



भारत हेवी इलेक्ट्रिकल्स लिमिटेड

(भारत सरकार का उपक्रम)

BHARAT HEAVY ELECTRICALS LIMITED

(A Govt. of India Undertaking)

TCN - 04

Ref: PSER:VIZ:C1128:TCN-04

Date: 03-11-2010

Sub	Tender Change Notice (TCN- 04).	
Job	Civil, Structural & Architectural Works for Levelling & Grading, Sweet Water Reservoir, Sweet Water Pump House, Boundary Wall, Ash Pond with Ash Water Recovery Water pump House (on EPC Basis), Watch Towers, Gate Complex, Plant Roads, Plant Storm Water Drains and Culverts, other Civil and Electrical Enabling Works for Covered /Semi Covered Stores, Office, Accommodation, Temporary Roads and Drains etc. for 2 X 520 MW HNPCL/ VIZAG TPP, Vishakhapatnam, AP.	
Ref	1.0	Tender no PSER:SCT:VIZ:C1128:10
	2.0	BHEL's NIT, vide reference no PSER:SCT:VIZ-C1128 Date: 28-09-2010
	3.0	BHEL's TCN-01, vide reference no PSER: SCT:VIZ:C1128:TCN-01 Date: 06-10-2010
	4.0	BHEL's TCN-02, vide reference no PSER: SCT:VIZ:C1128:TCN-02 Date:19-10-2010
	5.0	BHEL's TCN-03, vide reference no PSER: SCT:VIZ:C1128:TCN-03 Date:22-10-2010
	6.0	Other References,if any.

With reference to above, following points, relevant to tender, may please be noted and complied with while submitting the offer.

- 1) Technical Specification : Civil, Structural & Architectural Works (FILE-2) introduced.
- 2) Revised BOQ cum price schedule format VOL-III- PRICE SCHEDULE, REV-02 superseding VOL-III PRICE SCHEDULE, REV-01 issued earlier. (FILE-3).

Bidders are requested to submit their offer as per revised BOQ (Rev-02) only. Offer from bidders in superseded price schedule (Vol-III, REV-01) shall not be considered. Bidders are also requested to submit a declaration in techno-commercial offer that they have submitted their price bid in sealed envelope as per **REVISED price schedule format (VOL-III- PRICE SCHEDULE, REV-02).**

- 3) Clause No. 14.1.3 of Technical Condition of Contracts(TCC) is read as per Annexure -1 of TCN-04 (FILE-4) supersedes earlier Clause No. 14.1.3.
- 4) Due date of submission of offer is extended from 08-11-2010 to 18-11-2010 (14=00Hrs).

BIDDERS ARE REQUESTED TO SUBMIT THEIR OFFER BY THE EXTENDED DUE DATE OF SUBMISSION OF OFFER i.e. 18-11-2010 (14=00 Hrs).

- 5) Revised 'No deviation certificate' is attached. Bidder to submit 'No deviation certificate' as per attached format only.
- 6) All other terms & conditions shall remain unchanged.

Thanking you,

Yours faithfully,
for BHARAT HEAVY ELECTRICALS LTD

DGM(SCT)

Encl:

- 1.0 Technical Specification-Civil,Structural & Architectural Works
- 2.0 Revised BOQ cum price schedule format (VOL-III- PRICE SCHEDULE, REV-02)
- 3.0 Annexure -1 of TCN-04
- 4.0 Revised format of 'No deviation certificate'.

पावर सेक्टर पूर्वी क्षेत्र (मुख्यालय)

POWER SECTOR EASTERN REGION, DJ-9/1, SALT LAKE CITY, KOLKATA - 700 091

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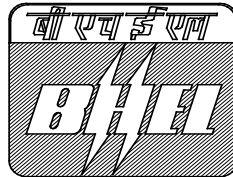
**HINDUJA NATIONAL POWER CORPORATION
LIMITED**

**VIZAG THERMAL POWER STATION
UNITS- 1 & 2 [2 x 520 MW]**

**VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS**

SPECIFICATION NO. PE-TS-361-600-C004

**SECTION - C
*SPECIFIC TECHNICAL REQUIREMENTS***



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

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1 General

1.1 Intent of Specification

Contractor shall read the parts of the specification relevant to the contract and shall ignore the other parts of the specification. In case of ambiguity between BOQ, Part C and Part D of specification, the following priority for acceptance of items may be followed :-

- a) BOQ
- b) Specific technical specification (Part C)
- c) General technical specification (Part D)

Description of various items of work under this specification and nature of work in detail are given hereinafter. The complete works under this specification is referred to as “Civil Works” including structures, plant, systems, facilities, etc., covered under the scope of this section of the specification.

The work to be performed under this specification shall also include design, engineering and providing all labour, materials, plant and equipment for construction, consumables, construction facilities and all incidental items though not specifically mentioned but necessary for completion and proper functioning of the plant, systems and facilities in strict accordance with the Specification.

All materials required for works under the Contractor’s scope shall be arranged and supplied by the Contractor.

The work shall be carried out according to the approved design and drawings, to be developed by the Contractor and approved by the Owner. For all plant, systems, facilities, structures, etc., necessary layout and details are to be developed by the Contractor keeping in view the statutory and functional requirements and providing enough space and access for operation, use and maintenance. The Contractor’s work shall comply with relevant Indian Standards & codes, requirements of various statutory bodies, international standards, best prevailing practices and to the complete satisfaction of the Owner.

The Contractor shall make the layout and levels of all structures from the general grid of the plot and the nearest Geological Survey of India (GSI) benchmark or other acceptable benchmark of Government Department, as per the directions of the Owner. The Contractor shall be solely responsible for the correctness of the layout and levels and shall also provide necessary instruments, materials, access to works, etc., to the Owner for general checking of the correctness of the civil works.

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

The Contractor shall fully apprise himself of the prevailing conditions at the proposed site including climatic conditions, monsoon pattern, soil conditions, local conditions and site specific parameters and shall provide for all such conditions and contingent measures, including those which may not have been specifically brought out in the Specification but required for successful execution of the work.

The preliminary Geotechnical investigation was carried out for the project during March 1995. Extract from this report for boreholes has been enclosed at Appendix-B for general guidance. The Contractor shall satisfy himself with the prevailing soil condition before making his offer. At the detailed engineering stage, detailed geotechnical investigation shall be carried out by the contractor and report submitted to the Owner for approval. The detailed design shall be based on the approved geotechnical parameters.

In case of any conflict between stipulations in various portions of the specification, most stringent stipulation shall apply for implementation by the Contractor.

1.2 Design Documents and Drawings

- (a) Commencement of fabrication, erection and construction shall be done after approval of the relevant design documents and drawings. All drawings shall be of standard sizes (metric system) and shall be made under AutoCad, whereas all documents shall be made using MS Office software such as MS Word, MS Excel.
- (b) The design documents and drawings for Civil Works related to all the areas, plants, equipment, systems and facilities (including pipes, cables, ducts etc.) included in Contractor's scope shall be submitted for approval / information of the Owner. However, drawings or documents requiring approval including extent of review shall be decided according to engineering co-ordination procedure document to be finalised after award of work to the successful Bidder.
- (c) The design documents and drawings to be submitted by the Contractor shall contain at least the following minimum information:
 - Project design intent document covering design criteria including loading assumptions, references, structural idealization/ mathematical model, load cases, load combinations, etc.
 - General arrangement of equipment, piping, cables ducts etc.
 - Loading plans indicating imposed loads, equipment loads and loads due to piping, cables and ducts.
 - Openings in floors, walls, cladding, roof, etc
 - Equipment mounting details.
 - General arrangement of foundations including loading data, bolt details, pocket details, etc.
 - Insert details, anchor fastener details along with their general arrangements.
 - Analysis and structural design calculations including input and out put data as applicable.
 - 3-D modelling of structures.
 - Details of corrosion protection measures.
 - Master plan for township.
 - Architectural drawings including finishing schedule.
 - Report of all detailed studies and investigations under the scope of Contractor.
 - Schemes for deep excavation, dewatering, erection, form work for major machine foundations, field quality assurance plan, bar bending schedule, fabrication drawings etc.
 - Any other submission, as indicated elsewhere in this specification and / or as required by the Owner.

1.3 Scope of Work

The Scope of work pertaining to different structure, facilities and system are covered under Volume-I of the technical specification.

The nature of work shall generally involve site specific study & investigation (like detailed Geo-technical investigation, area drainage study, sea-water intake study, model study for sump & forebay of pump house, flowability study for bunkers, wind tunnel study for natural draught cooling tower, route alignment survey for sweet water intake pipe line, sea water intake and discharge pipe line; approach road up to plant site and township etc), site clearance, earth work in site levelling, borrowing of earth, excavation in soil/rock, dewatering, dressing to required profile, sheet piling or shoring/strutting, controlled filling with earth/sand, backfilling around completed structures and plinth filling, disposal of surplus earth/rock, concreting including reinforcement and formwork, piling works, masonry work, vibration isolation system consisting of springs and dampers for machine foundations, plastering, painting, single / double skin metal wall cladding, roofing including permanent steel decking, flooring, acid and alkali resistant lining, doors/windows, ventilators, under deck insulation, false ceiling, false flooring, roof water proofing, fabrication and erection of all structural steel and miscellaneous steel (such as, steel staircase, cable/duct/pipe supports, ladders, walkways, railing, chequered plate/grating floor, inserts, anchor bolts, etc.), CW ducts/pipes, paving, gravel filling, precast RCC covers, cable ducts/duct banks, expansion joints, rain water pipe, water supply, toilet & kitchen fittings, lift-well, sewerage, insulation, stop logs/gates/valves, damp proofing, water proofing, anti-weed and anti-termite treatment, roads, drainage, fencing, final grading & landscaping and site clearance before handing over, other related items of work, etc., all complete as per specification and functional requirements. Contractor shall provide all temporary construction facility and enabling works.

The scope of work described here is of general in nature. The Contractor shall provide all structures/facilities required for the effective functioning of various systems of the power plant, whether or not they are specifically mentioned.

2 Geo-Technical Investigation and Foundation System

2.1 Geo-technical Investigation

Preliminary geo-technical investigation was carried out by the Owner during March 1995 and same is available with the Owner for reference. However, details of the boreholes carried out in the plant and vicinity area giving a general indication of the nature of strata are appended in Appendix-B. Revised coordinate / location of boreholes w.r.t revised survey co-ordinate / grid system has been marked in borehole location layout, drawing no253292-HNPCL-TDC-003,(refer Volume-III, tender drawings). The detailed geotechnical investigation shall be required to be carried out by the Contractor as per indicative requirements given below. The Contractor shall carry out detailed geotechnical investigation in all work areas under his scope for establishing the sub-soil conditions & to decide type of foundations for the structures envisaged, construction methods, any special requirements, ground improvement treatment called for/ remedial measures for sub-soil / foundations etc. for soft sub-soils (marine clay), aggressive sub-soils & water, expansive / swelling soils etc. prior to commencement of detailed design / drawings. Contractor shall obtain the approval for the field and laboratory-testing scheme proposed by him from the Owner before undertaking the geotechnical investigation work and shall submit the report containing the findings and recommendations.

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

Boreholes, Standard Penetration Test (SPT), collection of disturbed and Undisturbed soil/rock samples (UDS), Trial Pits (TP), Plate load test (PLT), Dynamic Cone Penetration Test (DCPT), Pressure meter tests (PMT), Seismic Refraction Test (SRT), Electrical Resistivity Tests (ERT) and collection of soil & water samples for chemical analysis etc.

2.1.1 Indicative Scheme for Detailed Geotechnical Investigation

The diameter of borehole shall be minimum 150 mm in soil and 76 mm in rock. The diameter of UDS sampler shall be 90 mm minimum. Drilling in rock shall be done by means of hydraulic feed equipment using double tube core barrel with diamond bit attachment.

Field investigations shall be done as indicated in the Table 2.1.

Table 2.1: Field Investigation

Sl. No.	Description	Nos. of Test
1	Bore Hole Test (Depth of the Bore hole for heavy structure shall be up to $RQD \geq 50\%$ subject to minimum of 5 meters in rock.)	(1)In accordance with provisions of the relevant parts of the latest revisions of IS: 1892. (2) Applicability of the particular test shall be according to the type of structures & facilities in different areas.
2	Dynamic Cone Penetration Test	
3	Electrical Resistivity Test	
4	Trail Pit	(3) Depth of exploration shall be minimum as specified in IS: 1982
5	Plate Load Test	
6	Cyclic Plate Load Test	
7	CBR Test	
8	Seismic Refraction Test	

Sl. No.	Description	Nos. of Test
9	Pressure Meter Test (PMT)	
10	Soil Permeability Test	

SPT shall be carried out in all types of soil deposits and in all rock formations with RQD \leq 20% within a borehole. This test shall be conducted at every 3.0 m interval or at change of strata, up to the final depth. Number of blows shall be recorded for every 15 cm of penetration up to 45 cm or 100 blows whichever occurs earlier. UDS shall be collected at every 3.0 m interval or at change of strata up to depth of borehole. Depth for DCPT shall be up to refusal (for DCPT, refusal shall be considered, when the blow count exceeds 150 for 300 mm penetration). Depth of PLT shall be at proposed founding level for shallow foundations only.

Field and laboratory investigations shall be done in accordance with provisions of the relevant parts of the latest revisions of Indian Standards. The laboratory tests shall be conducted on soil, rock & water samples collected during field investigations (bore holes, trial pits, borrow material) in sufficient numbers (minimum of 40% of samples disturbed and undisturbed each) and not be limited to the indicative type of laboratory tests. Laboratory tests shall be carried out on disturbed and undisturbed soil samples for Grain Size Analysis, Hydrometer Analysis, Atterberg Limits, Triaxial Shear Tests (UU & CD), Natural Moisture Content, Specific Gravity and Bulk Unit Weight, Consolidation Tests, Unconfined Compression Test, Free swell Index, Shrinkage Limit, Swell Pressure Test, Proctor tests, 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.

On completion of all field & laboratory work, contractor shall submit a detailed Geotechnical investigation report for Owner's approval. The detailed 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, recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, etc. The report shall also contain recommendations on type of foundations to be adopted for various structures, duly considering the sub soil characteristics, water table, total/ differential settlement permissible for structures and equipment, minimum depth and width of foundation with supporting calculations and type & design of piles in terms of safe capacity, length, diameter termination criteria etc.

Potential of liquefaction affect, if any under seismic condition due to presence of fine sand under saturated condition shall also be examined and finding shall be included in the report.

2.2 Foundation System

2.2.1 General Requirements

- (a) Contractor shall propose either open foundations (isolated/ combined footing/ raft) or pile foundations depending upon the results of the detailed geotechnical investigations to be carried out by him.
- (b) All foundations shall be designed in accordance with provisions of the relevant parts of the latest revisions of Indian Standards.
- (c) No major foundation shall rest in the filled up ground/ soil.
- (d) A combination of open and pile foundations shall not be permitted under the same structure.

- (e) Foundation shall be designed for worst combination of loads as described elsewhere in the specification.
- (f) Foundations for major dynamic equipment like Turbo Generator, Boiler Feed Pumps, Fans (ID/PA/FD), Crusher shall be supported on Vibration Isolation System (VIS) consisting of steel helical spring units and viscous dampers.
- (g) Suitable ground improvement particularly for marine clay areas shall be proposed by the contractor.

2.2.2 Open Foundations

In case, open foundations design and safety requirements such as, minimum depth, size, total permissible settlement and differential settlement shall be governed by IS: 1904 and IS: 13063 as well as from functional requirements, whichever is more stringent.

However, total settlement shall be restricted to the following:

Maximum allowable total settlement should be restricted to 25 mm for foundations (settlement sensitive) of all Main Plant structures like Main Power house, STG, Boiler, ESP, Mills and Mill building, PA Fan, FD Fan, ID Fan and BFP.

Maximum allowable total settlement should be restricted to 40 mm for all other Foundations.

2.2.3 Pile Foundations

Type and size of the Pile foundation shall be based on the recommendation in detailed geo-technical investigation report and subsequent established by initial pile load test at site and shall be designed as per IS: 2911 (relevant part).

In case of RCC bored cast-in-situ piles, boring shall be done by using rotary hydraulic rig. Two stages flushing of pile bore shall be ensured by air lift technique duly approved by Owner. The Construction methodology to be adopted shall be suitable to ensure proper termination of pile in the strata as specified elsewhere. For installation of piles under sea, mild steel liner of required diameter and thickness shall be used. Minimum cement content for piles shall be 400 kg/cum of concrete as per IS: 2911.

The uplift and lateral load capacities shall generally be restricted to 20% and 5% respectively of the allowable load capacity in vertical compression. However, the pile capacities to be adopted shall be the least of the estimated design values and that obtained from the pile load tests.

Only Straight piles shall be used unless otherwise specifically approved by the Owner.

The actual length of pile shall in no case be less than the design length. A minimum socketing length of four times the diameter of the pile into rock with core recovery greater than 20% shall be ensured in deciding the minimum length of pile.

Contractor shall furnish the design of piles (in terms of rated capacity, length, diameter, termination strata and criterion to locate the founding level for construction of pile, reinforcement for job as well as test piles etc.), construction methodology/ specifications for construction of piles and scheme and locations of initial pile load tests in vertical, lateral and uplift, and the details of equipment for Owner's approval.

Regular QA checks for density of circulation mud, contaminated mud and samples from pile bore bottom, slump of concrete, pile concrete integrity test on all piles etc. shall be done by the contractor.

Contractor shall install all the piles for initial pile load test (cyclic). Minimum number of initial load tests to be performed for each diameter and rated capacity for Vertical (Compression), Lateral (Horizontal) and Uplift (Tension) of pile shall be as per requirement of relevant IS codes.

The initial pile load test shall preferably be conducted with test load up to three times the estimated pile capacity but in no case test load shall be less than 2.5 times. In case of compression test, the method of loading shall be cyclic as per IS: 2911 (relevant part). Contractor shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory / institute prior to their use. Settlement / movement of the pile top shall be made by Linear Variable Differential Transducers (LVDT) having a least count of 0.01mm. Safe load interpretation from pile load test shall be as per IS: 2911 (Part-IV). Routine pile load tests shall also be performed for each diameter/ allowable capacity of pile as given below:

- (a) Vertical - 0.5% of the total number of piles provided subject to a minimum of one.
- (b) Lateral - 0.5% of the total number of piles provided subject to a minimum of one.

The routine test on piles shall generally be conducted up to test load of one and half times the allowable pile capacity by direct loading method. The test load on initial test piles shall be applied by means of reaction from anchor piles / rock anchors alone or combination of anchor piles / rock anchors and kentledge.

A report on the pile load tests shall be submitted for Owner's approval. In case, routine pile load test shows that the pile has not achieved the desired capacity or pile (s) have been rejected due to any other reason, then Contractor shall install additional pile (s) as required and accordingly, pile cap design should be reviewed and modified.

Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the routine load test and not intended to replace the use of static load test. This test is limited to assess the imperfection of the pile shaft and shall be undertaken by an independent specialist agency.

3 Design Criteria

3.1 General

This part generally outlines the design basis to be followed for all the buildings, structures and facilities listed in scope of work elsewhere in the specifications. All buildings/structures shall be designed as RCC or Steel framed structures with brick cladding or with pre coated metal cladding as described elsewhere in these specifications. Load bearing brick built structures shall not be adopted.

All buildings/structures shall be designed for all possible load combinations that it can experience during its life time. However the worst load combination shall be adopted for designing the buildings/structures.

The foundation system shall be decided as per detailed geotechnical investigation to be carried out by the Contractor.

Some basic types of loadings have been indicated below. Any other loadings not indicated but found necessary to be considered during detailed engineering shall be adopted in addition to the listed loadings. Load combination in accordance with the loadings shall be considered.

3.2 Corrosion Protection

3.2.1 General

Site is located in an corrosion aggressive marine environment, having high moisture and salt content in atmosphere, presence of sulphate & chloride salt in soil & ground water and use of sea water for cooling purpose and as such special corrosion protection for above and below ground structure would be required particularly steel and concrete works. Type of treatment of underground structure shall be decided on the basis of detailed soil investigations report and chemical analysis of soil & water. Further whenever structures are likely to be exposed to corrosive environment due to storage of chemicals or due to any other reasons, special measures are also required to be taken care of.

A comprehensive scheme for the corrosion protection shall be submitted to Owner for approval in line with the requirement specified below.

3.2.2 Plain and Reinforced Concrete

Plain Concrete is prone to sulphate attack and Reinforced Concrete to both sulphate as well as chloride attack. Corrosion protection shall be applied according to the IS: 456 and other related standards as given below.

- (a) Environmental exposure condition shall be as defined under Table-3 of IS: 456.
- (b) For different exposure conditions, minimum cement content, maximum water cement ratio and minimum grade of concrete for Plain & Reinforced Concrete work shall be as per Table-5 of IS:456.
- (c) Minimum cover to reinforcement to meet durability for different exposure conditions shall be as per Table-16 of IS: 456.

- (d) Requirements for Concrete exposed to Sulphate attack shall be as per Table-4 of IS:456.
- (e) When Chloride is encountered along with Sulphate in soil or ground water, provision of note-7 of Table 4 of IS: 456 shall be followed about type of cement to be used.
- (f) Super plasticizer admixer shall be added to concrete to enhance workability and reduction in water cement ratio.
- (g) Thermo-mechanically treated (TMT) bar shall be used as reinforcement for Concrete.
- (h) In case of direct exposure of reinforced concrete to the sea water, Sodium Nitrate base corrosion inhibitors in the form of additives shall be mixed with the concrete.
- (i) For RCC structure, control of crack width shall be ensured as per relevant IS codes.
- (j) Surface of cooling tower shall be coated with polyurethane or equivalent coating. However, bitumen coating shall be applied for underground structure.
- (k) In order to control the size and mitigate the occurrence of the cracks and to ensure concrete durability, smaller reinforcing bars well distributed over the zone of maximum concrete tension shall be used as per design requirements:
- (l) To protect inserts, anchor bolts and all steel items embedded in the concrete, galvanised material shall be used.
- (m) For protection against marine bio-fouling, suitable coating and/or chemical dosing shall be made

3.2.3 Steel Structure

(i) Painting

- (a) All steel members of buildings and structures shall be provided with suitable high performance chemical resistant protective coating system. The minimum maintenance free life of protective coating shall be ten years.
- (b) Minimum 75 micron DFT of organic zinc silicate primer shall be applied (over blast cleaned surface to near white metal conforming to Sa2 ½ finish) on all exterior and interior surfaces.
- (c) Intermediate coat which shall be applied for all interior and exterior surfaces shall consist of epoxy based Titanium dioxide(TiO₂) or Micaceous iron oxide (MIO)of minimum 75 micron DFT.
- (d) All exterior and interior surfaces shall be finished with (minimum 70 micron DFT) epoxy based paint, which shall be further finished with top coat of UV resistant (minimum 30 micron DFT) polyurethane of approved shade.
- (e) All paints shall be of high built constitution and minimum thickness shall be measured as per the provision of BIS / SSPC (Specification of society for protective coatings).
- (f) Provision of additional sacrificial thickness of 2 to 4 mm shall be made as a corrosion margin for steel members where protective coating can not be provided.

(ii) Galvanising

Galvanising shall be provided generally for switchyard structure, stop log and trash rack and electro forged greeting For outdoor structural steel works including switchyard structures, rate of galvanizing shall be minimum 900 gm/sq.m and for indoor application this shall be minimum 610gm/sqm.

(iii) Pre Coated Sheets

For outdoor application PVF2 (Polyvinylidene Fluoride) coating system shall be applied over a metal coating of Zn-Al alloy. For indoor exposure condition Silicon modified Polyester or Super Polyester coating can be used.

3.3 Requirements for Buildings and Facilities

Design and construction of buildings, structure etc., shall take into account requirement for operation and maintenance of all equipment and its users. The buildings will have good architectural features acceptable to the Owner. The surrounding area shall be properly micro levelled, graded and landscaped as per requirement.

3.3.1 Architectural Concepts for Buildings

The architectural design concept of buildings structure shall be evolved considering the functional, technological and other requirements for efficient operation, ensuring comfortable working environment for personnel, satisfying the aesthetic requirements. Special care shall be taken to provide elegance and aesthetics, with effective use of appropriate treatment, materials fittings and finishes. To achieve above objective Contractor shall employ a qualified architect / architectural firm to carry out all designs and hold all other architectural responsibilities for the project.

The Contractor shall obtain and be conversant with all laws, by-laws, regulations of local and Statutory Bodies as applicable to the project. The architectural concept evolved should also take care of these requirements. The Contractor shall provide the drawings and documents for such statutory approvals.

For details of Architectural concepts and other requirements reference shall be made to clause 19 of the specifications.

3.3.2 Roof Access

All roofs shall be provided with access thorough a suitable staircase or cage ladder as applicable.

3.3.3 Platforms and Walkways

Platforms shall be provided to all major equipment, not directly accessible from the floors, for maintenance. Platforms and connecting walkways shall have a minimum width of 750 mm. However, in case of space restriction, the minimum allowable clear width shall be 600 mm. Platforms in front of entry door etc shall be at least 900 mm wide. Platforms located close to each other shall be connected with walkways.

All steel platforms above grade level shall be constructed with kick plates at edge of the platform to prevent tools or materials from falling off. It shall consist of 8 mm thick steel plate projecting 100 mm above the platform surface. Kick plate shall be painted with the same type of coating as the material to which it is attached.

Continuous walkway at least 600 mm wide shall be provided along the crane girder level with handrails, on both side of the building. Approach to EOT crane shall be ensured by cage ladder or staircase.

3.3.4 Stairs and Ladders

All steel staircases shall normally have minimum clear width (back to back of stringer) of 1000 mm and maximum inclination with horizontal of 35.75°.

However, in case of space restriction, minimum clear width up to 750 mm and slope up to 45° may be provided. The vertical height between successive landings shall generally not to exceed 3m. Channels (min MC 200) shall be provided as stair stringers. Treads shall be minimum 250 mm wide of chequered plate/grating, with suitable nosing, and spaced equally so as to restrict the rise to maximum 180 mm (200 mm in exceptional cases).

Ladders shall be provided to platforms, walkways, instruments and equipment which do not require frequent access. Ladders shall preferably be vertical and its angle with vertical shall not exceed 5°. Ladders shall be of minimum 450 mm clear width with 20 mm diameter MS rungs spaced at 300 mm (maximum).

Ladders shall be provided with a safety cage of minimum 750 mm diameter clear when the top of ladder is more than 4.5 m above the landing level. However, safety cages shall start at 2.5 m above the lower landing level.

All RCC stairs shall have maximum riser of 180 mm and a minimum tread of 250 mm. However, for administrative building riser shall be limited to 150 mm and tread width of 300 mm. Minimum width of RCC stairs shall be 1500 mm generally. All stairs normally shall have not more than 15 risers in one flight. Aluminium angle nosing with minimum 50 x 25 x 3 angle shall be provided for edge protection of RCC stairs wherever required.

3.3.5 Handrails

Handrails shall be provided at appropriate places to ensure safety e.g. around all floors / roof openings, projections / balconies, walkways, platforms, steel stairs etc.

All handrails shall be of 32 mm nominal bore MS pipes (medium class) as per IS: 1161 / IS: 1239 suitably galvanised. Hand railing shall be a two-rail system with the top rail 1000 mm above the walkway surface and the intermediate rail 450 mm below the top rail. Handrail post spacing shall be limited to 1500 mm as far as possible but can be proportioned to the length of the opening. In such a case spacing shall not exceed 1850 mm centre to centre of posts. Hand railing shall be shop fabricated for specific locations and field welded or bolted to the erected structural steel. However, Stainless Steel handrails of Grade SS: 304 shall also be provided for important area like operating floor of turbo generated building as per requirement.

For RCC stairs, hand railing with 20 mm square MS bar balustrade with suitable MS flat and Aluminium handrail shall be provided, unless specifically mentioned otherwise. The overall provision of this component shall be aesthetically impressive.

3.3.6 Edge Protection

Wherever possible around floor openings an RCC kerb of 100 mm wide 150 mm high shall be provided. All concrete edges, where breakage of concrete corners are expected shall be provided with angles of minimum size L 50x50x6 with lugs for edge protection e.g. all-round the cut-outs/ openings in floor slabs, edges of drains supporting grating covers, edges of. RCC cable / pipe, trenches supporting covers, edges of manholes supporting covers and supporting edges of precast covers etc.

3.3.7 Anchor Bolts and Insert Plates

Anchor bolts shall be designed for working stress, in tension and shear, for embedded length of the anchor bolts and pipe sleeves. Shear and crushing strength of concrete shall also be checked. Increase in allowable stress for loading including seismic and wind loads shall not be permitted in design of anchor bolts.

Insert plates shall be designed and checked for shear and bending moment as per the provisions of relevant IS codes. All lugs shall be checked for tension. Bond strength of concrete shall be checked. Lugs using steel bars shall preferably be fillet welded to the plate to transfer full strength of the lug.

3.3.8 Vertical Headroom

All accessible areas shall be provided with minimum clear headroom as follows, unless otherwise specified.

- | | |
|--|---------|
| • Finished floors to ceiling (buildings) | 3000 mm |
| • Doors, Walkways, Platforms, Stairs etc | 2100 mm |
| • False ceiling of office areas | 2400 mm |
| • Above false ceiling
(Other than AC duct area) | 1000 mm |
| • Safety cage for ladders | 2500 mm |
| • Access for fork lift trucks | 3000 mm |
| • Main roads / Railway crossings & crane access | 8000 mm |
| • Other plant roads and truck access | 5000 mm |
| • Cable & Pipe rack (except at road and rail crossing) | 3000 mm |

3.3.9 Expansion and Construction Joints

Expansion and construction joints shall be provided wherever required. All expansion and construction joints of water retaining structures in RCC shall be made water tight using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops may be used for the base slabs and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 6 mm and minimum width 225 mm. For other than expansion joints these shall be 150 mm wide. For deep underground structure of coal handling plant etc, copper water stops shall be provided as specified under coal handling system.

Two part polysulphide sealant conforming to IS: 12118 shall be used for sealing of joints in contact with water. For other cases, bitumen sealing compound conforming to IS: 1834 can be used. Preformed bitumen impregnated fibre board conforming to IS: 1838 shall be used as joint filler.

Design and installation of joints in buildings shall be provided as per IS: 3414. Minimum 3mm thick Stainless Steel strip shall be used for expansion joints in buildings above ground level.

3.3.10 Brick Masonry and Parapet Wall

All masonry works shall be designed in accordance with IS: 1905, IS: 2212, IS: 4326 and other relevant IS codes as applicable. Structural design of non-load bearing walls constructed with solid fly ash based masonry units/bricks/blocks shall be in accordance with National Building Code of India.

All walls shall be non-load bearing infilled panels walls. External walls of all buildings shall be at least one brick thick. All internal walls shall be at least one brick thick except for internal partition walls for office area, canteen, change rooms, first aid rooms and toilets which may be half brick thick. RCC bands shall be provided wherever necessary.

50 mm thick DPC (1:1.5:3) with water proofing admixture and bitumen coating on top shall be provided at plinth level before starting masonry work.

Minimum 50 kg/sq.cm. compressive strength bricks shall be used for non-load bearing super structure brickwork. Cement sand mortar 1:6 for one brick thick walls and 1:4 for half brick thick walls shall be used. For half brick walls, RCC transoms and mullions shall be provided.

Type, thickness and height of external walling, facing the transformer yard to take care of fire accidents in transformer yard shall be according to the requirements of applicable norms and regulations.

Where metal cladding is specified, for initial 3 m height from the ground level, minimum one brick thick masonry wall shall be provided for all major buildings. Initial height of the brick wall can be limited to 900 mm for some other buildings.

All up stands and parapet walls on roof shall be of RCC or brickwork construction. Minimum height of parapet walls shall be 750 mm and thickness 125 mm / 230 mm (for brick wall) with aesthetics of architectural designs as approved by the owner.

3.3.11 Water Proofing of Underground Structures

All underground structures like basements, pump houses, water retaining structures etc., shall have plasticiser cum waterproofing cement additives conforming to IS: 9103. The concrete surface of these structures in contact with aggressive soil shall be provided with minimum two coats of bituminous painting of grade 85/25 conforming to IS: 702 @ 1.7 kg/sq.m. (minimum) for water and damp proofing. Also provision shall be made on the inner surface of walls and base slab, so that water proofing grouting can be injected later in case of leakage.

For deep underground basement structure requiring dry working conditions particularly coal handling system, special type of water proofing consisting of chemical injection grouting and polymer modified cementitious coating shall be provided as specified.

3.3.12 Anti Termite Treatment

Pre-construction anti termite treatment shall be given to all vulnerable areas susceptible to termite attack and shall include column pits, wall trenches, foundations filling below the floors etc., as per IS: 6313 and other relevant Indian Standards.

3.3.13 Plinth level

Finished ground floor level (plinth level) of all buildings and pump houses shall be minimum 500 mm above the formation level.

All cable vaults shall be located above ground level i.e., vaults shall not be provided as basements in the buildings.

Finished floor levels of Boiler area, transformer area yard paving shall generally be kept 150 mm lower than the finished floor level of turbine building.

3.3.14 Statutory Requirements

All the applicable statutory rules pertaining to Indian Factories act, Factory rules of State Government, Fire safety rules, Water act of Pollution Control boards, Explosives act, and stipulations of other relevant statutory authorities including local Municipality shall be taken into consideration at the time of design and construction.

Provisions of safety, health and welfare according to Factories act shall be complied with at design stage. These shall include provision of continuous walkway (minimum 600 mm wide) along crane-girder at crane girder level on both sides of the building, comfortable approach to EOT crane cabin, railings, fire escape, locker room for workmen, pantry, toilets, rest rooms etc.

Adequate no. of fire escapes shall be provided in the buildings. Fire proof doors, staircases, fire separation walls, lath plastering on structural steel member (in fire prone areas) shall be provided according to applicable norms and regulations.

For fire safety requirements of buildings IS: 1641 and IS: 1642 shall be followed in addition to other applicable requirements. All masonry firewalls shall be minimum 345 mm thick and RCC firewall shall be minimum 200 mm thick

3.4 Loading

3.4.1 Dead Loads

Dead loads shall include the weight of complete structure with finishes, fixtures & partitions and shall be taken as per IS: 875 (Part-1). Unit weight of certain specific materials like coal, fly ash, bottom ash shall be as specified elsewhere.

3.4.2 Imposed Loads

Imposed (Live) loads shall consist of uniform live loads and equipment live loads, hang load and dust load. Uniform live loads are assumed unit loads which are sufficient to provide for movable and transitory loads, such as the weight of people, portable equipment and tools, planking and small equipment, or parts which may be moved over or placed on floors during maintenance operations. Uniform live load is not be considered on the floor areas which shall be permanently covered with equipment.

The loads considered shall not be less than that specified in IS: 875 (Part-2).

Equipment live loads shall be calculated based upon the actual weight and size of the equipment and parts to be placed on floors during dismantling and maintenance, or to be temporarily placed on or moved over floors during installation, whichever is most severe.

Floors and supporting members which are subject to heavy equipment live loads shall be designed on the basis of the weight of the equipment in addition to a uniform load of 5 kN/m^2 , or specifically defined live loads, whichever is greater. Each member in the floor which may carry these loads shall be designed for the heaviest piece or pieces of equipment arranged in the most critical position. For loads caused by moving equipment over the floor for installation, consideration shall be given to the shoring of beams and floor from floors below.

3.4.3 Impact Loads

Impact loads shall be added to other loads for components supporting reciprocating or rotating machines, elevators, hoists, cranes, or other equipment creating dynamic forces. Impact load shall be applicable as per IS / IRC Codes, Indian Railway Standard or specified by the Equipment manufacturers as applicable.

3.4.4 Equipment Loads

Equipment loads shall be specifically determined and located. For major equipment, structural members and bases shall be specifically located and designed to carry the equipment load into the structural system. For equipment weighing less than the live load, the structural system shall be designed for the live load. Equipment loads shall be noted in the design calculations to permit separation in calculation of uplift and stability.

Pipe hanger loads for the major piping systems, such as the main steam, reheat steam, feed water and extraction systems, shall be specifically determined and located. Piping expansion and dynamic loads including thrust loads at bends shall be considered on an individual basis for their effect on the structural systems. Loads imposed on periphery beams around pipe chase areas shall also be considered on an individual basis. Salient points to be considered:

- (a) Static and dynamic loading of major equipments including Turbine generator, boiler feed pumps, PA, ID, FD fans, Coal mill and coal crusher shall be obtained from manufacturer certified drawings of specific equipment.
- (b) All equipment, tank and piping design loadings shall include hydraulic testing loads.
- (c) Air and gas duct loadings shall include weight of insulation duct attachments, dust accumulation loads, seismic, wind and other load as applicable.

- (d) Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as developed from the crane weights and wheel loads. Unless otherwise specified, the vertical and horizontal loadings will conform to the applicable sections of the IS codes.
- (e) Weight of equipment, ducts, tanks, pipes, conduits etc. supported by structure shall include maximum possible loading conditions i.e. flooded material contents and associated impacts, test loadings, anchorage and constraint effects.
- (f) All structural components shall be designed to accommodate anticipated concentrated loads which will or may be applied during the life of the plant. Where both concentrated and uniform loads cannot act simultaneously, the structure or component shall be analysed for both conditions of loading and shall be designed for more critical condition.
- (g) Jet forces resulting from guillotine type pipe ruptures shall be considered in the design.
- (h) Laydown areas in the turbine hall shall be investigated for concentrated loads resulting from equipment components to be stored during erection and maintenance operation. Where live load allowance is inadequate to permit storing of such equipment components, the design live load shall be increased to permit such use or the area shall be restricted by identifying laydown areas for specific components, each area to be identified by permanent marking.

