall be tested for impact resistance at room temperature. Plates beyond 12mm thickness and up to 40mm thickness shall be normalized rolled. Plates beyond 40mm thickness shall be vacuum degassed & furnace normalised and shall also be 100% ultrasonically tested as per ASTM –A578 level B-S2.

b) Pipes shall conform to IS: 1161.

c) Hollow (square and rectangular) steel sections shall be hot formed conforming to IS: 4923 and shall be of minimum Grade Yst 240 and minimum thickness shall be 4 mm..

d) Chequered plate shall conform to IS 3502 and shall be minimum 6 mm thick excluding projection. Steel for chequered plate shall conform to grade E250A semi killed of IS: 2062 or equivalent grade conforming to ASTM & BS standards only.

10.04.02 **Medium and High Tensile Steel**

Rolled Sections and plates shall be of grade designation E350 or higher, Quality B0 (Fully killed), conforming to IS: 2062. Plates beyond 12mm thickness and up to 40mm thickness shall be normalized rolled. Plates beyond 40mm thickness shall be vacuum degassed & furnace normalised and shall also be 100% ultrasonically tested as per ASTM –A578 level B-S2.

10.05.00 **Bricks**

Only fly ash bricks shall be used in all construction, except for elevator shafts, which can be either of burnt clay bricks or RCC construction as per functional / codal provisions. Bricks shall be table moulded/ machine made of uniform size, shape and sharp edges and shall have minimum compressive strength of 75kg/cm2. Burnt clay fly ash bricks and fly ash lime bricks shall conform to IS: 13757 and IS: 12894 respectively. Minimum fly ash content in fly ash based bricks shall be 25%.

10.06.00 **Foundation Bolts**

Material and details of foundation bolts shall conform to IS: 5624. Mild steel bars used for the fabrication of bolt assembly shall conform to grade 1of IS: 432 and/ or grade A of IS: 2062. Hexagonal nuts and lock nuts shall conform to IS: 1363 & IS: 1364 upto M36 diameter and IS: 5624 for M42 to M150 diameter.

10.07.00 **Stainless steel**

The material specification for stainless steel plates are mentioned in the design concept area of Mill Bunker building.

10.08.00 **Water**

Water used for cement concrete, mortar, plaster, grout, curing, washing of coarse aggregate, soaking of bricks, etc. shall be clean and free from oil, acids, alkalis, organic matters or other harmful substances in such amounts that may impair the strength or durability of the structure. Potable water shall generally be considered satisfactory for all masonry and concrete works, including curing. When water from the proposed source is used for making the concrete, the maximum permissible impurities, development of strength and initial setting time of concrete shall meet the requirements of IS: 456.

All materials brought for incorporation in works shall be of best quality as per IS unless specified otherwise.

10.09.00 PTFE (Poly Tetra Fluoroethylene) Bearing

The bearing shall be of reputed make and manufacturer as approved by the Engineer, for required vertical load and end displacement/rotation. PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg/sq.cm. In order to prevent cold flow in PTFE surface it shall be rigidly bonded by a special high temperature resistance adhesive to the stainless steel substrata. The stainless steel surface that slides against the PTFE is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of stainless steel plate shall be between 1.0 mm to 1.5 mm.

10.10.00 **Statutory Requirements**

Bidder shall comply with all the applicable statutory rules pertaining to Factories Act, Fire Safety Rules at Tariff Advisory Committee. Water Act for pollution control, Explosives Act, etc.

Provisions of safety, health and welfare according to Factories Act shall be complied with. These shall include provision of continuous walkways along the crane - girder level on both

sides of building, comfortable approach to EOT crane cabin, railing, fire escape, locker room for workmen, pantry, toilets, rest room etc.

Provisions for fire proof doors, number of staircases, fire separation wall, lath plastering/encasing the structural members (in fire prone areas), type of glazing etc. shall be made according to the recommendations of Tarrif Advisory Committee.

Statutory clearances and norms of State Pollution Control Board shall be followed.

Bidder shall obtain approval of Civil/Architectural drawings from concerned authorities before taking up the construction work.

CLAUSE NO.	TECHNICAL REQUIREMENTS
D-1-11	**Inspection, Testing and Quality Control**
11.01.00	Sampling and testing of major items of civil works viz. earthwork, concreting, structural steel work (including welding,sheeting, etc. shall be carried out in accordance with the requirements of this specification. Wherever nothing is specified relevant Indian Standards shall be followed. In absence of Indian Standard equivalent International Standards may be used. The Bidder shall submit and finalise a detailed field Quality Assurance Programme before starting of the construction work according to the requirement of this specification. This shall include frequency of sampling and testing, nature/type of test, method of test, setting of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of format for record, Field Quality Plan, etc. Tests shall be done in the field and/or at a laboratory approved by the Engineer. The Bidder shall furnish the test certificate from the manufacturer's of various materials to be used in the construction.
11.02.00	Workmanship and dimensional tolerances shall be checked as stipulated else where in the specification

D-1-12 **ANNEXURES**

D-1-12(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	33 grade 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) (Part 2)	Hollow & solid concrete blocks. 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:8112	43 grade ordinary portland cement.
IS:8500	Structural steel-Microalloyed (Medium and high strength qualities).
IS:12269	53 grade ordinary portland cement.
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 IS:1199	Method of test for strength of concrete. Methods of sampling and analysis of concrete.
IS:1791	General requirement for batch type concrete mixers.
IS:1834 IS:1838	Hot applied sealing compound for joints in concrete. 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 (Part 6/Sec.7)	National Building Code - Structural Design 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.

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 (Part-I)	Approval test for welders working to approval welding procedure. 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	Code of practice for ancillary structure in sewerage system.

	(Part 1 to 5)	
	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) (Part -2)	Pretreatment. 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	Code of practice for design loads (other than earthquake) for (Relevant parts) 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 transmission 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.

AMENDMENT NO. 5 TO TECHNICAL SPECIFICATION (SECTION VI)

S. NO.	SPECIFICATION REFERENCE				EXISTING (As per Base Specification)	PROPOSED CHANGE
	SEC/ PART	SUB-SEC.	PAGE NO.	CLAUSE NO.		
					building) shall lead the water / coal slurry to a local RCC pit (of 2 Cu.M. capacity) near each facility to allow settling of coal. The water from the pit shall overflow into contractor's R.C.C drain, which will lead the discharge to a coal slurry settling pit. In case of Control rooms and MCC buildings, Pump houses, etc water / coal slurry coming from down comers shall discharge into peripheral drains (Brick drains with steel gratings provided around the building) which will lead the water / coal slurry into contractor's RCC drain, which will lead the discharge finally into coal slurry settling pond.	~~building)~~ shall lead the water / coal slurry to a local RCC pit (of 2 Cu. M. capacity) near each facility to allow settling of coal. The water from the pit shall overflow into contractor's R.C.C drain, which will lead the discharge to a coal slurry settling pit. In case of Control rooms and MCC buildings, Pump houses, etc water / coal slurry coming from down comers shall discharge into peripheral drains ~~(Brick drains with steel gratings provided around the building)~~ which will lead the water / coal slurry into contractor's RCC drain, which will lead the discharge finally into coal slurry settling pond.
D1-36	VI/B	D-1-6	10 of 26	6.03.08.02	All liquid retaining structures shall be designed by working stress method as given in clause 4.5 of IS 3370(Part2).	All liquid retaining structures shall be designed as per IS 3370 with limiting crack width of 0.1
D1-37	VI/B	D-1-8	4 of 19	8.02.01	Include additionally in General (c)	<table><tr><td>Sl No</td><td>Description</td><td>Minimum grade of concrete</td></tr><tr><td>vii)</td><td>Chimney Foundation and Superstructure</td><td>M30</td></tr></table>
D1-38	VI/E				List of Tender Drawings Drg no. 8200-001-POC-A-008 – Safety Park Architectural Details and specifications	Deleted
D1-39	VI/E				Tender drawing 8200-001-POC-A-011 - WORKER'S REST ROOM	Drawing revised to revised title 8200-001-POC-A-011 – SHED FOR CONSTRUCTION WORKERS AND O&M WORKERS **Refer Annexure D1-39 to this Amendment.**
D1-40	VI/B	D-1-6		6.03.08.02	All liquid retaining structures shall be designed by working stress method as given in clause 4.5 of IS 3370(Part2).	All liquid retaining structures shall be designed as per IS 3370 with limiting crack width of 0.1
D1-41	VI/B	D-1-5	25 of 78	5.05.11	**All liquid retaining structure shall be designed by working stress method as per IS 3370 (Part-1&2):2009**.	**All liquid retaining structure shall be designed as per IS 3370 (Part-1&2) with Tightening Class 3 . The thickness**

AMENDMENT NO. 5 TO TECHNICAL SPECIFICATION (SECTION VI)

S. NO.	SPECIFICATION REFERENCE				EXISTING (As per Base Specification)	PROPOSED CHANGE
	SEC/ PART	SUB-SEC.	PAGE NO.	CLAUSE NO.		
					The thickness of base slab in liquid retaining/ carrying structures shall be minimum 150mm. Minimum grade of concrete for liquid retaining structures like Sumps/tanks/drain sumps etc shall be M-30.	**of base slab in liquid retaining tank shall be minimum 250mm**. Minimum grade of concrete for liquid retaining structures like Sumps/tanks/drain sumps etc shall be M-30.
D1-42	VI/B	D-1-5	25 of 78	5.05.12	For liquid retaining structures, the minimum reinforcement in each direction shall not be less than **0.24% of the gross cross-sectional area.**	For liquid retaining structures, the minimum reinforcement in each direction shall not be less than **as specified in IS 3370 Part 2**
D1-43	VI/B	D-1-5	25 of 78	5.05.13	All liquid retaining structures shall be tested for leak proofness with full water level in accordance with **clause no.12 of** IS 3370(Part 1)**:2009** and IS 6494.	All liquid retaining structures shall be tested for leak proofness with full water level in accordance with IS 3370(Part 1) and IS 6494.
D1-44	VI/B	D-1-6	15 of 26	6.03.13 S.No 1	1. Fly Ash silo shall be of RCC construction. The silo shall be designed as per the requirement of IS:4995. The pressure due to ash filling on the side wall and the bottom portion of ash bins/silos shall be taken as the maximum of (a) static pressure determined in accordance with the Jansen's formula multiplied by an impact factor of 1.4 and (b) pressure determined as per Walker's formula for static as well as dynamic conditions. The silo shall be designed for the following conditions:……..	1. Fly Ash silo shall be of RCC construction. The silo shall be designed as per the requirement of IS:4995. **The static pressure calculated at rest shall be multiplied by an over pressure factor of 1.35 for the top 1/3rd – portion and by a factor of 1.75 for the bottom 2/3rd portion The effect of hot temperature of ash on the concrete wall shall also be considered.** The silo shall be designed for the following conditions:……
D1-45	VI/B	D-1-5	37 of 78	5.17.01	**k) Coating** All concrete surfaces in direct contact with water/ water spray/moist air shall be applied with Moisture Compatible Corrosion Resistant Coating System or its equivalent as specified in Annexure-G. All concrete surfaces subject to water/ water spray/moist air upto and including Fan Deck slab level including basin slab, inner faces of peripheral walls, all faces of cell partition wall, all faces of columns, all faces of beams (both cast in situ and precast), bottom surface of fandeck slab for counter flow tower and both	**k) Coating** All concrete surfaces subject to water/ water spray/moist air including cold water basin, inner faces of peripheral walls, all faces of cell partition wall, all faces of columns, all faces of beams (both cast in situ and precast), bottom surface of fandeck slab for counter flow tower and both surface of fandeck slab for cross flow tower, inner face of fanstack, all faces of hot water basin (for cross flow tower), etc. **except exterior surface** shall be applied with High build heavy duty polyurethane coating having formulation of 100 %