3.4.5 Pipe Hanger Loads

Piping loads to account for miscellaneous piping systems shall initially be estimated as uniform loads per unit floor area based on the expected density and size of piping being supported in a specific floor area. These loads shall be carried to the columns and foundation as dead loads, but shall not be considered as reliable dead load for uplift. In addition to the uniform area load, a concentrated "phantom" load shall be placed on all primary beams for the purpose of sizing the member. This load shall not be carried over for sizing of other members. The magnitude of the phantom load shall be based on the mechanical piping engineer's experience for the miscellaneous piping systems to be routed in a specific floor area.

3.4.6 Test Load

The test load shall be defined as the gravity load imposed by method necessary to test vessels, tanks, equipment or piping.

3.4.7 Construction Loads

The integrity of the structures shall be maintained without use of temporary framing struts or ties and cable bracing in,sofar as possible. However, construction or crane access considerations may dictate the use of temporary structural systems. Special studies shall be made and documented to ensure the stability and integrity of the structures during any periods involving use of temporary bracing systems.

3.4.8 Wheel and Crawler Loads

Loads exerted on bridges, roadway pavements, parking and unloading areas, buried piping, box culverts, and embankments shall be reviewed and selected prior to design of the underlying items. The loads as recommended for IRC class AA loading and class A live load shall be utilized for the design of bridges, roadways, and parking and unloading areas as per IRC:6 (Section II). However, exact loadings shall be considered in areas where appropriate as loadings such as loaded scrapers, crawler cranes, stator transport trailers, etc., might exceed these loadings.

3.4.9 Dust Loads

All buildings/structures shall be designed for a dust load of 0.50 kN/m^2 on flat roof.

3.4.10 Crane Loads

Crane reaction loads shall be as per the crane manufacturer's details, and same shall be analysed according to the provisions of IS: 875.

3.4.11 Loads on Underground Structures

In addition to other loads, the following loads shall also be considered for underground structures:

- (a) Earth pressure – Earth pressure for all underground structures shall be calculated using co-efficient of earth pressure at rest, co-efficient of active or passive earth pressure (which as applicable).
- (b) Ground water pressure – Ground water pressure due to the highest water table assumed up to formation level shall be considered.
- (c) Surcharge load - Minimum surcharge load of 20 kN/m^2 shall be considered for the design of all underground structures located in the vicinity affected by vehicular traffic; including channels, sumps, cable & pipe trenches etc to provide for increase in earth pressure due to vehicular traffic.
- (d) Dynamic increment of earth pressure under seismic condition shall be considered along with hydrodynamic effect for water/liquid storage structures.

3.4.12 Thermal Load

Thermal loads shall be defined as forces caused by changes in temperature. The primary source of thermal loads in an industrial plant is the expansion or contraction of vessels and piping. Another source of thermal loads in a redundant structure is the expansion or contraction of the entire structure or individual structural component.

3.4.13 Hydrostatic Load and Buoyancy

Hydrostatic load is the load due to water pressure. The design of structures shall include hydrostatic loads where applicable. The buoyancy load is equal to the weight of the volume of displaced water. For working out such loads, water table shall be considered to as at formation level.

3.4.14 Dynamic Loads

Each structure shall be designed to withstand the effects of vibration and impact to which it may be subjected. Each structure and foundation supporting a compressor, turbine, pump, fan, mill or other machinery having significant dynamic unbalance shall be designed to resist the peak loads specified by the manufacturer. Vibration amplitudes of the supporting structure or foundation shall be kept within acceptable limits for dynamic forces that occur during normal machine operation. In the case of a tall and slender structure, there may be a need to investigate the dynamic effects of wind gusts.

3.4.15 Future Load

Loads from future expansion shall be considered when so directed by the Owner. Future loads may include any of the loads listed above.

3.4.16 Surge Load

Surge loads may occur in some vessels or equipment. In such cases, the magnitude and direction of the load shall be given by the equipment supplier.

3.4.17 Miscellaneous Loads

Miscellaneous loads shall be defined as loads that do not fit into the categories listed in this section. Typical miscellaneous loads are loads, during erection, maintenance and repair or forces due to creep, shrinkage, or settlement.

For the design of individual structural components, realistic load combinations in accordance with the relevant design standards shall be considered.

All loadings considered in the design shall be justified with supporting details.

3.4.18 Seismic Load

The project site is in Zone – III as per IS: 1893 (Part-I)

3.4.19 Wind Load

Basic wind speed at project site is 50m/sec. as per IS: 875 (Part-3).

Probability factor / risk coefficient (k_1), terrain, height and structure size factor (k_2) and topography factor (k_3) shall be as per IS: 875.(part-3)

3.4.20 Damping in Structures

The damping factor to be adopted shall not be more than as indicated in IS: 1893 (part-1) and other relevant IS Code.

3.4.21 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.

Systems and system component design criteria which require ambient temperature extremes, shall use the applicable range for dry-bulb temperatures.

3.4.22 Railway Load

Railway load for siding area shall be considered as per Indian Railways standards. Minimum axle load of 30 t shall be considered for design purpose.

3.4.23 Load Combinations

The different load combinations shall be taken as per IS: 875 and in case of special structure, other relevant standards shall also be followed.

- (a) Wind and seismic forces shall not be considered to act simultaneously.
- (b) For the design of main plant structures during seismic condition, the de-aerator feed water tank shall be considered full up to operating level. However, for other load combinations, de-aerator 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.
- (e) In case two cranes are provided and tandem operation is envisaged for some bays, then the load shall be taken as both the cranes fully loaded and standing side by side for these bays. For other bays, load shall be taken as one crane fully loaded and second crane without lifted load but standing idle adjacent to first crane.
- (f) Permissible stresses for different load combinations shall be taken as per relevant IS codes.

3.5 Basic Design Concepts for Design of RCC Structures

Individual members of the frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion, etc. Criticality of erection/maintenance loads shall also be checked separately in combination with other simultaneously occurring loads for possible design loadings.

3.5.1 Concrete & Reinforced Concrete for Structures

Concrete work shall secure a dense, homogeneous, smooth mass including required finishes, possessing required strength and resistance to weathering and abrasion for the structures and foundations.

Unless otherwise specified for special type of structure and foundations, minimum grades of concrete to be used shall be as specified in IS: 456 for different exposure conditions.

3.5.2 Foundations

Foundations for structures and equipment shall be proportioned to resist the worst conditions of loading and generally designed as per the provisions of IS: 1904 and IS: 456. The depth of foundation shall be determined based on loading on foundation, safe bearing capacity at the founding level, constructional and technological requirements. The allowable bearing pressure for design of foundation shall correspond to values confirmed by results of detailed soil investigation taking into account limits of allowable settlement considered for design of structures and equipment.

Safe bearing capacity shall be considered as per approved detailed geo-technical investigation report.

Generally foundation for buildings & equipment shall not be structurally connected to ground floor slab. The top level of the stem for building structural column foundations shall be so provided that no part of the steel column base assembly protrudes over finished floor level. The column base assemblies shall be encased with M-25 grade concrete up to 200 mm above floor level for inside the building and 300 mm above formation level for outdoor location. Suitable thickness of lean concrete of grade M7.5 for ordinary structure having minimum thickness 75mm and M10 of minimum 100 mm thickness for importance structure like machine foundation, chimney raft, water retaining structure etc. shall be provided as applicable, below footings, pile caps, base slab etc.

3.5.3 Underground Water Retaining Structures

Based on the data on subsoil and underground water, adequate precautions shall be taken for design of foundation and underground structure. Water retaining structures shall be designed as per provision of IS: 3370 (relevant parts), considering as un-cracked sections. However, in special cases, structural design can also be considered with limited crack width and reduced permissible steel stress. All underground structures such as sumps, pits, trenches etc shall be designed considering soil, water and surcharge pressures.

- (a) The water retaining structures shall be checked for three loading conditions:
- (b) With water inside up to full level and no earth fill outside.
- (c) Water in one compartment and other compartment empty (where two compartments are provided).
- (d) With outside earth and ground water up to maximum level and inside empty.

For design of walls of basement, trenches, channels etc. below ground, lateral pressure due to a vertical surcharge of 20 kN/m² shall be considered in addition to earth and ground water pressure etc. In case of heavy wheel loads, lateral surcharge due to actual wheel loads shall be substituted. When a portion or whole of the adjacent soil is below free water surface, computations shall be based on submerged weight of soil plus full hydrostatic pressure.

The structures shall also be checked for stability and factor of safety shall not be less than those specified under applicable Clause of IS 456 against overturning and sliding. Proper considerations in design shall be taken to prevent any possibility of floatation due to upward thrust caused by underground water. Factor of safety against uplift shall be at least 1.2 as per IS 3370 (Part-1). Pressure release valves of any form or type that allow ingress of water into the structure shall not be permitted. Special care shall also be taken to prevent floatation during construction period.

For all underground structures such as basement, sump etc., and water retaining structures special care shall be taken to water proofing. Water retaining structures shall be hydro-tested as per IS: 3370 and IS: 6494 for leakage and in case leakage is noticed pressure grouting or any other approved procedure shall be adopted to rectify it. Sumps with pumping arrangements shall be provided at suitable location in underground structures to collect and pump out any incidental water collection to nearest storm water drainage outlet.

3.6 Basic Design Concepts for Design of Structural Steel Work

Structural steel design shall be carried out as per IS: 800 unless noted otherwise. All work shall be done as per relevant latest IS codes, unless otherwise specified.

Lateral forces along with the length of the building will be resisted by bracings in horizontal and vertical frames. The transverse lateral load will be resisted by stiff jointed frame action. Additional bracing or moment connection will be used to assure stability of the structures.

Structural Steel conforming to IS: 2062 and chequered plate conforming to IS: 3502 shall be used.

All steel beams supporting RCC slab shall be provided with shear connector as per IS: 11384.

All indoor gratings shall be electro-forged types and outdoor gratings shall be welded type. Thickness of the grating shall be minimum 40 mm for indoor installation and 32 mm for outdoor installation of lightly loaded areas. 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. Cutting of gratings shall not be carried out at site. Any cutting of gratings required to provide passage for columns/pipes/cables/ducts, etc. shall be done by the Contractor in shop and cut edges of grating shall be suitably reinforced with binding strips. All gratings shall be hot dip galvanized at the rate of 610 gm/sq.m. and shall be painted wherever required after application of etching primer.

The Contractor shall submit the grating design for different spans and loading intensity along with fabrication drawings showing size and spacing of bearing bars and cross bars etc.

Hand-railings shall conform to IS: 1239 (medium grade) galvanized steel pipe and flush welded construction, ground smooth using 32 mm nominal bore pipes.

For steel structures, shop connections shall be all welded and field connections shall generally be bolted unless otherwise if specifically indicated by Owner. Field bolts, wherever provided shall be high tensile of 20 mm diameter or of higher diameter and of property class 8.8 (minimum) as per IS: 1367 for all major connections. All bolts, nuts and washers shall be procured from the manufacturers as approved by Owner. The bolted joints shall be designed for friction type connection and the HT bolts shall be tightened to develop the required pretension during their installation. However, the nominal connections in the field like purlins, stairs, wall beams shall be carried out by using MS black bolts not less than 16 mm diameter (minimum property class 4.6) conforming to IS:1363 unless specified otherwise. All removable type connections shall be with bearing type HT bolts of grade 8.8 (minimum).

Welding shall be in accordance with the recommendation of IS: 816 and IS: 9595. Built-up members shall be fabricated using submerged arc welding procedure. All electrodes, flux, bare wire etc shall be procured by the contractor only from manufacturers approved by owner. All butt-welds in beams, girders & columns shall be of full penetration. All butt-welds shall be radio graphically or ultrasonically tested as per QAP requirements.

Minimum tests to be carried out during fabrication & erection of structural steel works shall be as described under quality assurance section.

The bare wire electrodes for submerged arc welding shall conform to IS: 7280. The combination of wire and flux for submerged arc welding shall be as follows:

Low hydrogen electrodes as approved by the Owner shall be used in the following cases:

- (a) For welding of all important joints such as butt-joints in columns (flange or web), butt-joints in main frame beams (flange or web) etc.
- (b) For welding steel members having thickness more than 20 mm.

In case of fillet weld between two components, the thickness of the thinner part shall be considered. Minimum preheat & inter-pass temperature for welding shall be as specified in QA section.

All structural steel members for switchyard structures and gratings at power house shall be hot dip galvanized in accordance with IS: 4759 or equivalent. The fasteners for such connection shall also be galvanized as per IS: 5358.

Galvanising of steel structure shall be done after all fabrication work is completed. However, fasteners may be tapped or re-run after galvanizing. Threads of bolts & nuts shall be capable of developing the full strength of the bolt. The spring washers shall be electro-galvanized as per IS: 1573. All galvanizing shall be uniform and of standard quality and shall withstand test in accordance with IS: 2633. Zinc coating for galvanized surface of structural members shall not be less than 610 gm/m².

For all field connections whether welded or bolted, 80% of the shop design strength shall be considered.

3.6.1 Deflection Criteria

Vertical deflection as well as horizontal deflection shall be as specified in IS: 800 and other relevant codes.

3.6.2 Minimum Thickness of Structural Steel Elements

(i) Minimum Thickness

The minimum thickness of various components of a structure and hot rolled sections shall be as follows:

- The minimum thickness of rolled shapes shall mean flange thickness regardless of web thickness. Structural steel members exposed to corrosive environment shall be increased suitably in thickness for corrosion margin where application of protective coating would be a constraint.
- Minimum thickness of structural members other than gratings and chequered plate directly exposed to weather and inaccessible for painting and maintenance shall be 8 mm.

(ii) Minimum Sizes

The flange width of purlins supporting light weight concrete slab shall not be less than 65 mm and for those supporting roof sheeting and wall cladding it shall not be less than 50 mm. Width of steel rolled section connected to other member shall be at least 50 mm. The depth of beams for platform of all structures shall not be less than 125 mm.

3.6.3 Slenderness and Depth Ratio

The slenderness ratio of main members in tension, compression or bending shall be in accordance with IS: 800.

3.6.4 Design of Connections

Fabrication drawings shall be prepared considering the provisions of IS:800, IS:816, IS:9595, IS:1367 and IS:9178.

Connection of vertical bracings with connecting members and diagonals of truss members shall be designed for full tensile capacity of the bracings.

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

- (a) Full shear capacity or actual shear whichever is more for box section.
- (b) 80% of full shear capacity or actual shear (if indicated in drawings) or 0.5 times of the web thickness whichever is more. For I section, weld shall be double fillet.
- (c) All welds shall be continuous. The minimum size of the fillet weld shall be 6 mm.

Shear connections shall be designed for 75% of section strength or actual shear for rolled sections and 80% of section strength or actual shear whichever is higher for built-up section or rolled section with cover plates.

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

All butt-welds shall be full penetration butt-welds.

The connection between top flange & web of crane girder shall be full penetration butt-weld and for bottom flange, connection may be fillet weld.

Connection of base plate & gusset members with the columns shall be done considering that total load gets transferred through weld.

3.6.5 Splicing

All splicing work shall be full strength. Field splicing shall be done with web/flange cover plates. For exceptional cases, the field splicing shall be designed for 50% of load carried by the cover plates and remaining 50% load through full penetration butt-weld. Shop splicing for all sections other than rolled shall be carried out by full penetration butt-welds with no cover plates. Splicing for all rolled sections shall be carried out using web and flange cover plate.

3.6.6 Holding down Bolts and Shear Key

All structural steel column base shall be connected to RCC pedestals with holding down bolts. The bolts assembly shall be made of Mild Steel bar with minimum size 125mmx125mmx12mm thick anchor plates. Anchor plates shall be fillet welded to bolts with 8mm (minimum) weld at 100mm above the bolt bottom. Anchorage shall be determined based on bond stress developed between embedded bolt and concrete.

All column base plate at braced bay and other applicable column location shall be provided with shear key to transfer lateral load to the pedestals.

3.6.7 Painting

Shop primer paint shall be applied after proper surface preparation as per requirement specific under corrosion protection.

3.6.8 Grouting

Non-shrink expansive flowable cement based grouting material of approved make shall be used for under pinning work below base plate of columns. For grouting of base of machine foundation high strength ready mixed non-shrink flowable grout shall be used as per equipment manufacture's requirements. Crushing strength of the grout shall generally be one grade higher than the base concrete with minimum grade as M25.

Nominal thickness of grouting shall generally be at least 50mm for building columns and pedestals of major equipment. For secondary posts, stairs and ladder base etc grouting shall not be less than 25mm thick.

3.7 Design of Special Structures

3.7.1 Bunkers

Bunkers shall be installed in mill building.

- (a) A set of bunkers of required capacity for storage of coal shall be provided. Bunkers shall generally be circular in plan with conical hopper bottom. To facilitate easy and continuous flow of material, the angle made by the hopper wall with the horizontal, shall preferably be 15° more than the angle of internal friction of the materials, but should not be less than 60° to the horizontal. Actual shape and profile shall be finalised based on the flowability test.
- (b) The design of the bunker walls and supporting structure shall conform to IS: 9178 (Part I & II). Density of coal for storage vol. calculation shall be 0.8 t/m^3 and shall be 1.05 t/m^3 for weight calculation.
- (c) Maximum pressures during filling and emptying shall be considered. For the design of hopper bottom, maximum P_v (during filling) should be considered. For the design of side walls maximum P_w (emptying) shall be considered.
- (d) Check for the maximum pressure should be made for the rapid filling and pneumatic emptying condition.
- (e) Effects causing increase in bin loads and decrease in bin loads as per IS: 9178 (Part I) shall also be considered.
- (f) Wind load on bins shall be calculated in accordance with IS: 875 (Part-3).
- (g) Seismic load shall be calculated in accordance with the site spectra report/recommendations mentioned under IS: 1893.
- (h) Bunker shall be provided with 4 mm thick stainless steel liner.

Stainless steel liner in the coal bunkers shall be 6 mm thick of grade AISI 304; finish grade 2B (cold rolled, annealed & pickled and skin passed) and shall be provided on the inner faces of entire inclined portion of hoppers and mouth of the hoppers, without allowing any projections in coal flow path.

3.7.2 Silos

Silo for the storage of Fly ash shall be made either of Steel or RCC, with suitable shape and profile to ensure easy flow of fly ash. For steel silo design shall be carried out as per IS: 9178.

RCC silo shall be designed as per IS: 4995 and following loading conditions and effects shall be considered while designing the various components

- (a) Dead load of the structure.
- (b) Super-imposed loads due to material handling and transportation machinery, if any.
- (c) Bin load as per IS: 4995 (Part-I).
- (d) Live-load (for roof only) in accordance to IS: 875 (Part 2).
- (e) Wind load in accordance to IS: 875.
- (f) Seismic loads in accordance with the site spectra report/recommendations mentioned in IS: 1893.
- (g) Effect due to temperature variation.
- (h) Effect due to shrinkage of concrete.
- (i) Effect of fixity of the bin at the top and bottom edges and with adjoining structures.

Permissible stresses and design shall be as per IS: 4995 (Part-II).

3.7.3 Switch Yard Structures

Gantry structures shall consist of open web towers connected by girders. These shall be made of structural steel conforming to IS: 2062 and duly galvanized of required grade conforming to IS: 2629. All joints shall be bolted connections. All bolts of required diameter shall be conforming to IS: 12427 of property class conforming to IS: 1367(Part-6). Nuts shall conform to I.S 1363(Part-3). Butt splice shall be used for splicing the main members and splice shall be located away from the node point. IS: 802, shall be followed for design of structural supports. Height & type of towers shall be established based on electrical requirements.

Switchyard structures shall be designed for the worst combination of dead loads, imposed loads, wind load, seismic loads, temperature loads, loads due to deviation of conductor, loads due to unbalanced tension in conductor, torsional load due to unbalanced vertical and horizontal forces, erection loads, short circuit forces including snap in case of bundled conductors, etc. as specified in IS: 802. Design of foundations shall be carried out as per IS: 4091 and IS: 456.

The supporting structure for B.P.I., LA, CVT & Isolator equipment shall be comprised of Galvanised steel (ERW) pipe of required grade conforming to IS: 1161 & shall be designed as per IS: 806..

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

Supporting structural arrangement for Gas Insulated Switch Gear for indoor installation shall be as per manufacture's requirements.

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

Diagonal wind condition shall be considered for the design of lightning mast.

Lighting mast shall be provided with a structural steel ladder with protection rings. Where the platforms are provided on lighting mast for mounting of lighting fixtures, these shall have protection railings. The platforms shall be of steel grating.

Lighting mast shall be provided with minimum two numbers of platforms with one at top level and an internal ladder (with cage) for climbing purpose up to top level. Top of platform shall be covered with grating. Platforms shall be provided with MS pipe hand railing and toe guard plate.

3.7.4 CW Pump House

The pump house shall be designed as a framed structure with worst combination of loadings.

The pump house floors shall be checked for vibrations imparted by the pumps. The sump and fore bay shall be designed as water retaining structure

The sump shall be designed under the following conditions:

- (a) Walls fixed at bottom and hinged at top where top restraint is provided by floor slab/beams and earth pressure at rest. In case the wall shall be treated as a cantilever and active pressure co-efficient shall be considered.
- (b) Outside empty and extreme end compartments filled and inside compartments empty

- (c) Outside filled and extreme end compartments are empty and inside compartments filled.
- (d) Outside empty and alternate compartments filled
- (e) Outside filled and alternate compartments empty.

Fore bay shall be designed under following conditions.

- (a) Walls shall be cantilever or counter fort retaining walls.
- (b) Outside empty inside full.
- (c) Inside empty outside full.
- (d) Pressure release valve shall be provided, if required, in fore bay base raft to prevent uplift during construction.
- (e) Shear key can be provided for stability against sliding and design with passive pressure coefficient not exceeding 2.

3.7.5 CW Ducts

Design of C.W. ducts shall be done for the following conditions.

- (a) Internal Pressure Condition

Following cases shall be considered for the design of pipe:

- Maximum design water pressure
- Surge or water hammer pressure
- Pressure, under testing condition

- (b) External Pressure Condition

The pipe shall be designed for external pressure due to soil overburden, surcharge loading, vacuum condition in pipe, ground water, etc., taken together.

- (c) Practical Requirements

Design shall also be checked for handling stresses. Both stresses and the deflection of pipe shall be within the limits for the above design conditions. Deflection of the pipe under worst loading condition shall be restricted to 2 (two) percent of the pipe diameter.

For the concrete encased pipe, the design of pipe shall also be checked under concreting condition during construction. Moreover, temporary bracing shall be provided inside the pipe to limit the deflection within 2% of diameter of pipe during construction.

- (d) Top of C.W. duct shall be minimum 1.5m below grade/ formation level.

The design of C.W. steel pipe liners with concrete encasement shall be as per “Design and Construction of Buried Thin Walled Pipes” CIRIA (Construction Industry Research and Information Association, London) report and also as per American Water Works Association (AWWA) Manual.

3.7.6 Dynamic Machine Foundations

For the foundations of Turbo-generator, Boiler feed pumps, Fans (ID, FD and PA), Mills, etc. detailed static and dynamic analysis shall be done. The static analysis shall include all operating conditions, load cases and abnormal loads like short circuit, loss of blade, unbalance and seismic forces. Unbalanced loads for normal operating condition as given by machine manufacturer and/or VDI 2060 whichever is more conservative shall be used for calculating dynamic response. The dynamic analysis shall consist of free vibration analysis and forced vibration analysis. Transient analysis shall be carried out for the short circuit condition with an appropriate force function. Frequency separation criteria and amplitude criteria as laid down in IS:2974 and/or DIN 4024 and/or VDI 2056 and/or as required by the machine manufacturer, whichever is more stringent shall be satisfied. RCC design shall be done by the working stress method for all machine foundations. A fatigue factor of 2.0 shall be considered for dynamic forces. Minimum reinforcement shall be governed by IS:2974 as well as IS:456. However minimum reinforcement in bottom face of the foundation raft resting on soil or pile shall not be less than 0.2% of effective cross sectional area of the raft. The special requirements for concreting including grade, type of aggregate, use of admixture, temperature control, ultrasonic testing, etc., shall be as mentioned elsewhere in this specification.

For Coal crusher detailed dynamic analysis shall be done for the top deck together with springs and dampers and the natural frequencies and amplitudes of vibration shall be determined for different hammer broken conditions

All block foundations supporting rotating equipment resting on soil or piles shall be designed using the elastic half space theory. The mass of the RCC block shall not be less than three times the mass of the machine. Dynamic analysis shall be carried out to calculate natural frequencies in all the modes including coupled modes and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down in the relevant codes and/or by machine manufacturer whichever is more stringent shall be satisfied. Minimum reinforcement shall be governed by IS:2974 and IS:456. Minimum Reinforcement in base raft in either direction shall be as follows:

- (a) At bottom face - 0.2% of gross cross-sectional area
- (b) At top face - 0.12% of gross cross-sectional area

For the foundations supporting minor rotating equipment weighing less than one tonne or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structure, floors, etc., suitable vibration isolation shall be provided by means of springs, neoprene pads, etc., and such vibration isolation system shall be designed suitably.

Steam turbo-generators, Fans (ID, FD and PA), Boiler feed pumps and coal crusher shall be supported on vibration isolation system (VIS). However Mill foundation can be provided without VIS. The vibration isolation system shall consist of steel helical spring units and viscous dampers supporting the RCC deck, which would support the machine. The spring units shall conform to DIN 2089 and DIN 2096.

The vibration isolation system supplied shall be of proven make and shall be in successful operation supporting machines like steam Turbo-generators, ID/PA/FD Fans, BFP, etc.,

Isolation efficiency of at least 90% shall be provided for such foundations. The nominal spring capacity shall be at least 25% higher than the actual spring-supported weight for the TG, BFP, and ID/PA/FD fan and coal crusher. Viscous dampers shall be designed for 3% to 5% of critical damping. Springs and dampers of the vibration isolation system shall be located above the finished floor level for ID/PA/FD fans. Basements/pits/trenches shall not be provided for these machine foundations. Stiffness of supporting structure of vibration isolation system (VIS) shall be 10 times that of spring element as per DIN 4024.

The VIS shall be designed for a minimum operating life of 30 years.

3.7.7 Roads

Geometric design of road shall be in accordance with IRC: 73. Road width, curves and parking areas shall have adequate spaces for manoeuvring of vehicles. The ruling gradient for roads in longitudinal direction shall be 1 in 30. Normally the roads shall have much flatter gradient. Transverse camber of 1 in 50 shall be provided for the black topping of roads and a slope of 1 in 40 shall be provided on shoulders. For Plant area finished top of roads shall be 250mm above the surrounding formation level. Main roads shall be designed for movement of heaviest equipment of the plant.

Road shall be designed as Flexible pavement as per IRC: 37 for minimum cumulative traffic 3 msa for all major roads other than patrol roads. However all patrol road shall be designed for cumulative traffic of 1 msa.

California Bearing Ratio (CBR) method shall be followed for the design of roads as per IS: 2720 (Part XVI). CBR test shall be carried out in remoulded soil samples under soak condition.

The roads and pavements shall be constructed as per latest MOST standards.

3.7.8 Culverts

All Pipe and RCC Box culverts shall be designed for IRC Class' AA' loading and shall be checked for class' A' loading. The Equipment moving load shall also be properly considered

3.7.9 Other Miscellaneous Structures

Design criteria for other structures like cooling towers, chimney, ash dyke etc are covered separately under respective systems.

3.8 Codes & Standards

The engineering & execution of all Civil, Structural & Architectural works shall be based on the latest edition or revision of the applicable portion of the following Codes and Specifications. List of some of applicable codes and standards are given in Appendix-A for ready reference.

- (a) BIS Codes of practice
- (b) National building Code
- (c) Environmental protection agency
- (d) Indian Road Congress Standards

- (e) Indian Railway Standards
- (f) Statutory regulations of Tariff Advisory Committee
- (g) Rules & Regulations of local authorities.

In absence of any Indian Codes & Specifications for any portion of work, appropriate American / British /German Standards may be followed subject to prior approval of the Owner. English version copy of all international code and standard to be followed, shall be furnished for Owner's reference.

4 Infrastructures

4.1 Site Levelling

4.1.1 General

Topographical survey has been carried out for 1138.17 acres of land for the proposed plant. .

Based on the topographic survey the total area can be divided into following five zones:

- (a) Cashew garden
- (b) Sand dunes
- (c) Plain land
- (d) Saltpan and low lying area
- (e) Thorny bushes

Topographical survey for the plant area has been carried out. Details of topographical plan and contour plan layout has been shown in drawing no.-253292-HNPCL-TDC-001 & 002.(refer Vol.-III, tender drawings)

Contour levels for plant area are shown in the topographical survey drawing.

4.1.2 Basic Requirements

Formation level of the plant area shall be according to the approved general layout plan. Levelling and grading shall be carried out by selected cutting and filling of existing ground surface and earth. The cutting and filling requirements should balance each other to avoid earth from borrow pits as far as possible. If required borrow earth of approved quality shall be arranged. Similarly in case of any surplus earth suitable disposal of the same shall be made. Different grade levels may be adopted for different areas/blocks considering all functional requirements including top level of Railway siding at its entry point and to facilitate drainage by gravity. Where existing top surface is covered with Sand, top 500mm filling shall be provided with soil suitable for grass and plantation.

Degree of compaction for the filling, in construction area including railway siding shall be 95%, for other open area 90% of standard proctor density and for sand filling 85% of relative density. Desired compaction shall be achieved by suitable type of Roller.

4.1.3 Site Clearance

Before site levelling work, area shall be cleaned by removing existing Cashew plantation, bushes etc including suitable disposal of the same.

4.1.4 General Site Excavation and Fill

General site excavation and fill shall establish a uniform stable working surface in active station areas, provide for positive drainage compatible with natural drainage system around buildings and other structures, and provide adequate soil cover for underground utilities. Before the placement of fill material, the existing sub grade shall be prepared as follows:-

- (a) All vegetation, bushes, organic or otherwise incompetent material shall be removed. The remaining in-situ material shall be compacted to the depth and density determined by the detailed design. Compacted fill material shall consist of specified material obtained from an offsite source if not available within the limits of construction. This material shall be placed and compacted to the density and geometry determined by the detailed design. Slope stability, moisture and density relationship and compaction requirements shall be determined as a result of the geotechnical field and laboratory investigations.
- (b) Earth material shall be removed to the required lines and grades. Any remaining organic or otherwise incompetent material in an excavation shall be removed if so required. The remaining in-situ material shall be graded and compacted to the depth and density determined by the detailed design. Excavated material shall be used as general site fill or embankment fill provided it meets the necessary design requirements.
- (c) The size of the general site fill is defined by its geometrical boundaries. These shall be established in conformity with the arrangement of site facilities and the site design parameters subject to constraints imposed by the interfacing systems.
- (d) The natural soil strata and fill material shall be tested for presence of sulphates and chlorides. In the event high percentages of such compounds are found to be present, required special treatment/coatings shall be provided to the concrete and reinforcement surfaces for foundations and structures below ground for protection against the deterioration during the life-time of such structures.

4.1.5 Backfill

- (a) Structural backfill shall provide stable fill around and adjacent to structure foundations and buried utilities.
- (b) All organic and other existing material which can cause settlements due to soil volume change shall be removed prior to placing the fill material. Backfill shall be placed and compacted to the required limits. The use of heavy equipment or inundation for placing structure backfill shall be prohibited.
- (c) The extent of structure backfill shall be determined by the fill requirements for the various structure foundations.

4.1.6 Slope Protection

- (a) Slope protection shall protect earth slopes from erosion due to storm water runoff and wind damage or other natural phenomena.
- (b) All earth slope surfaces subject to erosion shall be provided with slope protection. Slope protection shall consist of grass cover, grout filled fabric forms riprap, or other effective slope protection methods. The type of slope protection shall be determined by the expected velocities of storm water runoff and any other appropriate factors and shall be subject to the Owner's approval.
- (c) The extent of slope protection shall be defined by the amount of earth surface subject to erosion and the type of erosion present. The material shall be sound, durable, and able to resist the effects of abrasion.

4.2 Boundary Wall & Watch Tower

4.2.1 Boundary Wall

Boundary wall shall be constructed as per approved general layout with MS gates provision at every entry & exit location. Main entry gate adjacent to gate Complex shall be of motorised sliding type.

Boundary wall shall be 3.0 m high above the formation level, in RCC framed construction with RCC columns at every 3.0 m intervals and RCC footings. RCC plinth beam is to be provided below the formation level and brick masonry is to be used for in filled walled panels. Surfaces of the wall shall be provided with cement sand plaster with water proof cement paint finish. Top of the wall is to be provided with RC coping. Over and above 3.0 m height of the wall MS Y-angle post of 0.6 m height is to be provided with Galvanised Concertina. All structural steel members shall be painted with high performance chemical resistant paint as per the specifications. Boundary wall is to be structurally designed for all conditions including wind forces as per IS Code provisions. Expansion Joint shall be provided at a spacing of maximum 30.0m. Due to variation of formation level boundary wall height shall be adjusted at a step of maximum 500mm for each stretch keeping minimum height of boundary wall equal to 3.0m.

4.2.2 Watch Towers

Watch towers shall be provided at the change of alignment of boundary wall and the inter distance not more than 500.0m. It shall have concrete frame structure with in filled brick wall & gazing as per the requirement. Suitable height shall be adopted while finalizing the tower structure with minimum height of observation platform as 6.0m. Roof shall be with proper drainage arrangement. Architectural finishes are to be adopted as per requirement and Owner's approval. Proper approach from the road shall be provided to the watch tower.

4.3 Roads

4.3.1 Basic Requirements

- (a) The roads system shall provide vehicular access throughout the plant area including access to all building and structure etc. The system shall provide access to all building and major activity areas of the site as per approved general layout plan including ash dyke and approach to jetty

In addition, approach road from Yelamanchali-Gajuwaka highway up to plant boundary (approx 10 km distance) shall also be constructed. Detailed route alignment survey for this work shall also be carried out.

- (b) The roads system shall be subjected to heavy vehicles and construction equipment during construction. All roads shall be subject to heavy wheel loads of off-road haul trucks, wheel loaders, and scrapers. Road system shall be designed as per IRC standards. All roads should be provided with adequate camber as per IRC standards.
- (c) The roads shall be divided into four types of roads as follows:
- Main approach road from Yelamanchali-Gajuwaka highway to Plant main entry shall be 2 lanes road having 7.0 m width and 2.5 m wide hard shoulder on both sides.
 - Main plant roads up to Service Building & Ash Silo shall be 10.50 m wide with 2.5 m wide hard shoulder on both sides of roads.

- Independent access to the township from the main approach road shall be provided by a 4 lane road with divider and minimum shoulder width of 1.5 m on each side. Overall width of road shall be minimum 20 m.
 - All other major roads in Plant area shall be 7.0 m wide with 2.5 m wide hard shoulder on both sides of road.
 - All secondary plant roads shall be 3.75 m wide provided with 1.5 m wide hard shoulders on both sides. This shall be applicable for peripheral road along the boundary wall and access to plant auxiliary areas and buildings.
- (d) Secondary access roads within the station complex shall be constructed during the site preparation phase of construction with RCC culvert at road junctions to cater for crossing of drains/cables etc. to avoid major road cuttings at a later date.
- (e) All roads shall be constructed on prepared sub-grade and stone sub-base and base layers of water bound macadam / bitumen macadam as per IRC-19. The sub-grade for the road shall be the natural/prepared ground, which shall be cleared of all loose material, organic matter, grass etc, scarified, rolled and compacted to proctor density of 95%. All the roads shall be topped with Premix carpet followed by Seal Coat. The total thickness and composition of the layers of the pavement shall be provided as per IRC standards. Shoulders shall be of minimum thickness of 150mm of Moorum or water bound macadam.
- (f) Crown of the Road shall be minimum 250mm above the formation level.
- (g) At the time of handing over after completion of project, road shall be repaired including laying of new premix carpet & seal coat wherever required

4.3.2 Road Sub-Grades

- (a) The sub-grades shall provide uniform and stable foundations for the roads.
- (b) Prior to construction of road sub-grades, all existing vegetation, organic or otherwise incompetent material, shall be removed. The remaining in-situ material shall be graded and compacted to the depth and density determined by the detailed design prior to the placement of fill material. During excavation, earth material shall be removed to the required lines and grades, any remaining organic or otherwise incompetent material shall be removed. The remaining in-situ material shall be graded and compacted to the depth and density determined by the detailed design before proceeding with the sub-grade construction.
- (c) Embankment fill material shall consist of specified fill material obtained from excavation at other onsite grading areas, buildings, or roadbeds. This material shall be placed and compacted to the density and geometry determined by the detailed design to provide the strength required and to limit settlements within the allowable limits. Slope stability, moisture and density relationship, and compaction requirements shall be determined based on results of geo-technical field and laboratory investigations.
- (d) Borrow material in excess of that provided by the sources described above shall be obtained from borrow areas or from an offsite source if not available within the limits of construction.
- (e) Sub-grade excavation shall be accomplished in the same manner as for general site excavation.
- (f) The sizing criteria and material selection criteria for road sub-grades shall be as described in general site excavation.

4.4 Culverts

For road / rail crossing of drains, trenches and other facilities Pipe or RCC Box culvert shall be provided as per design requirements as per IRC Standards, IS Standard and Railway norms as applicable.

4.5 Storm Water Drainage System

All storm water drainage shall generally be through open drains however all plant effluent drainage shall be through separate buried concrete pipes unless otherwise specifically required.

Open storm water drains shall be provided on both sides of the roads and shall be designed to drain the road surface as well as all the free and covered areas, etc.,

Open RCC rectangular section shall be provided for all drains. RCC drains located within and along both sides of peripheral roads of the main plant area shall be covered with perforated precast RCC slabs of minimum 75mm thickness with provision of openable galvanised steel grating covers at about 4.0M intervals.

Similarly all artillery drains and the drains along the periphery of building shall also have perforated precast RCC covers of minimum 75 mm thickness with provision of openable galvanised steel grating covers at about 4.0 m intervals. In areas where vehicular loads would be coming, precast RCC covers of suitable thickness without perforations and designed for the vehicular loading shall be provided. The thickness of side walls and bottom slab of RCC drains shall be minimum as per design considerations. RCC box/pre cast RCC pipe culverts shall be provided for road and rail crossing. All drains in the Main Plant area shall be provided with heavy duty galvanised steel grating.