AMENDMENT NO. 5 TO TECHNICAL SPECIFICATION (SECTION VI)

S. NO.	SPECIFICATION REFERENCE				EXISTING (As per Base Specification)	PROPOSED CHANGE
	SEC/ PART	SUB-SEC.	PAGE NO.	CLAUSE NO.		
					surface of fandeck slab for cross flow tower, inner face of fanstack, all faces of hot water basin (for cross flow tower), etc as applicable shall receive the said coating after cleaning and drying of the concrete surface. The detailed specification of the coating system on concrete surfaces is given in Annexure- G. External surfaces of Cooling tower peripheral walls and fanstack shall be painted with two or more coats of waterproof cement paint of approved shade, make and color.	solids, solvent free over proper cleaned and complete dried concrete surface. Thickness of polyurethane coating shall be 2.0 mm. Suitable primer as per standard Practice/manufacturers' recommendation shall be used. The detailed specification of polyurethane coating is given in **ANNEXURE-I**. **Exterior surfaces** of cooling tower shall be coated with one coat of High Performance Moisture Compatible Corrosion Resistant Coating System of minimum 150 micron as per **Annexure-G** followed by finish coat of two pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% ±2%) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 70 micron DFT. **"Annexure-I" mentioned is placed at Annexure- D1-45 to this Amendment.**
D1-46	VI/B	D-1-12			**-**	**ANNEXURE-I** "SPECIFICATIONS FOR 100% SOLIDS, HIGH BUILD, ELASTOMERIC POLYURETHANE COATING FOR CONCRETE" **"Annexure-I" mentioned is placed at Annexure- D1-45 to this Amendment.**
D1-47	VI/B	D-1-5	70 of 78	5.23.25.1	Minimum, 12 mm dia (NB)threaded nozzle of suitable length, shall be provided over the surface and along	deleted
D1-48	VI/B	D-1-5	8 of 78	5.17.02	(a) The design of all liquid retaining/conveying structures of cooling tower like C.W. basin, sump, hot water distribution channel/basin, sludge drain and pits shall be designed **by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2) : 2009**. These structures shall be designed for following conditions	(a) The design of all liquid retaining/conveying structures of cooling tower like C.W. basin, sump, hot water distribution channel/basin, sludge drain and pits shall be designed **as per IS 3370 with limiting crack width to 0.1mm**. These structures shall be designed for following conditions

D-1-12(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.

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.

D-1-12(D)

Annexure- (D)

CRITERIA FOR WIND RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT

All structures shall be designed for wind forces in accordance with IS:875 (Part-3) and as specified in this document. See Annexure – B for site specific information.

Along wind forces shall generally be computed by the Peak (i.e. 3 second gust) Wind Speed method as defined in the standard.

Along wind forces on slender and wind sensitive structures and structural elements shall also be computed, for dynamic effects, using the Gust Factor or Gust Effectiveness Factor Method as defined in the standard. The structures shall be designed for the higher of the forces obtained from Gust Factor method and the Peak Wind Speed method.

Analysis for dynamic effects of wind must be undertaken for any structure which has a height to minimum lateral dimension ratio greater than “5” and/or if the fundamental frequency of the structure is less than 1 Hz.

Susceptibility of structures to across-wind forces, galloping, flutter, ovalling etc. should be examined and designed/detailed accordingly following the recommendations of IS:875(Part-3) and other relevant Indian standards.

It should be estimated if size and relative position of other structures are likely to enhance the wind loading on the structure under consideration. Enhancement factor, if necessary, shall suitably be estimated and applied to the wind loading to account for the interference effects.

Damping in Structures

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

a) Welded steel structures : 1.0%

b) Bolted steel structures/RCC structures : 2.0%

c) Prestressed concrete structures : 1.6%

d) Steel stacks : As per IS:6533 & CICIND Model Code whichever is more critical.

ANNEXURE-I

SITE SPECIFIC DESIGN PARAMETERS

The various design parameters, as defined in IS: 875 (Part-3), to be adopted for the project site shall be as follows:

a) The basic wind speed "Vb" at ten metres above the mean ground level : 39 metres/second

b) The risk coefficient "K_1" : 1.06

c) Category of terrain : Category-2

D-1-12(E)

Annexure-(E)

CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT

All structures and equipment shall be designed for seismic forces adopting the design parameters provided in this document and using the provisions in accordance with IS:1893 (Part 1 to Part 4). Pending finalization of Parts 5 of IS:1893, provisions of part 1 shall be read along with the relevant clauses of IS:1893:1984, for embankments.

The peak ground horizontal acceleration for the project site, the acceleration spectral coefficients (in units of gravity acceleration 'g') in the horizontal direction for the various damping values and the multiplying factor (to be used over the spectral coefficients) for evaluating the design acceleration spectra are as given at Annexure-I.

Vertical acceleration spectral values shall be taken as 2/3rd of the corresponding horizontal values.

The design acceleration spectra specified at Annexure-I shall be used in place of the response acceleration spectra, given at figure-2 in IS:1893 (Part 1) and Annex B of IS:1893 (Part 4). The acceleration spectra along with multiplying factors specified in Annexure-I includes the effect of the seismic environment of the site, the importance factor related to the structures and the response reduction factor. Hence, the design spectra do not require any further consideration of the zone factor (Z), the importance factor (I) and response reduction factor (R) as used in the IS:1893 (Part 1 and Part 4).

Damping in Structures

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

a)	Steel structures	:	2%
b)	Reinforced Concrete structures	:	5%
c)	Reinforced Concrete Stacks	:	3%
d)	Steel stacks	:	2%

Method of Analysis

Since most structures in a power plant are irregular in shape and have irregular distribution of mass and stiffness, dynamic analysis for obtaining the design seismic forces shall be carried out using the response spectrum method. The number of vibration modes used in the analysis should be such that the sum total of modal masses of all modes considered is at least 90 percent of the total seismic mass and shall also meet requirements of IS:1893 (Part 1). Modal combination of the peak response quantities shall be performed as per Complete Quadratic Combination (CQC) method or by an acceptable alternative as per IS:1893 (Part 1).

In general, seismic analysis shall be performed for the three orthogonal (two principal horizontal and one vertical) components of earthquake motion. The seismic response from the three components shall be combined as specified in IS:1893.

The spectral acceleration coefficient shall get restricted to the peak spectral value if the fundamental natural period of the structure falls to the left of the peak in the spectral acceleration curve.

For buildings, if the design base shear (V_B) obtained from modal combination is less than the base shear ($\bar{V}_B$) computed using the approximate fundamental period (T_a) given in IS:1893:Part 1 and using acceleration spectra with appropriate multiplying factor specified at Annexure-I, the response quantities (e.g. member forces, displacements, storey forces, storey shears and base reactions) shall be enhanced in the ratio of $\bar{V}_B / V_B$. However, no reduction is permitted if $\bar{V}_B$ is less than V_B.

Design/Detailing for Ductility for Structures

The design acceleration spectra is a reduced spectra and has an in-built allowance for ductility. Structures shall be engineered and detailed in accordance with relevant Indian/International standards to achieve ductility.

ANNEXURE – I

SEISMIC PARAMETERS FOR DESIGN OF STRUCTURES AND EQUIPMENT

The various seismic parameters for the project site shall be as follows:

1) Peak ground horizontal acceleration (MCE) : 0.24g

2) Multiplying factor to be applied to the horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') to obtain the design acceleration spectra

a) for special moment resisting steel building frames designed and detailed as per IS:800 : 0.06

b) for special concentrically braced steel building frames designed and detailed as per IS:800 : 0.045

c) For special moment resisting RC building frames designed and detailed as per IS:456 and IS:13920 : 0.036

d) for RCC chimney, RCC Natural Draft Cooling Tower : 0.12

e) for liquid retaining tanks (ground supported) : 0.072

f) for steel chimney, Absorber tower, Vessels : 0.09

3) Multiplying factor to be applied to the horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') for design of equipment and structures where inelastic action is not relevant or not permitted : 0.12

Note: g = Acceleration due to gravity

The horizontal seismic acceleration spectral coefficients are furnished in subsequent pages.

ANNEXURE – I

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS FOR KODERMA PROJECT
(In units of 'g')

Time Period	Damping Factor (as a percentage of critical damping)		
(Sec)	2%	3%	5%
0.00	1.000	1.000	1.000
0.02	1.500	1.433	1.300
0.04	2.000	1.867	1.600
0.06	2.500	2.300	1.900
0.08	3.000	2.733	2.200
0.09	3.250	2.950	2.350
0.10	3.500	3.167	2.500
0.12	3.500	3.167	2.500
0.14	3.500	3.167	2.500
0.16	3.500	3.167	2.500
0.18	3.500	3.167	2.500
0.20	3.500	3.167	2.500
0.22	3.500	3.167	2.500
0.24	3.500	3.167	2.500
0.26	3.500	3.167	2.500
0.28	3.500	3.167	2.500
0.30	3.500	3.167	2.500
0.32	3.500	3.167	2.500
0.34	3.500	3.167	2.500
0.36	3.500	3.167	2.500
0.38	3.500	3.167	2.500
0.40	3.500	3.167	2.500
0.42	3.333	3.016	2.381
0.44	3.182	2.879	2.273
0.46	3.043	2.754	2.174
0.48	2.917	2.639	2.083
0.50	2.800	2.533	2.000
0.52	2.692	2.436	1.923
0.54	2.593	2.346	1.852
0.55	2.545	2.303	1.818

ANNEXURE – I

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS FOR KODERMA PROJECT
(In units of 'g')

Time Period	Damping Factor (as a percentage of critical damping)		
(Sec)	2%	3%	5%
0.56	2.500	2.262	1.786
0.58	2.414	2.184	1.724
0.60	2.333	2.111	1.667
0.62	2.258	2.043	1.613
0.64	2.188	1.979	1.563
0.66	2.121	1.919	1.515
0.67	2.090	1.891	1.493
0.68	2.059	1.863	1.471
0.70	2.000	1.810	1.429
0.72	1.944	1.759	1.389
0.74	1.892	1.712	1.351
0.76	1.842	1.667	1.316
0.78	1.795	1.624	1.282
0.80	1.750	1.583	1.250
0.82	1.707	1.545	1.220
0.84	1.667	1.508	1.190
0.86	1.628	1.473	1.163
0.88	1.591	1.439	1.136
0.90	1.556	1.407	1.111
0.92	1.522	1.377	1.087
0.94	1.489	1.348	1.064
0.96	1.458	1.319	1.042
0.98	1.429	1.293	1.020
1.00	1.400	1.267	1.000
1.02	1.373	1.242	0.980
1.04	1.346	1.218	0.962
1.06	1.321	1.195	0.943
1.08	1.296	1.173	0.926
1.10	1.273	1.152	0.909
1.12	1.250	1.131	0.893

ANNEXURE – I

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS FOR KODERMA PROJECT
(In units of 'g')

Time Period	Damping Factor (as a percentage of critical damping)		
(Sec)	2%	3%	5%
1.14	1.228	1.111	0.877
1.16	1.207	1.092	0.862
1.18	1.186	1.073	0.847
1.20	1.167	1.056	0.833
1.22	1.148	1.038	0.820
1.24	1.129	1.022	0.806
1.26	1.111	1.005	0.794
1.28	1.094	0.990	0.781
1.30	1.077	0.974	0.769
1.32	1.061	0.960	0.758
1.34	1.045	0.945	0.746
1.36	1.029	0.931	0.735
1.38	1.014	0.918	0.725
1.40	1.000	0.905	0.714
1.42	0.986	0.892	0.704
1.44	0.972	0.880	0.694
1.46	0.959	0.868	0.685
1.48	0.946	0.856	0.676
1.50	0.933	0.844	0.667
1.52	0.921	0.833	0.658
1.54	0.909	0.823	0.649
1.56	0.897	0.812	0.641
1.58	0.886	0.802	0.633
1.60	0.875	0.792	0.625
1.62	0.864	0.782	0.617
1.64	0.854	0.772	0.610
1.66	0.843	0.763	0.602
1.68	0.833	0.754	0.595
1.70	0.824	0.745	0.588
1.72	0.814	0.736	0.581

ANNEXURE – I

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS FOR KODERMA PROJECT
(In units of 'g')

Time Period	Damping Factor (as a percentage of critical damping)		
(Sec)	2%	3%	5%
1.74	0.805	0.728	0.575
1.76	0.795	0.720	0.568
1.78	0.787	0.712	0.562
1.80	0.778	0.704	0.556
1.82	0.769	0.696	0.549
1.84	0.761	0.688	0.543
1.86	0.753	0.681	0.538
1.88	0.745	0.674	0.532
1.90	0.737	0.667	0.526
1.92	0.729	0.660	0.521
1.94	0.722	0.653	0.515
1.96	0.714	0.646	0.510
1.98	0.707	0.640	0.505
2.00	0.700	0.633	0.500
2.02	0.693	0.627	0.495
2.04	0.686	0.621	0.490
2.06	0.680	0.615	0.485
2.08	0.673	0.609	0.481
2.10	0.667	0.603	0.476
2.15	0.651	0.589	0.465
2.20	0.636	0.576	0.455
2.25	0.622	0.563	0.444
2.30	0.609	0.551	0.435
2.35	0.596	0.539	0.426
2.40	0.583	0.528	0.417
2.45	0.571	0.517	0.408
2.50	0.560	0.507	0.400
2.55	0.549	0.497	0.392
2.60	0.538	0.487	0.385
2.65	0.528	0.478	0.377

ANNEXURE – I

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS FOR KODERMA PROJECT
(In units of 'g')

Time Period	Damping Factor (as a percentage of critical damping)		
(Sec)	2%	3%	5%
2.70	0.519	0.469	0.370
2.75	0.509	0.461	0.364
2.80	0.500	0.452	0.357
2.85	0.491	0.444	0.351
2.90	0.483	0.437	0.345
2.95	0.475	0.429	0.339
3.00	0.467	0.422	0.333
3.05	0.459	0.415	0.328
3.10	0.452	0.409	0.323
3.15	0.444	0.402	0.317
3.20	0.438	0.396	0.313
3.25	0.431	0.390	0.308
3.30	0.424	0.384	0.303
3.35	0.418	0.378	0.299
3.40	0.412	0.373	0.294
3.45	0.406	0.367	0.290
3.50	0.400	0.362	0.286
3.55	0.394	0.357	0.282
3.60	0.389	0.352	0.278
3.65	0.384	0.347	0.274
3.70	0.378	0.342	0.270
3.75	0.373	0.338	0.267
3.80	0.368	0.333	0.263
3.85	0.364	0.329	0.260
3.90	0.359	0.325	0.256
3.95	0.354	0.321	0.253
4.00	0.350	0.317	0.250

D-1-12(F)

Annexure-(F)

QA REQUIREMENT

All Civil, Structural and Architectural construction work at the project shall be executed strictly in accordance with the Quality Assurance guidelines specified in separate part of the Specification.

D-1-12(G)

ANNEXURE –G

Specification For High Performance Moisture Compatible Corrosion Resistant Coating System

a)Providing & applying **High Performance Moisture Compatible Corrosion Resistant Coating System** manufactured as per technical specifications of Central Electrochemical Research Institute, Karaikudi, (C.S.I.R. affiliate Institute), Tamil Nadu, Pin - 630 006.

b) The coating system shall be water compatible, compatible for applying in wet conditions also and shall be tolerant to under-prepared surfaces and existing residual tar / paint. The system shall also be quick curing so as to be suitable for application during shut downs.

The coating material shall be stored in the manner as per recommendations of the manufacturer until ready for use. The coating material shall be used within the manufacturer's written recommended shelf life.

c) The coating system shall conform to the following:

ANNEXURE – I

SPECIFICATIONS FOR 100% SOLIDS, HIGH BUILD, ELASTOMERIC POLYURETHANE COATING FOR CONCRETE

1.00.00 The PU coating shall meet minimum requirements for materials, equipment, application, inspection, repair and handling aspects associated with the coating of Concrete using 100% Solids (Solventless) Two Component, Fast Curing Elastomeric Polyurethane Coating classified under ASTM D -16, Type V.

1.01.00 The polyurethane on the surface of concrete shall provide a hard yet flexible, impermeable barrier with outstanding adhesion impact and abrasion resistance as well as crack spanning capability to protect the concrete from corrosion and abrasion. It shall cover all variations associated with operating conditions of cooling tower.

1.02.00 Supplier or his licensed applicator shall obtain prior written approval from the Owner for any deviations from the requirements of this specification and / or the standard referred herein.

1.03.00 The work shall conform to following documents (latest revision or as specified) and as referred in this specification.

a) SSPC-PS Guide 17.00, 1 Aug, 1991	Guide for Selecting Urethane Painting System
b) RP 0892-92	NACE International Linings Over Concrete for Immersion Service
c) RP 0187-96	NACE International Design Considerations for Corrosion Control of Reinforcing Steel In Concrete.
d) ASTM D 4541	Method for Pull Off Strength of Coatings Using Portable Adhesion Testers

2.00.00 **GENERAL REQUIREMENT**

2.01.00 The bidder shall perform all work in accordance with this specification and other requirements noted herein.

Bidder shall submit a detailed written description in the form of a manual covering coating equipment, procedure, materials, inspection, tests and repair etc, for Owner's approval.

2.02.00 The bidder shall also supply copies of test reports conducted by in internationally reputed test agencies evidencing that materials conform to minimum performance

requirements. The bidder shall also supply certificates from coating manufacturer as under.

- That the materials (with batch numbers, dates of manufacture and shelf life) are free from all manufacturing defects.
- That the materials will meet performance criteria as given below when applied.
- That the bidder or his applicator possesses the necessary technical skills and equipment to apply these materials and is authorized by the manufacturer for this purpose.

100% Solids, Two Component Polyurethane are specialized coatings. The coating shall be applied either by the coating material manufacturer himself or by his authorized applicator. The authorized applicator should have been trained and certified by the coating manufacturer and shall possess the necessary specialized equipment, trained crew and experience in spraying fast setting plural component polyurethane coatings. Contractor shall provide, for the owner's approval, details of coating manufacturer's authorized applicator including details of equipment, experience in spraying fast setting 100% Solids Polyurethane Coatings and client references for verification. In no case shall coating application be undertaken by coating contractors without prior track record of applying these materials. In addition, contractor shall provide certificate from coating materials manufacturers that the applicator possesses the necessary technical skills and equipment to apply these materials and is authorized by the manufacturer for this purpose.

2.03.00 Applied coating will be tested for dry film thickness and adhesion and hardness.

All coating operations shall be performed under the supervision of, and performed by, personnel skilled in the application of the coating system.

2.04.00 The bidder shall provide access, during all phases of work, to the Owner and their representatives.

2.05.00 All cleaning, priming and coating machines shall be equipped with rubber or wheels overlaid with hard fiber to prevent damaging the concrete surface.

2.06.00 The materials shall be applied by Airless Spray System, as per the standards specified by the material manufacturer.

2.07.00 100% Solids Polyurethane systems are solvent free eliminating solvent health hazards and flammability concerns All safety precautions warranted by good industrial hygiene practices and regulated by local, state or central laws must be taken into consideration while applying these coatings.

3.00.00 MATERIAL SPECIFICATIONS

CLAUSE NO.	TECHNICAL REQUIREMENT
3.01.00	ELASTOMERIC POLYURETHANE COATING : Spray applied, Impermeable, 100% Solids, Elastomeric Aromatic Polyurethane Coating (Non Tar Extended), as per ASTM D-16, Type V (Two Component, Chemical Cure). Shall meet following criteria. All tests at ambient (25 C) unless otherwise specified. • NOMINAL THICKNESS — 2,000 Microns • TENSILE STRENGTH ASTM D-638 — ASTM — 17 N / mm^2 • ADHESION ASTM D-4541 (Elcometer Pull Off) — 2 N / mm^2 • RECOVERABLE ELONGATION ASTM D-638 — 50% Min. • SURFACE HARDNESS D 2240 (Cured Film - Shore D) — ASTM — 50 Min. • WATER VAPOUR PERMEABILITY ASTM E - 96 / F-1249-90 — 0.3 gms. / 24 Hour / M2 Max. • RESISTANCE TEMPERATURES — 0° C to 60°C • FLEXIBILITY 180° Bend -1.0 mm thick ASTM D 1737 — Pass over 12 mm Mandrel • ACCELERATED WEATHERING ASTM G – 154 53 / BS 3800 2,000 Hours — Excellent. Some Discoloration. • ABRASION RESISTANCE ASTM D 4060 /FTMS 141 Taber Abraser H - 10 Wheel 1,000 gms., 1,000 cycles — Weight Loss 0.05 gms. Max • CHEMICAL RESISTANCE Immersion of 30 days in sea water followed by (%) Weight Change — < 1.0 % (%) Hardness (Shore D) Change — < 5.0 % (%) Tensile Strength Change — < 5.0 %
3.02.00	**PRIMER**

Primer shall be used on new concrete surfaces before application of PU coating.

Damp tolerant, penetrating, sealing primer shall be applied at 100-125 Microns Wet Film Thickness in accordance with the recommendation of the Polyurethane Coating manufacturer.

4.00.00 **SURFACE PREPARATION**

4.01.00 The bidder shall be responsible for the structural integrity of the concrete.

The use of form release agents shall be compatible to the coating. Contractor shall take measures in concrete casting to provide a suitable surface finish that shall be compatible with subsequent application of coating. The measures shall include providing well compacted, dense concrete with minimal air entrainment and a relatively smooth surface finish. Pond floor shall be vacuum dewatered.