All drains inside the building shall have minimum 40 mm thick grating covers. In areas where heavy equipment/ Vehicular loads would be coming, precast RCC covers shall be provided in place of steel grating.

Invert of the drains shall be decided in such a way that the water can easily be discharged to the natural water bodies above the high tidal / high flood level.

For pipe drains, concrete pipes of class NP3 (Minimum) shall be used. For road and rail crossings concrete pipes of class NP3 with concrete encasement shall be used. The pipes shall be laid as per IS: 783. In this case open catch water drain shall be provided on the other side of road and connected to pipe drain through RCC manholes. RCC manholes shall be provided at every 30m interval along the length, at connection points and at every change of alignment, gradient and diameter of pipeline.

The invert of the in-plant and plant peripheral drains shall be kept such that water can be discharged by gravity to the main/ trunk drains under all conditions.

Hydraulic design & sizing of the Storm water drain shall be done for the maximum hourly rainfall intensity in that area with minimum of 90mm per hour rainfall. Runoff coefficient for estimating the flow shall be considered as 0.9 for built-up areas, paved areas & road surfaces and 0.6 for other (open) areas.

Opening of drain at Boundary Wall location shall be provided with MS grating for security purpose.

A detailed area drainage study shall be carried out through a special agency before finalizing the storm water drainage system for safe disposal of water to nearest water body without affecting the plant or adjacent areas. Terms of reference for area drainage study are given under clause 4.5.1.

4.5.1 Terms of Reference for Area Drainage Study

- (a) Study of available information in the form of reports, literature, satellite imageries etc having a bearing on the storm water drainage plan for plant and adjoining area. The study shall include review of topographical features of the proposed site for the Power Project and its surrounding area.
- (b) Review and analysis of rainfall information to arrive at design storm scenarios and high tide level including tsunami affect.
- (c) Review and analysis of relevant topo sheets, topographic survey and satellite imageries.
- (d) Estimation of flood hydrographs considering historical as well as design rainfall to suggest complete scheme for storm water drainage of adjoining area of the plant including diversion of nallas / stream, if any.
- (e) Estimation and routing of design flood hydrograph through the drainage system of concerned catchments considering appropriate boundary conditions including pre project scenario as well post-project scenario for suggesting Safe Grade Level for the plant.
- (f) Site visit for acquaintance of prevailing conditions and collection of available data at site.
- (g) Liaisoning with all related departments and authorities to comply with their requirements and norms.
- (h) Submission of study report including findings and proposed scheme.

4.6 Rain Water Harvesting

A detailed scheme for rain water harvesting to recharge the ground water aquifer shall be prepared in consultation with Central Ground Water Authority /State Ground Water Board and it is to be implemented for effective operation. This shall include ground water recharging with clean water collected from roof of buildings like Administration Building and collection of clean rain water from other areas in a pond.

4.7 Sewerage System

Discharge from Toilets shall be collected through underground pipe network of sewerage lines which preferably shall be running along the road. Sewer line shall be laid with required slope to attain the self cleaning velocity.

Cement concrete pipes of class NP-3 as per IS: 458 shall be laid below ground as per IS:783, for sewage disposal in all areas other than main plant block. Proper corrosion protection to the pipes shall also be provided as per requirement. For pressure pipes and pipes laid under paving, in main plant block, spun C.I. pipes conforming to IS: 1536 of required class shall be used.

RCC manholes with CI cover shall be provided at every 30m along the length, at connection points, and at every change of alignment, gradient or diameter of a sewer pipeline. Details of manholes shall be as per IS: 4111 (Part-I).

Sewage pump house shall be provided as per IS: 4111 (Part-III) with intermediate lifting and final lifting at Treatment Plant with Vertical Pump having Level Switch arrangement.

Sewage treatment plant is to be provided for minimum 600 users (Industrial). In addition, sewage of minimum 1500 domestic users of township shall be considered. This shall be preferably located in township. This shall have to provide with complete arrangement for sewage disposal up to the Sewage treatment plant including pumping facilities. Extended Aeration method of sewage treatment shall be used and the design shall be as per "Manual on Sewerage and Sewage treatment" (Published by Central Public Health Environmental Engineering Organization, Govt. of India).

Treated water shall be collected in a separate sump with pumping arrangement and shall be used for horticulture purpose.

For buildings having low occupancy/ user level and located in remote/ isolated area, dedicated septic tanks with dispersion trench can be provided for treatment in place of connecting to main sewerage network. Details of Septic Tank shall be as per IS: 2470.

4.8 Temporary Office

The Contractor shall also build at his own cost a suitable temporary site office for Owner at the approved location. Office shall be of single storey Structure steel frame with metal sheet roofing, side cladding and false ceiling. Minimum floor area of the office shall be of 1000 sq.m and shall contain reception area, conference hall, Toilet, Pantry & Office etc.

4.9 Landscaping and Area Development

The landscaping and ground cover system having hard and soft treatment shall enhance the appearance of selected areas, enhance soil and slope stabilization on the generating station, and assist in reducing the noise level and fugitive dust generated by the plant.

Comprehensive landscaping & area development shall be provided included flower bed for seasonal flower, water body and fountains for important area like Gate complex including entry location, Administrative building, Service building and Canteen building.

The landscaping system shall include a routine maintenance program. Expected maintenance for the area shall be as follows:-

- Disease and insect control for plant material and turf.
- Weed control.
- Fertilization.
- Mowing and trimming.
- Pruning.
- Watering.

Landscaping and stabilization of the site should begin after excavation, trenching, backfilling, rough grading, surfacing, and paving have been completed. Slopes of three-to-one (3:1) or steeper shall be stabilized as soon as possible after final grading.

Pathways shall be provided with interlocking paver block in suitable pattern and colour combination.

Landscaping operations shall be confined within areas which have been disturbed by construction activities.

The ground cover areas shall be seeded with native grasses. Establishment of the cover areas shall include preparation of the soil surface, fertilizing, planting, covering and firming the seed to the soil, watering, and maintenance of the disturbed areas. Grasses for the ground cover shall be selected for drought tolerance and low maintenance.

A sufficient water and irrigation system shall be provided to service all landscaping and ground cover.

5 Buildings and Facilities in Main Plant Block

Following structures / buildings / areas / facilities are to be included in the main plant block. The description against each building / system is indicative only and not exhaustive. Although most of the systems are covered here but any other system (Civil, Structural and Architectural) required for successful completion of the project shall form a part of this contract and shall be deemed to be included.

5.1 Turbo Generator Building

This building shall consist of TG hall, heater & deareator bay and control room block. Layout & details shall be as per approved general arrangement drawing.

The turbine hall is clad steel framed structure, which shall house the turbine generator and related equipment. The building consists of an operating floor, mezzanine floors and a ground floor as per layout. The roof is supported by steel trusses. The structure is braced in the direction of the crane travel but provided with suitably designed rigid joints at roof level and framing at other floor levels with the electrical bays in the transverse direction.

E.O.T crane will operate in the turbine hall for handling equipment. For rigging and positioning of the turbo-generator and condensers, building frame shall not be of any hindrance and temporary openings in the building claddings and cladding supporting structures shall be maintained till completion of the rigging and positioning of the condensers.

Within the building, the concrete pedestal for supporting the turbine generators and boiler feed pumps/motors shall be completely isolated from the building floors for vibration control. The foundation for turbo-generator and boiler feed pumps/motors shall rest on suitable vibration isolation system (VIS) consisting of springs and viscodampers. The concrete operating floor shall be designed for construction and maintenance loadings of TG. Hatchways with removable chequered plates or grating floor covers shall provide access to equipment on lower floor and shall be within turbine hall crane access. The intermediate floors shall be of concrete with hatchways, as necessary. All external sides shall generally be clad with permanent colour coated single/double skin non-insulated metal cladding sheet from 3.0m (approx) above ground floor up to roof. Brickwork shall generally be provided all-round from ground floor up to 3.0m (approx) height. Permanently colour coated single skin metal cladding sheet (non insulated) shall be provided over brick wall above 3.0 m (approx) from ground floor only when brick wall is technically required and unavoidable for aesthetical matching. All internal walls shall be of brickwork. Windows, doors, claddings and finishing shall be as laid down elsewhere of this specification.

The roof over Turbine Hall shall be flat with a gentle slope of about 1 in 100 towards the transformer yard. The roofing will be done by cast-in-situ RCC slab over permanently colour coated (on exposed face) galvanized M.S. troughed metal decking of approved profile supported by steel purlins, spanning between two adjacent roof trusses. The minimum thickness of sheet shall be as per the design requirement considering worst load combination subject to a minimum thickness of 0.8 mm. The roof will be provided with membrane water proofing as per architectural specification for making the roof waterproofed. Roof water proofing treatment shall be as specified elsewhere in the specification. Provision shall be kept for entry of natural light by providing extended suitable structures over the roof with side glazing/ permanently colour coated metal cladding sheet.

Electrical and deaerator bay shall be continuous with the Turbine bay on the boiler side. This bay shall house the electrical switchgears, deaerator, heaters, control panels and provides space for major pipe lines and electrical cables. Elevator shall be provided in this bay.

The control room shall be located on the operating floor level. Control room shall be provided with false ceiling, masonry wall with air-lock photo operated sensor sliding doors, flooring and skirting, details of which are given elsewhere of this specification. The roof over deaerator and electrical bay shall be flat with a gentle slope of about 1 in 100 towards the boiler side. The roofing shall be of cast-in-situ RCC slab with or without using metal decking sheet as permanent shuttering.

All floors of turbine hall and deaerator bay shall be cast-in-situ RCC slab over removable shuttering with hatchways as required. RCC slab-on-grade on ground floor shall rest on well-compacted earth and metal fill. Ground floor slab will have drainage trenches covered with steel grating.

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

Expansion gap of 50 mm will be provided at all elevations between RCC floors and roofs of two adjacent units and at expansion joint locations. Steel columns at this location shall be about 1500 mm apart and shall have common foundation.

5.2 Mill & Bunker Building

This building houses coal pulverisers, coalbunkers, tripper conveyors, vibro feeders, ducts and piping. The bunker shall generally be circular in plan, cylindrical at top portion and conical at sloped hopper portion. Bunker shall be designed for storage capacity specified under Mechanical chapter (Volume II, Section B) A comprehensive flow ability study shall be conducted by the Contractor for the coal bunker including hopper to ensure smooth flow of coal in all seasons with different moisture contents, different percentage of fines and requirement of lining. Geometric parameters of hopper shall be decided considering the findings of flowability study. 4mm thick stainless steel plates conforming to AISI 304, Finish Grade 2B (cold rolled, annealed & pickled and skin passed) fitted without allowing any projections in coal flow path shall be provided for full height of hopper. On sides of the bunker necessary openings shall have to be provided for bunker ventilation / dust extraction. Minimum thickness of M.S. skin plate for both conical and cylindrical portion shall be 12mm. Electrodes used for connection of stainless steel plate shall be austenitic stainless steel electrode as follows:

- (a) For welding of stainless steel to stainless steel : E308L
- (b) For welding of stainless steel to mild steel : E309

Preformed open ended bellow straps of neoprene on minimum thickness 2mm and 200mm width with aluminium stripped edges, as a sealing between the top of the bunker and the bottom of tripper floor to avoid the coal dust nuisance shall be provided.

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

The framing shall be of structural steel. This shall be designed as a moment connected framing in the transverse direction and braced in the longitudinal direction. These structures primarily support coalbunkers, coal feeders and tripper arrangement to feed the coal into coal bunker. Supporting structure for mill maintenance arrangement shall be connected to this structure. Handrails shall be provided on all sides of feeder floor. Slit openings are to be provided in Tripper floor for entry of coal from tripper into bunkers. Framing arrangement for structural steel platform at various levels around the bunkers shall be provided, with proper access ladder for poking, striking and attending to air cannons, as required

All floors will be of reinforced concrete with hatchways, as required. Ground floor slab will have drainage trenches covered with steel grating.

Building roof shall be of cast-in-situ RCC. over permanently colour coated (on exposed face) galvanized M.S. troughed metal decking of approved profile supported on steel beams/girders and the sides shall be cladded with permanent colour coated single skin non insulated metal cladding sheet from Tripper floor to roof. The remaining portion of the building below tripper floor up to ground floor shall generally be uncladded. However, brick cladding shall have to be provided, if required, as per applicable and any other statutory requirements. Such brickwork shall be covered with single skin non-insulated metal cladding .Floors shall be of cast-in-situ RCC over removable shuttering.

Stairs and platforms shall be provided as required for maximum utility and safety as per applicable regulations and any other statutory requirements. Stair should be provided from ground up to roof.

5.3 Boiler and ESP Area Civil Work

Boiler and ESP supporting structure shall be of Steel structure frame supported on RCC foundation system. Boiler shall be provided with pre coated metal canopy. Boiler roof / canopy and side sheeting material as required shall be permanently colour coated single skin metal cladding sheet (non insulated). The specification of the sheet including thickness and profile shall be as specified elsewhere in the specification but shall not be less than the required design thickness.

Civil works for boiler elevator shall consists of RCC elevator pit, elevator shaft enclosure with pre coated metal cladding having airtight joints with sealing compound.

Machine room shall be designed as pressurised area with floor and roof of RCC construction and brick masonry walls

Flue gas duct support shall be of steel structure resting on RCC foundation.

RCC trench and steel silo shall also be provided in this area for mill reject system. pipe and cables shall be supported on steel trestle. Entire boiler area shall be paved with hardener concrete flooring except for peripheral area which shall be provided with precast concrete paver blocks.

Miscellaneous underground facility like trenches, drains, sewerage line, earthing mat, small equipment foundations etc shall also be provided as per the requirement.

Other structures & facilities for Coal & Ash handling system shall also be provided in this area as per system requirements.

5.4 Transformer Yard

Generator transformer, station transformer, unit auxiliary transformer and service transformer shall be located in front of the turbine building. Transformers are to be founded on RCC foundations with rails on the top with oil soak pits filled with clean metal aggregate of 40mm nominal size. Burnt oil pits shall be provided to convey leaked oil from the soak pit to the burnt oil pit. RCC fire wall of adequate thickness and height to satisfy applicable regulations shall be provided in between transformer and this shall be painted.

RCC foundations shall be provided with rail to transport transformer out of transformer yard during maintenance. Entire area shall be RCC paved surrounded with 3 m high PVC coated chain link fencing with gates. Where rails cross the fencing, fencing shall be made of removable type to facilitate transport of transformer. Floor shall be sloped towards peripheral drains, which shall lead to a sump from which the drainage is led through an oil water separator.

Foundation for Bus duct support, RCC trenches, RCC drains shall be provided as per requirement. Transformer track shall have rigid RCC foundation connected to unloading bay of TG building to facilitate handling and maintenance.

5.5 Ancillary Buildings

5.5.1 Service Building

This building shall be located close to the turbine building and shall be connected by a covered corridor to the Turbine building at least at the operating floor level.

This building shall be RCC framed structure having a minimum total built up area (sum of all floors) of about 4500 sq.m excluding atrium area. No. of floors shall be decided by the Contractor depending on the space requirement of various facilities proposed to be housed. A minimum of four (4) floors is envisaged. Walls shall be of brickwork. The atrium shall have UV resistant polycarbonate sheet dome cover of suitable shape at roof level.

This building has to provide offices for the office and maintenance staff, laboratories for Control & Instrumentation, relay testing & electrical testing. In addition, reception, conference room, archives, model room, change room with lockers for the O & M workmen, battery room, stores, pantry, air washer room, workshop, first aid centre and separate toilets for ladies and gents have to be provided, Areas such as cabins for senior staff, laboratories, conference room, model rooms etc., are to be air-conditioned by means of central air conditioning system. Clear head room below beams shall be designed to run AC ducts above false ceiling for these air conditioned areas. Level of false ceiling may be kept at 2700 mm in the ground floor and 2400mm in upper floors in these air conditioned areas.

Cabins for senior officers and conference rooms shall have attached toilet. The cabins shall be provided wherever required as directed by the owner

False ceiling including entrance lobby, conference room, office area etc shall be of colour-coated aluminium ceiling system.

Entrance to building shall have glazed aluminium door swing type with double leaf. Glazed aluminium partition shall be provided on either side of entrance door. Internal partition in the building shall be provided with a combination of pre-laminated particleboard and frosted glass in anodized aluminium framework. All doors to the cabins shall be teak veneered flush plywood door. In other utility areas, aluminium glazed or steel flush doors shall be used. Toilet shall be provided with BWP particle board doors. All windows shall be of glazed aluminium sliding types. In areas such as stores, archives etc., located on the ground floor, aluminium grills shall be provided for security.

Two elevators (capacity 13 each) shall be provided at the entrance lobby. Entrance shall be aesthetically decorated with required number of staircases based on statutory regulations. For the staircases in the lobby the treads and dado shall match with the floor finish. Aluminium handrail with stainless steel post shall be provided. At least one staircase shall lead to the roof.

The service building fascia shall have pleasing aesthetic. Landscaping shall be done around the area by developing garden with flowering plants and fountains etc.

Details for finishing requirements are covered separately under architecture and allied works.

5.5.2 Compressor House

This shall be a single storied steel framed building near turbo generator bay. Roof shall be of RCC supported on permanent deck Sheets supported on steel beams. Side cladding shall be with precoated metal profiled sheet. Rolling shutter of adequate size should be provided for taking the equipment inside and truck with compressor. The roof framing shall support an under slung crane of adequate capacity. Compressor foundation shall be isolated from the grade slab. Air receiver and Air drier can be supported from RCC grade slab. All trenches shall be sloped towards drain sumps. Trenches shall be provided with chequered plate cover. Aluminium glazed windows shall be provided for ventilation and natural lighting. A minimum of 2 flush type steel door shall be provided for movement of personnel. Dimension of the building shall be decided as per approved layout and functional & maintenance requirements.

5.5.3 DG Set Building

This shall be a single storied RCC framed structure with electric hoist. The dimension of the building shall be decided as per requirement to suit equipment supplied. D.G set foundation shall be isolated from the floor. Foundation and supporting structure for stack shall also be provided.

Proper acoustic treatment as per requirement shall be provided.

All trenches shall be of RCC and shall be designed as water tightness structure. There shall be no entry of cables / pipes to these trenches below grade level from outside. All these trenches shall be covered with chequered plate over steel framing. Adequate number of sumps shall be provided to drain these trenches.

5.5.4 ESP/VFD Control Room Building

ESP panel control room building shall be RCC framed building with brick walls plastered on both faces, complete as per approved layout. The building shall have a separate air-conditioned area: and a separate non air-conditioned area except as required for the contained equipment. The contractor shall ascertain the building size according to the design requirements.

One elevator of minimum 8 passengers shall be provided as per approved layout. Transformer foundations shall be provided as per requirement.

5.5.5 CPU Regeneration Building

Civil works shall be carried out as per approved layout and details. Requirements for this complex including building with control room, neutralisation pit, tank foundation etc shall be similar to demineralisation (DM) Plant.

5.5.6 Air Washer Room

This shall be a single/double storied steel framed building adjoining to the Turbo generator bay. Roof shall be of RCC supported on permanent deck sheets supported on steel beams. Side cladding shall be by brick supported on concrete encased steel beams. Internal wall surfaces shall receive cement mortar plastering mixed with water proofing compound. Water tank and RCC supporting structures for louvers, filter and foundation for equipment such as fans and pumps shall also be provided. Proper drainage of the floor has to be provided for. Doors shall be of flush welded steel and they shall be made airtight.

5.5.7 Auxiliary Boiler Complex

Civil work for this complex shall include foundation for auxiliary boiler and stack. control room shall be of RCC frame work with in filled brick masonry.

5.5.8 Other Auxiliary Buildings/Facilities

Any other auxiliary building/facility required as per approved final layout and system requirement shall also be provided.

6 Ch chimney

6.1 General

A single twin steel flue reinforced concrete chimney shall be provided. There will be one flue (liner) for each unit. The flue gas emission point shall be minimum 275 m above the plant grade level. The chimney shell (windshield) shall be constructed using slip form shuttering. Liner shall be of structural steel and of hung type with multiple supports and expansion compensator. The liner shall have resin bonded wool type thermal insulation. The liner portion above rooftop shall be constructed from acid & heat resistant bricks. Internal platforms of structural steel shall be provided for enabling access to various elevations of the stack and to support the steel liners. Platforms shall be spaced at a minimum spacing of 45.0m. The platform beams shall rest on bearing blocks made of mild steel with lead/stainless steel bearing strip, supported on concrete shell in the pockets provided for the purpose. Openings in the concrete shell for flue duct entry, access doors at platform levels, access door & truck entry door at the bottom of the chimney, air ventilation etc shall be provided. Hand railing shall be provided all around the external platforms, internal staircase & around the ventilation voids in the internal using min. 32 mm galvanized pipes medium grade of IS:1239/ IS:1161. Spacing of railing posts shall not be more than 1500 mm centre to centre with a minimum height of 1000 mm. The thermally insulated transition duct, supported from bottom, to be connected to horizontal rectangular duct outside the chimney shall be suitably profiled to circular shape inside the chimney through suitable (non-metallic) fluoroelastomeric fabric expansion joints. External platforms shall be of RCC with galvanised pipe handrail. Chimney roof shall be of RCC slab with rainwater drainage system over a grid of structural steel beams. An internal structural steel staircase with chequered plate floor panels and handrails of tubular section shall be provided for full height of the chimney and internal ladder for a small height, over last staircase landing, to access the chimney roof through a roof access hatch. The inside surface of the chimney shell above roof, horizontal surface of the shell at top, underside of roof slab, inside and outside surfaces of mini-shell, top exposed surface of external platforms etc shall be painted with acid & heat resistant black bituminous paint conforming to IS:158 (not less than four coats). Total dry film shall not be less than 150 micron. The entire outside surface of chimney shell shall be painted with alternate bands of signal red and bright white colours, out of which top 50 m shall be painted with acid & heat resistant polyurethane paint and balance of the outside surface shall be painted with synthetic enamel paint. The other components of the chimney include cast iron caps, liner test ports (for continuous pollution monitoring), liner hatches, grade level slab of RCC with metallic hardener floor finish, a large electrically operated grill type rollup door at grade level and personnel access metallic doors at all floors, roof drain basin, rain water down comer pipe (150 mm dia galvanized M.S), connection to plant drains, louvers with bird screens for ventilation openings and all gaps in the wind shield, galvanized mild steel discrete strake embedments, painting of balance chimney shell surfaces and painting/coating of all structural steel works and miscellaneous ferrous components (for a maintenance free life of at least ten years), all finishing works, electrical power distribution boards, lighting panels, power and control cabling and wiring systems, stair and platforms lighting, socket outlet, lightning protection and grounding system, aviation obstruction lighting, communication system, a rack and pinion elevator and other items of work, though not specifically mentioned but reasonably implied and necessary to complete the job in all respects.

6.2 Design Requirements

(a) Design and construction of various components and systems of the chimney shall be in accordance with relevant Indian Standard and where provisions are not covered in IS, reference shall be made to ACI, BS, CICIND and other international standards. In case of any conflict between this document and the Indian and International Standards, the stipulations of this document shall prevail. Imposed loading for design of all chimney components shall not be less than 5 KN/Sq.m Additional 25% of liner load shall be taken as impact loading for liner erection. Deflection of girders shall not exceed span/325. The min. thickness of web for girders carrying the load of steel flues shall be kept as 12 mm Seismic forces on the chimney system shall be as per IS : 1893. Wind forces on the chimney system shall be determined in accordance with IS:875 (relevant part). The chimney and its components shall be designed to resist the most onerous forces resulting from all the possible combinations of the various loadings. Design of all chimney components shall be based on working stress method. Design check by the limit state method may be carried out additionally, if so desired by the supplier and / or asked for by the Owner.

(b) Wind Shield

The windshield shall be designed for vertical loading, cross wind loading, seismic loading, circumferential wind loading, thermal gradients. The various loading combinations shall be as detailed in IS: 4998. The windshield shall be analysed for cases with and without flue liner loads. Forces/stresses in the wind shield due to eccentricity effects of local loadings, insulations effects, rotation of chimney foundations, construction tolerances and moments of second order shall also be considered. Seismic response of the chimney shall be computed by the response spectrum method. The crosswind analysis of the chimney shall be carried out irrespective of the value of the Scruton Number for the chimney and other empirical considerations, which suggest structural immunity to cross wind oscillations. The effect of the openings/cut-outs in the shell wall shall be duly considered in the design of the windshield. The minimum vertical reinforcement shall be 0.3% of the concrete area. The maximum spacing of the reinforcement bars shall not be more than 250 mm on each face. The minimum circumferential reinforcement shall be 0.2% of the concrete area. The circumferential reinforcement in the top 3 meters of the windshield shall be twice that required from design forces. The maximum spacing of the reinforcement bars shall not be more than 200 mm on each face. The clear cover to reinforcement shall be 50 mm. Grade of concrete for chimney shell, and other super structure shall be minimum M 30.

(c) Steel Liners

The flue diameter shall be so sized to ensure that the flue gas exit velocity is of the order of 20-25 m/s at the normal continuous operating load. It should be ensured that the flue gas exit velocity at the lowest continuous unit load is high enough (of the order of 15 m/s) to enable adequate dispersion of the flue gases. For the purpose, 100 percent turbine MCR condition with design coal firing shall be considered as normal continuous operating condition, and 60 percent turbine MCR condition with design coal/ worst coal firing (whichever yields lesser flue gas quantity) shall be considered as the lowest continuous load condition. Two manholes placed diametrically opposite shall also be provided in each flue at all platform levels. The supporting/restraining arrangements of the liners should be such that expansion of the liners longitudinally or circumferentially is not restrained. The liner thickness shall be determined from structural and corrosion potential considerations. However, the minimum thickness of the liner, determined from structural conditions alone shall not be less than 6 mm and the corrosion allowance adopted shall not be less than 4mm. Therefore, minimum installed thickness of the mild steel liners shall not be less than 10 mm.

(d) Gas Sampling Systems

Gas sampling ports for measuring concentration of particulate matters, NOX & SOX in the flue gas etc. shall be supplied & installed as per the approved drawings/ documents. Details of the same specified in the C & I section.

(e) Transition Ducting

The duct work profile and the guide vanes shall be so configured and sized to achieve the desired flue gas flow characteristics and to minimise flue gas pressure losses. The duct work and its supporting structures shall be designed for the most onerous of the possible combinations of gravity loading (accounting for ash accumulation), seismic loading, flue gas pressure loading and thermal loading. Like in the case of steel liners, the minimum thickness of duct plates shall not be less than 10 mm in any case from structural condition and corrosion allowance point of view. Clean-out door shall be provided below the each flue for the removal of ash.

(f) Brick Liners

AR Brick liners shall be provided above the rooftop. The brickwork shall be 115 mm thick and shall be laid with acid resistant mortar of potassium silicate type.

(g) Internal Platforms

The platforms shall be designed for dead, imposed (live), erection work and other possible loadings and temperatures effects. These platforms shall provide support and/or lateral restraint to the steel liners and provide access for inspections and maintenance. Forces imposed on the floors due to lateral restraint of flues shall be enhanced aptly for impact effects. These platforms shall also be designed suitably for the liner erection works.

(h) External Platforms

External Platforms, with a clear walking space of not less than 1000 mm, shall also be provided along the chimney height to match the levels of the internal platforms. Suitable provisions shall be made in the shell for enabling access to the external platform for inspection and maintenance of external surface of the chimney. 32 mm dia galvanized (GI) drainage spouts shall be provided in external platforms for drainage of rainwater.

(i) Internal Staircase

The staircase shall have a clear passage way width of not less than 800 mm. The risers and treads shall not be more than 175 mm and 225 mm respectively.

(j) Foundation

The chimney foundation shall be designed for the most critical combination of forces and moments, resulting from all possible combinations of the various loadings from the chimney system during all stages of constructions. The effect of water table shall be considered and the foundation shall be checked for overturning for minimum and maximum vertical loads. There should be no uplift under any portion of the foundation for any loading condition and as such pile shall not be subjected to any tension. Since chimney is a wind sensitive structure no allowance shall be made in the load carrying capacity of the bearing strata / piles under wind loading. No allowance shall be made in the stresses for design of foundation in seismic loading. The foundation diameter to depth ratio shall be maintained to around 10. Grade of concrete for foundation shall be minimum M 25.

(k) Thermal Insulation

The insulation shall be semi-rigid, resin bonded type, in the form of slabs and shall conform to IS: 8183. Blanket type insulation shall not be used. The density of insulation shall not be less than 64 kg/cu.m for resin bonded glass wool insulation and 100 kg/cu.m for resin bonded rock wool. The insulation thickness shall be determined based on the maximum ambient temperature, surface air velocity worked out based on the draught of ventilation air in the annular space between the flue liner and chimney shell, insulation surface emissivity of 0.3 and the insulation cold face maximum temperature not exceeding 55degreeC. The draught of air in the annular space shall be the natural draught created by the heating of air by the flue liner and the air being vented out through the openings in the chimney shell. The increase in the annulus air temperature due to the rising heated air shall be taken into account

while calculating the insulation thickness. The insulation thickness shall not be less than 100 mm, in any case, and shall be provided in two layers with the second layer of insulation covering the joints of the first layer. The insulation shall be wrapped on the outer-most surface with galvanised wire mesh.

(l) Electrical System

Electrical system shall comply with relevant IS / IEC standards. 415V, normal and emergency AC power supply for chimney shall be derived from main plant power supply system. Emergency supply shall feed 20% of platform lighting, 50% of staircase lighting, aviation obstruction lighting and elevator load. All other loads shall be connected on normal power supply. Ambient temperature for design of all equipment shall be considered as 55°C, which is likely to be encountered inside the chimney. The distribution boards of chimney shall comprise switch fuse units of appropriate ratings. Emergency board shall have two incomers, one from emergency supply and other from normal AC distribution board itself. Auto changeover scheme shall be provided in emergency board to enable changeover to healthy source on failure of any source. Dry type isolating transformer of Dyn connection shall be provided in emergency board to obtain neutral lead, in case 3 phase 3 wire emergency supply is derived from main plant. Various platforms shall be illuminated by 70/150W HPSV well glass lighting fixtures. Staircase lighting shall be with 70W HPSV well glass fixtures. Average illuminations level of 150 lux shall be maintained on equipment and 50 lux on platforms/staircases. Lighting system shall be controlled through MCB provided in lighting panel. A lighting and power panel each shall be located grade level and at other in between levels as required. All distribution boards, aviation lighting controls, etc. shall be located at grade level only. At each platform, 1 No. 63A, 415V welding receptacle and 1 No. 15A, 240V receptacle shall be provided and shall be fed from power panel. Wiring installation for lighting fixture shall be of PVC insulated copper/aluminium wires through galvanised steel conduits. Junction Boxes shall be installed at a specified interval throughout Chimney height. For each platform provision of separate conduit with junction box shall be made. Aviations obstruction lighting system shall conform to the requirements of the latest rules and regulations of the International Civil Aviation Organisation (ICAO), National Airports Authority (NAA) and Directorate of Air Routes and Aerodromes (DARA). The type of aviation obstruction lighting system shall be of high intensity aviation obstruction lights having an effective intensity of 4000 to 2,00,000 cd depending upon back ground illuminance. The aviation obstruction lighting system shall be of type FTB 205 and FTC 110N of Flash Technology Corporation of USA or equivalent. A minimum of three levels will be provided with aviation obstruction lights and there will be four light units per level. The lowest level should not be lower than 75 m above the ground and vertical spacing of the intermediate levels could vary between 75 and 105 m. Aviation obstruction lighting shall be complete with lights, photocell, controller, special cables, etc. A temporary aviation obstruction lighting system shall be provided during construction of the chimney. Cables from distribution board to lighting panels/power panels/receptacles shall be 1100V grade, HR-PVC/XLPE insulated armoured aluminium conductor FRLS PVC sheathed with a minimum size of 4 sq.mm. cables shall be laid on galvanised sheet steel cable trays. Cables shall be terminated using double compression type aluminium cable glands and solderless crimping type tinned copper cable lugs. Lightning protection system shall comprise minimum 3 vertical air terminations for each flue liner, horizontal air terminations and minimum 4 Nos. of down conductors spaced 90 degrees apart routed all along chimney height on external surface and connected to the earthing system. Above ground level earthing and lightning protection system shall comprise galvanised steel strips. These materials provided at top 12 m shall have additional coating of 2 mm thick seamless lead cover and the accessories like nuts, bolts, washers etc. shall be of stainless steel to take care of corrosion. Chimney earthing system shall be interconnected to main plant earthing system. A temporary lightning protection system shall be provided during construction of the chimney till a permanent lightning protection system is installed. Communication system comprising of telephone socket at every internal platform level and at grade level, necessary

wiring installation, a telephone hand set, junction boxes etc. shall also be provided. For various equipment, the technical requirements and practices shall conform to the relevant clauses of the main plant electrical specification.

List of mandatory spares to be supplied by the Contractor along with the bid. Contractor shall also provide technical data of equipment used. Other details as required shall be decided during detailed engineering.

(m) Rack and Pinion Elevator

A rack and pinion elevator, with a load carrying capacity of 400 kg., cabin floor size of Approx. 1100 mm x 1100 mm and an operating speed of 40 m/min., shall be provided for travel from the grade level to the top of the chimney. A landing platform shall be provided at all access/ platform levels. The elevator shall be of a proven and approved make. The lift shall be installed using anchor fasteners. The electrical requirement of the system shall conform to the main electrical specification drive motor shall be of S3 duty class with CDF of 25% and 80 starts per hour. The motor shall be provided with internal 220V AC space heaters or an alternate heating system. The elevator shall be supplied, installed, painted, tested, commissioned etc. complete with all mandatory spares and operation maintenance manual.

7 Coal Handling System

7.1 General

General arrangement, layout and details of different buildings and facilities shall be as per approved scheme for Coal handling system. This shall generally include civil, structural and architectural works related mainly for the areas described in subsequent clauses.

7.2 Wagon Tippler and Underground Tunnel

Hoppers shall be of RCC construction. The pit shall accommodate the hoppers along with feeder and conveyors below. The hopper pit shall be of RCC construction and designed as water retaining structure (basement type). During construction, proper provision shall be made to make the pit completely waterproof. Suitable sump shall be provided in the pit to effect surface water drainage. RCC access shaft shall be provided with staircase to the bottom of the pit. Monorail for taking machinery into the pit shall be provided in the access shaft projecting through two leaf steel sliding door. Plinth level of the pit shall be kept at 500 mm above graded level with RCC sloped paving all round to enable bulldozer movement. Shed above hopper pit shall be of structural steel construction. The columns shall be raised from the four corners of the pit and shall be designed as free standing, supported only by roof framing, to facilitate dozer movement. Roof shall be provided with permanently colour coated galvanized sheeting.

The vertical and inclined portion of coal hopper, the beams and top of coal tray in the track hopper structure shall be provided with 50 mm thick guniting (shotcreting). Complete inside surfaces of Wagon tippler hopper shall also be provided with 50mm thick guniting as per relevant IS: 9013.

Expansion joints shall be provided at a maximum distance of 45m wherever required. 600 mm wide water stop fabricated with 22G copper plate with bitumen board fillers and polysulphide sealing compound as specified elsewhere shall be used as expansion joint material.

Floor shall be provided with cross slope not flatter than 1 in 50 towards side drains. Side drains shall be sloped towards sump where sump pumps as specified elsewhere, shall be provided. The slope of side drains shall not be flatter than 1 in 400. Arrangement shall be made for disposal of water right up to the coal slurry setting tank. Side drains and sump shall have removable type steel grating cover. Gratings shall be galvanized to grade 610 gm/sq. m.

For the water proofing / damp proofing of under ground portion of wagon tippler, tunnels, underground (i.e. basement) portion of transfer houses, Contractor shall propose a comprehensive scheme for the approval. However one suggestive treatment is given below for reference:

- (a) Chemical injection grouting for inner faces as per IS: 6494.
- (b) Polymer modified cementitious coating on earth side face as per the following :
 - On the outer surface of walls, frames and roof slabs coming in contact with earth, polymer modified cementitious coating in two layers as specified and as per manufacturer's specifications shall be provided directly on the concrete surface.

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

Steel gratings of mesh size 350mm square for wagon tippler hopper shall be provided. The grating shall be built of min. 200mm x 28mm thick flats in main direction and min. 100mm x 20mm thick in secondary direction. The hopper and gratings shall be designed for movement of front end loader/ bulldozer over them. Bull-dozer weight shall be considered as about 35T. No painting/galvanization shall be provided in gratings. However, two coats of Red oxide Primer to be provided immediately after fabrication.

Wherever, slope of tunnel exceeds 10 degree, R.C C. steps shall be provided for the entire width of each walkway.

7.3 Overhead / Ground Conveyor Galleries and Trestles

Overhead conveyors shall be located in a suitably enclosed gallery of structural steel. The overhead gallery shall consist of two vertical latticed girders having rigid jointed portal frame at both ends. Cross beams at floor level supporting conveyor stringer beams shall be made of single rolled steel beam or single channel section (ISMB or ISMC) or plate girder. Horizontal bracings are to be provided at top & bottom plan of the gallery (latticed girders shall be braced together in plan at the top and bottom). Common end portal frame shall not be used for adjacent conveyor spans. Roof truss shall be provided at upper node points of latticed girders to form an enclosure. The maximum span of overhead gallery shall be limited to 25 m unless higher span is required due to site conditions, which shall be subject to approval of the Engineer. The gallery should as far as possible be erected as a box section keeping all the vertical and horizontal bracing tied in proper position. The gallery should be checked for all erection stresses that are likely to develop during handling and erection and if required, temporary strengthening of gallery members during erection shall be made.

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

The ground conveyors shall be located in suitably enclosed gallery of structural steel consisting of rigid portal frames spaced at regular intervals and suitably braced. Plinth protection along with drains shall be routed along the ground conveyors.