Remove any fins or protrusions using power grinding. These may also be required to be removed for applications requiring an even finish.

Residual bug – holes beneath the surface of the coating shall be opened by sweep blasting and flooded with Polyurethane coating during spray application. Any larger voids shall be filled with Elastomeric Polyurethane hand mix material or compatible grout. Active cracks shall be bridged by using Elastomeric Polyurethane over Industrial Nylon / Polyester Fabric. Any exposed steel surfaces shall be wire brush cleaned and primed before coating application.

4.02.00 Exterior waterproofing shall be applied to the structure below the finished ground level and upto atleast 300 mm above it. The structure shall be sealed from the exterior (soil side) to block capillary action of moisture through the concrete. Leaks from groundwater can permeate the entire concrete thickness. The exterior waterproofing system must be suitable for the expected exposure condition.

4.03.00 Before general surface preparation, surface contaminants (if any) shall be removed. Oil and Grease shall be removed by multiple detergent wash, preferably using steam. (Solvents shall not be used as they will cause the petroleum products to penetrate the concrete surface). Chemically contaminated concrete shall be neutralized prior to complete surface preparation. Acidic surfaces shall be neutralized using an alkaline cleaner and rinsed with fresh water and then cleaned with steam and detergent. After chemical cleaning, surface will be tested for residual chemicals. pH shall be tested using ASTM D - 4262 using pH test paper on rinse water . Concrete shall be dried thoroughly thereafter.

4.04.00 Sweep blast the concrete surface using expendable abrasive. The blast nozzle should be kept at sufficient distance to avoid over blast and exposing of aggregate. Following blasting remove dust using air jet (with the abrasive turned off).

4.05.00 Any of the following methods of surface preparation may be used to achieve a near

white blast cleaned surface:

a) Dry abrasive blasting using compressed air, blast nozzles and abrasive.
b) Dry abrasive blasting using a dosed cycle, re-circulating abrasive system, with compressed air, blast nozzle, and abrasive, with or without vacuum for dust and abrasive recovery.
c) Dry abrasive blasting using a dosed cycle, re-circulating abrasive system with centrifugal, wheels and abrasive (such as Wheelabrator).

4.06.00 Compressed air used for blast cleaning shall be dean, dry and free of moisture and oil. Moisture separators, oil separators, traps or other equipment may be necessary to achieve dean, dry air.

4.07.00 Blast cleaning operations shall be done in such a manner that no damage is done to partially or entirely completed portions of the work.

4.08.00 Dry blast cleaning shall not be concluded during times when the surface will become wet after blast cleaning.

4.09.00 Non-metallic disposable mineral abrasive such as silica sand shall be the chosen abrasive for open blasting operations Steel grit and shot are approved abrasive media for blast cleaning in closed cycle, recirculating abrasive systems (compressed air, vacuum and centrifugal wheel). No other abrasive media shall be used without prior approval.

4.10.00 The cleanliness and size of recycled abrasive shall be maintained to ensure compliance with this standard.

4.11.00 The blast cleaning abrasive shall be dry and free of oil, grease and other contaminants. Applicator shall use abrasive media of size that will ensure the necessary roughness desired.

4.12.00 Dust and residues shall be removed from prepared surface by brushing, blowing off with dean, dry air or vacuum cleaning. Moisture separators, oil separators, traps or other equipment may be necessary to achieve clean, dry air.

4.13.00 Prior to the application of Elastomeric Urethane on new concrete surface, sufficient time must pass to allow the excess moisture to evaporate. This time will vary on conditions and is normally 14-28 days. After the curing period has elapsed, concrete must be checked for the presence of excess moisture on and beneath the surface using a Delmhorst BD-8 Moisture Detector. A reading of 2% and under indicates that the concrete is ready to be coated. The moisture content must not only be checked on the surface but beneath it by driving nails 6-12 mm into the concrete and placing the probes on the nail - heads. Alternatively the moisture may be tested by the Plastic Sheet Test ASTM D-4263. The test involves taping a 450 mm X 450 mm , 0.1 mm thick dear plastic sheet to the surface of the concrete for a duration of 16 hours. Absence of any droplets of moisture underneath the plastic sheet indicates that the concrete is ready for

	coating. In cases of continued ingress of moisture from localised areas of concrete, apply propane blow torch to ensure that the moisture content as specified above is achieved.
5.00.00	**PRIMING**
5.01.00	Before beginning priming and coating, measure the humidity using a sling psychrometer and calculate the dew point. The relative humidity must be lower than 85%. Temperature of concrete surface must be at least 3°C higher than the dew point. Under controlled conditions, it is possible to heat the concrete surface to eliminate condensation problems.
5.02.00	The type of primer used shall be as described in the coating specification 3.02.00.
5.03.00	Primer shall be sprayed onto the cleaned surface with a wet film thickness of 75-125 Microns. Since the primer penetrates into the concrete surface, no DFT measurements will be taken and estimation shall be on volumetric basis. The primer on application shall be free from runs or drips or areas of excessive thickness.
5.04.00	The primed surface shall be protected so that it will not come into contact with rain, dust or other substances until completely hardened and coated with the Elastomeric Polyurethane Top Coat.
5.05.00	Primed surface should be over coated within the time recommended for the approved type of primer. In the event that the re-coat interval of primed surface is exceeded without top-coating with the Elastomeric Polyurethane, the surface must be re-primed.
6.00.00	**COATING**
6.01.00	Nominal thickness of the Elastomeric Polyurethane shall be 2,000 Microns, measured in accordance with 7.02.02. Being a thixotropic, high build, non-levelling coating, the Elastomeric Polyurethane coating shall take the contour / profile of the substrate. Coating shall be done only at times when the substrates temperature is at least 3°C over the dew point. Hourly measurements of dew point and surface temperatures shall be made prior to and when coating is under progress. Surface temperature should be minimum 5°C and should not exceed 70°C.
6.02.00	Equipment for the spray application shall be in conformity with system specification, meeting minimum specified by the coating manufacturer. Equipment shall consist of Material Feed Pumps, Purge Pump, Proportioning Pump, Mix Manifold, Static Mixer, Interconnecting Hoses etc.
6.03.00	Partially used and unused material drums must be tightly sealed and contain a blanket of nitrogen to prevent moisture contamination when not in use.

6.04.00 Before application on the substrate apply a test patch for runs or drips and gel time as well as tack free time.

6.05.00 The proportioning pump shall be fitted with a numeric counter to keep track of the volume while spraying.

6.06.00 Entire thickness shall be built up in a single application (with a number of passes). If the surface is large enough to require more than one day for the coating, the edges of the coated areas shall be feathered and roughened with a grinding too) prior to beginning priming and coating.

6.07.00 Areas not to be coated shall be masked with disposable plastic sheets, cardboard etc.

6.08.00 Visual inspection shall be made for film discontinuities such as air bubbles, blowholes, skips, shadows. Such defects will be marked and repaired with Elastomeric Polyurethane hand mix kit with slower pot life after roughening the edges.

7.00.00 **INSPECTION**

7.01.00 All work under this specification shall be subject to inspection by the owner or his representative. All parts of work shall be accessible. The applicator shall correct such work as is found defective and not as per the specifications.

7.02.00 The following tests shall be made :

During coating application the wet film thickness will be measured using Nordson wet Film Gauge as per ASTM D 4414.

7.02.01 Adhesion

Pull Off adhesion to Concrete measured using an portable adhesion tester such as Positest AT-CM Elcometer or equivalent as per ASTM D4541 on fully cured (7 days) concrete. Frequency shall be 3 readings per 1,000 Sq.M of coated area. The average of readings from three randomly selected areas shall constitute the adhesion and shall be minimum 2 N/mm2 (see below). Test area to be flat (without curvature). The following method will be used to determine whether coating meets adhesion requirements

Elcometer Reading	Type of Failure		Result / Conclusion
> 2 N / mm^2	T1	90% or more of break at coating - concrete interface	Coating meets adhesion criteria. Take actual reading of bond strength.

	T2	90% of more of break within the concrete	Concrete Failure. Coating adhesion exceeds 2N/mm^2
< 2 N / mm ^{2}	T1	90% or more of break at coating - concrete interface	Coating does not meet adhesion criteria. Take actual reading of bond strength achieved.
	T2	90% of more of break within the concrete	Concrete lacks sufficient strength to provide necessary adhesion figure. Coating adhesion accepted.

7.02.02 Film Thickness (DFT)

The film thickness shall be determined from the thickness of the coating detached along with the Elcometer dollies of the adhesion test and the readings shall be recorded. Frequency shall be identical to adhesion test. Average of 3 reading shall constitute the film thickness and shall be at least 2,000 Microns. Minimum spot reading shall be 1,800 Microns. Recommended spread rate by the manufacturer for the specified thickness of the PU coating shall be ascertained and adhered to during the coating process.

7.02.03 Hardness (Durometer)

Cured films (7 days) shall be tested for hardness using Durometer (Shore D) as per ASTM D 2240.

3.00.00	**GEO-TECHNICAL INVESTIGATION & FOUNDATION SYSTEM**
3.01.01	Owner (DVC) had carried out preliminary geo-technical investigation in the proposed cooling tower site. The sub-strata details encountered at various bore holes (BH-17 & BH-18) in the cooling tower area are enclosed as Annexure-1. The geotechnical data attached shall be solely for the purpose of guidance to the bidder. BHEL/owner does not take any responsibility about the accuracy and applicability of the geo-technical data furnished herewith. The onus of correct assessment/interpretation and understanding of the existing sub-strata conditions is on the bidder. Any variation in the data between the one furnished and to that found during execution of the work at site shall not constitute a valid reason in affecting the terms & conditions of this bid and the bidder shall note that nothing extra will be payable on this account. The bidder shall fully satisfy himself about the nature of sub-strata expected to be encountered including the type of foundation, ground water table and construction methodology to be adopted etc prior to the submission of the bid.
3.01.02	Detailed geo-technical Investigation report shall be made available to the successful bidder during contract engineering stage. If the bidder desires to carry out additional geo-technical investigation he/she may do so with prior information/permission of BHEL/owner at no extra cost to BHEL/owner. No extension in time schedule shall be permitted on this account. The bidder shall obtain approval on the agency for conducting geo-technical investigation work, field and laboratory testing schedule proposed by the bidder etc from BHEL/owner before undertaking the geo-technical investigation work. However, the Net Allowable Bearing Pressure of shallow foundation to be adopted for the design of foundations during detailed engineering shall be limited to the values mentioned elsewhere in the specification and any value of Net Allowable Bearing Pressure higher than the one indicated shall not be accepted. However, bidder shall note that the Net Allowable Bearing Pressure and foundation depth to be adopted for design during detailed engineering stage shall be got approved by BHEL/owner.

ANNEXURE- D1-10

CLAUSE NO.	TECHNICAL REQUIREMENTS
7.00.00	**FOUNDATION SYSTEM AND GEOTECHNICAL DATA**
7.01.00	**Soil Data** Owner has carried out preliminary geotechnical investigation at the project site. Few borelogs are available in the proposed stage-II area. Available bore logs of the stage-II area along with laboratory test results are enclosed at Annexure-C for Bidder's reference. The geotechnical investigation report of this area will be made available for the Bidder's study at the Owner's consultant office, if required. The onus of correct assessment / interpretation and understanding of the existing subsoil condition / data lies with the Bidder. If bidder feels furnished data is inadequate, he may carry out his own geotechnical investigation at site before bidding for his Information at no extra cost and time to owner. Such data collected by bidder is only for the purpose of bidding and it shall not be a part of technical documents related to this package. However, final design shall be based upon the detailed geotechnical investigation, which is to be conducted by successful bidder as per the clause 7.08.00 after placement of award. The Bidder should note that nothing extra whatsoever on account of variation between the foundation system assumed by bidder before bidding and that finalized based on the detailed geotechnical investigation after award, shall be payable. No time extension in the bidding time will be given to bidder for carrying out geotechnical investigation. **Bidder may refer enclosed topographical survey drawings 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	Successful bidder shall carryout his own detailed soil investigation for facilities under this package and shall be as per the scheme approved by owner**.** The scheme for geotechnical investigation shall be as given at Clause 7.08.00 and shall be approved by owner before execution. Geotechnical investigation work shall got executed by the Contractor through the agencies as mentioned in Clause No. 7.07.03. 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. The report shall be submitted for Owner's approval prior to commencement of design of foundation.
7.01.02	**The furnished borelog details are specific to the co-ordinates where the boreholes have been carried out and are provided for bidder's information only. Soil profile in the proposed area may vary with respect to the borelogs enclosed for bidder's information. Bidder has to consider all such variations in his estimation, over the extent of the work to be carried out. The Bidder should note that nothing extra whatsoever on account of variation between soil data collected by Owner and that found by the Bidder during geotechnical investigation by him or during execution of works, shall be Payable.**
7.01.03	Tank Foundations a) The tanks shall rest on flexible tank pad foundation, resting on sand with concrete ring wall to retain sand. Base of the concrete ring wall shall not rest on the expansive soil, if any. b) Entire loose/ soft soil inside the concrete ring wall shall be removed and shall be filled with natural sand/ sand manufactured from other than natural sources as specified elsewhere in the technical specification. Sand for filling shall be clean and well graded conforming to IS 383 with grading Zone I to III.

c) Sand shall be spread in layers not exceeding 30cm compacted thickness over the area. Each layer shall be uniformly compacted by mechanical means like plate vibrators, small vibratory rollers, etc to achieve a relative density of not less than 80%.

d) Other requirements of tank foundations shall be as per IS 803 and as specified elsewhere in the specifications.

7.02.00 **Foundation System**

The requirements for the foundation system to be adopted are as given in subsequent clauses. Depending upon the depth of competent strata/stratum, type of structures, functional requirement of facility, extent of cutting / filling, suitable open 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) foundation 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, 0.6m below rock level 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 0.6 m into the weathered rock shall be removed and built up through PCC M10 upto the designed founding level. Thus, maintaining the same founding level for all the footings of a structure.

f) The last layer of about 300 mm before reaching the founding level shall be excavated carefully by such equipment so that soil / rock at the required level will be left in its natural condition.

g) During detailed engineering, the Allowable Bearing Pressure shall be adopted after approval of geotechnical investigation report. However, the maximum allowable bearing pressure shall be lower of the two values i.e. as per approved geotechnical report and as per the values furnished in Table-1.

Table-1

In case of founding stratum is Soil

Structure	Lowest NGL (m)	Df below NGL (m)	Net Allowable Bearing Capacity (t/sqm)			
			S=12 mm	S=25mm	S=40 mm	S=75 mm
				Width upto 6m		Width >6m
Main powerhouse and TG Foundation U#3 (BH14, BH26)	369.5	1.0m below NGL	-	15	15	15
		2.0m below NGL	-	25	25	25
		3.0m below NGL	-	30	30	30
		4.0m below NGL	-	35	35	35
		4.5m below NGL	-	40	40	40
		5.5m or more than 5.5m below NGL	-	45	45	45
Main powerhouse and TG Foundation U#4 (BH 13, BH25)	371.8	1.0m below NGL	-	20	20	20
		2.0m below NGL	-	25	25	25
		3.0m below NGL	-	30	30	30
		4.0m below NGL	-	35	35	35
		4.5m below NGL	-	40	40	40
		5.5m or more than 5.5m below NGL	-	45	45	45

Boiler and Mill Bunker U#3 (BH04, BH12)	370.0	1.0m below NGL	-	20	20	20
		2.0m below NGL	-	25	25	25
		3.0m below NGL	-	30	30	30
		3.5m below NGL	-	35	35	35
		4.0m below NGL	-	40	40	40
		5.0m or more than 5.0m below NGL	-	45	45	45
Boiler and Mill Bunker U#4 (BH11, BH27)	372.0	1.0m below NGL	-	20	20	20
		2.0m below NGL	-	25	25	25
		3.0m below NGL	-	30	30	30
		3.5m below NGL	-	35	35	35
		4.0m below NGL	-	40	40	40
		5.0m or more than 5.0m below NGL	-	45	45	45
ID Fan U#3 (BH08)	367.8	1.0m below NGL	-	12	12	15
		2.0m below NGL	-	25	25	25
		2.5m below NGL	-	30	30	30
		3.5m or more than 3.5m below NGL	-	40	40	40
ID Fan U#4 (BH08)	369.6	1.0m below NGL	-	20	20	20
		2.0m below NGL	-	25	25	25
		2.5m below NGL	-	30	30	30
		3.5m or more than 3.5m below NGL	-	40	40	40
Chimney (BH08)	368.4	1.0m below NGL	-	12	12	20
		2.0m below NGL	-	25	25	25
		2.5m below NGL	-	30	30	30
		3.0m below NGL	-	35	35	35
		3.5m or more than 3.5m below NGL	-	40	40	40
ESP U#3 (BH10)	370.1	1.0m below NGL	-	12	12	20
		2.0m below NGL	-	25	25	30
		2.5m below NGL	-	30	30	30
		3.0m below NGL	-	35	35	35
		3.5m or more than 3.5m below NGL	-	40	40	40
ESP U#4 (BH09)	371.4	1.0m below NGL	-	12	12	18
		2.0m below NGL	-	22	24	24
		2.5m below NGL	-	30	30	30
		3.0m below NGL	-	35	35	35
		3.5m or more than 3.5m below NGL	-	40	40	40
FGD U#3 (BH22, BH23)	366.2	1.0m below NGL	-	20	20	20
		2.0m below NGL	-	25	25	25
		2.5m below NGL	-	30	30	30

		3.5m or more than 3.5m below NGL	-	35	35	35
FGD U#4 (BH20, BH21)	369.4	1.0m below NGL	-	12	12	15
		2.0m below NGL	-	18	20	25
		2.5m below NGL	-	28	28	30
		3.5m or more than 3.5m below NGL	-	35	35	35
Ash Handling facilities (BH24)	Refer Topo survey drawing	1.0m below NGL	-	12	12	20
		2.0m below NGL	-	18	20	25
		2.5m below NGL	-	28	28	30
		3.5m or more than 3.5m below NGL	-	35	35	35
Cooling Tower U#3 (BH17)	369.5	1.0m below NGL	-	12	12	15
		1.5m below NGL	-	16	16	25
		2.5m below NGL	-	30	30	30
		3.5m or more than 3.5m below NGL	-	40	40	40
Cooling Tower U#4 (BH18)	362.8	1.0m below NGL	-	15	15	15
		1.5m below NGL	-	20	20	20
		2.0m below NGL	-	25	25	25
		2.5m below NGL	-	30	30	30
		3.5m or more than 3.5m below NGL	-	40	40	40
Settling Surge Tank, Dewatering Bins (BH29)	369.0	1.0m below NGL	-	12	12	15
		1.5m below NGL	-	15	15	24
		2.0m below NGL	-	25	25	25
		3.0m below NGL	-	30	30	30
		4.0m or more than 4.0m below NGL	-	35	35	35
Biomass, Biomass Storage silo, Gypsum dewatering shed, Gypsum dewatering building, Lime stone CH, Lime Handling area, Truck tippler complex (BH28)	Refer Topo survey drawing	1.5m below NGL	-	-	12	12
		2.5m below NGL	-	-	13	13
		3.0m below NGL	-	-	20	20
		3.5m or more than 3.5m below NGL	-	35	35	35
WTP area (BH07)	380.0	1.0m below NGL	-	22	22	22
		1.5m below NGL	-	25	25	25
		2.0m below NGL	-	30	30	30
		3.0m or more than 3.0m below NGL	-	40	40	40
Stacker reclaimer, TP17, TP24, TP25, TP26, TP27 (BH05)	373.0	1.0m below NGL	-	12	12	15
		1.5m below NGL	-	15	15	20
		2.0m below NGL	-	20	20	25
		3.0m or more than 3.0m below NGL	-	35	35	40
Switchyard, Transformer yard, CWPH, O&M Store, MCC, Lime Handling area, Wagon Tippler, Track Hopper, CSSP, Crusher, any other structures not	Refer Topo survey drawing	1.0m below NGL	-	12	12	15
		1.5m below NGL	-	20	20	20
		2.0m below NGL	-	25	25	25

mentioned above (BH01, BH02, BH03, BH05, BH06, BH15, BH16, BH19, BH30, BH31, BH32)		2.5m below NGL	-	30	30	30
		3.5m or more than 3.5m below NGL	-	40	40	40

In case of founding stratum is rock			
Minimum 0.6m embedment into rock	35	35	35
Minimum 1.0m embedment into rock	40	40	40
Minimum 2.0m embedment into rock	45	45	45
4.0m or more than 4.0m embedment into rock	50	50	50

To determine the Natural Ground Level (NGL), tender drawings titled "TOPGRAPHICAL SURVEY" shall 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.
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 power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	25 mm
Isolated & Strip (other than Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	40 mm
Raft (other than Main power house, TG Area Footings, Boiler, Mill, Bunker Footings & Fans) resting on soil	75 mm
Foundations in Weathered rock / rock	12 mm

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

7.03.00 Special Requirements

7.03.01 Details of treatment for foundations / underground structures required to counteract soil / water chemical environment shall be as per detailed geotechnical investigation to be carried out by contractor. Contractor shall carry out chemical analysis during detailed geotechnical investigation and required treatment shall be provided accordingly.

7.04.00 Excavation, Filling and Dewatering

7.04.01 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.

7.04.02 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.