For double stream conveyor gallery, two side and one central walkway of width 800 mm and 1100 mm respectively shall be provided. The width of two side walkways for single stream conveyor gallery shall be 800 mm and 1100 mm respectively. Both sides of central and side walkways shall be provided with pipe handrails all along the conveyor gallery. Hand railing should not be supported on conveyor supporting stringers. The walkways shall be chequered plate construction with anti - skid arrangement. The anti - skid arrangement will consist of welding of 10 mm square steel bars at a maximum spacing of 500 mm along the length of the gallery. Where the slope of walkway is more than 10 degree, chequered plate steps with nosing and toe guard shall be provided. The floor of conveyor gallery all along the gallery length, shall be provided with minimum 12 gauge thick seal plates and other drainage arrangements.

Conveyor gallery shall have permanently colour coated steel sheet covers on roof and both sides. However in roof, a panel of minimum 1.5 m x 1.5 m area at about 6.0 m centre shall be provided with translucent sheets of polycarbonate material for natural lighting. A continuous slit opening of 500 mm shall be provided on both sides just below the roof sheeting. Adequate provision of windows shall be kept on both sides of conveyor gallery. Windows shall be provided with wire mesh.

Cross - over with chequered plate platform and ladder for crossing over the conveyors shall be provided at approximately every 100 m intervals of conveyor. Crossover shall preferably be located over four-legged rigid trestle location.

For railway tracks passing below overhead conveyor gallery and along conveyors, the railway clearances both underground as well as over ground shall have to be adhered to for design, execution and erection of foundations, trestles, galleries etc., so that movement of locomotives and wagons is not hampered in any way during execution and afterwards. However, at the location where the overhead conveyor gallery crosses road / rail line, minimum clearance of 8.0m above the road crest / rail top shall be provided.

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

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

For trestles and trestle foundations for conveyor galleries located adjacent to existing structures, over ground and under ground facilities, location and details of these trestles and foundations shall have to be decided such that there is no interference both underground as well as over ground with existing structures and facilities. Trestle columns / ground conveyor portal column base shall be kept 300 mm higher than the existing ground level.

7.4 Transfer Houses

The over ground portion of the transfer house shall be framed structure of structural steel work with permanently colour coated profiled steel sheet side cladding and RCC. floors and roof over structural beams. However the lower portion of side cladding for a minimum height of 0.9 m above the finished floor level shall be one brick thick wall plastered on both side. In some areas like MCC floors etc., one brick thick wall cladding shall be provided. Brick wall cladding shall be supported on encased wall beams and suitably anchored to adjoining columns and beams.

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

7.5 Crusher House

The crusher house shall be framed structure of structural steel work with permanently colour coated profiled steel sheet side cladding. However, panels of suitable size to suit the architectural treatment and made of translucent sheets of polycarbonate material shall also be provided on the side cladding for natural lighting. The lower portion of side cladding for a height of minimum 0.9m above the finished floor level shall be of one brick thick wall plastered on both faces. Floors and roof shall be of RCC. supported on steel beams. Within this building cubicles are to be provided for resting room of operators and these shall be constructed with one brick thick brickwork having both sides plastered and roof slab. Roof shall be provided with roof water proofing treatment as specified elsewhere. Adequate doors and windows for natural lighting and ventilation shall be provided. Building shall be provided with a elevator.

Coal Crushers shall be supported on RCC. deck, which in turn will rest on suitable vibration isolation system consisting of springs and dampers. This RCC. deck shall be isolated from the floor. However, the vibration isolation system consisting of springs and dampers may rest on main building framework.

7.6 Stackers- Reclaimer Foundation

Stacker - Reclaimer foundation shall be of RCC. and shall be designed as a continuous wall or R.C.C. framed structures (in longitudinal and transverse direction). Lateral tie beams between two rail supporting elements shall be provided at a regular interval of approx. 3.0 m centre to centre. The foundation shall be designed for the most critical combination of loads as furnished by the equipment supplier. RCC retaining wall on both sides of the S/R foundation shall be provided wherever required.

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

7.7 Control Building and M. C. C. Buildings

These shall be R.C.C. framed structures with columns, beams, slabs and foundations etc. Cladding shall be of brickwork with plastering on both sides. Roof shall be provided with roof water proofing treatment.

All air conditioned areas, shall be provided with the suspended permanently colour coated aluminium false ceiling system.

Adequate aluminium doors and windows shall be provided for natural lighting, ventilation and view.

7.8 Pump Houses

These shall be of RCC. or steel framed structure with columns, beams, slab and foundations etc. cladding shall be of brick work with plastering on both sides. Roof shall be provided with roof water proofing treatment as specified elsewhere. Underground sump and water tanks shall be of RCC. Adequate number of doors, Windows and Rolling Shutters shall be provided.

Galvanized steel ladder / rung ladder shall be provided for access to the roof level of the pump house and water tanks.

7.9 Pent House

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

7.10 Office cum Workshop Building

Minimum built up area for this facility shall be 1000 sq m. This shall be steel frame structure with RCC floor and RCC roof over permanent deck sheeting. Worksop area shall be provided with material handling facilities line EOT / monorail. Office area shall be double storied. In workshop area metal sheet cladding and in office area brick cladding shall be provided.

7.11 Bull Dozer Shed

This shall be steel framed structure with permanently colour coated sheeting with a column free area for bull dozer movement in shed area. Minimum area for this facility shall be 150 sq m. The floor shall be of RCC slab designed for heavy duty loading with granolithic and non-metallic hardener finish.

7.12 Coal Slurry Settling Pond

This shall be of RCC construction. General arrangement and details of the same shall be as per approved scheme and system.

8 Ash Handling System

8.1 General

Civil works for Ash handling system shall consist of dry fly ash collection and wet disposal of bottom & fly ash using sea water as per approved layout according to system requirements. Dry collection of bottom ash for subsequent use shall be provided as an alternative scheme specified under mechanical section and alternative offer shall be made accordingly.

8.2 Structures and Facilities

Ash Handling System shall generally comprise of ash water pump house, ash slurry pump house, compressor house, switch gear / MCC & control room for different buildings, bottom ash slurry pump house, vacuum pump house, steel trestles for supporting Ash slurry piping within plant area and dry fly ash transportation pipe pedestals up to silo, RCC pedestal & thrust block for supporting ash disposal pipes including garlanding on dyke, bottom ash slurry pedestal, fly ash storage silo area including silo & utility building, Miscellaneous work like transformer foundation, fencing, paving. In case of dry collection of bottom ash conveyor supporting structure, foundation for crusher, storage silo etc shall be provided as per the finalised layout and scheme.

All buildings and structures shall generally be RCC framed structures with RCC footings and RCC sump as applicable. All buildings, unless specified otherwise, shall be provided with brick cladding.

Dry fly ash silo storage area shall be provided with the sump for collection of ash water. An office block with minimum area of 50 sq.m and watchman cabin with minimum area of 5 sq.m (minimum) shall also be provided in the ash silo storage area. The minimum clear distance between the bottom of the hopper and the top of the ground floor paving of the silo area shall be 6.0m. The office block shall be provided with toilet facility. Interior and exterior finishes, RCC paving etc. shall be as specified elsewhere in this specification.

Pipelines shall be supported on RCC pedestals having RCC foundations. The top level of the pipe pedestals shall be minimum 300 mm above the formation level. Pipes shall be suitably anchored with RCC pedestals to resist lateral and vertical movement.

For road / rail crossings, pipes shall be laid through RCC Box culverts / steel bridge as required.

Dry ash storage silo area shall be provided with PVC coated chain link fencing along with gates.

9 Fuel Oil Handling System

9.1 General

Details and general arrangement for the fuel oil handling system shall be provided as per approved layout. Civil works shall generally covers the areas described in subsequent clauses

9.2 Unloading / Forwarding Pump House

This shall be single storey RCC frames structure building with brick cladding. A separate maintenance bay and MCC/Control room shall also be provided in the pump house.

Unloading RCC platform with ramp for unloading of adequate numbers of fuel oil tanker shall be provided.

9.3 Pipe / Cable Trestles

For routing fuel oil pipes, four legged trestles and foundations are to be provided for supporting the pipelines/cables at suitable intervals. Crossovers, operating platforms and necessary thrust resisting arrangement at pipe bends shall be provided as required. 750 mm wide platform shall be provided as a walkway along the length of the trestles.

9.4 Dyke Area

RCC dyke wall of minimum 1.2m clear height above formation level shall be constructed around the tanks. Fuel oil steel storage tank and foundation with anti corrosive bitumastic layer below tank shall be provided as per IS: 803.

RCC oil water separator pit shall be provided as per American Petroleum Institute Standard.

10 Water Intake System

10.1 General

Requirement of sea water intake system shall be based either on the closed cycle cooling (using cooling tower) or once through (open cycle) cooling. The Contractor shall adopt and offer any one of the systems based on techno-economic consideration. In case of once through system temperature difference between sea water and discharge water shall not more than 7⁰C as per environmental guidelines. In addition discharge point shall be located at a suitable distance away from the intake location to avoid temperature affect of discharge water. The Contractor shall also indicate, the method / arrangement, he would like to adopt to achieve maximum 7⁰C temperature different in case of once through cooling system.

Sea water intake system shall generally cover the following:

- (a) System study including investigation
- (b) Off shore intake Pump House
- (c) Jetty for approach and routing of above sea water pipes
- (d) On shore Switch gear / control room
- (e) Pipe support for intake and effluent disposal system
- (f) Desilting basin located inside the plant
- (g) Laying of discharge pipe and construction of discharge flume (independent of approach jetty structure) in case of once through cooling system

10.2 System Study

10.2.1 General Requirement

Study shall be carried out for actual sea water requirement in terms of intake as well as effluent discharge, as per system requirement.

Identification of suitable location of the intake structures and pipe corridor shall be made for cooling water requirement of the plant from the sea for the power plants. The scope of work involves the Oceanographic Studies, Geo-Technical and Geophysical Investigations, Environmental Impact Assessment, Design of Water Intake, Conveyance and Disposal System in the Sea. Existing data available with specialised agency can also be utilised to the extent applicable only after the consent from the Owner.

10.2.2 Data Collection in Sea

- Tidal measurements including tidal variation, tidal currents, coastal effects, reflection & resonance, and prediction of tides in the specified zone.
- Study of long shore sediment transport along coast line (Littoral drift) and at the location of intake / discharge structures.

- To measure, collect data and to study the shore and bed materials to identify suitable route for intake and discharge ducts including location of intake and discharge / outfall structure. Investigation shall include Geo-technical investigation of sea bed also.
- Measurements of various parameters of waves including reflection and the wave refraction for the near shore region. The study should cover wave forecasting, wave structure interaction and diffraction if any, including long wave, wave set-up, resonance in harbour basins etc.
- Study regarding the suitability of sea water intake and discharge locations.
- Study of thermal dispersion and identification of suitable warm water discharge location.
- Study of thermal tolerance of species.
- Study of marine EIA, bio-fouling and remedial measures
- Analysis of sea water.
- Corrosion study and remedial measures.
- To measure and collect meteorological data like wind speed, air-temperature & humidity etc.

10.2.3 Engineering Study

(a) Civil System

- Study for location of intake structure considering various aspects such as bed levels, LLWL in sea, wave height etc.
- Study of various possible alternative schemes for the make-up water system. A detailed comparative study of intake well make-up water system with submerged gravity type for sea-water intake system or with other alternative schemes. Study of other possible alternatives. Study for sizing of intake structures.
- Study of type and size of intake duct for make-up water system in the sea portion (in case of water drawl from sea) and in the land portion upto plant area. Study to include detailed Techno-economic study of various options available.
- Study of effect of sea-water on the intake pump house. Study to recommend various civil & structural design, construction and maintenance aspects of the pump house.
- Study of desilting basin including all arrangements required for cleaning and maintenance. Desilting basin shall specifically provide for cleaning of biofouling residue.
- Study of effect of sea water on the cooling water pump house and CW channel at the plant end. Study to recommend all aspects of civil and structural design, construction and maintenance.
- Study of effect of sea water on intake and discharge duct system from cooling water pump house (in the plant area) to condenser and from condenser to cooling towers. Various options regarding the type of material to be used to be studied for optimum duct system including maintenance of the same.
- Study of the effect of sea water on the design and construction aspects of Natural Draught Cooling Towers.
- Study of discharge system from central monitoring basin to the disposal point in the sea. Study to include all aspects for outfall structure in sea or any other suitable location.
- Study shall include the type of discharge structure, sizing, location etc. at the sea. Study shall include type and size of the discharge ducts.

- (b) Study for analysis of hydraulics, biofouling, environmental impact assessment, corrosion, construction and maintenance aspects.
- (c) Study of alternatives in terms of Make-up water intake and disposal schemes and choice of material (with quantity estimate and cost of all the alternatives considered).

10.3 Intake Well

Sea water intake well shall generally be circular in shape of required diameter to house vertical wet pit pumps of required capacity and associated electro chlorination system, switch gear room, travelling water screen, stop log gates and trash racks. The well shall be provided with entry post of adequate numbers and size. For similar type of intake arrangement for a adjacent power project, location of the intake well at nominal distance of around 700 m from sea coast having Chart Datum-CD (-) 10.0m and operating floor at CD (+) 10.0m has been adopted. However, exact details shall be based on the detailed study report. Intake well shall be designed for force and moment due to specified wave height at specified wave period along with storm surge as per findings of the study. Superstructure of Pump house shall be of RCC with brick cladding. Sinking of well below sea bed shall be executed as per the requirements of IRC: 78.

10.4 Approach Jetty

Approach of required length from sea beach to sea water intake well pump house, shall be provided in the open sea, including support for the intake and effluent pipelines. Deck slab of the jetty shall be supported on piles having permanent MS liners. Width of RCC bridge / jetty shall be sufficient to accommodate pipes and single lane road of 3.75 m width.

10.5 Pipe Pedestal

RCC pipe pedestal with thrust block shall be provided for over/under ground intake and disposal pipe from jetty to the plant area as per approved layout and scheme.

10.6 Desilting Chamber

Desilting basin shall be designed and constructed as vertical wall chambers of 2x100 percent capacity with one chamber as standby. Each chamber shall have gated arrangement to isolate it for cleaning and maintenance purpose. Efficiency of the chamber shall be for removal of 90% of particle of size 0.1mm and above. RCC desilting chamber shall be provided inside the plant area as per detailed design and the system requirement.

10.7 Provision for Future Expansion

To facilitate installation of CW pumps of similar capacity and routing of intake pipe for future expansion, additional two numbers of pumps bay in the intake pump house and additional jetty width shall be made during the present stage of the construction. The Contractor shall quote extra cost for this additional civil works separately. However, the Contractor should take prior Owner's approval before start of this additional work.

11 Cooling Water System

11.1 General

Sea water shall be used for condenser cooling purpose and a cooling water (C.W.) pump house for housing cooling water pumps shall be provided. Separate bays shall be provided for each pump by providing intermediate dividing piers of RCC between the pumps as per approved scheme.

- (a) Pump house shall be provided with minimum two sets of stoplogs for the respective pump bay dimensions along with electrically operated hoisting arrangements. Steel embedments required for stoplogs shall be provided for all the bays.
- (b) All bays of pump house shall be provided with a removable trash rack including electrically operated hoisting arrangements and cleaning arrangements. Moreover, one spare trash rack of respective pump bay dimension shall also be supplied for pump house. Steel embedments required for trash racks shall be provided for all the bays.
- (c) Stoplogs, trashracks and hoists shall also be supplied in accordance with the specifications covered elsewhere.

The sub-structure of all pump house including their forebays shall be RCC with M30 grade of concrete conforming to IS: 456. The superstructure of all pump houses shall consist of structural steel frames, side metal sheet cladding and RCC roof over permanent shuttering desk sheets.

C.W. pump house and other pump houses shall be structurally separated from their forebays by providing an expansion joint. All pump houses shall be provided with a separate maintenance bay for maintenance of various equipment and an electrical switchgear room. Length of maintenance bay shall be adequate for one pump maintenance. G.I. Hand-rail with NB 32 mm (medium) pipe shall be provided on the operating floor towards forebay side.

11.2 Model Study

- (a) The dimension of pump bays and forebay for C.W. pump house shall be fixed up initially based on Hydraulic Institute Standard. For concrete volute pumps dimensions and geometry of draft tube shall be furnished by the pump manufacturer. All the dimensions of pump bays, forebays and draft tube (applicable for concrete volute pumps) shall be further confirmed by conducting a Hydraulic Model Study at a recognised hydraulic research laboratory. Scale of the model shall be 1:12. The hydraulic model study shall be conducted to study the flow conditions in the approach C.W. channel, forebay, pump bays, draft tubes (applicable for concrete volute pumps) for different discharges and different depths of water, different combinations of pump operations to study the velocity distribution in approach channel, forebay area, pump bays, draft tube (for concrete volute pumps) etc. The model shall be based on Froude's law of similitude and shall also be tested for the following two more flow conditions viz.:
 - At twice the prototype maximum Froude number, i.e., the Froude number of model is two times that of the prototype.
 - At equal velocity criterion, i.e., the velocity is same both in the model and prototype.

- Recommendations for modification shall be made based on hydraulic model studies for the forebay length, angle of divergence of expansion for forebay, pier length, opening below breast wall, clearances around bell-mouth, draft tube dimensions, additional structural features required, such as flow straighteners, baffle walls, mesh screens, guide vanes, splitter cones, etc. for elimination of non-uniform velocity distribution, swirls and vortices in the model etc.
 - The report of model study shall be submitted for owner approval . The model study shall be carried out in advance, to avoid any delay in the release of construction drawings of pump house, forebay and CW channel. Owner/Owner's Consultant shall be intimated in advance to witness the model test.
- (b) For the pump houses other than C.W. pump house, the dimensions and geometry of forebay and pump house sub-structure shall be decided based on the Hydraulic Institute Standards and the Hydraulic model study for these pump houses shall not be necessary.

11.3 Design of Pump Houses

Design of substructure of the pump houses shall be divided into two parts, namely,

- (a) Stability analysis, and
- (b) Structural analysis and design.

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

11.4 Stability Analysis

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

- (a) Under Operation Stages

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

- (b) Condition (a) + earthquake
- (c) Under Construction Stages

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

- (d) Condition (c) + earthquake

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

- (a) Check for overturning

Factor of safety against overturning, i.e., the ratio of stabilizing moment to overturning moment shall be as per IS: 456. For the above condition, uplift due to maximum Ground water table (GWT) acting on the base slab and side pressures on the walls due to earth and ground water shall be considered as destabilizing forces. In order to have no tension condition at tip of the base slab, resultant of all the forces acting on the pump house under different conditions of loading as listed above shall fall within middle one third of the base width provided. Maximum compressive stress at other end of the base slab shall be within the safe bearing capacity of soil / rock. Under earthquake condition, resultant of all the forces

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

(b) Check for Sliding

Factor of safety against sliding under static condition, i.e. ratio of horizontal frictional resistance to horizontal sliding force shall be as per IS:456. For this condition, earth pressure at rest and the maximum GWT pressure from sides shall be taken as de - stabilizing forces. Keys shall be provided, if found necessary, to increase the factor of safety against sliding. To ensure an adequate factor of safety under earthquake condition, the factor of safety against sliding shall not be less than 1.2.

(c) Check for Uplift

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

11.5 Structural Analysis

11.5.1 Base Slab

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

- (a) Maximum water level in the sumps with maximum GWT.
- (b) No water in the sumps and maximum GWT.
- (c) Alternate bays of sumps filled with water with maximum GWT.
- (d) Same as in (iii) above but with minimum water level.

11.5.2 Intermediate Piers

Intermediate piers shall be designed by working stress method as per IS: 456 (latest), with limiting crack width of 0.1mm for the worst combination of maximum water pressure on one side and no water in the adjacent sump. These shall be designed as RC walls fixed at base and supported (hinged) at top by the deck slab. Since a breast wall may be provided for stop logs and back wall is provided connecting all the piers at the rear end, additional restraints for the pier due to breast walls and back wall may also be accounted for. Intermediate piers are also to be checked for the combined action of direct load due to superstructure and bending due to water pressure from one side.

11.5.3 End Piers

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

- (a) Soil pressure + maximum GWT + surcharge of 2 t / sq.m at FGL from outside or design surcharge load at floor level with no water in the sumps.
- (b) Only maximum water level in the sump.

End piers shall be designed by working stress method as per IS:456 (latest), with limited crack width of 0.1mm on water face and the outside, i.e., earth side shall be designed as cracked section as per IS : 456. Since end piers are fixed at base and supported (hinged) at top by deck slab, there will be negligible yielding of the wall at top. This will give rise to earth pressure at rest and therefore an earth pressure at rest, $K_0 = (1 - \sin \phi)$ is considered where ϕ = angle of internal friction of soil. End piers shall also be checked for the combined action of direct load due to super structure and bending due to earth pressure with surcharge and ground water pressure.

11.5.4 Back Wall

Back walls shall be designed as fixed at bottom of the base slab and on two vertical sides by the piers and supported at top by the deck slab. Since back walls are also of the unyielding type, earth pressure at rest, K_0 , shall be considered for design. Back walls shall be designed by working stress method as per IS:456 (latest), with crack width limited to 0.1 mm on water face and as cracked section on outer face as cracked section as per IS :456. Following load combinations shall be considered:

- (a) Soil pressure + maximum GWT + surcharge of 2 t / sq m at FGL from outside with no water inside the sump.
- (b) Only maximum water level inside the sump.

11.5.5 Operating Floor Slab

Operating floor slab or deck slab shall be designed for loads of the pumps and other equipment, which may be placed on it. A live load of 1.5 t / sq m shall be considered on the deck slab. The deck / slab shall have monolithic construction with the piers and shall be designed as a continuous RC slab supported on piers. Design of bottom face shall be by working stress method as per IS: 456 (latest), with crack width limited to be 0.2 mm. Floor slab of switchgear room and maintenance bay may be designed as slabs on grade. A live load of 3 t /sq.m may be considered for the maintenance bay floor slab. Dynamic analysis shall be carried out to ensure proper separation of natural frequency of the structure and pump operating frequency.

11.6 C.W. Ducts

CW ducts from C.W. pump house up to condensers and from condensers up to cooling towers shall be steel pipe encased in concrete.

Top of C.W. ducts shall be minimum 1.5 m below grade/formation level.

Sand filling shall be provided as back fill, minimum up to the centre of the pipe in case of steel hume pipe. For steel lined concrete encased ducts, selected non expansive material having permissible concentrations of sulphates and chlorides as approved shall be used for back filling and same shall be arranged by the Contractor. Excavated earth can also be used for backfilling, if the same is non-expansive and having permissible concentrations of sulphates and chlorides.

For steel pipes encased in concrete, concrete encasement to steel pipe shall be with minimum 20 grade concrete conforming to IS:456 and shall be minimum 300 mm thick all round for pipes up to 2100 mm diameter and 500 mm all around for pipes having diameter more than 2100mm.

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

- (a) For pipes up to and including 2200 mm dia - 12 mm
- (b) For pipes above 2200 mm up to and including 3200 mm dia - 14 mm
- (c) For pipes greater than 3200 - 16 mm

Maximum velocity of water in ducts shall not exceed 2.2 m / s.

Required number of stub connections shall be provided to fix air release valves. Flow measurement devices as required shall also be provided. As required ducts shall be tested for leak proof up to a pressure up to 1.5 times the normal operating pressure. Pressure tests shall be conducted in segments after laying.

The CW duct crossing Road or Railway line, RCC encasement with M25 grade shall be provided with suitable increase in liner thickness.

All additional measures as necessary for protection against corrosion of C.W. pipes and to take care of any adverse soil characteristics shall be provided.

All duct installation & jointing shall be strictly in accordance with the stipulation given in the specification. All the joints of liners shall be butt welded joints. All field joints shall be tested for 100% radiography. The circular deformation of liner shall be less than 1% of diameter of liner while handling, transportation, erection & construction. If required, temporary bracings may be provided, during handling, transportation & concreting to reduce the deformation.

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

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

Manholes shall be provided in the duct to facilitate maintenance / dewatering of CW duct, at centre-to-centre spacing of 150m (max.) both in intake & discharge ducts. At least one manhole shall be provided at the deepest point for both intake & discharge duct.

11.7 CW Channel

The channel shall be of RCC section with wall projecting minimum 500mm above finished ground level. GI Handrails with NB 32 mm (medium) pipe shall be provided on both walls of the channel where height of channel wall is less than 1200 mm above finished ground level. The channel cross section near cooling tower shall match the cross section details of outlet channel from cooling tower. An expansion joint with PVC water stop shall be provided in the outlet channel from cooling tower.

Each CT discharge channel shall be designed to carry the maximum water discharge with a provision of 10% margin with minimum water level in cooling tower basin and considering minimum value of rugosity coefficient (n) of 0.018 for concrete surface. The CW channel (on down stream of intersection of CT discharge channels from cooling towers) shall be designed to carry discharge of all the CT's, in addition to make-up water quantity.

The channel shall be designed with (i) no water inside the channel, with earth pressure of soil up to FGL, ground water table up to FGL and surcharge load of 2.0 t / sq m from out side, and (ii) with water inside the channel up to maximum level in the forebay / channel and no earth pressure, ground water pressure and surcharge load from outside. The channel shall be checked against uplift due to 50% of the total water head considering ground water table up to FGL. In addition pressure release valves (flap valves) with under drainage arrangement in the channel shall be provided to prevent uplift of the channel as per relevant IS Codes. Minimum wall thickness shall be 200 mm. Suitable contraction, construction and expansion joints at regular intervals shall be provided in the channel as per relevant Indian or International standards. Expansion, contraction and construction joints shall be provided in the channel as per relevant IS Codes.

11.8 Forebay Structure

Forebay consists of retaining wall and forebay slab. The walls shall be analysed as a cantilever wall for stability against overturning and sliding, similar to end piers of the pump house. Pressure release valves (flap valves) and under drainage arrangements shall be provided below the forebay slab to prevent uplift of the forebay slab. Size and spacing of pressure release valves shall be designed by the Contractor to take care of the uplift due to ground water table. Minimum thickness of wall at top shall be 200 mm.. Handrails with NB 32 mm (medium) pipe shall be provided on both walls of the forebay.

11.9 Stoplogs and Trash Racks

The stoplog units shall be operated under balanced head and they shall be designed for maximum water head to which they shall be subjected to. The stoplog shall be used only for the maintenance/ inspection of pumps. These are not to be designed for lowering under flowing water. The stoplog shall be operated by means of a monorail trolley with electric rope hoist and a lifting beam which shall engage and disengage automatically with stoplog in required position. Lifting beams shall be designed and fabricated by the Contractor in coordination with the manufacturer of monorail with electric hoist. The structural design of stoplog shall conform to IS: 5620.

Trash racks shall be installed in inclined position. Trash racks shall be designed for a differential head of 1m of water column. Each unit of trash rack shall consist of vertical flats and horizontal flats of minimum 10 mm thickness from durability point of view. Size of the openings for the trash racks shall be 50 mm x 50 mm (clear). All trash racks should be capable of being lowered in the associated stoplog grooves to enable drawl of clean water while a particular trash rack is raised for cleaning purposes. Details of block-outs to be provided in structural concrete for stoplogs and trash racks shall also be shown on the drawings. The structural design of trash rack shall conform to IS: 11388.

Contractor shall conduct all tests according to relevant I.S. or according to relevant British/ American Code of Practice.

Tests on motors shall be conducted as per IS: 325 and IS: 4029. Tolerance in dimensions shall be within the limits as prescribed in the relevant I.S. Codes and Standards. Surface defects shall be removed as required by the relevant Standards. All local repairs, grinding or machining shall be smoothly blended into the surrounding surface.

All exposed surfaces of hoists, gear housing, shafting bearing pedestals, base plates and other machinery for stop log & trashrack shall be fully galvanised.

The Contractor shall furnish to the Owner a complete and unused set of all special tools and tackles, which are necessary, or convenient for erection, commissioning, maintenance and overhauling of any of the equipment provided under the specification. The tools shall be shipped or transported in separate containers clearly marked with the name of equipment for which they are intended.

Materials for the various components of Stop logs:

Table 11.1: Components of Stoplogs

Sl. No.	Component Parts	Recommended materials	Reference
1	Stoplog/Gate Leaf Stoplogs/Gate frames and embedded parts, Guide Shoe.	Structural Steel	IS: 2062
2	Wheels (the hardness of wheel track surface shall be kept 50 points higher than that of wheel tread), Guide.	Cast steel	IS: 1030
3	Wheel axles,	Steel	IS-1570
4	Seals	Rubber	IS: 5620 Appendix-D
5	Bearings	SKF or equivalent	04 Cr 19 Ni
6	Seal seats, Lifting Pin	Stainless Steel	IS: 1570

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 gm/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.

11.10 Chlorination Building

This shall be single storey building with RCC framed structure with in-filled Brick masonry. This shall be located near CW Pump House.

12 Sweet water System

12.1 Water Reservoir

The capacity of the sweet water reservoir shall be for minimum 21 days requirements. Shape, size and detail of the same shall be as per approved drawings. The reservoir shall be provided with a free board as per requirements of IS: 10635, but in no case, the same shall not be less than 1000 mm. The reservoir shall have two compartments with separate inlet and outlet arrangement. The reservoir embankment shall be made in earthwork with side slopes 1V : 2H (minimum). The reservoir embankment shall be designed and constructed as an earthen dyke founded on natural ground with proper foundation. The entire area, top soil shall be increased to the required level as per actual conditions to totally removal of all vegetation, organic matters, roots, soft spots etc.

Required slush removal sump, provision for deep sump shall be provided in the pumping suction to ensure the pumping head. Also, a suitable spillway arrangement shall be provided to take care of any heavy storm event. The bund shall have adequate width on top to form the road for vehicle movement with minimum width as 4.0 m. WBM road shall be constructed as per IRC:19. On the down stream slope of the embankment, turfing shall be provided with a provision of Toe drain.

The bund shall be of homogeneous type with impervious geo-membrane (HDPE 750 micron thick) layer on water contain face including base. 150 mm thick sand blanket is recommended below the geo-membrane bottom as a cushion. The reservoir shall be provided with 50 mm thick precast concrete tiles of M20 grade concrete over HDPE film / sand planked lining. The protective layer over HDPE shall be provided over entire bed and side slopes.

Material to be used for bund construction shall be as per IS: 1498. Top layer of reservoir basin sub grade shall be compacted to at least 95% of Standard Proctor density by vibro compaction equipment or by any other suitable equipment.

12.2 Pump House

This shall consist of pump house with fore bay located adjacent to the reservoir. Details for pump house shall be similar to cooling water pump House except that sweet water shall be used in place of sea water.

12.3 Water Duct

In case steel lined concrete encased duct is used for pumping sweet water to water treatment plant, it shall be similar to cooling water duct of required size, except that sweet water shall be used in place of sea water.

12.4 Intake Water Pipe

Civil works for routine of intake pipe from tapping point (outside plant boundary) upto water reservoir shall be carried out as per approved layout and details.

13 Natural Draught Cooling Tower

13.1 General

Sea water shall be used for cooling purpose. Special precaution for corrosion protection including marine bio-fouling and other special provision shall be provided in addition to the detail mention in the subsequent clauses.

13.2 Design Criteria

The complete analysis and design of natural draught cooling towers consisting of structural analysis and design shall be carried out by a reputed associate/agency and approval shall be obtained from the Owner as specified under volume-I clause 1.5.2.

The loads as mention in the subsequent clauses shall be considered for the design of cooling towers.

13.2.1 Dead Load

For assessing the self-weight of the structure, the unit weight of the concrete shall be taken as 2500 kg/cu.m. All other dead loads shall be assessed in accordance with relevant codal provision. Dead load shall include the self weight of structure, weight of fill material, weight due to algae growth, weight of falling water, weight of hot water pipe, weight of water in hot water channel and distribution system including the self weight of channel and distribution system, weight of drift eliminators, etc. Secondary stresses, if any, due to permanent fixtures on the shell shall also be considered.

13.2.2 Wind Pressure

The wind pressure on the towers shall be assessed on theoretical basis as well as with the help of Model tests in a wind tunnel of turbulent boundary layer. All the theoretical methods outlined hereunder for estimating wind loads on cooling tower shell shall be valid only if the towers spaced at clear distance of greater than 0.5 times the base diameter at the finished graded ground level. The theoretical method outlined herein forms the basis only for assessing lowest limit of wind forces and shell structure interaction.

For conducting Model tests, Contractor should survey the whole terrain and make their own assessment of likely critical wind forces & wind-structure interaction. It would be the responsibility of the Contractor to collect necessary meteorological data duly vetted from the recognized govt. agencies/ institutions. After collection of necessary meteorological data, most critical wind speed, wind pressure distribution and other necessary parameters shall be determined by the Contractor and got vetted by the above agency/appropriate agency(s). Then with the help of physical model tests in a wind tunnel, offering appropriate aerodynamic similitude, the bidder shall obtain the most critical forces, stresses etc. for the cooling tower at various levels and locations. Such model tests shall also include all adjacent topographical features, buildings and other structures, which are likely to influence the wind load pattern on the tower significantly. The model test shall be carried out in a well-reputed institute/testing laboratory after obtaining prior approval from the Owner. The testing agency selected by the Contractor shall have requisite experience and should have successfully carried out tests in the past for at least one cooling tower of similar capacity. The model tests shall be duly witnessed and approved by the Engineer. The model test results shall be made available before final approval of the design.

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

Under the theoretical method, the circumferential net - wind-pressure distribution and wind pressure coefficient (p) for the tower shell (without meridional ribs) shall be obtained from the "Criteria for Structural design of Reinforced concrete Natural Draft Cooling Towers" IS: 11504. The above circumferential wind pressure coefficient (p_1) shall be increased by multiplying it by 1.43 to account for turbulence in the incident wind and load intensification due to turbulence induced by the adjacent cooling tower or the other structures of significant dimensions. Therefore, the actual design circumferential net wind pressure coefficient (p) shall be computed as $p = 1.43 (p_1)$, where (p_1) is the wind pressure coefficient as per IS: 11504.

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

In order to compute the quasi-static design wind pressure at a given height along the circumference of the tower, the net design pressure coefficient (p) shall be multiplied by the wind pressure acting at that height [$P(z)$].

The wind pressure at a given height [$P(z)$] shall be computed as per the stipulations of IS:875 (part3). For computing the design wind pressure at a given height the basic wind speed (V_b) shall be taken as $V_b = 50$ m/s at 10.0 m height above mean ground level. For computing design wind speed (V_z) at a height z , the risk coefficient $K_1=1.2$ shall be considered. For coefficient K_2 , Terrain category 2 and class 'c' as per IS-875 (Part-3) shall be considered. Coefficient K_3 shall be determined by taking into account the local topography and tall plant structures in the vicinity. The wind direction for design purposes shall be the one, which would induce worst load conditions. However, Coefficient K_3 shall not be less than one under any circumstances. The wind pressure at a given height shall be computed theoretically in accordance to the IS Codal provision.

The Contractor shall also compute the wind pressure (p_z) along the wind direction by Gust Factor (GF) or Gust effective factor method (GEF). Method for estimating the wind load on the tower and other elements shall be based on IS-875 (part-3). While calculating the gust factor, the term 'b' shall be taken as the diameter of the throat in Fig. 10 of IS:875 (Part-3). Dynamic effects on the tower due to wind action shall also be investigated to ascertain the wind-induced oscillation such as ovaling and excitation along and across the wind direction. Contractor shall carry out detailed analysis for the tower and consider the worst combination of static and dynamic effects.

Design of the tower shall satisfy quasi-static method & GEF method. In case the bidder proposes to adopt aerodynamic rough surface such as provision of meridional ribs in the cooling tower shell, the pressure coefficients as given in the VGB-BTR KUHLTUMRE GERMAN SPECIFICATIONS (latest) (structural design of cooling towers) shall be permitted. The provisions of the above standard may be adopted for choosing the value of circumferential wind pressure coefficient (p_1) only. The wind pressure coefficient (p_1), as obtained from BTR after accounting for internal suction, shall be multiplied by a factor 1.43 to arrive at the net design pressure coefficient (p). The bidder shall furnish authorized English Translation of VGB-BTR KUHLTURME GERMAN SPECIFICATIONS for the review of the Owner. All other stipulations as specified in these specifications shall be met with.

Entire analysis and designs adopted shall be fully supported with authenticated literatures/documents along with relevant references where the same has been successfully implemented. The wind load as specified in clause above shall be the minimum loading to be considered for analysis and design. However, bidder shall also carry out the entire analysis and design on the basis of BS: 4485 for smooth shell surface and BTR (latest) in case of ribbed shell surface. The design of entire tower including foundation shall be checked as per BS: 4485/BTR as the case may be.

The final design shall be based on the worst case situation i.e. each element including foundation of the tower shall be designed on the basis of highest loading/ stresses computed as per above. However, the basis of wind speed shall be as per clause above.

Model test shall be carried out for Cooling Tower if height is more than 120 m or base diameter is more than 100 m as per IS: 11504.

13.2.3 Earthquake Forces

The seismic analysis shall be carried out in accordance with IS: 1893 by modal analysis for the hyperbolic cooling towers or any other method as approved by the owner. The earthquake analysis of the shell and its support columns including the foundations shall be carried out by response spectrum method. For the fill supporting structures (RCC frames) response spectrum method is permitted.

The modulus of elasticity for concrete shall be obtained from IS: 456. All the analysis shall be carried out as per the theory of elasticity. Entire analysis and designs adopted shall be fully supported with authenticated literatures/documents along with relevant references where the same has been successfully implemented.

13.2.4 Loads Due To Temperature Effects

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

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

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

13.2.5 Constructi onal Loadings

The method of construction and the type of formwork to be used shall be decided by the Contractor in advance. Construction loadings that may occur during execution of work shall be considered in the design of the cooling tower structure.

Factors causing temporary loading may include the following depending upon the method of construction.