CLAUSE NO.	TECHNICAL REQUIREMENTS
7.04.03	**Backfilling in Power House & 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. **Backfilling in other area** Backfilling around foundations, pipes, trenches, sumps, pits, plinths, etc. shall be carried out with approved material in layers not exceeding 300 mm compacted thickness (higher thickness of layers upto 500mm with heavy mechanical compacting equipment) and each layer shall be compacted to 90% of standard proctor density for cohesive soils and to 80% of relative density for non cohesive soils. Rock pieces having size less than 150 mm and interstices filled with soil may be used for backfilling around foundation, plinths etc. and shall be compacted to minimum of 85% of original stack of material after filling the interstices.
7.04.04	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.
7.04.05	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.
7.04.06	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.
7.05.00	**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.
7.05.01	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).
7.05.02	a) Contractor shall engage an agency expert in blasting such as, NIRM (National Institute of Rock Mechanics), CMPDIL, Central Institute of Mining and Fuel Research Dhanbad, Dept. of Mining of Govt. Institutions etc. to design detailed blasting scheme and get the same approved from Engineer before carrying out the blasting operation. All blasting shall be done as per the approved blasting scheme & initial blasting operations shall be done under the supervision & guidance of the representative of the blasting expert. b) All the statutory laws, (Explosives Act etc.) rules, regulations, Indian Standards, etc. pertaining to the acquisition, transport, storage, handling and use of explosives, etc. shall be strictly followed. c) The Contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives as per explosives act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive Materials. d) The Contractor shall be responsible and liable for any accident and injury / damage which may occur to any person or property of the project or public on account of any operations connected with the storage, transportation, handling or use of explosive and blasting operations.

CLAUSE NO.	TECHNICAL REQUIREMENTS
7.06.00	**Sheeting & Shoring** The contractor shall ascertain for himself the nature of materials to be excavated and difficulties, if any, likely to be encountered in excavation while executing the work. Sheet piling, sheeting and shoring, bracing and maintaining suitable slopes, drainage, etc. shall be provided and installed by the Contractor, to the satisfaction of the Engineer.
7.07.00	**Geotechnical Investigation** The Contractor shall carry out detailed geotechnical investigation in the areas under his scope for establishing the sub-surface conditions and to decide type of foundations for the structures envisaged, construction methods, any special requirements/treatment called for remedial measures for sub-soil/ foundations etc. in view of soft sub-soils, aggressive sub-soils and water, expansive/swelling soils etc. prior to commencement of detailed design/drawings. The Contractor shall obtain the approval for the field testing scheme proposed by him from the Owner before undertaking the geotechnical investigation work.
7.07.01.00	**Scheme of geotechnical Investigation**
7.07.02.01	Field test shall include but not be limited to the following: Boreholes, Standard Penetration Test (SPT), Dynamic Cone Penetration Test (DCPT), collection of disturbed samples (DS) and undisturbed soil samples (UDS), Trial Pits (TP), Plate Load Tests (PLT), Electrical Resistivity Test (ERT), In situ field permeability tests, collection of water samples, etc.
7.07.02.02	The diameter of borehole shall be minimum 150 mm in soil and 76 mm in rock. The diameter of UDS sampler shall be 100 mm minimum. Core drilling in rock shall be done by using hydraulically feed rotary drill & double tube core barrel with diamond bit.
7.07.02.03	The minimum tests are indicated in Clause No. 7.08.00. Adequate number of tests shall be conducted up to sufficient depth for complete determination of subsoil conditions. The depth of boreholes shall be as specified in Appendix A. SPT shall be carried out in all types of soil deposits and in all rock formations with core recovery up to 20%, met within a borehole. This test shall be conducted at every 3.0 m interval or at change of strata, up to the final depth. SPT 'N' of 100 and above shall be referred as refusal. UDS shall be collected at every 3.0 m interval or at change of strata up to depth of borehole. UDS may be replaced by additional SPT, if SPT'N' value in the strata is above 50.
7.07.02.04	Laboratory tests shall be done as per relevant IS codes. The laboratory tests, not be limited to the following shall be conducted on disturbed and undisturbed soil samples, rock samples & water samples collected during field investigations in sufficient numbers. **Laboratory Tests on Soil Samples** Laboratory tests shall be carried out on disturbed and undisturbed soil samples for Grain Size Analysis, Hydrometer Analysis, Atterberg Limits, Triaxial Shear Tests (UU), Natural Moisture Content, Specific Gravity and Bulk Unit Weight, Consolidation Tests, Unconfined Compression Test, Free swell Index, Shrinkage Limit, Swell Pressure Test, Chemical Analysis test on soil and water samples to determine the carbonates, sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel. **Laboratory Tests on Rock Samples** Moisture content, porosity & density, Specific Gravity, Hardness, Soundness, Slake durability index, Unconfined compression test (Both at saturated and in-situ water content), Point load

strength index and deformability test (Both at saturated and in-situ water content) shall be carried out on rock samples.

7.07.02.05 Geotechnical investigation (field & laboratory) shall be carried out in accordance with the provisions of relevant Indian Standards.

On completion of all field & laboratory work, geotechnical investigation report shall be submitted for Owner's review/approval. The Geotechnical investigation report shall contain geological information of the region, procedure adopted for investigation, field & laboratory observations/ data/ records, analysis of results & recommendations on type of foundation for different type of structures envisaged for all areas of work with supporting calculations. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, etc.

Recommendations on foundation system and the net allowable bearing pressures and pile capacity shall be based on the conservative values of geotechnical investigation data.

7.07.03 **Geotechnical investigation work may be got executed by the Contractor through the following suggested agencies**

1. C.E.TESTING COMPANY Pvt. Ltd, Kolkata

2. Cengrs Geotechnica Pvt. Ltd, New Delhi

3. KCT Consultancy Services, Ahemdabad

4. M.K. Soil Testing Laboratory, Ahemdabad

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

7.08.00 Geotechnical Investigation Scheme

a) **Boreholes (Minimum)**

S.	Structure	Spacing/Number of borehole	Depth of borehole	Remarks
1	Main Plant structures (Transformer Yard, Main power house, Boiler, ESP, chimney, Mills, Fans etc)	About 60-70 m along the rows of main powerhouse columns. Minimum 3 boreholes under each Boiler, Mill & Bunker, minimum 5 under each ESP structure and 3 boreholes under Chimney, Minimum 2 boreholes under each TG, ESP Control Room, TPs. 4 boreholes in Transformer yard	Depth of boreholes shall be 20 to 25m.	Depth of boreholes shall be as menti

2	Switchgear room, control room and transformer fdn	Minimum 4 no of boreholes	10 to 15 m	oned in column "Depth of Borehole" or 5m continuous in rock with RQD > 50% whichever is earlier.
3	Biomass and Lime Handling area	Minimum 8 boreholes	10 to 15 m	
4	FGD area	Minimum 10 boreholes	15 to 20 m	
5	Coal Handling Plant structures	Minimum one borehole under each TP and two under each crusher and one borehole under each structure. Minimum 5 no of under each stockpile area	15 to 20 m	
6	Ash Handling & AWRS Structures	Minimum 8 boreholes	10 to 15 m	
7	Service building, FOPH and Other Off-site Structure / Facility	Minimum Two boreholes under each area / facility	10 to 15 m	
8	Water treatment plant structures	Minimum 8 no of borehole	10 to 15 m	
9	Switchyard Structures	Minimum 8 no of borehole	10 to 15 m	
10	Cooling Towers	Minimum 4 no of borehole in each CT	10 to 15 m	
11	Wagon Tippler	Minimum 3 no of borehole	25 to 30m	
12	CW Pump House	Minimum 1 no under each structure/ facility	15 to 20 m	
13	Track Hopper	Minimum 4 no under each structure/ facility	20 to 25 m	
14	Settling tank, dewatering bins area	Minimum 5 nos	10 to 15 m	

15	**Conveyors**	**1 no @ 200m c/c**	**10 to 15 m**	
16	**Other structure/ facility**	**Minimum 1 no under each structure/ facility**	**10 to 15 m**	

b) Other Field Tests (Minimum)

1	Plate Load Test (PLT)	1 no each in ESP, transformer yard area, Ash handling, switchyard and other area, where open foundations are feasible.	Test Depth from 2 to 3 m	
2	Cyclic Plate Load Test (CPLT)	1 no in each TG, Mill, FGD and ID fans	Test Depth from 2 to 3 m	
3	Trial Pit (TP)	About 10 Nos.	Depth upto 3 m	
4	In Situ Permeability Test In Boreholes	In minimum 8 Nos. of boreholes	Tests shall be conducted at depths of 1.0m, 3.0m, 5.0m, 8.0m and 12.0m.	
5	ERT	2 Nos. each in Transformer yard, TG, Boiler, Chimney, Ash handling area, ESP Control Room, coal handling area, ash handling area 1 No near each Pump House other than mentioned above		
6	CROSS HOLE	1No. in each TG, 1No. in each Mill & bunker and 2 Nos in ID Fan, 1 no in each FGD, 1No in crusher House	Depths covering from 1.0 m to 20.0 m	
7	PMT	40 no of tests in main power house area covering power house to chimney, TPs.	Depths covering from 1.0 m to 20.0 m	

- Depth and location of Boreholes and other field tests (PLT, CPLT, CROSS HOLE TEST, PMT, TP, ERT, field permeability tests etc.) shall be approved by Owner before execution of geotechnical investigation work.

- Investigation in any other building / structure / facilities / trestles which are not mentioned above shall also be carried out, if required, by the bidder for the facilities under his scope.

CLAUSE NO.	TECHNICAL REQUIREMENTS

Project : Geotechnical Investigation work at Kodarma Thermal Power Station PH-II. CETEST

Job No : 4708 | Created by : Chandrani | Created on : 11/12/2023 | Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.17 — Co-ordinates E=3496.867 N=13084.502

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	7
		Disturbed (DS)	3
Vane (V)		Water Sample (WS)	1

Commencement Date : 05/12/2023
Completion Date : 06/12/2023
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 372.508 M.
Water Struck At :
Standing Water Level : 2.80 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Filled up soil consists with coal dust & boulder. 0.50m.			DS-1	0.50
Brownish grey, silty sand wtih decomposed rock (Old fill). 1.30m.	I	4 7 13 — 20	*UDS-1	1.00-1.45
			SPT-1	1.55-2.00
Medium dense, brownish grey, silty sand wtih decomposed rock. 3.00m.		14 25 30 — 55	DS-2	2.50
			WS-1	2.80
			SPT-2	3.00-3.45
Very dense, brownish grey, silty sand wtih decomposed rock. 5.00m.	II	40 62 5.0 cm Penetn. — >100	DS-3	4.00
			SPT-3	4.50-4.70
	V	100 3.0 cm Penetn. — Refusal	*SPT-4	5.00-5.03
			R1	CR=21% RQD=NIL
			R2	CR=23% RQD=NIL
Completely to highly weathered, brownish grey, coarse grained, fractured rock. 9.50m.		N.X rotary drilling from 5.00m to 18.50m	R3	CR=22% RQD=NIL
			R4	CR=17% RQD=NIL
		100 2.0 cm Penetn. — Refusal	*SPT-5	8.00-8.02
			R5	CR=12%/RQD=NIL
		100 2.0 cm Penetn. — Refusal	*SPT-6	8.75-8.77
			R6	CR=10%/RQD=NIL
		100 3.0 cm Penetn. — Refusal	*SPT-7	9.50-9.53
Highly weathered, light pinkish grey, medium grained, moderately fractured rock. 11.00m.	V		R7	CR=24% RQD=NIL
			R8	CR=25% RQD=NIL
Highly weathered, light pinkish grey, medium grained, moderately fractured rock. 13.25m.	VI		R9	CR=33% RQD=NIL
			R10	CR=36% RQD=NIL
			R11	CR=34% RQD=NIL
Moderately to slightly weathered, light pinkish grey, medium grained, moderately fractured rock. 18.50m.	VII		R12	CR=58% RQD=27%
			R13	CR=62% RQD=44%
			R14	CR=60% RQD=27%
			R15	CR=64% RQD=45%
			R16	CR=67% RQD=39%
			R17	CR=58% RQD=40%
			R18	CR=65% RQD=42%

5.00 5.75 6.50 7.25 8.00 8.75 9.50 10.25 11.00 11.75 12.50 13.25 14.00 14.75 15.50 16.25 17.00 17.75 18.50

N.B. — '*' means sample could not be recovered.