- (a) Transportation of concrete
- (b) Scaffolding and formwork
- (c) Loads produced by anchoring devices of climbing scaffolds.
- (d) Hoist fixings
- (e) Storage of materials on scaffolding
- (f) Temporary access
- (g) Tower Crane fixings
- (h) Works temporarily omitted for access purposes.

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

13.2.6 Any Other Load Such as Foundation Settlement

All loads likely to act on cooling tower but not specified herein shall also be considered for the design of cooling tower structures. In case different degrees of subsoil stiffness exist, effect of the same shall be taken into account. In such a case, for computing settlements, load-distributing capacity of the shell may be considered. Differential settlement between adjacent sections of foundation shall be considered under most unfavourable load combination.

13.2.7 Load Combinations

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

- (a) $DL + WL + SL$
- (b) $DL + Se L$
- (c) $DL + TL$
- (d) $DL + WL + TL + SL$
- (e) $DL + Se L + TL + SL$
- (f) $1.0 DL + 1.5 WL$

Where $DL =$ Dead Load,

$WL =$ Wind load,

$SL =$ Settlement Load,

$Se L =$ Seismic Load,

$TL =$ Thermal Load.

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

13.2.8 Permissible Stresses

For load combination (a) to (e), the basis for design of all RCC structures shall be Working Stress Method of design as outlined in IS: 456.

Design of structures such as staircase etc. which are not in contact with water / water spray / moist air shall be carried out adopting material stresses as given in IS: 456. However, design of structures like shell, columns, beams, fins, walkways, slabs, etc. which are in contact with water / water spray / moist air, shall be carried out adopting concrete stresses as given in IS : 456 & limiting the stresses in reinforcement to the values as given in IS : 3370 and the crack width shall not exceed 0.1 mm in tensile zone.

CW Basin wall, sump, column foundations, outlet channel, duct, sludge pit, Hot water distribution basin / Hot water Channel shall be designed as uncracked section as per IS : 3370 (Part - I to IV). The allowable stresses for concrete and steel shall be as per IS: 3370 (Part - I to IV).

For the load case (f) the shell of cooling towers shall be designed by limit state method as per IS:456. The stress in the reinforcement steel shall not exceed 87% of the specific characteristic strength of reinforcement steel and the compressive stress in the concrete shall not exceed 45 % of the specified 28 days cube strength of the concrete as per IS: 456.

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

Permissible stress for steel structures shall be as per IS: 800.

13.3 Tower Design Consideration

13.3.1 General

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

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

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

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

Boundary conditions shall be realistic and based on actual configuration. The magnitude of the calculated displacements should be within limits of the applied theory.

A detailed dynamic analysis shall be carried out for the complete tower for seismic forces by response spectrum method. Cooling tower shall also be designed for cross wind oscillations (Wind induced vibration) if the fundamental natural frequency of the tower is less than or equal to 1 Hz. Frequency calculation for free vibration analysis shall also be furnished during detailed engineering.

13.3.2 Size and Shape

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

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

$$H/D=1.2 \text{ to } 1.55$$

Where H is the total tower height above basin sill level

$$H_b/H = 0.75 \text{ to } 0.85$$

H_b is the vertical distance from the throat to basin sill level and 'D' is the base diameter at basin sill level.

However, other proven profiles may be permitted subject to approval from the Owner. Contractor shall submit complete details of the profile, in case the profile is not within the limits stated above, and the names of the sites where such shell profiles have been successfully constructed. Notwithstanding what is stated above, the Owner reserves the right to accept /reject the shell profile.

13.4 Tower Shell Boundary conditions

13.4.1 Shell Analysis and Design

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

(a) At upper Edge

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

(b) At Lower Edge

The lower edge of the shell shall be thickened to form a lower ring beam. The thickness transition from shell to lower ring beam shall be smooth and shall be considered as an integral part of the shell. The lower boundary of the shell shall be considered as elastically supported by discrete columns. The influence of both support structure flexibility and foundation settlement shall be considered in the analysis and design of cooling tower shell. The shell analysis should include following information at every 10° plan angle and at not more than 0.05 of the shell height interval:

- Meridional and circumferential direct stress resultants and the tangential shear stress resultants.
- Meridional and circumferential bending moments.
- Displacements normal to the shell mid-surface.

13.4.2 Buckling of Tower shells

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

$$P_{cr} = 0.07 E_c (d)^{7/3} r^{th}$$

Where, P_{cr} = Critical dynamic pressure.

E_c = Modulus of elasticity of concrete of the shell (short term modulus)

d = Thickness of the shell

r^{th} = Throat radius of the shell

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

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

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

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

13.4.3 Openings in Shells:

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

Openings shall be provided with additional edge reinforcement of a minimum cross sectional area at each edge equal to 75% of the reinforcement intercepted by the openings in the direction parallel to the edges. In addition, diagonal reinforcement shall be provided at each corner as close as possible.

The total cross-sectional area in sq.cm of this reinforcement shall be $0.5 d$, at each corner where 'd' is the shell thickness in cm.

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

13.4.4 Minimum Thickness of Shell:

The minimum thickness of the shell shall not be less than 200 mm.

13.4.5 Minimum Reinforcement in Shell, Spacing and Placement:

The Minimum reinforcement to be provided shall be as follows:

Top one-third portion of shell 0.4% of concrete cross - sectional area along circumferential direction and 0.35 % of concrete cross sectional area along meridional direction.

Remaining two-third portion 0.35% of concrete cross-sectional area in both of shell meridional and circumferential directions.

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

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

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

The concrete cover shall be 50 mm minimum. However, the clear cover shall not be less than 1.5 dia of bars.

The relevant provisions of IS: 2210 and IS:2204 shall also be deemed to be applicable. All other design criteria for the cooling tower shell which are not specified above shall be in accordance with BS:4485 (Part 4) and BTR.

13.4.6 Provision of Meridional Ribs in Cooling Tower Shell

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

- (a) Minimum thickness of shell excluding ribs shall not be less than 200 mm.
- (b) Co-efficient for pressure distribution around the cooling tower circumference including suction may be taken as per VGB-BTR KUCHLTURMEN GERMAN SPECIFICATIONS. All other factors including load intensification factors shall be as specified else where in these specifications.
- (c) Shell buckling and strength shall be checked as per clause-b above without considering the effect of ribs.
- (d) All other stipulations as specified in this specification shall be met with.
- (e) Contractor shall furnish an authorized English translation of the VGB-BTR KUHLTURME GERMAN SPECIFICATIONS.

13.5 Raker Columns

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

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

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

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

13.6 Prestressed Concrete Members

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

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

13.7 Liquid Retaining Structures

- (a) The cold water basin including sludge pits, cold water channels, shall be designed for the following condition:
 - Water filled inside up to maximum level and no earth outside.
 - Earth pressure with surcharge load of 2.5 t/sq m, as applicable, and with/ without ground water table at final graded ground level outside and no water inside.

- (b) The basin and associated structure shall be checked against uplift for basin empty condition. Stability shall be checked during construction stage as well as maintenance stage. The factor of safety shall be as per IS:3370.
- (c) Loads during construction, erection and maintenance stage shall also be considered.
- (d) Temperature fluctuations from operation shall be obtained from the design data. Hot water temperature inside and cold air temperature outside shall be considered.
- (e) Minimum thickness of basin slab shall be 300 mm with minimum reinforcement 0.35 % of gross sectional area in both the directions. Reinforcement shall be placed in two layers, top and bottom surface.
- (f) The effect of provision of flap valves/pressure release valves shall not be considered in the design of C.W. basin.
- (g) In the space underneath the basin floor slab a layer of at least 100 mm thick P.C.C. of concrete grade M10 shall be provided.

13.8 Water Distribution System

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

- (a) Self weight, other imposed loads/live load.
- (b) Hydraulic pressures during normal operations including pressure surges.
- (c) Hydraulic pressure due to mal-operation of the tower or supply pumps.

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

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

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

The design shall be carried out based on uncracked section as per IS-3370 under normal operating conditions. Strength check for worst loading including malfunctioning shall be carried out with stress limitations as per IS :3370.

The construction shall be completely water tight without the use of fillets, sealing compounds etc. The method of construction shall be such so as to avoid excessive rise in temperature of concrete due to release of heat of hydration.

13.9 Platforms, Walkways, Stairways, Staircases, Internal Grillage, Etc.

They shall be designed as per working stress method IS:456 and IS:800. A minimum live load of 400 kg/sq m shall be considered for the design of all platforms, walkways, staircases, etc. in addition to their own weight.

13.10 Steel Structures

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

Stoplogs shall be designed for worst combination of operating and maintenance condition. All steel However, all side guides and second stage embedment shall be of stainless steel of grade AISI 304.

13.11 Foundations

The design of the tower foundation structures shall be based on IS: 456 as per working stress method for worst load combination.

In case of load combination DL+1.5 WL, the limit state method as per IS: 456 shall be adopted.

Foundation shall be checked for safety against overturning, sliding and uplift.

While checking stability of the structure, favourably acting loads from water fill, soil cover beyond the edge of the foundation shall be neglected. High ground water level up to final graded ground level shall be considered to take into account buoyancy effect.

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

While accounting for over burden of the soil for checking the foundation against up-lift, dead weight of the soil directly above the pile cap or ring raft, as the case may be, shall only be considered, neglecting the weight of soil in the cone of up-lift above the foundation.

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

- (a) Most critical forces transferred from superstructure for the various load combinations.
- (b) Loading due to foundation settlement.
- (c) Concentrated local loading from column nodes.
- (d) Thermally induced local loading where hot water ducts pass through the foundation structure without structural isolation.
- (e) Surcharge of 2.5 t/sq m.

C.W. basin surcharge load shall also be considered in addition to the other relevant loads for the design.

13.12 Fill Support Structures

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

Live load of 250 kg/sq m on the walkways and platforms shall be considered.

Hand railings shall be designed for horizontal load of 60 kg/m.

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

The cold water basin slab/raft shall form the common foundation for the pack support structures.

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

13.13 Requirements for Construction Material

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

Durability of the concrete shall conform to very severe exposure category as per table 3 of IS: 456 except noted specifically otherwise.

Reinforcement shall conform to grade Fe 415/500 as per IS: 1786 except noted otherwise. All reinforcements used in RCC structures shall be thermo mechanically treated (TMT) type.

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

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

The minimum grade of concrete for structural works of cooling towers shall be as follows in accordance with IS: 456 :

- (a) Precast pre-stressed elements - M-40 grade
- (b) Entire tower shell, columns and basin - M-35 grade
- (c) PCC encasement - M-20 grade (Except levelling course)
- (d) Mud Mat PCC - M-10 grade
- (e) Piles/Tower foundation - M-25 grade
- (f) All other RCC elements - M-30 grade

Coarse and fine aggregates shall be specially selected to ensure that they are not susceptible to alkali/chloride attack or prone to disintegration at high temperatures. In particular limestone aggregates shall never be used. The maximum size of coarse aggregate shall not be larger than 1/8th narrowest dimension between reinforcement bars nor more than 20 mm.

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

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

Admixtures shall be used in accordance with relevant IS codes to modify the rate of hardening or setting, to improve workability or as an aid to control concrete quality. Particular attention must be given to concrete placement because of the thin wall section and the presence of reinforcing steel. Consolidation of concrete shall be by vibration. Removal of air and water at the form surface shall be by vibration and roding. Particular attention shall be paid to accurately shape the corners at all openings.

Point of discharge of the concrete in to the forms is 1500 mm above the concrete surface. Concrete shall be deposited in approximately level layers not greater than 400 mm deep unless permitted otherwise.

Concrete in the cooling tower shell in each lift shall be so laid that the number of vertical or inclined construction joints are minimized to the extent possible.

Horizontal construction joints shall be maintained at uniform spacing throughout the height of the cooling tower as per the directions of the Engineer.

Special attention shall be paid to proper curing of vertical faces of the cooling tower shell so that these do not remain dry. All thin walled structural members shall be protected by means of curing agents. It is recommended to use a curing agent for the cooling tower shell providing additional protection like a single transparent cooling with a material based on vinyl mixed polymer.

Sampling and testing of concrete shall be carried out as per quality assurance program.

However, following minimum tests shall be carried out for compressive strength

- Columns - 1 cube per column
- Shell - 2 cubes per climbing section.

13.14 Cover to Reinforcement

Unless indicated otherwise on the clear concrete cover for reinforcement shall be as per IS 456 for durability requirements specified for very severe exposure condition.

The correct cover shall be maintained by cement mortar cubes or other approved means, Reinforcement for footings/pile caps, grade beam, and slabs on subgrade shall be supported on precast concrete cover block as approved by Engineer. The use of pebbles or stones as cover blocks shall not be permitted.

All lapping of reinforcement bars in the cooling tower shell shall be by lapping as per relevant codal provisions. Prior approval of the Engineer shall be taken for deciding the method of lapping the reinforcement bars in the shell.

13.15 Requirements for Staging and Forms

Automatic Climb form scaffolding system shall be used. Slip form with proven record for similar towers may be used subject to specific approval of Owner. The design and detailed construction of the formwork and the scaffolding system shall be based on the relevant IS code. In absence of the same, DIN 4420/ACI 347 shall be followed. Realistic loads shall be considered for platforms with regard to the classification of scaffolding system used. For material transport, it shall be designed by accounting for all transportation loads.

The connection between individual scaffolding units shall be made in such a way that in case of collapse of one unit, the adjoining units are not affected. Scaffolding system should have at least two independent safety measures against collapse.

Concrete shall have sufficient strength to withstand the anchoring loads of scaffolding system. The concrete strength shall be continuously checked and documented during the climbing process of the scaffolding.

Contractor shall prepare detailed scheme, design calculations, detailed working drawings showing all details of form work, staging, scaffolding, member section, connection details and other arrangements for the concreting work and submit the same for approval within one (1) month before the commencement of the NDCT civil work. Only on receipt of the approval from the Engineer the work shall be taken up. However approval of the same by Owner in no way relieves the Contractor of his responsibility for the proper functioning and safe working of the scaffolding system.

13.16 Hoisting for Personnel

The arrangement and method of raising and lowering of personnel, concrete, reinforcement and other materials to various levels for the cooling tower shell shall also be got approved from the Owner. Details of equipment and procedure shall be submitted for approval.

Any change in the originally approved scheme, design of detailed drawings at a later date shall be adopted only after obtaining the written approval.

For shuttering, following provisions shall be complied with:

- (a) Self-weight of (scaffold + platforms) + minimum superimposed load of 370 kg/sq m on total working platform areas at various levels.
- (b) Self-weight of (scaffold + platforms) + minimum superimposed load of 50% of 370 kg/sq m on total working platform area at various levels + earthquake loads.
- (c) Self-weight of (scaffold + platforms) + superimposed load of 370 kg/sq m on total working platform areas at various levels + wind load.
- (d) For load combination (a) above, no increase in the permissible stresses shall be allowed. For load combinations (b) and (c) above increase of 33.3% in permissible stresses shall be permitted.

Design and execution of form work, stagings, shutterings and scaffolding shall conform to National Safety Council and all relevant IS Code provisions, i.e. IS 2750, IS:4014, IS:4923, IS:800,IS:14687 etc. In case the IS Codes do not cover the specific type of shuttering system, then any International Code of Practice, as approved by the Engineer, may be followed.

Notwithstanding the stipulations contained in various codes, safe slenderness ratio shall be determined as follows:

- (a) Vertical members: Effective length shall be taken equal to the maximum distance between consecutive horizontal runners in any plane.
- (b) Horizontal and diagonal member: Effective length shall be taken equal to centre-to-centre distance between two nodes.

If the support from shell for scaffolds is to be taken, following provisions shall be adhered to:

- (a) Members connecting/joining scaffolds with shell shall act as propping supports. Use of pre-tensioned or pre-compressed members for propping action shall not be permitted under any circumstances. Connection of propping members with shell shall be designed complying with the above stated requirements.
- (b) All prop supports shall be taken at nodal points of scaffolds only.

Splicing joints in vertical pipes shall be such that the joints shall be rigid and the entire cross section area of the pipe takes part in load transference.

Special inspection hoist shall be provided for regular inspection. The hoist should be so placed that the inspection, checking of scaffolding members, joints etc. are easily carried out. Regular check at every fortnight of the joints and other elements of scaffolds shall be carried out. Detailed inspection record shall be maintained by the Contractor and same shall be produced to the Engineer wherever required.

Notwithstanding the approval from Engineer, the Contractor and his collaborator will be solely responsible for the safety, security, functioning proper functioning and the speed of the construction work.

The formwork for shell shall be capable of adjusting to shell profile and thickness accurately, and shall be rigidly braced to prevent deflection or movement during concreting.

Forms shall be designed to produce hardened concrete having the shape, lines and dimensions indicated on the drawings. Forms shall be constructed and maintained in proper position and accurate alignment. Accurate alignment shall include maintaining hyperbolic shape, round cross section, and plumbness of concrete shell.

Forms shall maintain vertical alignment of form seam marks. Forms for the exterior of the shell shall produce surfaces having a smooth uniform appearance.

Forms shall be specially designed and installed so as to prevent leakage of mortar, produce a smooth exterior surface, and permit removal without injury to the adjoining work.

The insides of the forms shall be coated with an approved non-staining parting agent that will not impair the blend coatings. The Contractor shall ensure that the parting agent is not applied to the reinforcement.

Forms shall not be removed until the concrete has adequately hardened and attained sufficient strength to maintain its shape with no spalling and to support safely its own weight together with any construction loads likely to be imposed.

All details of formwork staging, placing, tying etc. shall be subject to the approval of the Engineer and the Contractor shall submit drawings, when required, showing details of procedure of construction. Contractor shall be responsible for the adequacy of the formwork to withstand the pressure of freshly placed concrete or other loads imposed without, movement or deflection of the parts.

For concrete surfaces that are exposed to view and for all other concrete surfaces that are to be finished smooth, the lining of forms shall be of smooth non-absorbent lining material. All edges of panels shall be square and straight in both directions and all panels shall match perfectly in length, width and alignment as required.

Minimum time of form work shall be approved by the Engineer for RCC shell depending upon weather conditions, quality of cement, etc.

Outer ends of the permanently embedded portions of form ties shall be at least 25 mm recessed from the adjacent outer concrete faces.

All MS embedment shall have anti-corrosive treatment as per Technical Specification.

13.17 Work Execution and Supervision

Contractor shall furnish a list of equipment he proposes to deploy in the work. He shall provide and maintain at site all equipment and plants necessary to perform the work. All arrangements for transporting the equipment, material, personnel, etc. to and from the site shall be done.

The Owner reserves the right to order from time to time in writing, during the progress of work the removal and proper re-execution of any work which in the opinion of the Owner, is not in accordance with the specification in respect of materials and workmanship.

During inclement weather the Contractor shall suspend concreting for such times as the Owner may direct, and shall protect from damages all the works already in progress or completed.

Deployment of a tower crane of appropriate height with a rotating boom of sufficient length capable to deliver the materials such as concrete, reinforcement, etc. regularly and smoothly to the farthest points of the shell at all elevations and plan angles for speedy construction of cooling towers shall be required.

13.18 Setting Out of the Shell

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

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

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

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

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

All measuring points on the shell and the chord gauges shall be predetermined by the contractor and got approved by the Engineer.

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

Tolerances for the cooling tower construction shall be in accordance with the following along with provisions contained elsewhere:

- (a) Shell wall centre line in horizontal plane measured radially at mid point on a 3m wide chord : ± 15 mm
- (b) Shell wall centre line in meridional plane measured over a height of 1m : ± 10 mm
- (c) Shell thickness : + 10 mm or- 5 mm
- (d) Horizontal radius of shell at any section other than shell base : ± 50 mm
- (e) Horizontal radius at shell base : ± 40 mm

Checking of Shell Geometry

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

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

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

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

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

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

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

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

13.19 General Requirements

In case the basin slab is divided, the same shall be divided into two equal parts by a partition wall designed to withstand full hydrostatic pressure, with one side empty. The basin construction joints shall be made watertight by injection of chemical grout through nipples. The basin construction shall be tested for water tightness, in accordance with IS: 3370 (Part-1).

PVC ribbed water stops with central bulb shall be used where expansion joints are envisaged. The minimum thickness of PVC ribbed water stops with central bulb will be 10 mm and minimum width 225 mm.

The basin floor of each compartment shall be provided with a slope of not less than 1 in 120 towards sump for dewatering. From sump, the water will be drained by C.I. drain pipe, embedded below the basin floor, into a drain chamber outside the tower basin or as per the arrangements described elsewhere in the Bidding documents. Suitable operating platform with access ladders for operating the gates or valves and pipes, if specified, shall be provided in the drain box.

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

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

The stoplogs shall be structural steel with anti-corrosive coating specified elsewhere. One set of stoplogs shall be provided per tower. Proper rubber seal shall be provided so as to avoid any leakage of water. The rubber seal provided for the stoplogs be tested in accordance with the relevant Indian Standard Code. Stoplogs shall be checked for water tightness and smooth operation in dry and wet conditions. Suitable facilities, as approved by the Owner, shall be provided for handling of stoplogs.

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

Lean concrete below other foundations and underground structures, unless noted otherwise, shall be of concrete grade M10 (with aggregate of nominal size 40 mm maximum) and shall be at least 100 mm thick.

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

All concrete surfaces in direct contact with sea water/ water spray shall have coatings based on the use of high build heavy-duty polyurethane having formulation of 100 % solids, solvent free. Thickness of polyurethane coating shall be 2.0 mm. Suitable primer as per standard practice/manufacturers' recommendation shall be used. All concrete surfaces subject to water/ water spray up to Drift eliminator level shall receive the said coating after grit blasting of the concrete surface.

All other exposed surfaces of concrete including surface of cooling tower shell, shall be given two or more coat of waterproof cement paint of approved make and colour.

Unless noted otherwise all concrete surface which are in contact with the earth shall be applied with anti-corrosive coat system.

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

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

The hand railing on both sides of the staircase shall be galvanized and shall have rails of NB 32 mm pipes conforming to medium class as per IS: 1239, and posts conforming to medium class as per IS: 1239 of 32 mm dia galvanized pipes spaced not more than 1.5 m centers. The top Galvanised handrail shall be at 1000 mm above the steps. Safety kerbs with 50 mm (minimum) width shall be provided along each edge. Complete handrails shall be applied with anti-corrosive coating system as specified elsewhere.

All galvanization work shall have minimum 610 gm/sq m of deposit. Approved walkways and platforms shall be provided inside the tower at distribution pipe level. These walkways and platforms shall provide safe and clear access to all sprayers and all distribution pipes. A reinforced concrete platform of 1500 mm clear width shall be provided around the tower periphery, which will be a means of access to next walkways, and all end valves. Other walkways shall be at least 600 mm wide with 50 mm (minimum) safety kerbs along each edge. Access ways shall be clear of all obstructions such as distribution pipe support beams, drift eliminator support beams, etc. The walkways with proper slope shall be provided with transverse slots or other opening which will permit the free passage of air and water. Hot double dip galvanized M.S. handrails as described above shall be provided on all sides where there is a risk of falling through the fill.

Aviation warning light shall be provided, if required, separately for the cooling tower. Details of lighting arrangement shall be similar to that specified for chimney.

Reinforced concrete platforms 1.2 m clear width all around the tower circumference shall be provided on the tower for fixing of aviation warning light at levels specified elsewhere. Two (2) diametrically opposite galvanized M. S. caged ladders, 600 mm wide, made out of 6 mm x 10 mm flats for full height of the tower shall be provided. Galvanization & anticorrosive coating shall be provided as per specifications. The ladder shall have 20 mm dia rungs at 300 mm centres, with stays at every 2250 mm, connected to the concrete shell and galvanized M.S. caging consisting of 50 mm x 70 mm vertical cage flats on the exterior surface of each cooling tower up to throat. Above throat level, these ladders shall be continued along the inside surface of the tower up to the top of the tower. A RCC landing of minimum size 1 m x 1 m with galvanized handrails and galvanized steel door at the throat for interchange shall be provided. In addition to the top platform, intermediate landings of 1.0 m x 1.0 m with handrails shall be provided at every 8 to 10 m height of the M.S. Ladders throughout. Some of these landing levels shall be suitably adjusted to give access to aviation warning beacons for maintenance.

Handrails as described above shall be provided on all platforms. The ladder leading to the top platform shall have approach form the ground via the RCC. staircase.

In order to provide approach for maintenance of shell (inside & outside surfaces), all platforms shall have 20 mm wide radial openings shall be provided in the platform floors at locations, approved by Owner. Adequate numbers of 75 mm internal diameter puddle flanged C.I. pipes shall be embedded in this platform for passing ropes during maintenance of tower shell.

Steel gratings shall be provided as per requirement. All steel gratings shall be galvanized and applied with anticorrosive coating.

Treads for staircases, where needed, shall be of similar grating construction but provided with toe flats of 6 mm thick, and non-skid nosing in an approved manner extending up to 100 mm above the walkway surface.

All mild steel parts of structures used in cooling towers shall be hot double dip galvanized. The minimum coating shall be 610 gm/sq m and shall comply with relevant IS Codes. Galvanizing shall be checked and tested in accordance with IS: 2629. The galvanized shall be followed by the application of an etching primer and anti corrosive high performance coating system. All welding shall be done before galvanizing.

Any site joints required to be carried out after galvanizing shall be either flanged or screwed joints. Nails, nuts, bolts and all components coming in direct contact with water shall be of stainless steel of AISI 304 or equivalent.

The finished ground level shall be paved for 10 m width all-round the outer edge of the cold water basin. The paving shall consist of 150 mm thick RCC slab of M-25 grade. The minimum reinforcement shall be 10 mm dia spaced 150 mm centre to centre both ways top and bottom. The RCC slab shall be overlaid 75 mm thick PCC layer and 230 mm thick compacted crushed stone base

14 Water Treatment System

14.1 Pre Treatment Plant

14.1.1 General

Pre treatment plant, using available sweet water, shall be as per approved layout and system requirements and generally cover Clarifiers, Clarified storage plant, chemical house, gravity filter & pump house for potable water and DM water, filtered water storage tank, filtered water pump house, chlorination building and other associated civil works.

14.1.2 Clarifiers

These shall be of partly underground RCC construction, reactor type and circular in shape. This shall be designed as water retaining structure. Inside water surface shall be provided with protective coating to take care of chemical dosing.

14.1.3 Chemical House

This shall be two storied building with RCC framed structure and in-filled brick masonry.

14.1.4 Clarified Water Pump House

This shall be of single storey structural steel framed structure with RCC concrete roof over permanent decking of colour coated troughed sheets supported on steel beams. Side of pump house shall be colour coated galvanised sheeting except for bottom three metres high brickwork. Ventilation and natural lightning shall be provided with glazed aluminium windows. Roof shall be provided with a minimum of 1 in 100 slop for proper drainage. Maintenance bay of pump house shall have RCC grade slab with metallic hardener floor finish. Adequate handling facilities for pumps shall be provided, supported from the roof beams. Roof, shall be given liquid membrane water proofing treatment. Approach to roof, shall be provided with steel cage ladder

14.1.5 Clarified Water Storage Tank

These shall be of RCC construction, water tight and having partly above ground and partially under ground.

14.1.6 Gravity Filter, Filter Water Pump House and Filtered Water Storage Tank

These shall be RCC structure.

14.1.7 PT Chlorination Building

This shall be single storied building with RCC framed structure and in-filled brick masonry. Toner area shall be provided with concrete jalli with sunshade from top.

14.2 Demineralisation (DM) Plant

DM Plant civil works shall be as per approved layout and system requirements. This shall generally consist of DM plant building, DM tanks with foundation, neutralisation pit and other miscellaneous civil works.

The DM Plant Building shall be of RCC frame structure with brick cladding. The flooring inside shall be of acid / alkali resistant bricks. Adjoining Control Room and Laboratory shall be provided. Staircase in the control room complex shall be extended to roof also. Storage Tank shall be provided with RCC foundation as per IS 803. Neutralisation pit shall be under ground RCC water retaining Structure.

AR lining shall be provided for Neutralisation Pit, RCC Drains and floor area coming in contact with aggressive effluent.

14.3 Effluent Treatment Plant (ETP)

All civil works required for ETP pertaining to coal slurry settling system and waste service water system shall be as per the approved layout and details of effluent treatment system. This generally consist of coal slurry settling pond & pump house, waste service water sump & pump house, flash mixer, tube settler clarifier, Central Monitoring Basin (CMB) for treated water and CMB pump house etc. Details for coal slurry treatment are cover under Coal Handling System.

16 Ash water Recirculation System

16.1 General

Civil works for ash water recirculation system shall be according to the finalised system and layout including disposal of treated effluent having sea water.

16.2 Pump House

This shall be construction adjacent to the overflow lagoon. This shall be single storey RCC framed structure building with in filled brick work.

16.3 Pedestals and Thrust Blocks

RCC pedestals including thrust block shall be provided for above ground routing of the recirculation pipe from ash dyke to treatment plant in main Plant area.

16.4 Clarifier

RCC clarifier shall be used for treatment of the ash water for reuse or direct disposal to sea as per finalised scheme.

17 Switchyard Civil Works

17.1 General

Civil works for Switchyard area shall be carried out as per approved layout and system requirement and shall generally cover the following:

- Building for indoor switchyard (considering the coastal environment) and switchyard control room
- Supporting structure for towers, lightning masts, beams, columns, equipment etc.
- Foundations for towers, lightning masts, buildings, transformers, shunt reactor, equipment supports, etc.
- RCC Cable trench with covers, 3 meter high PVC coated chain link fencing with 200mm high toe wall finished with plaster & painting, gate, fire protection walls, earthing mat, etc.
- Roads (flexible pavement of 3.75 m width having 1.5 m wide hard shoulder on both sides) & RCC drains
- Area paving for entire switchyard with 150 mm thick gravel filling over ground treated with anti weed chemicals, gravel layer consist of 75 mm thick stone metal filling of 40 mm stone aggregate on the top and 75 mm thick filling of 20 mm stone aggregate below, each layer compacted by using 1/2 tonne roller with 4-5 passes and suitable water sprinkling.
- Oil soak pits, oil separation pits, oil drains to the oil separation pits.

17.2 Control Room Building

Switchyard Control Room shall be constructed as per approved layout plan and details. This shall be a two storied RCC framed structure with brick cladding. This shall accommodate cable vault, stores, offices, staircase, panel handling arrangement, battery room, relay panels area, toilets etc.

17.3 Gas Insulated Switchyard (GIS) Building

This shall be single storey building of wide span with height as per requirement having overhead handling facility of required capacity. Structure shall be made of RCC columns and roof truss with flat RCC roof laid over permanent shutter of pre-coated metal deck sheets.

17.4 Structural Steel

All structural steel members including stub members, bolts, nuts, spring washers, etc., and shall be hot dip galvanized after fabrication. Weight for zinc coating shall be minimum 900 g/sq.m & 610 g/sq.m for indoor and outdoor conditions respectively. Galvanised Bolts and nuts of required grade shall be used.

17.5 Miscellaneous Requirements

Structural arrangement, foundation system, miscellaneous requirements, finishes, etc., shall be as specified elsewhere in this specification.

17.6 Masts

Lightning masts shall be provided with minimum two number of platforms, (with one at top level) and an internal ladder for climbing purpose up to platform at top level. Top of platform shall have grating, railing and toe guard plates.

17.7 Cable Trenches

Cable trenches shall be provided for routing of cables from control room to equipment through a common marshalling box for each bay. Each cable trench shall generally cater to two bays on either side. The cable trench shall be of adequate size. The trenches located within switchyard shall project at least 200 mm above the finished formation level so that no storm water shall enter into the trench. The bottom of trench shall be provided with a longitudinal slope of 1:500. The downstream end of cable trenches shall be connected through pipe drains to the nearby RCC manholes (to convey water from trenches) of storm water drainage system or it shall be connected to sump pit. The precast covers shall not be more than 300mm in width and shall not be more than 65 kg. Lifting hooks shall be provided in the precast covers. Trenches shall be given a slope of 1:50 in the direction perpendicular to the run of the trenches. Angle of size 50x50x6 mm (minimum) with lugs shall be provided in the edges of RCC cable trenches supporting cover, edges of manhole supporting, supporting edges of precast RCC cover and any other place where breakage of corners of concrete is expected.

18 Offsite & Non-plant Buildings

18.1 Administrative Building

This building shall be multistoried (preferably G+3), RCC framed structure with brick cladding. Total built up area of this building shall be minimum 5000 sq m (excluding atrium area). This is one of the most prestigious buildings within the plant area, both location wise and function wise, which calls for an identity of its own.

This building shall house reception, offices, conference room, documentation room, telecommunication room, etc. This will be fully air conditioned building with adequate provision of toilets, pantry etc. 2 nos. passenger lifts (capacity 13 each) shall be housed within the central atrium. The atrium shall have polycarbonate sheet dome cover of suitable shape at roof level. Finishing requirement for this building shall according to the stipulation specified under architectural and allied works. However, all the details of finishing, fittings and layout of rooms etc. shall be finalised during detail engineering stage and the entire requirement should be of Owner choice.

There shall be decorative boundary wall with separate entry gate and security post. This building shall also have covered shade car parking space for car and two wheelers. Detailed landscaping including water bodies and fountains shall also be provided for this complex.

18.2 Canteen Building

Canteen building shall be RCC framed structure with brick cladding having ground plus first floor including separate dining hall for officers, kitchen, store, hand wash, toilets, waiting area. The first floor shall be used as meeting hall and common purposes with adequate toilet facilities. Built up area of Canteen building shall be minimum 500 sq m having common dining hall for catering approximately 75 users at a time. Comprehensive landscaping shall be done in this area.

18.3 Fire Station Building

The Fire Station Building shall provide support, enclosure, and access for such needed facilities as per applicable requirements. This building shall also contain office areas, fire panel room, toilet facilities, rest room for firemen and storage facilities for portable fire fighting equipment. Manual hoists and trolleys shall be provided for the installation and maintenance of equipment.

The Fire Station Building shall have minimum built up area of 400 sq m with provision of garage facilities for 2 nos fire tenders and shall have one end of the building left open for truck access. The building shall be RCC framed structure with RC roof and plastered brick work finished with paint/coating.

This building shall be complete with drains, plumbing, sanitary drainage and treatment piping, space conditioning, building lighting, station communications, and fire protection.

18.4 Gate Complex

It shall be of two storied RCC framed structure (minimum built up area 400 sq m) with in filled brick masonry consisting of mainly reception, visitor's waiting area, gate pass counter, search centre, Security Gate house and Time keeping office. First floor shall accommodate office area and rest rooms for security staff. It shall be provided near the main entry location.

There shall be a total of three gates for entry and exist. For vehicular entry and exit two separate motorized sliding MS gate shall be provided. In addition to this, separate pedestrian gate shall be provided. Gate Complex area shall be covered by detailed landscaping both, inside as well as outside the entry gate with provision of parking area.

18.5 Work Shop

It shall be of RCC structure with steel truss framing with brick cladding and roof metal decking with minimum built up of 2000 sq m. It shall be provided with cast-in-situ concrete roof. Cranes/ Monorails shall be provided as per requirements. It shall accommodate the machinery and facilities listed in the Mechanical section of the document. In addition, the workshop shall provide for office space, locker room and change room for workers, toilet etc. Entry and exit of trucks / forklift shall be through adequately sized rolling shutters. A minimum of 2 single-leaf, steel flush doors shall be provided for entry of the staff. Adequate windows with grills shall be provided for ventilation and lighting. Offices inside shall be of glazed Aluminium partition above 900 mm high single-brick wall. Total height of partition including brickwork shall be 2400 mm.

18.6 Hydrogen Generation Plant

This shall be a single storey RCC frame structure with brick cladding and shall conform to the requirement of explosive norms. The facilities housed in this building are rectifiers, electrolysis plant, air compressors, control room, gas bottling manifolds, gas cylinder storage area, toilet etc. Roof shall be of RCC with no beam projection inside the room to prevent accumulation of gas. All doors and windows shall be of shatterproof glass. All doors in the hazardous areas shall be swing type opening outwards. Hydrogen cylinder storage area shall be well ventilated without any glass window. Acid/alkali resistant brick flooring shall be provided in areas where acid/alkali spillage is anticipated. Building shall be located in an isolated area as per norms and shall have separate fencing with gate & approach road etc.

18.7 Permanent Stores

Permanent Stores shall be of RCC framed structure with brick cladding with minimum built up of 3000 sq m. Roofing shall be of in-situ RCC. Loading and unloading platform for trucks, ramps for movement of forklift etc shall also be provided. Separate office space, chemical storage, hot storage, electrical storage, A/C storage, toilets etc shall be provided. All windows shall be provided with MS grills for security. Rolling shutter of adequate size shall be provided for movement of truck / forklift etc. Grade slab shall be designed for truck traffic. Provision for open and semi-covered storage areas shall also be provided in stores complex. RCC paving shall be provided for open yard storage.

The store complex shall be enclosed with chain link fencing having entry gate and security post.

Outside are shall be paved for open air storage.

18.8 Parking Shed

Car park shall be partly covered parking having total parking area 750 sq.m..

Cycle & scooter shed shall have 500 sq.m.area.

Shed area shall be of structural frame with regular rolled / circular section with metal sheeting. Concrete floor shall be placed on well compacted hard base. Floor shall be constructed with proper expansion/construction joints.

Covered & open parking space shall be provided near different buildings and facilities as per requirements.

19 Architecture and Allied Works

19.1 General Architectural Concepts

Layout of the plant area shall have definite hierarchy of road network depending upon its usage, aesthetic, visual sensibilities for creating road vistas, focal points, building back drops, building frames. General layout shall be evolved taking over the basis of landform and local climate and due consideration shall be given to orientation and wind direction. The resulting built mass shall present a definite image with in distinct vocabulary in the form of landmarks, nodes and skyline.

Main plant building shall be architecturally treated in such a way that it retains a monumental scale, yet presents a pleasing composition of mass and void with suitable and functionally designed projections and recesses. The overall impact of the building shall be one of aesthetically unified architectural composition having a comprehensible scale, blending tonal values with the surroundings and taking full consideration of the climatic conditions, the building orientation and the existing structures nearby.

All other buildings and structures shall be architecturally treated in such a way so as to be in complete harmony with the main plant, surrounding structures and environment. Local architectural characters and materials may be judiciously imbibed. The building shall be designed initiating an architectural control common to all buildings. The architectural control shall be clearly spelt out in terms of scale, man and form.

Overall colour scheme of the plant and other buildings shall be designed judiciously and in a comprehensive manner taking into account the mass and void of buildings, its facade, equipment, exposed structural elements, piping, trestles, bus ducts and other service elements.

Overall emphasis shall be on developing eco-friendly architecture, merging with the nature with its own sustainable energy management systems. The scheme shall be conceptually finalised in totality including that of equipment so that the proper coordination with other agencies can be taken up at appropriate time.

Due consideration shall be given to provide treatment to all buildings and structure to take care of the coastal (aggressive) marine environment.

19.2 Architectural Design

- (a) Natural light shall be used to the maximum extent especially in the form of north light/ sky light. For adequate light and ventilation, National Building Code recommendations shall be followed.
- (b) Entrance canopies, chajjas (projections, recesses) over openable windows and door openings on exterior facades shall be provided.
- (c) All the buildings shall be architecturally designed to meet the National Building Code (SP: 7) norms and Local Building Bye Laws, wherever applicable.
- (d) Architectural design and detailing aspects of all the buildings shall be rendered through professional services of an architect.
- (e) Statutory requirements may be required to be met with, wherever essential.

- (f) The architect shall evolve the design philosophy based on Owner's guidelines and shall present it in the form of presentation drawings, perspective views, 3-D models and detail drawings.
- (g) An architectural design intent memorandum shall be submitted to the Owner which shall include proposals for the following scheme components: shape, form, colour, and basic materials for interior and exterior architecture along with an appropriate landscaping scheme during detailed engineering stage. All schemes shall be supported by an architectural statement explaining the factors considered in the design. A minimum of two schemes shall be provided, from which the Owner shall select.
- (h) The architectural components shall be designed for the conditions at the plant site for the design life of 30 years unless specifically noted otherwise.

19.3 Exterior Architecture

General design criteria for the exterior architectural systems shall be as given below. Quality plans and detailed specifications for all items to be incorporated in the works shall be approved by Owner.

19.3.1 Walls and Cladding:

The function of all exterior walls is to provide enclosures for buildings. The exterior enclosure protects the enclosed system and personnel from adverse weather conditions and allows for a controlled interior environment. The cladding of the main plant buildings shall consist of brickwork, walls up to a height of 3 m from ground level, wherever metal cladding is specified and metallic cladding with colour pre-coated galvanized metallic cladding sheets shall be provided above 3 m level up to roof level. However for some low height buildings, initial masonry wall height can be provided for 0.9 m only.

19.3.2 Brickwork

The exterior brickwork walls shall generally consist of non-load bearing type construction. For walls heights exceeding 3.0 m required reinforcement shall be provided to meet the applicable building codes and standards. Bricks of minimum 50 kg/ sq cm crushing strength shall be provided. Brick work shall be carried out in cement sand mortars 1:6 or higher cement content. Cement sand mortar shall conform to IS: 2250. All external wall shall be one brick thick. However, internal partition walls shall generally be with half brick thick. Brick work shall be provided with plastering on both faces.

19.3.3 Plastering

All exterior and interior brick work walls shall be provided with plaster on both faces. 12 mm and 18 mm thick plaster shall be provided on the even and rough faces respectively. Minimum cement sand mix of 1:6 shall be used for plaster. Plastering shall conform to IS: 1661. Ceiling plaster shall be 6 mm thick with cement sand mix of 1:4.

Wherever required for the painting on interior surfaces, minimum 2mm thick Plaster of Paris shall also be applied to give even and smooth surface.

At the junction of RCC and Masonry work, galvanised chicken wire mesh conforming to IS: 3150 shall be provided.

Provision of suitable groove and drip course shall be provided as per the requirement.

19.3.4 Metal Cladding and Roofing

Double skin insulated or un-insulated / single skin cladding / roofing made of troughed pre coated sheet of required profile and sectional properties shall be provided for side cladding and roofing. Bare metal thickness shall be minimum 0.5 mm thick for high tension steel and 0.6 mm for mild steel. Rate of metallic coating of Al-Zn alloy shall be minimum 150 gms/sq.m. Exterior surface (exposed to outdoor condition) shall be precoated with minimum 20 micron PVF2 paint. For interior application silicon modified super polyester paint can also be used. Ridge, hip, flashing, closer etc shall be made out of flat sheet of same material as profile sheet. Self tapping screws of required type & numbers shall be used for fixing.

Light gauge metal sheets shall be designed as per IS: 801.

19.3.5 Metal Decking

Metal decking of required profile and sectional properties for roofing or flooring wherever required, shall be of minimum bare metal thickness of 0.8mm. This shall be either Zn coated or Zn-Al alloy coated as specified. Interior exposed bottom surface shall be coated using minimum 20 micron Dry Film Thickness (DFT) silicon modified polyester or super polyester paint. RCC slab of minimum 40 mm clear thickness in excess of trough depth shall be provided over metal decking.

19.3.6 Insulation

The insulation shall be of resin bonded mineral wool of density 48 kg/cu.m and thickness minimum 50 mm. Insulation materials shall be added to walls where necessary to reduce cooling loads. Also, insulation shall be used for sound absorption on walls which enclose equipment that has been identified as a source of generating excessive noise. This sound insulation shall be provided in interior face of wall or insulated metal wall panel liners as appropriate. The overall noise reduction coefficient shall be 0.80 or more.

19.3.7 Windows and Ventilators

Aluminium section used for windows, ventilators and partitions shall be made of extruded anodised and electro colour dyed aluminium, which is resistant to the corrosive environment. Ventilation sections shall be compatible with the frames providing a weather-tight seal of neoprene gasket.

All extruded aluminium sections shall be made of heavy gauge considering cyclonic wind load etc of approved make.

Corrosion protection of the aluminium including bi-metallic corrosion protection, particularly with steel member shall also be provided.

Glazing of windows shall be done with minimum 4 mm thick float glass of best quality for windows located in ground floor and at accessible floors.

Glazing of windows and ventilators located at higher elevations where frequent replacement is not feasible, shall be done with 6 mm thick wired glass conforming to IS: 5437.

For partition walls minimum 5.5mm thick clear glass shall be used. However for partition between air conditioned and non air conditioned area, composite double glazing shall be used which consist of clear float glass of 6mm on one side and tinted glass of 6mm thick on other side separated with 12 mm air gap, hermetically sealed by beading of anodised aluminium.

All windows shall be glazed and fully flashed and sealed for weather-tightness. The entire building enclosure shall be completely weather-tight and air tight. All window hardware shall be substantially made, smoothly finished, accurately fitted, and smooth in operation.

Windows shall close tightly without binding. Operators shall operate freely and smoothly, adjusted to close tolerances for positive closing of windows with a minimum of play in operator linkages. All ground floor windows shall be lockable and shall be provided with security grills.

Steel or other tried and proven material which is resistant to the corrosive environment can also be permitted for Coal Handling Structures.

19.3.8 Louvers

Ventilation openings shall be provided with drainable formed gutter type storm-proof blade louvers complete with bird screens. Operating damper blades shall be provided behind the fixed louvers to allow closing of the openings. On long expanses of louvers, a continuous blade concealed support system shall be provided. Louvers shall be fabricated from extruded aluminium, steel, or other tried and proven material which is resistant to the corrosive environment and shall be provided with a poly-vinylidene fluoride finish.

19.3.9 Doors

Personnel doors in plant buildings shall be of 45 mm thick insulated hollow metal flush type with formed hollow metal frames. The doors shall be constructed from 1.2 mm steel sheets with an internally reinforced, insulated core. Frames shall be constructed of 1.6 mm steel, with all joints mitered, welded, and ground smooth. Both doors and frames shall be factory galvanized, primed and field painted. In areas of the plant where excessive negative pressure hinders normal door operation, special balanced door hardware shall be provided.

For the office area, aluminium doors frame shall be of extruded anodised and electro colour dyed aluminium of minimum 3 mm thickness of best quality and workmanship of approved make. Glazing of fully glazed doors and partitions shall be done with 5.5 mm thick float glass of best quality. However, 12mm thick BWP particle board shall also be provided in toilets and other areas wherever required.

Doors shall have a glazed vision panel when required by door function. Glazing shall consist of tempered safety glass or wired glass.

Doors located on the ground floor of buildings shall swing out. Doors at other levels shall swing in or as required to meet egress requirements. Heavy duty hardware shall be used. All outside doors shall be provided with door closers. Locks shall be provided on interior and exterior doors as required by the Owner.

Fire doors shall conform to hollow metal door requirements and shall be provided with fillers adequate to meet the required fire rating. The door, frame, and hardware shall bear a certification label for the class of opening and rating. Doors for fire exits shall be secured with panic bars. Fire doors shall conform to IS-3614 (Part I & II).

For equipment and vehicular access, vertical lift type rolling shutters with weather seals and wind locks shall be provided. Components shall be formed from galvanized steel, factory primed and field painted. Doors at high traffic areas shall be motor-operated. Doors shall be manually operated where access is infrequent. Rolling shutters shall conform to IS: 6248. For a very large access opening, suitable double leaf hollow metal sliding type of doors can also be provided.

Suitable automatic operation system for sliding doors shall also be provided in area like main entry door of central control room.

19.3.10 Flat Roof Treatment

Roof slab shall be of adequate thickness and laid to proper slope for easy drainage of rain water. Wherever required screed concrete shall be provided to maintain the adequate slope of about 1 in 100. Adequate numbers of Galvanised MS rain water pipes of adequate size shall be fitted at designated locations as per IS code. Suitable parapets/handrails shall be provided. Roof drain shall be designed as per IS: 1742. Galvanised mild steel pipe, medium class upto 150mm size shall conform to IS: 1239. For higher diameter pipe galvanised ERW steel pipe shall be used. Rain water downcomer pipe shall be encased or concealed

Water proofing treatment to the roof slab shall be provided with high solid content liquid applied urethane based elastomeric membrane of jointless dry film thickness of minimum 1.5mm conforming to ASTM C 836 and C 898. Wearing course on the top of membrane shall consist of 25mm thick PCC of grade M20 cast in panel of maximum 1.5mx1.5m size and reinforced with galvanised chicken wire mesh including panel joint sealing. Wherever required, chequered concrete tile flooring minimum 22mm thick of approved colour and shade conforming to IS: 13801, shall also be provided.

19.3.11 False Flooring

Where indicated on the technical drawings, the contractor shall furnish and erect removable modular panels conforming to the following requirements:-

(a) Material

Composite panels made of high density (675 kg/m^3) waterproof chipboard and aluminium sheets for protection of the interior face. The panel edges shall be slightly chamfered (5°) and protected by an aluminium profile.

Topping shall be made of high pressure laminate 1.3 mm thick.

(b) Size of the panels

- Nominal size shall be 600 x 600 mm.
- Tolerance:
 - 0.2 mm width and length
 - 0.3 mm diagonal
 - 0.2 mm thickness

- Minimum thickness of the panels 40 mm
- (c) Loading (except if noted otherwise in the execution drawings) 30 kN/sq.m. The maximum allowed deformation shall be 2 mm under 5 kN point load.

Minimum height of the free space between sub-floor and raised floor surface for control rooms shall be 1.0 m.

- (d) Substructure

The substructure shall consist of adjustable pedestals and stringers. The pedestals are to be fixed by bolts to the concrete base slab floor. The stringers are bolted to the pedestal so that large cut-outs are possible.

The whole system shall be constructed in such a way as to allow conductivity of electrostatic charges and shall be connected to the earthing system.

Penetrations for cables and pipes shall be arranged.

For allowing an elastic connection to abutting walls, a peripheral joint of 3 mm width shall be arranged and sealed with an appropriate neoprene sealant.

19.4 Interior Architecture

Interior architectural systems shall conform to the following general design criteria. Fire rated architectural systems shall be provided when required by building or fire codes. All normally occupied areas shall be provided with finish.

19.4.1 Partitions

Interior walls shall be constructed of masonry, stud framing with gypsum board, metal wall panel, and factory finished assembled demountable type partitions.

Interior walls shall be constructed of concrete block/brick masonry, structurally designed and reinforced, where other interior walls shall not provide durability. Plaster finish shall be applied to brick masonry walls followed by paint in approved colour.

19.4.2 Ceilings

False ceiling shall be provided for all air-conditioned areas and other areas where required from functional requirement.

Ceilings in unfinished areas shall leave the overhead structural frame exposed. The exposed structure shall be painted in unfinished areas.

Ceilings in finished areas shall generally consist of a suspended, exposed grid, lay-in acoustical type. The ceiling shall not sag when exposed to high local humidity. False ceiling wherever envisaged shall be of pre-coated aluminium alloy of minimum 0.60 mm thickness. Generally 600x600 sq.mm or 100mm wide lineal type of aluminium false ceiling shall be provided. However at some locations like control room 12mm thick Glass reinforced Gypsum board in desired profile and shape shall be provided.

For metal false ceiling, over deck insulation shall be provided using minimum 50mm thick mineral wool / glass wool wrapped in polyethylene sheet bags. However, for under deck insulation below ceiling, minimum 30mm thick (density 32 kg/cu.m) polyisocyanurate or rigid phenolic foam (fire retardant and non-toxic) shall be used.

False ceiling shall be provided with arrangement for AC ducts, return air grills, lighting fixtures and cat way etc wherever required.

19.4.3 Grade Floor

Reinforced concrete grade floor shall be provided at ground level in the power plant area comprising of the area from transformer yard to boiler area upto chimney. The grade floor shall be in minimum grade M20 concrete of minimum thickness of 150 mm and 50mm top finish as per the requirement, laid over PCC and compacted crushed stone base of 230 mm thickness. Grade slab shall be provided with reinforcement both ways, top and bottom with minimum 8 mm diameter TMT steel bars at minimum 200 mm c/c.

19.4.4 Floor Finish

Total thickness of floor finish (including under bed of Cement Mortar or PCC and top finish) shall be 50 mm. Height of matching skirting shall be minimum 150 mm and height of dado shall be minimum 2200mm for toilets and up to bottom of false ceiling for other area if required.

In general following type of floor finish shall be adopted for different area as per functional requirement. However, contractor shall prepare a comprehensive scheme of floor finish with complete plan and details of the material to be used for the approval of the Owner before the execution of the work.

(a) Vitrified Ceramic Tiles with or without mirror polish

- This shall be homogeneous and compact throughout the entire body and fully vitrified. The minimum compressive strength and modulus of the tile shall be 700 kg per sq.cm and 300 kg per sq. respectively and MOH hardness not less than 6 (unpolished).
- Following sizes of the tiles shall generally be provided based on the area of application.
 - 400mm x 400mm x 8mm (nominal)
 - 600mm x 600mm x 9mm (nominal)
 - 750mm x 750mm x 10mm (nominal)

(b) Heavy duty cement concrete tiles

Size of the tiles shall be 300mm x 300mm x 25mm and conforming to IS: 1237. Top wearing coat shall be made of white cement mixed with pigment and abrasion resistant carborundum / quartz stone chips of different colours. Tile shall be laid as per IS: 1443.

(c) Cement concrete flooring with metallic or non-metallic hardener topping

This shall consist of 12mm thick metallic hardner topping with OPC. In case of non metallic hardner finish, readymix non metallic hard granules shall be spread directly over concrete base at a rate of 5kg per square meter.

(d) Cement concrete flooring with neat cement finish

Ordinary grey cement finish shall be applied over green concrete at the rate of 2.5 kg/sq.m and finished smooth.

(e) Cement concrete flooring with epoxy resin finish

This shall be laid with acid, alkali and oil resistant high build, solvent free, self smoothing, seamless epoxy resin floor finish. Total Dry Film Thickness (DFT) of the coating (excluding primer) shall be minimum 300 micron.

(f) Interlocking Concrete Paver Block

This shall be provided as per IRC: SP:63

(g) Granite Stone flooring

Pre polished Granite stone of minimum 18mm thickness shall be provided and nominal size of a single slab shall not be less than 0.4 sq.m.

(h) Marble Stone flooring

Rajnagar Marble of 18mm thickness shall be plain white marble with coarse grain predominantly showing mica particles giving reflection in bright light.

(i) Acid and Alkali resistant lining

- Acid and Alkali resistant lining for DM plant, CPU regeneration complex including neutralisation pit, acid battery area etc shall conform to the following
- Bitumen Primer shall conform to IS: 158
- Bitumastic compound shall conform to IS: 9510. Where the height of Bitumastic layer on vertical surface is more than 2.0 meter, the Bitumastic layer shall be reinforced with diamond pattern expanded metal steel sheets conforming to IS: 412.
- A.R. Bricks / Tiles shall conform to class II of IS: 4860 and IS: 4457 respectively.
- Potassium Silicate bedding mortar and resin type joint mortar shall conform to IS: 4832 Part-I & II.

19.4.5 Painting for Masonry Works

(i) Water proof Cement Based Paint

On all external surfaces exposed to outdoor conditions which does not require aesthetically special treatment, water-proof cement base paint conforming to IS: 5410 shall be applied.

(ii) Oil Bound Distemper

Oil Bound Distemper shall conform to IS: 428. The primer shall be cement primer or distemper primer. Only sufficient quantity of distemper required for a day's work shall be prepared.

(iii) Acrylic Emulsion Paint

Acrylic Emulsion Paint shall be water based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigment and fungicide conforming to IS: 5411 (Part-I)

(iv) Chemical Resistant Paint

Chlorinated Rubber Paint shall be made from natural rubber and chlorine. Suitable colour pigment shall be added for finishing coat. For primer, chlorinated rubber zinc phosphate shall be used. Titanium dioxide / micaceous iron oxide shall be used for intermediate coat.

(v) White Wash

In unimportant area like portion above False Ceiling etc., white wash shall be applied as per IS: 6278.

(vi) Granular Textured Coating

Resin bonded granular textured decorative coating shall consist of adhesive synthetic resins and natural crushed stone chips or pigmented synthetic granules. For interior applications, nominal thickness of 1.2mm of pigmented granular coating and for external finish, nominal thickness of 2.5mm coating using natural stone chips shall be used. For application of coat, the plastered surface shall be prepared and coating applied as per the manufacturer's recommendations. This shall be of approved make with satisfactory performance for a minimum period of 10 years.

19.4.6 Painting for Structural Steel

Type and details of paint shall be as mentioned under corrosion protection requirements. Properties of the paint shall conform to BS: 5493. In addition final coat shall be UV resistant particularly for outdoor application.

19.4.7 Plinth Protection

All buildings shall be provided with minimum 1000 mm wide and 100 mm thick concrete paving around the outside with peripheral toe drain. Plinth protection shall be laid over prepared subgrade and base formed with broken brick bats or rubble laid to a thickness of 150 mm.

19.4.8 Water Supply, Sanitation and Plumbing

Roof water tank of adequate capacity depending on the number of users and 8 hours requirement shall be provided for each building and pump house. Polyethylene water storage tank conforming to IS:12701 shall be used. The tank shall be complete with all fittings including float valve, stop cock etc.

Galvanised MS pipe of medium class conforming to IS:1239 shall be used for internal piping works for potable water supply.

Sand C.I. pipes with lead joints conforming to IS:1729 shall be used for sanitary works above ground level.

Minimum one toilet block with all the facilities shall be provided on each floor of turbo-generator building, administrative building and service building. Separate toilets for ladies shall be provided wherever required. Attached toilets shall be provided for all senior executive rooms and conference rooms. All other buildings where toilet is specified shall have 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 below. 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.

Each toilet block shall have the following minimum facilities. Unless specified all the fittings shall be of chromium plated brass (fancy type).

- (a) One set of WC (Indian type) Orissa pattern as per IS: 2556 (Part-3) and 1 no. bibcock with all fittings including flushing arrangement of appropriate capacity and type.
- (b) One set of WC western type as per IS: 2556 (part 2) with toilet paper roll holder and bibcock and all fittings including, flushing system of appropriate capacity and type.
- (c) Minimum two sets of urinal with all fittings with photo voltaic control flushing system as per IS: 2556 (Part-6, Sec.1).
- (d) Two sets of wash basin (oval shape) with all fittings as per IS: 2556 to be fixed on concrete platform finished with 12 mm thick polished granite stone.
- (e) Wall to wall Bathroom mirror (5.5 mm thick float glass) with bevelled edges including all fittings.
- (f) Two sets of stainless steel towel rail (600 x 20mm).
- (g) Two sets of stainless steel liquid soap holder cum dispenser.
- (h) Janitor room.
- (i) Provision for installation of water cooler.
- (j) Provision of ventilation shaft.

Attached toilets provided for senior executive rooms and conference rooms shall have 1 WC, 1 urinal, 1 washbasin, 1 mirror, 1 no. towel rail, 1 liquid soap holder cum dispenser. WC shall be of western type as per IS: 2556(Part-2) with toilet paper roll holder and all fittings including flushing valve of appropriate capacity and type. All toilets shall have atleast 1 no. of exhaust fan. Final no. of exhaust fans shall be decided as per ventilation requirements to maintain hygienic conditions in the toilet.

An eye & face fountain (combined unit with receptacle) 'conforming to IS: 10592 shall be provided in battery room (acid type), D.M plant and Chlorination plant.

Provision of toilet, bath room with shower facility and pantry shall be provided in different building as per requirement.

Stainless steel kitchen sink (750 mm size) for pantry shall be provided. Platform in pantry shall be finished with 18 mm thick polished granite stone.

Laboratory sink shall be of white vitreous china of size 600x400x200 mm conforming to IS: 2556(Part-5) in laboratories and battery room.

In Main Turbine building, Service building and Administrative building at least one toilet block shall be provided for ladies.

All sanitary fittings and plumbing fixtures shall be of the best quality and make, and shall be subject to Owner's approval. All water supply fittings in toilets, kitchen etc viz., bibcocks, pillar cocks, P-traps, towel rail, shower rose, gratings etc., shall be of best quality chromium plated brass of approved make.

19.5 Fencing and Gate

19.5.1 Fencing

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

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

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 RCC 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 cement paint of approved colour and shade. Toe wall shall be provided with weep holes at appropriate spacings.

19.5.2 Gate

All gates shall be of structural steel of minimum 3.75 m width for single lane access road and 7.75 m width for double lane access roads. The height of gate shall be same as that of the fence. Each gate shall have provision for wicket gate of size 1.0 m x 2.1 m. The gate frame and post shall be fabricated from medium class MS pipe of nominal diameter not less than 75 mm. The panel plate shall be of minimum thickness 2.5 mm conforming to IS: 513.

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

19.6 Finishing Schedule

Interior and Exterior Finishes shall be as given in Table 19.1 and Table 19.2 respectively.

Table 19.1: Interior Finishing Schedule

Sl. No.	Description of Area	Flooring	Wall Finish over Cement Plaster	Ceiling Finish over Cement Plaster
1	Operating / Maintenance areas of workshop, Pump houses, Compressor house, DG set, Air washer building, AC Equipment Room, Air handling room, Mill & Bunker building, Transfer points.	RCC with Metallic hardener topping for general area For Control room area- Mirror polished verified Cermaic tiles	Oil bound distemper For Control room Acrylic emulsion paint over plaster of paris	Oil bound distemper For Control room Pre-coated (colour) Aluminium false ceiling in approved pattern
2	General storage areas	RCC with Metallic hardener topping	Oil bound distemper	Oil bound distemper
3	Cable Vault / Cable spreader	-do-	-do-	-do-
4	Boiler area paving			
	a) Equipment / Vehicle movement area	RCC with Metallic hardener topping	-	-
	b) Balance area	Concrete Paving Block	-	-
5	Turbo-generator building (Main Plant Building)			
	a) Ground Floor			
	(i) Railway track area	RCC with Metallic hardener topping	Oil bound distemper	Oil bound distemper

	(ii) Balance area including passage	RCC with metallic hardener topping	-do-	-do-
	b) Mezzanine floor (excluding grating area)	Heavy duty concrete tiles	-do-	-do-
	c) Deareator floor	RCC with metallic hardener topper	-do-	Metal deck
	d) Operating floor			
	(i) Operating area, Laydown area, Heater area	18mm thick polished granite stone (1st quality) with combination of 10 mm polished vitrified ceramic tiles and heavy duty concrete tiles.	Acrylic emulsion paint over plaster of paris (except cladding area) Adjacent to control room area 1.2mm thick resin and polymer bonded granular textured coating finish above the glazed area	Oil bound distemper (except metal deck area)
	ii) General circulation and movement areas	10mm thick vitrified ceramic tiles in combination of mirror polished and unpolished tiles	Oil bound distemper over plaster of paris (except cladding area)	-do-
6	a) MCC room	10mm thick vitrified ceramic tiles (unpolished)	Oil bound distemper over plaster of Paris	Oil bound distemper
	b) Switchgear room	RCC with metallic hardener topping	Oil bound distemper	Oil bound distemper
7	a) Control room area including Central control room, Computer room and Control equipment room. (False flooring area may be restricted in control room)	10mm thick mirror polished vitrified ceramic tiles. False flooring area with Pre laminated over high density particle board	Mirror polished Vitrified ceramic tiles up to false ceiling height.	Precoated colour) / Al. Lineal false ceiling in approved pattern With combination of Gypsum board for area requiring profiled shape
	b) Conference room, Senior executive room	Mirror polished Vitrified tiles	Acrylic emulsion paint over plaster of paris.	-do-
	c) Record room	Mirror polished Vitrified tiles	Oil bound distemper over plaster of Paris	Oil bound distemper
	d) Locker room	Mirror polished Vitrified tiles	Oil bound distemper over plaster of Paris	Oil bound distemper

8	Toilet area	Unpolished Vitrified Ceramic tiles	Coloured ceramic tiles upto 2.2m with border tiles wherever required and oil bound distemper over plaster of paris for balance height	Oil bound distemper
9	Pantry Area & Canteen	i)10mm thick vitrified ceramic tiles in combination of mirror polished and unpolished tiles ii) 18mm thick polished granite stone for counter platform	Coloured ceramic tiles up to 1.2m and oil bound distemper over plaster of paris for balance height	Oil bound distemper
10	Office Room, Staff Room	Mirror Polished vitrified ceramic tiles	Acrylic emulsion paint over plaster of paris	Precoated (colour) Al. Lineal false ceiling in approved pattern
11	SWAS room	Mirror Polished vitrified ceramic tiles	Acrylic emulsion paint over plaster of paris	-do-
12	Laboratory area	10mm thick vitrified ceramic tiles in combination of mirror polished and unpolished tiles	Acrylic emulsion paint over plaster of paris	Oil bound distemper
13	RCC Stair case	Combination of 18mm thick marble and kota stone (first quality) for tread & riser respectively	Coloured ceramic tile matt finish up to 1.2m ht & 1.2mm thick Resin bonded granular texture finish for balance height.	Oil bond distemper over plaster of paris on underside of staircase
14	Entrance lobbies and Lift areas	18mm thick polished granite stone	1.2 mm thick resin bonded granular textured finish. Mirror polished vitrified ceramic tiles on lift facia.	Precoated (colour) Al. Lineal false ceiling in approved pattern
15	Passages and General circulation areas	18mm thick Marble stone (first quality) with border	Oil bond distemper over plaster of paris	-do-
16	Battery Room			

	i) For lead acid batteries	20mm thick acid resistant tiles over bitumen primer.	20mm thick acid resistant tiles over bitumen primer upto 1.2 m height and chemical resistant paint for balance height	Chemical resistant paint.
	ii) For Ni-Cd batteries	10mm thick verified ceramic tiles.	Oil bound distemper over Plaster Of Paris	Oil bound distemper
17	Oil canal, oil room, oil purification tank and other areas where oil spillage is likely to occur.	Oil resistant paint (epoxy based amine cured) 150 micron over primer on CC flooring	Oil resistant paint upto 1.2m height and Oil bound distemper for balance height.	Oil bound distemper except oil canal area.
18	Re-generation and other areas requiring acid / alkali resistant treatment.	Acid & Alkaline resistant bricks, tiles with applicable mortar	Oil bound distemper above acid resistant skirting	Oil bound distemper
19	Covered parking area	Interlocking cement concrete blocks	-	Pre coated metal sheet
20	Pathways including equipment installation area on top of roof	22mm thick concrete chequered tiles.	-	-

Notes:

- 1) All wall and roof areas above false ceiling shall be plastered and white washed.
- 2) For wall finishing shall be provided above 150mm height matching skirting
- 3) The colour and pattern of finish shall be as per approved details.
- 4) All material shall be of reputed and established brand approved by Owner.
- 5) Wherever alternative materials are specified, the final selection rests with the Owner.
- 6) This finishing schedule shall also be applicable to similar functional areas for all other buildings and facilities.
- 7) All the finishing materials shall be applied / provided as per manufacturer specification and guidelines under the supervision & guidelines of manufacturer.
- 8) Requirement given above are suggestive and minimum. Contractor is free to suggest alternative scheme conforming to design & functional requirement subject to approval of the Owner.

Table 19.2: Exterior Finishing Schedule

Sl. No.	Description of Area	Walls and Projections	Soffit of Projection
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1	Turbine building and mill building	<p>i) Initial height of 3m (nominal) permanent finish using bricks cladding in cement mortar, finished with plastering, smooth finish and 2.5mm thick resin and polymer bounded granular textured coat.</p> <p>ii) Approved color / color combination of color coated metal cladding for balance height.</p>	<p>i) Two coats of water proof cement based paint as per IS:5410. over primer coat.</p> <p>ii)Approved color /color combination of color coated metal cladding.</p>
2	Building with concrete frame work, fire walls etc.	2.5mm thick resin and polymer bounded granular textured coat.	Two coats of water proof cement based paint as per IS:5410. over primer coat.
3	Steel structures, trestles etc.	High performance chemical resistant painting system having UV resistant top coat with approved colour and shade as per requirement of corrosion protection.	-
4	Chimney	Top 50 m painting using polyurethane with colour band for aviation requirements as per technical specification. The balance portion shall receive two coats of synthetic enamel paint.	-
5	Cooling tower	Two coats of water proof cement based paint as per IS:5410. over the primer coat.	-
6	Boundary wall	Two coats of water proof cement based paint as per IS:5410. Over the primer coat applied on plaster surface.	-

Note:

1. The colour and pattern of finish shall be as finalized by the Owner.
2. All materials shall be of reputed and established brand approved by the Owner.
3. All the finishing work shall be carried out as per manufacturer specifications and of approved colour.

20 Constr uction and Allied Requirements

20.1 General

All construction shall be carried out based on approved final construction and fabrication drawings. Execution shall be done as per all the relevant Indian Standards and good engineering practices. Quality control, testing and acceptance shall be on the basis of approved Quality Assurance Plan (QAP). For stacking and storage of construction material at site IS: 4082 shall be followed. Due very aggressive coastal (marine) environment special precaution shall be taken for storage of structural steel and reinforcement

20.2 Materials

20.2.1 Cement

Ordinary Portland Cement, grade 43, conforming to IS:8112 shall be used for RCC work of Chimney, Cooling Tower, rotating equipment foundations (TG, Mill, BFP, PA, ID, FD) including top deck and any other major equipment foundations.

For other concrete and masonry works, Ordinary Portland Cement or Portland Slag Cement conforming to IS: 455 or fly ash based Portland Pozzolana cement conforming to IS: 1489 (Part -1) may be used.

Higher grade of Ordinary Portland Cement, grade 53, conforming to IS: 12269 may also be used for specific application considering proper measure to take care of higher heat of hydration.

For specific corrosion protection, wherever necessary, special type of cement shall be used as specified.

20.2.2 Coarse Aggregate

Coarse aggregate for concrete shall be crushed stones, chemically inert, hard, strong, durable against weathering, limited porosity and free from deleterious materials. It shall be properly graded. It shall meet the requirements of IS: 383. Aggregate shall also be checked for alkali-aggregate and alkali-carbonate reaction including Petrographic examination particularly for machine foundation and water retaining structures and suitable precaution shall be taken, if necessary. For RCC work maximum size of coarse aggregate shall generally be of 20mm. However, for certain concrete work maximum size shall be not more than 12.5mm. For lean concrete provided as mud mat below structural concrete, maximum size up to 40mm shall be used.

20.2.3 Fine aggregate

Sand shall be hard, durable, clean and free from adherent coatings of organic matter and clay balls or pellets. Sand, when used as fine aggregate in concrete shall conform to IS: 383. For plaster, it shall conform to IS: 1542 and for masonry work to IS: 2116.

20.2.4 Reinforcement Steel

Reinforcement bars shall be thermo mechanical treated(TMT) bars of grade Fe415/ Fe500 conforming to IS:1786 . However, for grade, Fe500 elongation requirement shall be same as for Fe415 for its ductile behaviour.

Mild steel bars shall conform to grade-1 of IS: 432 (Part- 1) or grade A of IS: 2062.

Welded wire fabric shall conform to IS: 1566.

20.2.5 Structural Steel

Structural steel (including embedded steel) shall be straight, sound, free from twists, cracks, flaw, laminations and all other defects. .

Mild Steel shall conform to Grade-A of IS: 2062 for rolled steel members or plates up to 20 mm thickness. For plates above 20 mm thickness and welded construction steel conforming to Grade-B (killed and normalized) of IS: 2062 shall be used. Plates beyond 40mm thickness shall be normalized and ultrasonically tested. Medium & High tensile grade steel can also be used with proper precaution for welding and preheating.

Chequered plate shall conform to IS: 3502 of grade-A of IS: 2062 and minimum thickness of chequered plate for floorings, covers etc shall be 6 mm (on plane)

Hollow (square and rectangular) steel sections shall be hot formed conforming to IS: 4923 and Pipes shall conform to IS: 116 of grade of steel Y_{st} 240.

20.2.6 Bricks

Burnt clay bricks of class designation 5 (minimum) conforming to IS: 1077 shall be used in case fly ash based brick is not available.. Fly ash lime bricks shall conform to IS: 12894 and fly ash clay bricks shall conform to IS: 13757. Minimum percentage of fly ash shall be 25%.for flyash based brick.

20.2.7 Water

Water used for cement concrete, mortar, plaster, grout, curing, washing of coarse aggregates, 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. Sea water shall not be used for mixing in concrete and for curing.

20.3 Concrete Works

20.3.1 General

Concrete work shall be carried out 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 IS: 10262. Specific approval of the Engineer shall be obtained regarding degree of quality control to be adopted for design mix.

20.3.2 Grade of Concrete

Minimum grade of concrete for all RCC work shall be M25 and actual grade shall be as per actual exposure condition as specified in IS: 456. However minimum grade of concrete for ordinary structure under indoor conditions may be M20.

The grades of concrete for some of the major structures and machine foundations are given in Table 20.1

Table 20.1: Grade of Concrete

Sl. No.	Description	Minimum grade of concrete
i)	TG Top Deck	M35
ii)	ID, FD and PA fan Deck	M35
iii)	Block type foundation like Coal Mill	M30
iv)	Sub structure supporting top decks of TG, ID/FD/PA Fans, Mills including raft/ footings	M30
v)	BFP foundations including deck	M35
vi)	CW Pump House, CW Channel	M30

Higher grade of concrete than specified above may be used at the discretion of the Contractor.

20.3.3 Temperature Control of Concrete

The temperature of fresh concrete used for top decks of machine foundations shall not exceed 25⁰C when placed. For maintaining the temperature of 25⁰C in the top decks of machine foundations, crushed ice shall be used in mixing water and cooling of aggregate.

20.3.4 Admixture

Plasticizer/super plasticizer admixture shall generally be added to concrete for promoting workability and pumping of concrete. In addition, plasticizer/super plasticizer-cum-retarder shall be added to retard the setting time for mass concreting work as required. Admixture shall conform to IS:9103. 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 in Table 20.2.

Table 20.2: Slump of Concrete

Description	Slump Value
Top decks of STG	150 mm to 200 mm
Block foundation	100 mm to 150 mm
Column	100 mm to 150 mm
Piling	150 mm to 180 mm

20.3.5 Form work and Staging

All formwork shall be formed using approved quality BWP type, densified plywood with suitable overlay (film faced) and conforming to IS: 35139 (Part-III) and IS: 4990 to produce a perfectly levelled, uniform and smooth surface. Film face shall have minimum 250 gm/sqm coating. Form work shall conform to IS: 456 and IS: 14687.

The staging shall be true and rigid and thoroughly braced in both directions as well as cross braced, strutted and propped such that it will not deform unduly under weight of concrete and other loads.

Removal of formwork shall be as per IS: 456.

20.3.6 Placing of Concrete

General placement of all RCC work shall be by pumping as per the site condition and work requirement. Placement of concrete in piles shall be through tremie pipe. However placement of non structural concrete (PCC) such as flooring, plain / lean concreting can also be done by other means.

Top deck of machine foundations shall be cast in a single pour.

Adequate curing for required period shall be ensured using water or curing compound.

20.3.7 Chemical Injection Grouting

Chemical injection grouting shall be provided for the waterproofing of underground concrete structure including joints as shown in final construction drawing according to IS: 6494.

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

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

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

20.3.8 Ultrasonic Testing

Ultrasonic pulse velocity test shall be carried out for the critical structure like top decks of TG etc to ascertain the homogeneity and integrity of concrete. In addition, additional cubes (at the rate of one cube per 150.0 cu.m of concrete subject to a minimum of six cubes having size 150mmx150mm x150mm) shall be taken to carry out Ultrasonic Pulse velocity (UPV) testing on the cubes, to serve as reference UPV values. Testing shall be done as per IS: 13311 (Part-1). In case of any defect, the Contractor shall rectify the defects suitably using cement or low viscosity epoxy grout, etc.without any extra cost to the Owner.

20.4 Broken Hard Stone Filling

For the sub grade of RCC grade slab and area paving 63mm to 45mm graded hard stone aggregate shall be used as per IRC specification including filling of interstices of stone aggregate with Sand or Moorum. Minimum thickness of the filling shall generally be 225 mm with nominal thickness of each layer as 75mm.