BH-17/Sheet-1

Project : Geotechnical Investigation work at Kodarma Thermal Power Station PH–II. CETEST

Job No : 4708 | Created by : Chandrani | Created on : 21/12/2023 | Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.18

Co–ordinates E=3329.020 N=12681.963

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	4
		Water Sample (WS)	0

Commencement Date : 18/12/2023
Completion Date : 19/12/2023
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 373.084 M.
Water Struck At :
Standing Water Level : 0.40 m.

DESCRIPTION	SYMBOL	N–VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Filled up soil with coal dust & boulder. 0.70m.			DS–1	0.50
Brownish grey to light grey, silty sand (Old fill).		6 9 13 (22)	*UDS–1	1.00–1.45
			SPT–1	1.55–2.00
			DS–2	2.50
3.00m.		18 28 36 (64)	SPT–2	3.00–3.45
Very dense, light grey, sitly sand with decomposed rock.	II	22 38 50/3.0 cm Pentn. (>100)	DS–3	4.00
			SPT–3	4.50–4.83
			DS–4	5.50
6.00m.		100/2.0 cm Pentn. Refusal	*SPT–4	6.00–6.02 6.00
			R1	CR=17%/RQD=NIL
Completely to highly weathered, brownish grey, medium grained, fractured rock.	V	100/2.0 cm Pentn. Refusal	*SPT–5	6.75–6.77 6.75
			R2	CR=15%/RQD=NIL
		100/3.0 cm Pentn. Refusal	*SPT–6	7.50–7.53 7.50
8.25m.		N.X rotary drilling from 6.00m to 17.25m	R3	CR=24% RQD=NIL 8.25
			R4	CR=28% RQD=NIL 9.00
Highly to moderately weathered, brownish grey, medium grained, fractured rock.	VI		R5	CR=36% RQD=NIL 9.75
			R6	CR=39% RQD=NIL 10.50
			R7	CR=32% RQD=NIL 11.25
12.00m.			R8	CR=44% RQD=NIL 12.00
			R9	CR=60% RQD=32% 12.75
			R10	CR=74% RQD=40% 13.50
Moderatrely to slightly weathered, light pinkish grey, medium to fine graind, fractured rock.	VII		R11	CR=75% RQD=45% 14.25
			R12	CR=70% RQD=36% 15.00
			R13	CR=65% RQD=40% 15.75
			R14	CR=68% RQD=39% 16.50
17.25m.			R15	CR=75% RQD=42% 17.25

N.B. – '*' means sample could not be recovered.

BH–18/Sheet–1

DAMODAR VALLEY CORPORATION
(ESTABLISHED BY THE ACT XIV OF 1948)

CORRIGENDUM NO. 25 **Dated 09/02/2024**

Reference : DVC/C&M/Engineering/KTPS (2X800 MW)/EPC/IPHB Dated 30.10.2023

Title of Work: "EPC Package for KODERMA TPS PH-II (2X800 MW)"

---

1. Amendment No. 15 & 16 to Technical Specifications of Bidding Documents is attached herewith.

Note:

1. All other terms and conditions shall remain unaltered
2. This Corrigendum shall be considered as a part of the original Tender Document

AMENDMENT NO. 15 TO TECHNICAL SPECIFICATION (SECTION VI)

S. NO.	SPECIFICATION REFERENCE				Instead of	Read as
	SEC/ PART	SUB-SEC.	PAGE NO.	CLAUSE NO.		
D1-80	VI/B	D-1-7	2 to 6 of 11	7.02.02	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) …… c) ……. d) …….. e) …… f) …….. g) During detailed engineering, the Allowable Bearing Pressure shall be adopted after approval of geotechnical investigation report. However, the maximum allowable bearing pressure shall be lower of the two values i.e. as per approved geotechnical report and as per the values furnished in Table-1.	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) …… c) ……. d) …….. e) …… f) …….. g) During detailed engineering, the Allowable Bearing Pressure shall be adopted after approval of geotechnical investigation report. However, the maximum allowable bearing pressure shall be lower of the two values i.e. as per approved geotechnical report and as per the values furnished in Table-1.

AMENDMENT NO. 15 TO TECHNICAL SPECIFICATION (SECTION VI)

S. NO.	SPECIFICATION REFERENCE				Instead of	Read as
	SEC/ PART	SUB-SEC.	PAGE NO.	CLAUSE NO.		

Instead of

Table-1

In case of founding stratum is Soil

Structure	Lowest NGL (m)	Df below NGL (m)	Net Allowable Bearing Capacity (t/sqm) S=12 mm	S=25mm Width upto 6m	S=40 mm	S=75 mm Width >6m
Main powerhouse and TG Foundation U#3 (BH14, BH26)	369.5	1.0m below NGL	-	15	15	15
		2.0m below NGL	-	25	25	25
		3.0m below NGL	-	30	30	30
		4.0m below NGL	-	35	35	35
		4.5m below NGL	-	40	40	40
		5.5m or more than 5.5m below NGL	-	45	45	45
Main powerhouse and TG Foundation U#4 (BH 13, BH25)	371.8	1.0m below NGL	-	20	20	20
		2.0m below NGL	-	25	25	25
		3.0m below NGL	-	30	30	30
		4.0m below NGL	-	35	35	35
		4.5m below NGL	-	40	40	40
		5.5m or more than 5.5m below NGL	-	45	45	45
Boiler and Mill Bunker U#3 (BH04, BH12)	370.0	1.0m below NGL	-	20	20	20
		2.0m below NGL	-	25	25	25
		3.0m below NGL	-	30	30	30
		3.5m below NGL	-	35	35	35
		4.0m below NGL	-	40	40	40
		5.0m or more than 5.0m below NGL	-	45	45	45
Boiler and Mill Bunker U#4 (BH11, BH27)	372.0	1.0m below NGL	-	20	20	20
		2.0m below NGL	-	25	25	25
		3.0m below NGL	-	30	30	30
		3.5m below NGL	-	35	35	35
		4.0m below NGL	-	40	40	40
		5.0m or more than 5.0m below NGL	-	45	45	45
ID Fan U#3 (BH08)	367.8	1.0m below NGL	-	12	12	15
		2.0m below NGL	-	25	25	25
		2.5m below NGL	-	30	30	30
		3.5m or more than 3.5m below NGL	-	40	40	40
ID Fan U#4 (BH08)	369.6	1.0m below NGL	-	20	20	20
		2.0m below NGL	-	25	25	25
		2.5m below NGL	-	30	30	30
		3.5m or more than 3.5m below NGL	-	40	40	40

Read as

Table-1

In case of founding stratum is Soil

Structure	Df below NGL (m)	Net Allowable Bearing Capacity (t/sqm) S=25mm Width upto 6m	S=40mm	S=75mm Width>6m
Main powerhouse and TG Foundation U#3 (BH14, BH26)	1.0m below NGL	15	15	15
	2.0m below NGL	25	25	25
	3.0m below NGL	30	30	30
	4.0m below NGL	35	35	35
	4.5m below NGL	40	40	40
	5.5m or more than 5.5m below NGL	45	45	45
Main powerhouse and TG Foundation U#4 (BH 13, BH25)	1.0m below NGL	20	20	20
	2.0m below NGL	25	25	25
	3.0m below NGL	30	30	30
	4.0m below NGL	35	35	35
	4.5m below NGL	40	40	40
	5.5m or more than 5.5m below NGL	45	45	45
Boiler and Mill Bunker U#3 (BH04, BH12)	1.0m below NGL	20	20	20
	2.0m below NGL	25	25	25
	3.0m below NGL	30	30	30
	3.5m below NGL	35	35	35
	4.0m below NGL	40	40	40
	5.0m or more than 5.0m below NGL	45	45	45
Boiler and Mill Bunker U#4 (BH11, BH27)	1.0m below NGL	20	20	20
	2.0m below NGL	25	25	25
	3.0m below NGL	30	30	30
	3.5m below NGL	35	35	35
	4.0m below NGL	40	40	40
	5.0m or more than 5.0m below NGL	45	45	45
ID Fan U#3 (BH08)	1.0m below NGL	12	12	15
	2.0m below NGL	25	25	25
	2.5m below NGL	30	30	30
	3.5m or more than 3.5m below NGL	40	40	40
ID Fan U#4 (BH08)	1.0m below NGL	20	20	20
	2.0m below NGL	25	25	25
	2.5m below NGL	30	30	30

AMENDMENT NO. 15 TO TECHNICAL SPECIFICATION (SECTION VI)