20.5 Steel work

Fabrication and erection of structural steel works including welding, bolting shall be carried out as per IS: 800 and requirement specified under design criteria & Quality Assurance Plan.

20.6 Construction and Erection Methodology

The Contractor shall execute all works at site as per approved construction and erection methodology based on the detail given herein:

- Construction and erection activities shall generally be mechanised.
- The Contractor shall prepare detailed construction and erection methodology scheme, which shall be compatible to the requirements.
- All excavation and backfilling works shall be done using excavators, loaders, dumpers, dozers, poclains, jcb's excavator, rock breakers, vibro compactors, vibratory rollers, vibro rollers, sprinklers, water tankers, etc. Manual excavation can be done only on isolated places, with specific prior approval of the Owner..

- Sheet Piling shall be used in the deep foundation like Wagon Tippler, CW Pump House and other areas wherever is required.
- De-watering wherever required shall be done using the combination of electrical and standby diesel pumps. Wherever necessary, well-point de-watering system shall generally be deployed. Sludge pumps and high head pumps, wherever required, shall be used.
- For controlled rock blasting (if applicable) specialist agency, equipped with sensors to assess the impact of the blast on the adjoining existing structures, shall be employed. Pneumatic wagon drills with compressors shall be deployed for controlled blasting.
- In case of Bored pile, installation shall be done using rotary hydraulic rig capable of boring up to 30m below FGL or as applicable and suitable for flushing with air lift technique.
- All concreting shall be done using centralised batching plant, transit mixers, concrete pumps and electrical hoists. Individual mixers for localised concreting can only be used for PCC works.
- The structural steel shall generally be fabricated and erected frame wise and bay wise and if required temporary strengthening of members during erection shall be made.
- All fabrication and erection activities of structural steel shall generally be carried out using automatic submerged arc welding machines, MIG welding machines, welding generators, pug cutting machines, cutting torches, pillar drill machines, gantry cranes, crawler mounted heavy cranes and other equipment like heavy plate bending machines, shearing machines, lathe, milling machines, grinders, etc.
- Fabricated structure shall preferably be transported from the pre-assembly / fabrication yard to the erection site by trolley moving on rails.
- Fabrication and erection of all structural steel works shall be done with the help of cranes only. Use of derricks shall not be preferred. Gantry cranes / truck mounted / cranes / crawler cranes shall be used in pre-assembly yard / fabrication yard. Heavy crane having lifting capacity and boom length matching with the heaviest part to be lifted shall be used for the erection work, in combinations of other cranes. For erection of heavy members simultaneous use of two cranes may be required. Columns and roof trusses shall be erected in single piece, unless specified otherwise.
- Blast cleaning of the steel surfaces shall be done in a suitable enclosure, so as not to cause any damage / pollution to the adjoining areas. Painting shall generally be done using airless spray guns. Handling of the structures shall be done in a mechanised way.
- Modular units of scaffolding and shuttering shall be used. Slipform shuttering shall be used for chimney.
- Grouting shall be carried out using hydraulically controlled grouting equipment.
- All finishing items including roofing / cladding / sheeting, etc, shall be installed / fixed in position, using appropriate modern mechanical tools and deploying expert technicians. Manual punching, etc, shall not be permitted.
- Electrical power winches, electrically operated heavy duty hoists and tyre mounted mobile tower crane, for lifting of construction materials shall be deployed.
- Cleaning of surfaces wherever required, shall be done by compressed air using heavy duty compressors.
- Stone / tile / marble / granite cutting and polishing machines shall be deployed for flooring works.
- Breaking of concrete, wherever required, shall be done by using jack hammers, diamond cutter as per requirement.

- Field laboratory shall be provided with all latest equipment for survey, testing of soil, aggregates, concrete, etc. For testing of structural steel works, ultrasonic testing machines, radiographic testing machines, dye penetration test equipment, etc, shall be deployed as specified in Quality Assurance requirements. Help of specialist agencies shall be taken for ultra sonic/radiographic and other specialised testing.
- Other materials like cables, slings, heating ovens, pre-heating arrangement, materials for making platforms and platform supports, etc, shall be mobilised as per the requirement.
- All persons working at site shall be provided with necessary safety equipment such as gloves, goggles, safety belts, safety helmets, reflective jacket etc.
- All safety aspects shall be duly considered for each construction/erection activity. Contactor shall prepare a activity wise detailed safety plan for the approval from Owner, considering risk involved & its safety measure for all types of activities to be taken place during project etc.
- Contractor shall also ensure the availability of adequate medical facilities at site as per approved plan.
- Only the persons who are trained in the respective trade shall be employed for executing that particular type of work.
- Construction of machine foundation and other main foundations shall be done after the approval of the scheme for staging and concreting.
- All layouts and levels shall be taken using digitised theodolite and level i.e. Total workstation.
- Concrete core cutting machine and concrete sawing machine shall be used respectively for making circular and slit type opening in the concrete. Rebar detector shall be used to identify the location of reinforcement, before making opening in the concrete.
- Comprehensive scheme for the construction of Offshore Intake structure shall be prepared including towing & placing of the well in Sea, sinking of well below sea bed and bottom plugging etc. for the approval from the Owner. Further for construction of approach bridge (jetty), construction methodology shall also be furnished.
- The Contractor shall mobilise all plants, equipment & machineries required for successful completion of the work. A suggested list of the plants, equipment & machineries required to be deployed by the Contractor (for main plant works) to match with the agreed work schedule and the construction and erection methodology is appended as Appendix – C to this document. This list, however, is not an exhaustive list but specifies the suggested minimum requirements of plant, equipment and machineries to be deployed for the execution. Any additional plants, equipment and machinery required for the timely completion of the works but not listed in the Appendix – C shall also be deployed by the Contractor, as directed by the Owner.

21 Township

21.1 General

The township is to be designed and developed on a land of about 12 acres (excluding peripheral green belt) to accommodate 200 employees and their families and must also host basic social amenities for its inhabitants.

This shall include site planning, preparation of master plan, architecture detailing, execution of civil works, erection and commissioning of buildings including plumbing, fitting & fixtures, electrification, interiors, landscaping, water supply, sewage treatment, necessary assistance for obtaining approval from all appropriate authorities for all works and systems involved.

21.2 Requirements

21.2.1 Housing

(i) Residential Buildings

The site has to accommodate 200 dwelling units of residential buildings as given below:

- (a) Deluxe Type – 1 Unit
- (b) Type I – 14 Units
- (c) Type II – 35 Units
- (d) Type III – 75 Units
- (e) Type IV – 75 Units

(ii) Barracks for Security Personnel

21.2.2 Non Residential Buildings

- (a) Bank
- (b) Post office
- (c) Community Centre
- (d) Club
- (e) Dispensary
- (f) Guest house
- (g) Sports complex
- (h) Estate office
- (i) Telephone exchange
- (j) Transport centre
- (k) Shopping centre

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- (l) Primary school

21.2.3 Utilities

- (a) Electricity supply and distribution system.
(b) Water supply and distribution system.
(c) Sewage system including treatment plant.

21.3 Planning and Design

21.3.1 Township Planning

The planning of the township is to be done in way to provide comfortable living and a good quality of life to its employees. The plan must aim to make the township self sufficient in all possible aspects and units to be grouped in residential cluster and public building in an accessible quarter of the site.

- Safety and security of the users to be considered primary in the planning and design of the site.
- While planning the site it is important to give due consideration to the conservation of the environment.
- The plan should try to preserve natural features including topography and vegetation.
- Cutting and filling may be adopted in creating levels for making public spaces appealing and interesting.
- The design should try to maximize the utility of land on the site.
- Rainwater harvesting structures to be incorporated in the design of the site to augment water requirement for landscaping.
- A compound wall of height of 3 m along the perimeter of the site and separate entry gate with security guard cabin.
- Detailed site analysis and site assessments to be made prior to zoning and conceptualisation of the design.
- Zoning of site to consider for following aspects.
 - Accessibility and circulation
 - Security
 - Site geometry
 - Topography
 - Noise
 - Visual connectivity
 - Purpose
 - External environment

21.4 Access

21.4.1 Access to the Site

Independent access to the township from the nearest main road shall be provided by a 4 lane road with divider of at least 20 m in overall width.

21.4.2 Internal Access

- Vehicular access to be provided around the township with bituminous paving and other than community centre and market place, which shall be provided with concrete paving as per IRC 58.
- Separate paved pedestrian access around the township connecting the residential and public areas not conflicting with vehicular movement around the area.
- Design should encourage pedestrian access over vehicular access around the area.
- Vehicular access to be provided to each housing unit.

21.5 Spatial Organisation of Built units

Grouping of public buildings of similar character is to be considered to emulate modern urban clusters.

21.6 Orientation and Alignment of Building Units

Geometric alignment is to be adopted in positioning of building units with reference to each other and to roads.

21.7 Drainage

The design of drains shall follow general site topology and commensurate with site geometry. Under ground pipe drain and rectangular drain with a pre-cast cover shall be provided. Detail of the drainage system shall be as stipulate as under clause 4.5.

21.8 Architectural Works

Integrity of theme to be observed in the design of residential and public spaces should be with due consideration for aesthetic appeal.

21.8.1 Residential Units

The details for residential units for different types are indicated in table below

Table 21.1: Details of Residential Units

Category of Housing	No. of Units	No. of Stories	Details of Accommodation	Built up area
Type – Deluxe	1	Single Storey	3BR+1DR+1Kitchen+2WC+ 1 office room with attached toilet	170 sq.m
Type – I	14	Single Storey	3BR+1DR+1Kitchen+2WC	140 sq.m
Type – II	35	Ground + 1 st Floor	2BR+1DR+1Kitchen+2WC	115 sq.m
Type – Iii	75	Ground + 2 nd Floor	2BR+1DR+1Kitchen+1WC	90 sq.m
Type - IV	75	Ground + 2 nd Floor	1BR+1DR+1Kitchen+1WC	70 sq.m

- Housing block not to exceed G+2 for any catagories.
- Use of architectural elements where required to enhance the appearance of the housing units.

21.8.2 Barracks for Security Personnel

Barracks for 50 security personnel with dormitory type accommodation with minimum 5 m² floor area of personal space per person shall be provided. In addition kitchen & dining hall and common room to be provided shall not be less than 150 m².

21.8.3 Design of Non Residential Building

The broad specification for design of public buildings and spaces are indicated below.

(i) Bank

- Building to accommodate a bank with office, cash counters, safe deposit vaults and an ATM suitable to host a branch office of a nationalised/ leading private bank shall be provided
- The built up area of the bank shall not be less than 120 m².

(ii) Post Office

- Building for post office with mail sorting facility, storage and office for clerical staff shall be planned.
- The built up area of the post office shall not be less than 80 m².

(iii) Community Centre

A community hall for 500 people with reception, air conditioned hall, kitchen, toilets and dining facilities shall be designed.

The built up area of the community hall shall not be than 950 m².

(iv) Club

A social club for 60 people with card room, billiard room, cafeteria and bar shall be planned.

The built up area of the club shall not be less than 280 m².

(v) Dispensary

- A medical dispensary catering to the employees to include first aid centre, 10 beds, medical storage and dispensing facilities and covered parking for ambulance shall be provided.
- The built up area of the dispensary shall not be less than 200 m².

(vi) Guest House

- A guest house of two storey building having 20 air conditioned rooms (single and double) with reception and guest lobby, kitchen and dining hall shall be planned.
- Rooms to have a utilitarian area shall not be less than 20 m² per guest.
- The built up area of the guest house shall not be less than 750 m².

(vii) Sports Complex

- A sports complex shall not be less than 1900 m² of area with sports facilities including tennis courts, volleyball court and basketball ground.
- Covered sports facilities including table tennis, shuttle courts and gymnasium housed in a building with build up area shall not be less than 400 m².

(viii) Estate Office

- An estate office to accommodate offices for administrative managers and engineers shall be planned. In addition back end workshops and storage yard for site maintenance equipment shall be provided.
- The build up area of the estate office shall not be less than 450 m² with sufficient space for open yards.

(ix) Telephone Exchange

- A telephone exchange for a telephony and data services shall be provided
- The arrangement and area requirement of the telephone exchange shall be as approved layout.

(x) Transport Centre

- A transport centre shall be provided for company vehicles and public vehicles including buses, vans, taxis and auto rickshaws.
- Completely paved area shall not be less than 1400 m². The terminal to include rest shelters and drivers lounge and administrative offices shall not be less than 280 m² built up area.

(xi) Shopping Centre

- A shopping centre with no less than 10 shops with a minimum carpet area of 20 m² each shall be provided.
- The built up area of the shopping centre shall not be less than 470 m².

(xii) Primary School

- A primary school with playground shall not be less than 930 m² of area.
- Built up area of the school shall not be less than 470 m².
- The school to have at least 10 class rooms with a seating capacity of 30 students each with adequate space for admin room, stores, pantry and toilet block.

(xiii) Common Guidelines

- Toilets are to be provided in public spaces as per requirements and to relevant design standards.
- Car and 2-wheeler parking are to be estimated and provided as per requirement maintaining design standards adjoining non residential buildings.
- Compound wall/fencing shall be designed adequately to secure and segregate zones of different nature/character.
- Street lighting shall be provided to illuminate township roads and public access areas as per requirement.

21.8.4 Architectural Detailing

- (a) During detailed engineering, architectural plan, elevation and section shall be prepared for Owner's approval. This shall also include details of finishing schedule, fitting and fixture.
- (b) All building other than bank, post office and shopping centre shall be completed with all fitting and fixture including cub board, kitchen cabinet, curtain rod, geyser etc for ready to occupy. However, curtain, carpet and furnitures shall be procured separately.
- (c) Exact type of finishing shall be finalised during detailed engineering. However, some of the basic requirements are as follow:
 - Exterior masonry surface of building shall be finished with 27 mm nominal thick washed stone grit plaster in two layer made in panel with groove, under layer 12mm cement plaster 1:4 and top layer 15mm thick white cement plaster using marble and other types of chips.
 - Roof water proofing cum insulation treatment using 120mm (average) thick brick bat coba shall be provided, where false ceiling and under deck insulation not envisaged such as the case of residential building.

- Flooring shall generally provided with vitrified ceramics tiles (unpolished and mirror polished) of different size and colour.
- Internal wall shall generally be provided oil bound distemper on plastered surfaces. However all important areas like guest house, deluxe type residential house etc. shall be provided with acrylic emulsion paint over POP surface.
- Windows shall generally be provided using electro colour coated extruded aluminium section and minimum 4mm thick float glass.
- Door shall be generally provided using 35 mm thick solid core flush door shutter, as per IS: 2202 (part-II) and factory made panel door for residential building, guest house etc and for other buildings, aluminium, door shall be provided.
- High quality colour sanitary wares, fitting and fixture shall be used for guest house, deluxe type residential building and for other buildings, material shall be as specified under chapter 19.

21.9 Utilities

- (a) Electricity supply and distribution system (11/33 kV) shall be designed as per requirement.
- (b) Water supply and distribution system including over head RCC tank, underground caste iron pipe distribution network etc. shall be designed as per requirement.
- (c) Sewage system including treatment plant shall be design requirement as mentioned under clause 4.7. Sewage treatment plant for township can be combined with the main plant.

21.10 Landscaping

Landscaping of site shall be incorporated in the planning of site and design of built form.

21.10.1 General Landscaping

- Green strips along the pedestrian access ways.
- Lawns adjoining each cluster of residential units.
- Native species of plants combined with hard landscape features need be used for general landscaping.
- Benches and hard seats to be provided at places where public could be gathered.
- Ornamental lighting to be adopted in spaces of intimate scale.

21.10.2 Paving

Paving of pedestrian access and interconnecting spaces adjoining public buildings.

21.10.3 Park

A park with a multipurpose sports ground, vegetated garden and children play area with installed equipment such as slide, swings, see-saw and jungle gym shall be planned in an area of 2800 m².

21.10.4 Landscape Conservation

- Buffers required for conservation of natural/ecological features shall be adopted.
- Vegetative cover shall be provided for conservation of slopes.

21.11 Structural Design

All buildings shall be provided with RCC framed structure with infilled brick masonry works. Design of structures shall be as specified under clause 3.0 of the specification pertaining to civil, structural and architecture works.

22 Quality Assurance

Sampling, testing and quality assurance requirements for civil works(for civil ,structural and architectural) are given in Volume-1, Section-9 of Technical Specifications. This covers the construction tolerance, acceptance criteria and QA requirements etc, list of typical field quality laboratory equipment for different activities. Contractor shall prepare and submit Field Quality Plan (FQP) in line with the technical requirement to follow during execution of works after approval.

Appendix A List of Codes and Standards

A.1 Excavation and Filling

- IS: 2720 Methods of test for soils (relevant parts)
- IS: 4701 Code of practice for earthwork 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.

A.2 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 hard drawn steel wires
(Part 1&2) for concrete reinforcement
- IS: 455 Portland slag cement
- IS: 702 Industrial bitumen
- IS: 712 Specification for building limes
- IS: 1077 Specification for common burnt clay building bricks
- IS: 1161 Steel tubes for structural purposes
- IS: 1239 Mild steel tubes, tubulars and other wrought steel fittings - 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 Technical supply condition for threaded fasteners
(Part 1-18)
- IS: 1489 Portland-pozzolana cement, Fly ash based
(Part-I)
- 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	Steel for general structural purposes
IS: 2116	Sand for masonry mortars
IS: 2386	Testing of aggregates for concrete
(Part I-VIII)	
IS: 3819	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: 12269	53 grade ordinary portland cement.
IS: 12894	Specification for fly ash lime bricks
IS: 13757	Burnt clay fly ash building bricks

A.3 Cast in-Situ Concrete and Allied Work

IS: 280	Mild steel wire for general engineering purpose.
IS: 456	Code of practice for plain and reinforcement concrete
IS: 516	Method of test for strength of concrete
IS: 1199	Methods of sampling and analysis of concrete
IS: 1791	General requirement for batch type concrete mixers
IS: 1834	Hot applied sealing compound for joints in concrete
IS: 1838	Preformed fillers for expansion joints in concrete pavement and structures.
IS: 2438	Specification for roller pan mixers
IS: 2502	Code of practice for bending and fixing of bars for concrete reinforcement
IS: 2505	Concrete vibrators - immersion type
IS: 2506	General requirements for screed board concrete vibrators
IS: 2722	Specification for Portable Swing weigh batchers for concrete (single and double bucket type).

IS: 2750	Steel scaffoldings
IS: 2751	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction
IS: 3150	Hexagonal wire netting for general purposes
IS: 3366	Specification for pan vibrators
IS: 3370	Code of practice for concrete structures for the storage of liquids
(Part 1-4)	
IS: 3558	Code of practice for use of immersion vibrators for consolidating concrete
IS: 4014	Code of practice for steel tubular scaffolding
(Part-1&2)	
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	Code of practice for extreme weather concreting
(Part -1&2)	
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: 13290	Code of practice for ductile detailing of Reinforced Concrete Structures subjected to Seismic force.
IS: 14687	Guidelines for false work for Concrete structures
SP-16	Design codes for reinforced concrete to IS: 456
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.

A.4 Precast Concrete Works

SP: 7	National Building Code – Structural Design of prefabrication and system building.
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

A.5 Masonry & Allied Works

IS: 1905	Code of practice for structural use of un-reinforced masonry
IS: 2212	Code of practice for brickwork
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.

A.6 Sheet Metal Works

IS: 277	Galvanised steel sheets (Plan & corrugated)
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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 galvanise steel sheets and coils.
BS: 5950	Code of practice for design of light gauge profiled steel sheeting
(Part-6)	
AS/NZS: 2728	Pre finished / pre painted sheet metal product for interior / exterior building applications – Performance requirements
AS: 3566	Self drilling screw for building and construction industry.

A.7 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 substructure 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 chequered 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	Submerged 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 Fusion welding of steel.
(Part - I)	
IS: 7310 (Part-I)	Approval test for welders working to approval welding procedure Fusion welding of steel
IS: 9178	Criteria for design of steel bins for storage of bulk material
(Part-1 to 3)	

IS: 9595 Recommendations for metal arc welding of carbon & carbon manganese steel

IS: 12843 Tolerances for erection of steel structures

SP: 6 ISI Hand book for structural Engineers (Part 1 to 7)

(Part 1 to 7)

A.8 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 Gypsum building plaster

(Parts 1 & 2)

A.9 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 Method of Test for chemical resistant tiles

(Part I & II)

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

A.10 Water Supply, Drainage and Sanitation

IS: 458 Precast concrete pipes (with & without reinforcement)

IS: 554	Dimensions for pipe threads, where pressure tight joints are required on the thread
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: 1239	Mild Steel tubes, tubular and other wrought steel fittings (Part 1&2)
(Part 1&2)	
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	Sand cast iron spigot and socket soil, water and ventilation pipes, fittings and accessories
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	Seamless or electric welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm 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: 4764	Tolerance limits for sewage effluents discharged into inland surface waters
IS: 4827	Electroplated coating of nickel and chromium on copper and copper alloys.
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 Publication-	Manual on sewage and sewage treatment

A.11 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: 420 Putty, for use on metal 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 Timber panelled and glazed shutters (doors shutters)

(Part I)

- IS: 1003 Timber panelled and glazed shutters door shutters

(Part-1)

- 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 board face panels and hard board face panels.
- (Part-2)
- IS: 2209 Mortice locks (vertical type)
- IS: 2553 Safety glass General purposes

(Part-1)

- 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.
IS: 14900	Transparent Float Glass

A.12 Roof Water Proofing and Allied Works

IS: 306	Code of practice for general design details and preparatory work for damp proofing and water proofing of buildings
ASTM C836-89a	Standard specification for high solid content cold liquid applied elastomeric water proofing membrane for use with separate wearing course
ASTM C898-89	Standard guide for use of high solid content cold liquid applied elastomeric water Proofing membrane for use with separate wearing course

A.13 Floor Finishes and Allied Works

IS: 1237	Cement Concrete Flooring Tiles
IS: 1443	Code of practice for laying and finishing of cement concrete flooring tiles
IS: 2571	Code of practice for laying in situ cement concrete flooring
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

A.14 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 ferrous metals in buildings
- (Part -1) Pre-treatment
- (Part -2) Painting
- IS: 1650 Specification for colours for building and decorative materials
- IS: 2074 Ready mixed paint, air drying, red oxide-zinc chrome, priming
- IS: 2338 Code of practice for finishing of wood and wood based materials
- (Part -1) Operations and Workmanship
- (Part -2) Schedule
- IS: 2395 Code of practice 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: 5411 Plastic emulsion paint (Part-1&2)
- (Part-1&2)
- 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 packs)
IS: 13239	Epoxy surfacer (2 packs)
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.

A.15 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
IS: 2950 (Part-1)	Code of practice for designs and construction of Raft foundation 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 (Part -1) (Part -2)	Code of practice for calculation of settlement of foundation Shallow foundations Deep foundations
IS: 12070	Code of practice for design and construction of shallow foundations on rocks
IS: 13301	Guidelines for Vibration Isolation for Machine Foundations
VDI: 2056	Criteria for assessing mechanical vibrations of machines.
VDI: 2060	Criteria for assessing the of balance of rotating rigid bodies.

- DIN: 2089 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.

A.16 Roads

- IRC: 5 Standard specifications and Code of practice for road bridges, (Section-1) General Features of Design.
- IRC: 14 Recommended practice for 2cm thick bitumen and tar carpets.
- IRC: 16 Specification for priming of base course with bituminous primers.
- IRC: 19 Standard specifications and Code of practice for water bound macadam.
- 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: 63 Guidelines for the use of Interlocking Concrete Block Pavement.
- 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 - Ministry of Surface Transport (Road wing), Publication specifications for road and bridge works.
- IS: 73 Paving bitumen.

A.17 Loading

- IS: 875 Code of practice for design loads (other than earthquake) for buildings and structures
- IS: 1893 Criteria for earthquake resistant design of structures
- IRC: 6 Standard specifications & Code of practice for road bridges (Section-II) loads and stresses

A.18 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 Safety code for scaffolds and ladders
(Part-1&2)
- 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

A.19 Architectural Design of Buildings

- SP: 7 National Building Code of India
- SP: 41 Handbook on functional requirements of buildings (other than industrial buildings)

A.20 Chimney

- 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

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	Rigid steel conduits for electrical wiring
	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

A.21 Ash Dyke

IS: 1498	Classification and Identification of Soils for General Engineering Purposes
IS: 7894	Code of Practice for stability Analysis of Earth Dams
IS: 8237	Code of Practice for Protection of Slopes for Reservoir Embankment
IS: 8826	Guidelines for design of large Earth and Rockfilled Dams
IS: 9429	Code of Practice for drainage system for Earth and Rockfill Dams
USBR	Design of Small Dams
USBR	Earth Manual

A.22 Geotechnical Work

IS: 1498	Classification and Identification of Soils for general engineering purpose
IS: 1888	Method of Load test on Soil
IS: 1892	Code of practice for sub surface investigation for foundation
IS: 2131	Method of Standard Penetration Test for Soils
IS: 2132	Code of Practice for Thin walled tube sampling of Soils
IS: 2720	Method of Test for Soils (relevant Parts)

IS: 2809	Glossary of Terms and Symbols relating to Soil Engineering
IS: 2810	Glossary of Terms relating to Soil Dynamics
IS: 3043	Code of Practice for Earthing
IS: 4434	Code of Practice for In-situ Vane Shear Test for Soils
IS: 4453	Code of Practice for Exploration by Pits, Trenches, Drifts and Shafts
IS: 4464	Code of Practice for presentation of Drilling information and Core description of Foundation Engineering
IS: 4968 II)	Method for Subsurface Sounding for Soils – Dynamic method using Cone and Bentonite (Part-
IS: 4968 (Part-III)	Method for Subsurface Sounding for Soils – Static Cone Penetration Method
IS: 5313	Guide for Core Drilling Observations
IS: 5529 (Part-II)	Code of Practice for in-situ Permeability Test- Test in Over Burden
IS: 6926	Code of Practice for Diamond Core Drilling for Site Investigation for River Valley Projects
IS: 6935	Method of determination of Water Level in Bore-Hole
IS:7422 (Relevant Parts)	Symbols and Abbreviations for use in Geological Maps, Sections and Subsurface Exploratory Logs
IS: 8763	Guide for Undisturbed Sampling of Sands
IS: 8764	Method for determination of Point Load Strength Index of Rocks
IS: 9143	Method for the determination of Unconfined Compressive Strength of Rock Materials
IS: 9179	Methods for preparation of Rock Specimen for Laboratory Testing
IS: 9198	Compaction Rammer for Soil Testing
IS: 9214	Determination of Modulus of Subgrade Reaction in Field
IS: 10060	Code of Practice for Subsurface Investigation for Power House Sites
IS: 10837	Specification of Moulds for determination of Relative Density and its accessories

IS: 11315 Description of Discontinuities in Rock Mass – Core Recovery and Rock Quality (Part-II)

IS: 13372 Code of Practice – Seismic Testing of Rock Mass.

A.23 Miscellaneous

IS: 802 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: 11504 Criteria for Structural Design of Reinforced Concrete Natural Draught Cooling Tower

IS: 11592 Code of practice for selection and design of belt conveyors

CIRIA Publication Design and construction of buried thin-wall pipes.

Appendix B List of suggestive Construction Plants Equipment and Machineries

S. No.	Description	Nos
1	Rotary hydraulic piling rig with accessories to drill in all type of soils and rock upto average depth of 30m from FGL.	4
	Crane with 15T capacity minimum 15 m boom	4
	Casing pipes of minimum 6.0m length with minimum clearance of 25 to 30 mm between inner side of casing pipe to outer side of auger / bucket	
	760mm Diameter or above as per the requirement	20
	Up to 600 mm Diameter	5
	Compressor for flushing of piles bore for air lift technique (minimum capacity of 740 cft/min. & air pressure of 12kg/sq.cm)	2
	Flushing pipe (5" dia)	1Set per Rig
	Tremie pipe (8" dia)	1Set per Rig
	Bentonite recirculation pump (minimum 25 HP vertical pump)	3
	Bentonite feed pump (minimum 35 HP pump)	3
	Hose pipe for bentonite recirculation	As per requirement
	Kentledge with reaction system for	
	760 dia	1 Set
	600 dia	1 set
2	Crane - 150 MT	1
3	Crane – 100 MT	2
4	Crane – 75 MT	2
5	Gantry Crane - 20 MT	2
	Gantry Crane - 8 MT	1
	Mobile Crane - 20 MT	3
	Mobile Crane - 8 MT	1
6	Hydra 12 MT	10
7	Tractor - 50 H.P.	3
8	Trailers – 50 MT capacity	3
	Trailers – 10 to 15 MT capacity	6
9	Trolley for transporting fabricated material	6
10	Submerged Arc Automatic Welding Machine (Can be substituted by suitable numbers of MIG Welding)	3
11	MIG welding set	45
12	Welding transformer	10
13	Welding generator / rectifiers -400 A to 600 A	
	for Structural Steel Works	45
	for piling works	8
14	Pug cutting machine	24
	Gas cutting machine	4

S. No.	Description	Nos
15	Pillar drill machine - upto 2"	4
	Radial drill machine	2
16	Bench grinder	6
17	Hand grinder	24
18	Flexible grinder	5
19	Portable drill machine	4
20	Cutting torches	20
21	Electrical power winches for varying capacities	30
22	Chain pulley block - 5 MT to 20 MT	10
23	Chain pulley block - 1 MT to 5 MT	6
24	Radiographic testing machine	3
25	Ultrasonic testing machine	3
26	Dye penetration test	As per requirement
27	Destructive testing equipment	-do-
28	Lab equipment	As per given in Table 11.1 pertaining to Quality Assurance Requirement under Volume-I
29	Batching plant (with computer printout) of quantities 30/40 Cu.M./Hr	2 Sets
30	Concrete mixers 10/7Cu.M./hr. capacity	8
31	Transit mixer-minimum 5.0 Cu.M. capacity	6
32	Concrete pump - 37 Cu.M / Hr.	4
33	Excavator (Poclain and J.C.B.)	2+2
34	Vibrators - Needle type	12
35	Vibrators - Float, plate etc.	3
36	Staging for TG / BFP/ ID Fan - Full set for one unit	1
37	Lathe machine	1
38	De-watering pumps	
	3 H. P. to 5 H.P.	6
	10 H.P. to 20 H.P.	6
39	Sludge pump	1
40	High head pump	2
41	Dumper / trucks	10
42	Scaffolding units including shuttering plates	As per requirement
43	Service compressor with hose	2
44	Floor cutting and polishing machine	3
45	Speed winches / Hoists (for concrete and other building material)	6
46	Jack hammers/Pavement Breakers	2
47	Wagon drills (pneumatic) with compressor for control blasting	As per requirement
48	Portable magazine	-do-
49	Scaffolding pipe staging including clamps	-do-
50	Marble / Tile cutting machine.	4
51	Vibro compactor / vibro roller / double drum vibratory roller	

S. No.	Description	Nos
	Drum width 500mm	1
	Drum width 750mm	1
	Drum width 900mm	1
	Plate Compactor	4
52	Truck mounted concrete pump along with mixer/alternatively truck mounted mixer with placing boom of minimum 40M high.	2
53	Portable hydraulic hammer / chisel	1
54	Concrete coring machine for drilling in concrete upto 150mm diameter along with diamond bits	1
55	Total workstation for surveying including Digital Theodolite and Digital Level.	1
56	Painting equipment set complete with compressor, hopper, screen, blasting hose pipe, nozzle, airless /conventional Spray etc.	10 Sets
57	Plate Bending Machine (25mm x 2500 mm)	2
58	Plasma cutting machine	1
59	Concrete paver / spreader	As per requirement
60	Concrete sawing machine for cutting slit type opening in concrete	1
61	Water tanker	2
62	Arrangement of construction water complete with pumps / pipes / water tanker / underground tank / over ground tank etc.	As per requirement
63	Preheating / post weld heat treatment equipment / arrangement for welding of structures	-do-
64	Rebar detector for detecting the reinforcement bar position in concrete before creating, in situ opening.	1
65	DG Set 125 KVA	1
66	Plate straightening machine	
	20 X 2500 MM	1
67	Chipping Hammer	2
68	Punching Machine (Minimum Letter size 20 mm)	4 Sets
69	Bar Bending and Cutting Machine	4
70	Bull dozer	2
71	Road Paver & Finisher	1
72	Roller (10 Tonne Capacity)	3
73	Vibratory Roller	1
74	Sheep Foot Roller	2
75	Slipform Shuttering	1
76	Verticality Measuring Plumb	As per Requirement
77	Verticality Measuring Laser System	-do-
78	Misc. Tools & Tackles	-do-
79	Sheet Pile driving Rig (Vibratory Type)	1
80	250 MT Capacity crane ¹	1 (whenever required)

- ¹ It is suggested that one no. of 250 tonnes capacity crane shall be put inside the plant on permanent basis for general erection work which shall be utilised for erection of civil structures as and when required.

**VOLUME-III REV-02
PRICE SCHEDULE: (PART A AND PART B)**

SCOPE OF WORK :

PART A - Construction of Ash Pond with recovery water pump house etc. on EPC basis

PART B - Civil, structural & architectural works for leveling & grading , Sweet water reservoir, Sweet water Pump house, Boundary wall, watch towers, gate complex, plant roads, plant storm water drains and culverts, other civil and electrical enabling works for covered/semi covered storage shed, office, temporary roads and drains etc.

for 2 X 520 MW HNPCL/ VIZAG TPP, Vishakhapatnam, AP.

TENDER NO - PSER:SCT:VIZ:C1128:10

PREAMBLE

01	This preamble forms part of tender document and schedule of items. The tenderer should read this preamble carefully in filling rates for various items. Clauses under this preamble shall be read in conjunction with various volumes of tender as per NIT together with subsequent changes/ modifications etc thereto as applicable as on date of submission of price offer.
02	The work shall be carried out strictly as per specifications, description of the items in these schedule and / or engineer's instructions.
03	Items of work provided in this schedule but not covered in this specification shall be executed strictly as per instruction of the engineer.
04	Unless specifically mentioned otherwise in the tender document, the tenderer shall quote for the finished items and shall provide for the complete cost towards power, fuel, tools, tackles, equipment, constructional plants, temporary works, labour, dismantling of all temporary piping, structures, valves, pumps, tanks & other misc equipment, strengthening of roads/culverts/bridges etc including arranging all clearances etc required for carrying out different activities & tests, materials, levies, taxes, transport, layout, repairs, rectification, maintenance till handing over, supervisions, colonies, shops, establishments, overheads, profits and all incidental items not specifically mentioned but reasonably implied and necessary to complete the work according to the tender document and this schedule.
05	The rates quoted for PART- A shall be inclusive of cleaning of site of any vegetation, dressing and leveling etc including fixing of grid pillars, benchmarks etc required for commencement of site activities. No separate payment will be made towards the same for PART-A.
06	Rates shall be quoted in figures and in words in clear legible writing. No overwriting is allowed. All scoring and cancellations should be countersigned and in case of illegibility the interpretation of engineer shall be final. All entries shall be in English.
07	The tender shall be deemed to have visited site and made himself aware of all the site conditions, studied the specifications and details of work to be done within the time schedule attached and to have acquainted himself of the conditions prevailing at site.
08	Engineer's decision shall be final and binding on the contractor regarding clarification of items in the schedule with respect to the other sections/volumes of the contract.
09	The quantities of the various items mentioned in this schedule of items (for Part B) are approximate, based on very preliminary information and may vary to any extent or be deleted altogether. The quoted/ accepted rates shall remain firm and valid as long as variation in total value of work executed under this contract (for part B of the Price Schedule) including extra items, but excluding any price escalation, remains within +/- 30% (thirty percent) of the contract price (for Part B of the price schedule) given in the LOI/WO.
10	All works item wise shall be measured upon completion and paid for at the rates quoted and accepted. Note: Bidder may note that Dimensions indicated against ST No. 3400 (SI. No. 319) are tentative in nature.
11	EVALUATION SHALL BE DONE BASED ON OVERALL QUOTED PRICE FOR BOTH PART - A AND PART - B COMBINED TOGETHER.

VOLUME-III , REV 02

PRICE SCHEDULE: (PART A AND PART B)

SUMMARY OF PRICES FOR PART A + PART B .

SCOPE OF WORK :

PART A - Construction of Ash Pond with recovery water pump house etc. on EPC basis

PART B - Civil, structural & architectural works for leveling & grading , Sweet water reservoir, Sweet water Pump house, Boundary wall, watch towers, gate complex, plant roads, plant storm water drains and culverts, other civil and electrical enabling works for covered/semi covered storage shed, office, temporary roads and drains etc.

for 2 X 520 MW HNPCL/ VIZAG TPP. Vishakhapatnam. AP.

TENDER NO - PSER:SCT:VIZ:C1128:10

SL. NO.	PACKAGE	TOTAL PRICE (IN RS.)
1.0	LUMPSUM PRICE AS PER RATE SCHEDULE OF PART A (Construction of Ash Pond with recovery water pump house etc. on EPC basis).	
2.0	TOTAL PRICE AS PER RATE SCHEDULE OF PART B (Civil, structural & architectural works for leveling & grading , Sweet water reservoir, Sweet water Pump house, Boundary wall, watch towers, gate complex, plant roads, plant storm water drains and culverts, other civil and electrical enabling works for covered/semi covered storage shed, office, temporary roads and drains etc.)	
3.0	GRAND TOTAL OF PRICES AT SL. NO. 1 + SL NO. 2 (IN RS.)	

Notes:

1	Bidder to note that total price indicated above at Sl. No. 3.0, shall be considered for evaluation and hence should be complete in all respect for the full scope defined and considering all terms and conditions.
2	In case, price indicated above does not match with the total of item wise break-up given at Price Schedule Part-A and Part-B respectively, the highest price so calculated shall be considered for evaluation but in case of order, the same shall be placed at the lowest price.

VOLUME-III REV-02

PRICE SCHEDULE: (PART A)

PART A - Construction of Ash Pond with recovery water pump house on EPC basis.