S. NO.	SPECIFICATION REFERENCE				Instead of							Read as				
	SEC/ PART	SUB-SEC.	PAGE NO.	CLAUSE NO.												
					Chimney (BH08)	368.4	1.0m below NGL	-	12	12	20		3.5m or more than 3.5m below NGL	40	40	40
							2.0m below NGL	-	25	25	25	Chimney (BH08)	1.0m below NGL	12	12	20
							2.5m below NGL	-	30	30	30		2.0m below NGL	25	25	25
							3.0m below NGL	-	35	35	35		2.5m below NGL	30	30	30
							3.5m or more than 3.5m below NGL	-	40	40	40		3.0m below NGL	35	35	35
					ESP U#3 (BH10)	370.1	1.0m below NGL	-	12	12	20		3.5m or more than 3.5m below NGL	40	40	40
							2.0m below NGL	-	25	25	30	ESP U#3 (BH10)	1.0m below NGL	12	12	20
							2.5m below NGL	-	30	30	30		2.0m below NGL	25	25	30
							3.0m below NGL	-	35	35	35		2.5m below NGL	30	30	30
							3.5m or more than 3.5m below NGL	-	40	40	40		3.0m below NGL	35	35	35
					ESP U#4 (BH09)	371.4	1.0m below NGL	-	12	12	18		3.5m or more than 3.5m below NGL	40	40	40
							2.0m below NGL	-	22	24	24	ESP U#4 (BH09)	1.0m below NGL	12	12	18
							2.5m below NGL	-	30	30	30		2.0m below NGL	22	24	24
							3.0m below NGL	-	35	35	35		2.5m below NGL	30	30	30
							3.5m or more than 3.5m below NGL	-	40	40	40		3.0m below NGL	35	35	35
					FGD U#3 (BH22, BH23)	366.2	1.0m below NGL	-	20	20	20		3.5m or more than 3.5m below NGL	40	40	40
							2.0m below NGL	-	25	25	25	FGD U#3 (BH22, BH23)	1.0m below NGL	20	20	20
							2.5m below NGL	-	30	30	30		2.0m below NGL	25	25	25
							3.5m or more than 3.5m below NGL	-	35	35	35		2.5m below NGL	30	30	30
					FGD U#4 (BH20, BH21)	369.4	1.0m below NGL	-	12	12	15		3.5m or more than 3.5m below NGL	35	35	35
							2.0m below NGL	-	18	20	25	FGD U#4 (BH20, BH21)	1.0m below NGL	12	12	15
							2.5m below NGL	-	28	28	30		2.0m below NGL	18	20	25
							3.5m or more than 3.5m below NGL	-	35	35	35		2.5m below NGL	28	28	30
					Ash Handling facilities (BH24)	Refer Topo survey drawing	1.0m below NGL	-	12	12	20		3.5m or more than 3.5m below NGL	35	35	35
							2.0m below NGL	-	18	20	25	Ash Handling facilities (BH24)	1.0m below NGL	12	12	20
							2.5m below NGL	-	28	28	30		2.0m below NGL	18	20	25
							3.5m or more than 3.5m below NGL	-	35	35	35		2.5m below NGL	28	28	30
					Cooling Tower U#3 (BH17)	369.5	1.0m below NGL	-	12	12	15		3.5m or more than 3.5m below NGL	35	35	35
							1.5m below NGL	-	16	16	25	Cooling Tower U#3 (BH17)	1.0m below NGL	12	12	15
							2.5m below NGL	-	30	30	30		1.5m below NGL	16	16	25
							3.5m or more than 3.5m below NGL	-	40	40	40		2.5m below NGL	30	30	30
					Cooling Tower U#4 (BH18)	362.8	1.0m below NGL	-	15	15	15		3.5m or more than 3.5m below NGL	40	40	40
							1.5m below NGL	-	20	20	20	Cooling Tower U#4 (BH18)	1.0m below NGL	15	15	15
							2.0m below NGL	-	25	25	25		1.5m below NGL	20	20	20
							2.5m below NGL	-	30	30	30		2.0m below NGL	25	25	25
							3.5m or more than 3.5m below NGL	-	40	40	40		2.5m below NGL	30	30	30
					Settling Surge Tank, Dewatering Bins (BH29)	369.0	1.0m below NGL	-	12	12	15		3.5m or more than 3.5m below NGL	40	40	40
							1.5m below NGL	-	15	15	24	Settling Surge Tank, Dewatering Bins (BH29)	1.0m below NGL	12	12	15
													1.5m below NGL	15	15	24
													2.0m below NGL	25	25	25
													3.0m below NGL	30	30	30

AMENDMENT NO. 15 TO TECHNICAL SPECIFICATION (SECTION VI)

<table>
<tr><th rowspan="2">S. NO.</th><th colspan="4">SPECIFICATION REFERENCE</th><th rowspan="2">Instead of</th><th rowspan="2">Read as</th></tr>
<tr><th>SEC/ PART</th><th>SUB-SEC.</th><th>PAGE NO.</th><th>CLAUSE NO.</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>
<table>
<tr><td></td><td></td><td>2.0m below NGL</td><td>-</td><td>25</td><td>25</td><td>25</td></tr>
<tr><td></td><td></td><td>3.0m below NGL</td><td>-</td><td>30</td><td>30</td><td>30</td></tr>
<tr><td></td><td></td><td>4.0m or more than 4.0m below NGL</td><td>-</td><td>35</td><td>35</td><td>35</td></tr>
<tr><td rowspan="4">Biomass, Biomass Storage silo, Gypsum dewatering shed, Gypsum dewatering building, Lime stone CH, Lime Handling area, Truck tippler complex (BH28)</td><td rowspan="4">Refer Topo survey drawing</td><td>1.5m below NGL</td><td>-</td><td>-</td><td>12</td><td>12</td></tr>
<tr><td>2.5m below NGL</td><td>-</td><td>-</td><td>13</td><td>13</td></tr>
<tr><td>3.0m below NGL</td><td>-</td><td>-</td><td>20</td><td>20</td></tr>
<tr><td>3.5m or more than 3.5m below NGL</td><td>-</td><td>35</td><td>35</td><td>35</td></tr>
<tr><td rowspan="4">WTP area (BH07)</td><td rowspan="4">380.0</td><td>1.0m below NGL</td><td>-</td><td>22</td><td>22</td><td>22</td></tr>
<tr><td>1.5m below NGL</td><td>-</td><td>25</td><td>25</td><td>25</td></tr>
<tr><td>2.0m below NGL</td><td>-</td><td>30</td><td>30</td><td>30</td></tr>
<tr><td>3.0m or more than 3.0m below NGL</td><td>-</td><td>40</td><td>40</td><td>40</td></tr>
<tr><td rowspan="4">Stacker reclaimer, TP17, TP24, TP25, TP26, TP27 (BH05)</td><td rowspan="4">373.0</td><td>1.0m below NGL</td><td>-</td><td>12</td><td>12</td><td>15</td></tr>
<tr><td>1.5m below NGL</td><td>-</td><td>15</td><td>15</td><td>20</td></tr>
<tr><td>2.0m below NGL</td><td>-</td><td>20</td><td>20</td><td>25</td></tr>
<tr><td>3.0m or more than 3.0m below NGL</td><td>-</td><td>35</td><td>35</td><td>40</td></tr>
<tr><td rowspan="5">Switchyard, Transformer yard, CWPH, O&M Store, MCC, Lime Handling area, Wagon Tippler, Track Hopper, CSSP, Crusher, any other structures not mentioned above (BH01, BH02, BH03, BH05, BH06, BH15, BH16, BH19, BH30, BH31, BH32)</td><td rowspan="5">Refer Topo survey drawing</td><td>1.0m below NGL</td><td>-</td><td>12</td><td>12</td><td>15</td></tr>
<tr><td>1.5m below NGL</td><td>-</td><td>20</td><td>20</td><td>20</td></tr>
<tr><td>2.0m below NGL</td><td>-</td><td>25</td><td>25</td><td>25</td></tr>
<tr><td>2.5m below NGL</td><td>-</td><td>30</td><td>30</td><td>30</td></tr>
<tr><td>3.5m or more than 3.5m below NGL</td><td>-</td><td>40</td><td>40</td><td>40</td></tr>
</table>
<table>
<tr><td colspan="5">In case of founding stratum is rock</td></tr>
<tr><td>Minimum 0.6m embedment into rock</td><td>35</td><td>35</td><td>35</td></tr>
<tr><td>Minimum 1.0m embedment into rock</td><td>40</td><td>40</td><td>40</td></tr>
<tr><td>Minimum 2.0m embedment into rock</td><td>45</td><td>45</td><td>45</td></tr>
<tr><td>4.0m or more than 4.0m embedment into rock</td><td>50</td><td>50</td><td>50</td></tr>
</table>
To determine the Natural Ground Level (NGL), tender drawings titled “TOPGRAPHICAL SURVEY” shall be referred.

The NGL for……in consultation with Engineer.
</td><td>
<table>
<tr><td></td><td>4.0m or more than 4.0m below NGL</td><td>35</td><td>35</td><td>35</td></tr>
<tr><td rowspan="4">Biomass, Biomass Storage silo, Gypsum dewatering shed, Gypsum dewatering building, Lime stone CH, Lime Handling area, Truck tippler complex (BH28)</td><td>1.5m below NGL</td><td>-</td><td>12</td><td>12</td></tr>
<tr><td>2.5m below NGL</td><td>-</td><td>13</td><td>13</td></tr>
<tr><td>3.0m below NGL</td><td>-</td><td>20</td><td>20</td></tr>
<tr><td>3.5m or more than 3.5m below NGL</td><td>35</td><td>35</td><td>35</td></tr>
<tr><td rowspan="4">WTP area (BH07)</td><td>1.0m below NGL</td><td>22</td><td>22</td><td>22</td></tr>
<tr><td>1.5m below NGL</td><td>25</td><td>25</td><td>25</td></tr>
<tr><td>2.0m below NGL</td><td>30</td><td>30</td><td>30</td></tr>
<tr><td>3.0m or more than 3.0m below NGL</td><td>40</td><td>40</td><td>40</td></tr>
<tr><td rowspan="4">Stacker reclaimer, TP17, TP24, TP25, TP26, TP27 (BH05)</td><td>1.0m below NGL</td><td>12</td><td>12</td><td>15</td></tr>
<tr><td>1.5m below NGL</td><td>15</td><td>15</td><td>20</td></tr>
<tr><td>2.0m below NGL</td><td>20</td><td>20</td><td>25</td></tr>
<tr><td>3.0m or more than 3.0m below NGL</td><td>35</td><td>35</td><td>40</td></tr>
<tr><td rowspan="5">Switchyard, Transformer yard, CWPH, O&M Store, MCC, Lime Handling area, Wagon Tippler, Track Hopper, CSSP, Crusher, any other structures not mentioned above (BH01, BH02, BH03, BH05, BH06, BH15, BH16, BH19, BH30, BH31, BH32)</td><td>1.0m below NGL</td><td>12</td><td>12</td><td>15</td></tr>
<tr><td>1.5m below NGL</td><td>20</td><td>20</td><td>20</td></tr>
<tr><td>2.0m below NGL</td><td>25</td><td>25</td><td>25</td></tr>
<tr><td>2.5m below NGL</td><td>30</td><td>30</td><td>30</td></tr>
<tr><td>3.5m or more than 3.5m below NGL</td><td>40</td><td>40</td><td>40</td></tr>
</table>
<table>
<tr><td colspan="4">In case of founding stratum is rock</td></tr>
<tr><td>Minimum 0.6m embedment into rock</td><td>35</td><td>35</td><td>35</td></tr>
<tr><td>Minimum 1.0m embedment into rock</td><td>40</td><td>40</td><td>40</td></tr>
<tr><td>Minimum 2.0m embedment into rock</td><td>45</td><td>45</td><td>45</td></tr>
<tr><td>4.0m or more than 4.0m embedment into rock</td><td>50</td><td>50</td><td>50</td></tr>
</table>
To determine the Natural Ground Level (NGL), tender drawings titled “TOPGRAPHICAL SURVEY” shall be referred.

The NGL for……in consultation with Engineer.
</td></tr>
<tr><td>D1-81</td><td>V1/A</td><td>IID</td><td>8 of 8</td><td>2.03.01</td><td>The contractor shall develop the following facilities before using the allocated laydown area.</td><td>The contractor shall develop the following facilities before using the allocated laydown area.</td></tr>
</table>

AMENDMENT NO. 15 TO TECHNICAL SPECIFICATION (SECTION VI)

S. NO.	SPECIFICATION REFERENCE				Instead of	Read as
	SEC/ PART	SUB-SEC.	PAGE NO.	CLAUSE NO.		
					a. … b. … c. Security of material shall be responsibility of the EPC Contractor, including gate control. **d. RCC drains in the entire laydown area and along roads shall be planned so as to ensure proper disposal of rainwater.** e. … f. …	a. … b. … 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. … f. …