TENDER NO :- PSER:SCT:VIZ:C1128:10

Bidders are requested to submit their price only as sought under price schedule below :-

SL. NO	DESCRIPTION OF ITEM	QUANTITY a	UNIT	UNIT RATE (in Rs) b	TOTAL AMOUNT (in Rs) (In figures & In Words) a x b
1.0	LUMPSUM PRICE FOR Construction of Ash Pond with recovery water pump house etc. on EPC basis.	1	LOT		

**VOLUME-III REV-02
PRICE SCHEDULE: (PART B)**

PART B - Civil, structural & architectural works for leveling & grading , Sweet water reservoir, Sweet water Pump house, Boundary wall, watch towers, gate complex, plant roads, plant storm water drains and culverts, other civil and electrical enabling works for covered/semi covered storage shed, office, temporary roads and drains etc.

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
	100	EARTH WORK				
		Earth work In excavation, backfilling and disposal including necessary men/women, materials, equipment, loading, transportation, unloading, dewatering etc as per specification, drawing and as directed by engineer- in-charge for the following.				
1.0	101	Earth work in excavation in all types of soil including ash which can be excavated by any means including setting out, levelling, dewatering (but excluding special type of dewatering viz. well point method), shoring & strutting (wherever required), dressing the sides & bottom, all lifts, ramming/compacting the excavated bottom, stacking, disposal of surplus excavated materials within a lead upto 500 m, spreading/levelling of disposed materials etc all complete for following depths below ground level.				
1.1	a	Depth from ground level but not exceeding 2 m	CUM	101839		
1.2	b	Depth exceeding 2 m but not exceeding 4 m	CUM	12122		
1.3	c	Depth exceeding 4 m but not exceeding 6 m	CUM	3930		
1.4	d	Depth exceeding 6 m but not exceeding 8 m	CUM	1315		
1.5	e	Depth exceeding 8 m but not exceeding 10 m	CUM	250		
1.6	f	Depth exceeding 10 m but not exceeding 15 m	CUM	120		
2.0	102	Extra over ST No. 101 for dewatering of ground water by well point method as per IS 9759.	CUM	22932		
3.0	107	Back filling upto any depth below ground level around foundations, plinths, trenches, drains etc to proper grade and level in layers not exceeding 250 mm thickness using/with selected materials from compulsorily excavated soil available within a lead upto 500m and compacted as specified including re-excavation of stacked earth, watering, ramming/compaction by manual/mechanical means, dressing etc all complete.for the following.				
3.1	a	Each layer compacted so as to achieve at least 95% maximum dry density as per IS-2720 (Part-VII)	CUM	3369		
3.2	b	Each layer compacted so as to achieve at least 90% maximum dry density as per IS-2720 (Part-VII)	CUM	2246		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
3.3	e	Each layer compacted so as to achieve at least 85% relative density as per IS-2720 part XIV in case of sandy soils.	CUM	16845		
4.0	108	Back filling upto any depth below ground level around foundations, plinths, trenches, drains etc to proper grade and level in layers not exceeding 250 mm thickness using/with selected materials directly from excavation and compacted as specified including watering, ramming/compaction by manual/mechanical means, dressing etc all complete for the following. (Backfilling is from selected materials directly from excavation i.e. without any intermediate stacking. Hence no lead is considered in this item).				
4.1	a	Each layer compacted so as to achieve at least 95% maximum dry density as per IS-2720 (Part-VII)	CUM	7860		
4.2	b	Each layer compacted so as to achieve at least 90% maximum dry density as per IS-2720 (Part-VII)	CUM	5240		
4.3	e	Each layer compacted so as to achieve at least 85% relative density as per IS-2720 part XIV in case of sandy soils.	CUM	39302		
5.0	109 a	Extra over ST No. 101 and 107 for carriage of excavated earth/selected materials for every 1 KM or part thereof beyond an initial lead of 500m.	CUM	37012		
6.0	110	Back filling upto any depth below ground level around foundations, plinths, trenches, drains etc to proper grade and level in layers not exceeding 250 mm thickness using/with approved borrowed soil (borrowed soil to be arranged by the bidder) and compacted as specified including supplying borrowed soil, royalty (if any), watering, ramming/compaction by manual/mechanical means, dressing etc all complete for the following.				
6.1	a	Each layer compacted so as to achieve at least 95% maximum dry density as per IS-2720 (Part-VII)	CUM	1125		
6.2	b	Each layer compacted so as to achieve at least 90% maximum dry density as per IS-2720 (Part-VII)	CUM	750		
6.3	e	Each layer compacted so as to achieve at least 85% relative density as per IS-2720 part XIV in case of sandy soils.	CUM	8289		
7.0	111	Supplying and filling sand upto any depth under floors, around foundations, plinths etc. in layers not exceeding 250 mm thickness and compacted so as to achieve at least 80% relative density as per IS-2720 (Part-XIV) including spreading, watering, ramming/compaction by manual / mechanical means, dressing, royalty (if any) etc. all complete.	CUM	65		
	200	CONCRETE WORKS				

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
		Providing and placing concrete work including cost of labour, materials and equipment for handling, transportation, batching, mixing, placing, vibrating and curing, (excluding cost of centering, shuttering and reinforcement) with mechanised equipments like batching plant, transit mixer, concrete pump etc. complete as per drawing, specifications and as per direction of engineer in charge for the following. (Cement will be supplied by BHEL as per SCC free of cost):				
8.0	201	Concrete of grade M7.5 (1 part cement, 4 part sand, 8 parts of 40 mm graded aggregate by volume) as filling course at any depth below finished floor level, under and around foundations/floors, mass fill etc.	CUM	245		
9.0	202	Concrete of grade M10 (1 part cement, 3 part sand, 6 parts of 40 mm graded aggregate by volume) as lean concrete, levelling course , mud mat under and around foundations/floors at any depth below finished floor level etc.	CUM	1044		
9.1	A202	Concrete of grade M7.5 (1 part cement, 4 part sand, 8 parts of 40 mm graded aggregate by volume) as lean concrete, levelling course, mud mat under and around foundations/floors, pipe encasement, anchoring of HDPE liner etc at any depth below finished floor level etc.all inclusive	CUM	5349		
10.0	203	Concrete of grade M15 (1 part cement, 2 part sand, 4 parts of 40 mm graded aggregate by volume) as lean concrete, levelling course , mud mat under and around foundations/floors at any depth below finished floor level etc.	CUM	217		
11.0	204	Concrete under floors, paving, plinth protection, pipe encasing etc complete with 20 mm nominal size graded aggregate at any depth below finished floor level for the following grades.				
11.1	b	M20 Grade	CUM	14		
12.0	205	Providing and laying Design Mix cement concrete conforming to IS:456 & IS 10262-2009 for reinforced concrete works with coarse sand and graded hard stone aggregate of 20mm nominal size in foundations/substructure, grade slab, paving, drains, under floors etc at any level below finished floor level, any shape, position or thickness etc complete including use of plasticizer/ superplasticizer conforming to IS:9103 (latest) to achieve required slump in concrete all complete as per specification & drawing for the following.				
12.1	a	M25 Grade	CUM	12640		
12.2	b	M30 Grade	CUM	18310		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
12.3	A205	Providing and laying Design Mix cement concrete conforming to IS:456 & IS 10262-2009 for reinforced concrete works with coarse sand and graded hard stone aggregate of 20mm nominal size in foundations/substructure, grade slab, paving, drains, under floors ,concrete bands on slope etc at any level below finished floor level, any shape, position or thickness etc complete including use of plasticizer/ superplasticizer conforming to IS:9103 (latest) to achieve required slump in concrete all complete as per specification & drawing for the following.				
12.3.1	a	M20 Grade	CUM	750		
13.0	206	Providing and laying Design Mix cement concrete conforming to IS:456 & IS 10262-2009 for reinforced concrete works with coarse sand and graded hard stone aggregate of 20mm nominal size in superstructure at any level above finished floor level, any shape, position or thickness etc complete including use of plasticizer/ superplasticizer conforming to IS:9103 (latest) to achieve required slump in concrete all complete as per specification & drawing for the following.				
13.1	a	M25 Grade	CUM	1620		
13.2	b	M30 Grade	CUM	410		
14.0	211	Providing and encasing of structural steel member with concrete using nominal aggregate size of 12.5mm down. Encased member shall be wrapped with welded wire mesh/chicken wire mesh with proper lap etc. complete as per specification for the following grades. (Payment of welded wire mesh, chicken wire mesh shall be made separately)				
14.1	b	M25 grade	CUM	50		
14.2	212	Screed concrete conforming to IS 456 with coarse sand and graded hard stone aggregate 12.5mm/6 mm nominal size on the roof at any level or thickness, drains etc complete as per following.				
14.2.1	a	1:2:4 (1 part cement, 2 part sand, 4 parts of aggregate by volume)	CUM	12		
15.0	213	Providing and laying Design Mix cement concrete as per IS:456 & IS 10262-2009 for reinforced concrete works using graded aggregate for Concrete in precast works like roof slabs/trench covers, fins, lintels, chajas, beams, columns, wall panels, facias etc.at all levels in all kinds of work including formwork/moulds, curing, rendering the top exposed surface with cement sand mortar (1:3), handling, storing, transpoting, all leads, erection without damage, setting in position with cement sand mortar (1:3), filling the gaps between adjacent precast units with M30 grade concrete or cement sand mortar (1:3) and including making of holes for bolts for fixing, welding etc.complete with graded aggregate (20/12.5/10 mm) and as per specification and drawing for following grades.				
15.1	a	M 25 grade	CUM	30		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
15.2	b	M 30 grade	CUM	30		
16.0	214	Providing and laying Design Mix cement concrete as per IS:456, IS 3370 & IS 10262-2009 for reinforced concrete works using graded aggregate for Concrete in water retaining/conveying structures including addition of suitable plastisizer cum waterproofing cement additives conforming to IS 9103 latest to achieve a slump more than 125 mm in concrete as per manufacturers recommendation and conforming to limits of permeability as per IS 2545 and specification with 20 mm nominal size graded aggregate for following grades.				
16.1	b	M 30 grade for below and above FGL	CUM	350		
17.0	215	Dismantling concrete work for all types of structures at all levels including stacking of servicable material to a lead of 500 m and disposal of unservicable material upto a lead of 2 km, cutting of reinforcement, labour, equipment, safety precautions etc all complete as per drawings, specification and instructions of engineer in charge.				
17.1	a	Plain cement concrete of all grades	CUM	15		
17.2	b	Reinforced cement concrete of all grades	CUM	48		
18.0	216	Chipping of concrete in reinforced concrete work, cutting pockets, making openings at all levels and according to shapes, disposal of waste materials upto a lead of 2 km as directed by engineer including equipment, safety precautions, making good the broken surface etc all complete as per specification, drawing, instructions of engineer in charge but excluding cutting of reinforcement .	CUDM	100		
19.0	217	Extra over and above St No 216 for cutting of reinforcement , all sizes and types including labour, equipment, return of cut reinforcement to store etc all complete as per specification, drawings and instructions of engineer in charge. Measurement shall be on the cross sectional area of reinforcement cut.	SQCM	120		
20.0	218	Cutting Reinforced concrete with mechanised tools like Core drilling machine etc. for cutting pockets, holes, cores in slab, beam, column or foundation as per direction of engineer in charge.	CUDM	100		
21.0	219	Providing and applying curing compound of approved make where ever required as per manufacturer's specification.	SQM	200		
	300	FORM WORKS				
		Providing, fixing and removing formwork at any elevations for all structures, as per specifications and including all labour, material, scaffoldings and centering complete including pockets etc. complete as per drawing, specifications and as per direction of engineer in charge for the following.				
22.0	301	Fairface form work with good quality water proof ply wood of required thickness and smooth surface below finished ground floor level for foundations, footings, base of columns, walls, columns, pilasters, beams, mass concrete, trenches etc.	SQM	11445		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
23.0	A301	Formwork using approved quality BWP type, densified plywood with suitable overlay (film faced) and conforming to IS: 35139 (Part-III) and IS: 4990 to produce a perfectly levelled, uniform and smooth surface below finished ground floor level . Film face shall have minimum 250 gm/sqm coating. Form work shall conform to IS: 456 and IS: 14687.	SQM	92362		
24.0	302	Fairface form work with good quality water proof ply wood of required thickness and smooth surface above finished ground floor level for columns, beams, suspended floors, roofs, lintels, cantilevers, staircases, landings, balconies, domes, arches, circular overhead tanks etc. for all heights.	SQM	9845		
25.0	A302	Formwork using approved quality BWP type, densified plywood with suitable overlay (film faced) and conforming to IS: 35139 (Part-III) and IS: 4990 to produce a perfectly levelled, uniform and smooth surface above finished ground floor level . Film face shall have minimum 250 gm/sqm coating. Form work shall conform to IS: 456 and IS: 14687.	SQM	42520		
26.0	304	Providing, fixing and removing formwork in block-outs/pockets and openings (below 0.1 sqm plan area) at all elevations including cutting, formation of all shapes and all other operations required for making the required shape and size all complete as per specification, drawing and instruction of engineer in charge.				
26.1	a	Upto 150 mm depth	Each	30		
26.2	b	Pockets of depths more than 150mm and upto 300 mm depth	Each	20		
26.3	c	Pockets of depths more than 300mm and upto 600 mm depth	Each	10		
26.4	d	Pockets of depths more than 600mm and upto 1000 mm depth	Each	5		
26.5	e	Pockets of depths more than 1000mm and upto 1500 mm depth	Each	5		
	400	REINFORCEMENT				
27.0	401	Providing, straightening, cutting, bending, placing in position at any level, binding of mild steel reinforcements conforming to grade 1 of IS:432 part 1 in concrete including cost of reinforcement and binding wire, labour, scaffolding, transportation to & from stores etc. all complete as per specifications & drawings. (ALL MATERIALS TO BE SUPPLIED BY CONTRACTOR FROM SAIL/RINL/TISCO ETC) Payment terms - a) On receipt of materials at site - 65%; b) On completion of erection & fixing - 35%.	MT	30		
28.0	402 A	Providing, straightening, cutting, bending, placing in position at any level, binding in position of steel reinforcements of TMT steel of grade Fe-500 confirming to IS:1786 including cost of reinforcement and binding wire, labour, scaffolding, transportation to & from stores etc complete all as per specifications, drawings and as directed by Engineer. (ALL MATERIALS TO BE SUPPLIED BY CONTRACTOR FROM SAIL/RINL/TISCO ETC) Payment terms - a) On receipt of materials at site - 65%; b) On completion of erection & fixing - 35%.	MT	20		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
29.0	402 B	Transportation, straightening, cutting, bending, placing in position at any level, binding in position of steel reinforcements of TMT steel of grade Fe-500 confirming to IS:1786 including cost of binding wire, labour, scaffolding, transportation to & from stores etc complete all as per specifications, drawings and as directed by Engineer. (Reinforcement will be supplied by BHEL as per SCC free of cost)	MT	155		
30.0	403	Transportation, straightening, cutting, bending, placing in position at any level, binding in position of steel reinforcements of TMT steel of grade Fe-500D or 500EQR confirming to IS:1786 including cost of binding wire, labour, scaffolding, transportation to & from stores etc complete all as per specifications, drawings and as directed by Engineer. (Reinforcement will be supplied by BHEL as per SCC free of cost)	MT	1723		
31.0	405	Transportation, straightening, cutting, bending, placing in position at any level, binding in position of corrosion resistant steel -HCRM re-bars of approved make with steel of grade Fe-500 confirming to IS:1786 norms including cost of binding wire, labour, scaffolding, transportation to & from stores etc complete all as per specifications, drawings and as directed by Engineer. (Reinforcement will be supplied by BHEL as per SCC free of cost)	MT	196		
32.0	406	Providing, straightening cutting, bending, placing in position at any level, binding of mild steel reinforcements in brickwork including cost of reinforcement and binding wire, labour, scaffolding etc. complete all as per specifications & drawings. (ALL MATERIALS TO BE SUPPLIED BY CONTRACTOR FROM SAIL/RINL/TISCO ETC) Payment terms - a) On receipt of materials at site - 65%; b) On completion of erection & fixing - 35%.	MT	10		
33.0	407	Transportation, straightening, cutting, bending, placing in position at any level, binding in position high yield strength steel reinforcements in brickwork including cost of binding wire, labour, scaffolding etc. complete all as per specifications & drawings. (Reinforcement will be supplied by BHEL as per SCC free of cost)	MT	15		
	500	WATER PROOFING WORKS				
		Water proofing works including all labour, material, equipment, transportation, handling, curing, sampling, testing etc at any level as per specification, drawings and as directed by engineer - in - charge. (Contractor has to furnish a guarantee for material and workmanship for a minimum period of 10 years). (Cement will be supplied by BHEL as per SCC free of cost).				
34.0	501	Providing and laying underbed grading plaster with cement mortar 1:4 (1 cement : 4 sand) and average thickness of 25 mm including preparation of surface, batching, mixing, leveling etc. all complete.	SQM	230		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
35.0	506	Providing and applying PU based water proofing treatment with one coat of polyurethane or any other equivalent material based primer with an application rate of minimum 6 sq.m per litre and two successive liquid coatings of high solids content urethane pre-polymers or equivalent material based finish coats as per relevant IS/ASTM standards to form an elastomeric membrane with overall dry film thickness 1.5 mm subject to minimum 500 gm/sqm/coat application rate. Item includes surface preparation, polyscrim cloth /fabric for edges, joints & vulnerable points etc all complete as per specifications and directions of engineer in charge.	SQM	230		
36.0	A507	Providing and laying wearing course consisting of 25mm thick plain cement concrete of grade M20 (1:2:4) with graded aggregate of 12.5mm size cast in panels of maximum size 1.5mx1.5m and reinforced with 0.56 mm dia. galvanised chicken wire mesh and sealing of joints (in grooves of 6mm X 6mm) using silicon /elastomeric compound etc all complete.	SQM	230		
37.0	508	Providing and laying cement concrete chequered flooring tiles of 22 mm thickness and size 250x250 mm / 300x300 mm conforming to IS 13801 with 8 mm thick 1:4 cement mortar over the top most layer of roofing treatment in pathway and entire equipment area with fine joints including sealing of joints (silicon/elastomeric sealant) etc all complete. (Water proofing paid elsewhere)	SQM	53		
38.0	509	Providing and applying two coats of bitumen grade 85/25 as per IS 702 (@ 1.7kg/sqm)with 1% antistripping compound conforming to IS 6241 in foundation, wall, column etc on concrete surfaces exposed to soil / ash including surface preparation etc. all complete.	SQM	350		
39.0	511	Providing and mixing water proofing compound conforming to IS:2645 in concrete or cement mortar all complete.	KG	610		
40.0	512	Anti termite chemical treatment of soil with Chloropyrifos emulsifiable concentrates (1%) conforming to IS :8944 all complete.	SQM	50		
41.0	513	Providing and applying concrete structures two coats of ERPB (Epoxy rasin based anticorrosive and chemical resistant paint) over a coat of CPCI (concrete penetrating bipolar corrosion inhibitor) with 300 to 325 micron DFT for protection of concrete against carbonation and chloride penetration in saline/marine enviornment all complete of approved make and as per manufacturer's recommendation	SQM	150		
	600	JOINTS AND FILLERS				
		Joints & fillers including all labour, material, equipment, transportation, handling etc at any level as per specification, drawings and as directed by engineer - in - charge.				
42.0	601	Supplying & installation of bitumen impregnated fibre board confirming to IS 1838 as joint filler at joints in concrete including nailing, coating of both faces with coal tar pitch/bitumin etc. all complete.				
42.1	a	12 mm wide joints.	SQM	40		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
42.2	b	20 mm wide joints.	SQM	25		
42.3	c	25 mm wide joints	SQM	25		
42.4	d	50 mm wide joints	SQM	15		
43.0	602	Providing and applying polysulphide based sealant conforming to IS:12118 in expansion joints in concrete including cleaning of joints, raking out groove, application of primer, scaffolding etc. all complete for following size grooves:				
43.1	a	12mm X 25mm	RM	120		
43.2	b	20mmX25mm	RM	170		
43.3	c	25mmX25mm	RM	20		
44.0	604	Supplying and filling in position hot applied bitumen sealing compound (Grade B) conforming to IS 1834 including cleaning, mixing, heating, pouring/injecting sealing compound in gaps in joints including application of primer etc. all complete.				
44.1	a	10mm X 40mm	RM	100		
44.2	b	12mm X 25mm	RM	160		
44.3	c	20mmX25mm	RM	20		
45.0	606	Providing and fixing PVC water stops in joints conforming to IS 12200 & IS 15058 all complete for the following:				
45.1	c	150 mm wide and 6 mm thick	RM	350		
45.2	d	230 mm wide and 6 mm thick	RM	300		
		700 MS EMBEDMENTS				
		Embedments including all labour, material, equipment, transportation, handling etc. at any level as per specification, drawings and as directed by engineer - in - charge.				
46.0	701	Supply, fabricating and fixing of mild steel embedments, inserts, pipe sleeves, angle pieces, rungs of various diameters, plates of dimensions as required etc. including welding, bolting, cutting, drilling, scaffolding, setting etc. all complete. (Contractor to supply all materials) Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	MT	18		
47.0	703	Supply,fabrication & fixing of embedments, inserts, pipe sleeves, angle pieces, anchor bolts of various diameters, plates of dimensions as required etc. including scaffolding, setting in position, etc. all complete. (Contractor to supply all materials) Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	MT	2		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
48.0	704	Supply, Fabrication, transportation, delivery at site and erection, installation and alignment of mild steel foundation bolt assembly conforming to IS:2062 and grade 1 of IS:432 in concrete along with nuts, lock nuts (as per IS:1363, 1364 and IS:3138), washers, anchor plates, stiffner plates, protective tape, pipe sleeves, templates etc. including welding, cutting, grinding, threading, drilling etc. all complete. Contractor to supply all materials. Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	MT	1		
49.0	705	Supplying, fabricating, erecting and installing following items in concrete/brickwall for all kind of works, including setting material in concrete, layout, scaffolding, cutting, forming, grinding, drilling, bolting, welding, jointing, testing etc. all complete. (Contractor to supply all materials) Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.				
49.1	a	MS pipes of all diameters	Quintal	15		
49.2	b	PVC pipes / conduits of all diameters	Quintal	2		
49.3	c	UPVC pipes / conduits of all diameters	Quintal	2		
49.4	d	Expansion fasteners (mechanical galvanised) of HILTI make or equivalent of safe tensile capacity as specified below for brick work with expansion sleeve of A6 polyamide:				
49.4.1	i	Upto 250 kg	Each	10		
49.4.2	ii	Beyond 250 Kg and upto 500 kg	Each	25		
49.4.3	iii	Beyond 500 Kg and upto 750 kg	Each	10		
49.5	e	Expansion fasteners (mechanical galvanised) of HILTI make or equivalent of safe tensile capacity as specified below for concrete work with expansion sleeve of stainless steel:				
49.5.1	i	Upto 250 kg	Each	10		
49.5.2	ii	Beyond 250 Kg and upto 500 kg	Each	25		
49.5.3	iii	Beyond 500 Kg and upto 750 kg	Each	10		
49.6	A705e	Expansion fasteners (chemical adhesive type , galvanised) of HILTI make or equivalent of safe tensile capacity as specified below for concrete work with expansion sleeve of stainless steel:				
49.6.1	i	Upto 250 kg	Each	10		
49.6.2	ii	Beyond 250 Kg and upto 500 kg	Each	25		
49.6.3	iii	Beyond 500 Kg and upto 750 kg	Each	10		
	800	GROUTING				

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
		Grouting including all labour, material, equipment, roughening surface, cleaning, ramming, curing etc. at any level unless otherwise specified as per specification, drawings and as directed by engineer - in - charge.				
50.0	801	Providing & grouting with cement slurry mix of approved ratio using pressure pump for water retaining concrete structures as per approved procedure including cost of nipples/ nozzles, cement, admixture, curing, pressure pumps, slurry agitator etc. all complete. Cost shall include fixing of nipples at minimum 500 mm centre to centre spacing, cutting of nipples after completing of grouting, making good of the nipple hole with appropriate non-shrink cement paste, water tightness test etc. all complete wherever specified in the drawing. (Cement will be supplied by BHEL as per SCC free of cost).	SQM	628		
51.0	802	Providing & grouting of pocket holes, pipe sleeves under base plates, machinery, pipe supporting structures etc. with mix 1:1 (1 cement :1 sand) using non shrink admixture etc. all Complete. (Cement will be supplied by BHEL as per SCC free of cost).	CUM	5		
52.0	803	Providing & grouting of pocket holes, pipe sleeves and under base plate of structural steel work/ machinery/ pipe supporting structures including roughening of surface, cleaning, ramming, curing etc. all complete with mix 1:1:2 (1 cement : 1 coarse sand : 2 aggregate of 6 mm down graded stonechips) using non shrink admixture. (Cost of all material and cleaning the pocket by compressed air shall be in the scope of the contractor). (Cement will be supplied by BHEL as per SCC free of cost).	CUM	5		
53.0	804	Providing & grouting of pocket holes, pipe sleeves and under base plates of structural steel work/ machinery/ pipe supporting structures including roughening of surface, cleaning, ramming, curing etc. all complete with ConbextraGP-1 or equivalent . (Cost of all material and cleaning of the pockets by compressed air shall be in the scope of the contractor).	CUM	4		
54.0	805	Providing & grouting of pocket holes, pipe sleeves and under base plates of structural steel work/ machinery/ pipe supporting structures including roughening of surface, cleaning, ramming, curing, etc. all complete with Conbextra GP-2 or equivalent . (Cost of all material and cleaning of the pockets by compressed air shall be in the scope of the contractor).	CUM	2		
	900	DOORS, WINDOWS, VENTILATORS, LOUVERS				
		Doors, windows, ventilators, louvers, roof ventilators, rolling shutters, partitions including all labour, material, equipments, transportation, handling, preparation of working drawings etc. at any level as per specification, drawings and as directed by engineer - in - charge. (all steel doors, windows and rolling shutters etc.shall be blast cleaned to near white metal surface (Sa 2 1/2), painted with two coat of red oxide zinc primer and finished with two coats of synthetic enamel paint confirming to IS2074)				

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
55.0	A904	Providing and fixing single or double steel door shutters with 45mm thk flush design shutter comprising of two outer sheets of 18 gauge steel sheets rigidly connected and reinforced inside with continuous vertical 20 gauge stiffeners, factory galvanised, primed and field painted, spot welded in position at not more than 150mm on centres including void filled with mineral wool (density as per specification), all fittings, Godrej or equivalent make mortice lock with handle on both sides, shop and final painting etc all complete. Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	SQM	15		
56.0	905	Providing and fixing single or double steel door shutters with 18 gauge M.S. sheets shutter presenting a flush surface on the outside and inside stiffened with semitubular edge and central stiffening rail which shall convey the lock including fixtures, Godrej or equivalent make mortice lock with handle on both sides, shop and final painting etc all complete. Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	SQM	10		
57.0	A906	Providing and fixing anodized extruded aluminium doors (single or double shutter) conforming to IS:1948, IS:1949 fabricated from extruded sections of HINDALCO/JINDAL or equivalent make having minimum 3mm wall thickness as per IS:1285, IS:733 and anodized and electro color coating of required shade as per IS 1868 (minimum anodized coating of grade AC15). fixed with rawl plugs, expansion fasteners,SS screws / fixing clips necessary filling of gaps at Junctions, at top, bottom & sides with required PVC / neoprene felt for bi-metallic protection etc. Glazing shall be clear float glass of 5.5mm thickness including snap fit type beading, concealed screws, fixtures, Godrej or equivalent make Mortice lock with handle on both sides, etc all complete. Aluminium section shall be smooth, free of stains, straight, mitred & jointed mechanically wherever required. (Glazing shall be paid separately)	SQM	36		
58.0	907	Providing and fixing fire proof steel doors (single or double shutter) with panic devices shall be 45mm thk flush design comprising of two outer sheets of 18 gauge steel sheets rigidly connected and reinforced inside with continuous vertical 20 gauge stiffeners, spot welded in position at not more than 150mm on centers including all fittings, shop painting with approved post office/signal red color fire resistant paint and mineral wool insulation (64 kg/cum density) complete and shall be fire proof as per IS:3614, TAC requirements and as per specification. Minimum ratings shall be 2 Hrs. Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	SQM	3		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
59.0	A909	Providing and fixing anodised aluminium work including bimetallic corrosion protection of Jindal, Hindalco or other equivalent approved make for door frames, windows, ventilators, partitions, railing etc with extruded standard tubular and other sections including all fittings & fixtures and accessories of approved make conforming to IS733 and IS1285, anodised and electro color dyed to required shade according to IS 1868 (minimum anodic coating of grade AC15), fixed with rawl plugs, expansion fasteners, SS screws or with fixing clips, including necessary filling of gaps at junctions, at top, bottom and sides with required PVC/neoprene felt for bi-mettalic protection etc.including preperation of working drawings, aluminium cleat angle, aluminium snap-on-beading for glazing/panelling, stair case tread nosing, with all fittings and fixtures (like tower bolts, handles, door stopper with rubber shoes, 'L' drops, stays, floor springs, hydraulic door closures etc.), CP brass/stainless steel screws, providing and fixing hinges/pivots, and making provision for fixing of fitting wherever required including cost of PVC/neoprene gasket, all complete as per drawing, specification and instructions of engineer in charge (Glazing and panelling shall be paid seperately).Weight of aluminium section only shall be measure.	Kg	2700		
60.0	911	Providing and fixing of door closers as per IS 3564, of approved make & quality all complete of following type :				
60.1	a	Over head hydraulic door closures	Each	4		
60.2	b	Floor mounted Hydraulic door closers	Each	4		
61.0	A912	Providing and fixing factory galvanised, primed and field painted pressed steel frames , fabricated from min 1.6mm M.S sheet mortised, reinforced drilled and tapped for hinges and locks bolts strikes, hold fasts adjustable floor anchors, floor tiles/weather bars ,paintings etc all complete as per specifications.	Kg	135		
62.0	913	Providing and fixing in position rolling shutter of hot rolled double dipped galvanised steel lath section of 18 SWG tested mild steel strips at 75mm rolling centres interlocked together through their entire length and jointed together at the end by end locks mounted on specially designed pipe shaft with brackets, side guides and arrangements for inside and outside locking with push and pull operation including wire springs, top cover, primer & shop coats of approved enamel paint etc, all complete as per IS 6248 and specification of approved make of following types: The bottom lath shall be coupled to a lock plate fabricated from 3mm thick galvanised steel plate and securely rivetted with stiffening angles.(partly coiled and lath/full lath). Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.				
62.1	a	Hand Operated	SQM	3		
62.2	b	Mechanically Operated	SQM	9		
62.3	c	Electrically operated	SQM	9		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
63.0	915	Providing, fixing and fitting of glazing of first grade class in steel/aluminium/wooden frames, where ever required, cleaning after fixing including hardware, gaskets, clips, beadings etc. all complete.				
63.1	b	4 mm thick clear float glass	SQM	130		
63.2	c	5.5 mm thick clear float glass	SQM	50		
63.3	d	6 mm thick wired glass	SQM	160		
63.4	k	One outer 6mm thick tinted heat-reflecting type float glass and one inner 6mm thick plain float glass hermetically sealed and seperated by 12 mm thick gap for thermal insulation (only single elevation area to be measured).	SQM	40		
64.0	916	Supplying and fixing weather stripping of approved make and quality to doors as per instructions of engineer in charge and specification complete.	RM	20		
65.0	917	Providing and fixing 12 mm thick BWP particle board , decorative veneer (prelaminated) on both sides, as panels in aluminium framed door shutter, fixed with necessary snap-on-beading etc. all complete (excluding aluminium works).	SQM	12		
	1000	BRICKWORK				
		Brickwork masonry including all labour, material, equipment, transportation, handling, scaffolding etc. at all levels as per specification, drawings and as directed by engineer - in - charge. (Cement will be supplied by BHEL as per TCC free of cost).				
66.0	1001	Providing brick work in cement mortar 1:6 (1 part cement 6 parts coarse sand) in walls, chambers etc. in thickness varying from 230mm to 460mm at all depths, places and positions below plinth including raking out joints, curing, scaffolding etc. complete excluding plastering and painting.				
66.1	d	Using burnt clay bricks of class designation 5.0 of nominal dimension	CUM	79		
66.2	Aa	Using fly ash lime bricks confirming to IS 12894 with crushing strength of 50 kg/cm ²	CUM	201		
66.3	Ab	Using clay ash bricks as per IS 13757 with crushing strength of 50 kg/cm ² and minimum percentage of fly ash 25%	CUM	53		
66.4	Ac	Using fly ash cement bricks confirming to IS 12894 with crushing strength of 50 kg/cm ²	CUM	201		
67.0	1002	Providing brick work in cement mortar 1:6 (1 cement 6 coarse sand) in walls, chambers etc. in thickness 230mm at all heights, places and position above plinth including raking out joints, curing, scaffolding etc complete excluding plastering and painting.				
67.1	d	Using burnt clay bricks of class designation 5.0 of nominal dimension	CUM	703		
67.2	Aa	Using fly ash lime bricks confirming to IS 12894 with crushing strength of 50 kg/cm ²	CUM	1758		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
67.3	Ab	Using clay ash bricks as per IS 13757 with crushing strength of 50 kg/cm ² and minimum percentage of fly ash 25%	CUM	469		
67.4	Ac	Using fly ash cement bricks confirming to IS 12894 with crushing strength of 50 kg/cm ²	CUM	1758		
68.0	1003	Providing brick work in cement mortar 1:4 (1 cement 4 coarse sand) in partition walls chambers etc. in thickness 115mm at all heights, places and position above or below plinth/graded level including providing two nos. 6 mm diameter MS bars at every third layer, raking out joints, curing, scaffolding etc complete excluding plastering and painting as per specification.				
68.1	d	Using burnt clay bricks of class designation 5.0 of nominal dimension	SQM	6		
68.2	Aa	Using fly ash lime bricks confirming to IS 12894 with crushing strength of 50 kg/cm ²	SQM	16		
68.3	Ab	Using clay ash bricks as per IS 13757 with crushing strength of 50 kg/cm ² and minimum percentage of fly ash 25%	SQM	4		
68.4	Ac	Using fly ash cement bricks confirming to IS 12894 with crushing strength of 50 kg/cm ²		16		
69.0	1004	Providing brick soling including spreading of earth, ramming, watering including 25mm thick cushion of sand complete but excluding excavation and disposal of surplus earth (excavation and disposal of surplus earth shall be measured under applicable item). Using brick on edge.				
69.1	d	Using burnt clay bricks of class designation 5.0 of nominal dimension	SQM	15		
69.2	Aa	Using fly ash lime bricks confirming to IS 12894 with crushing strength of 50 kg/cm ²	SQM	38		
69.3	Ab	Using clay ash bricks as per IS 13757 with crushing strength of 50 kg/cm ² and minimum percentage of fly ash 25%	SQM	10		
69.4	Ac	Using fly ash cement bricks confirming to IS 12894 with crushing strength of 50 kg/cm ²	SQM	38		
70.0	1005	Providing brick soling including spreading of earth, ramming, watering including 25mm thick cushion of sand complete but excluding excavation and disposal of surplus earth (excavation and disposal of surplus earth shall be measured under applicable item.)- Using flat bricks.				
70.1	d	Using burnt clay bricks of class designation 5.0 of nominal dimension	SQM	10		
70.2	Aa	Using fly ash lime bricks confirming to IS 12894 with crushing strength of 50 kg/cm ²	SQM	38		
70.3	Ab	Using clay ash bricks as per IS 13757 with crushing strength of 50 kg/cm ² and minimum percentage of fly ash 25%	SQM	10		
70.4	Ac	Using fly ash cement bricks confirming to IS 12894 with crushing strength of 50 kg/cm ²	SQM	38		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
71.0	1006	Breaking of existing brick work at all levels including plastering, removing the rubbish up to a distance of 500 m including transportation, loading, unloading etc. all complete as directed by the engineer.	CUM	40		
72.0	1007	Providing and encasing of structural steel member with masonry work around flanges, webs etc. and filling the gap between steel and masonry by minimum 12mm thick mortar. Encased member shall be wrapped with chicken wire mesh with 50mm lap etc. complete as per specification. (Chicken wire mesh to paid separately)	CUM	5		
73.0	1008	Providing and laying 75 mm thick bed of dry brick aggregate including of excavation, disposal of surplus earth spreading of earth, ramming, watering etc. complete in all respects as directed by the engineer.	SQM	10		
74.0	1009	Making openings in existing brick wall or partition wall including making good the broken edges/surface with cement mortar etc. complete.	CUM	2		
75.0	1010	Supply and placing in position mild steel wire fabric of square mesh 25 mm size and wire diameter of 2 mm for encasing of steel sections in concrete including cutting, bending, fixing etc. complete.	SQM	10		
76.0	1011	Filling existing brick wall/ partition wall opening at all level including making good the broken edges/surface with cement mortar, painting, finishing to match with existing finishing, scaffolding/supporting at any level, removal of debris upto a lead of 1 km including loading, unloading, transportation etc. all complete.	SQM	50		
77.0	1012	Providing and filling brick bats in soak pits all complete.	CUM	25		
	1100	DAMP PROOF COURSE				
		Damp proof course including all labour, material, equipment, transportation, handling, shuttering, centering, curing etc at any level as per specification, drawings and as directed by engineer - in - charge.				
78.0	A1101	Providing Damp Proof Course 50mm thick 1:1.5:3 concrete (10mm and down graded aggregate) with 2% of approved admixture of water proofing compound all complete. Two layers of hot bitumen coating 85/25 grade as per IS:702 @ 1.7Kg./sqm shall be applied one before & one after the DPC.	SQM	1058		
	1200	CEMENT MORTAR PLASTER				
		Cement mortar plaster including making grooves wherever required including all labour, material, scaffolding, curing etc at any level as per specification, drawings and as directed by engineer - in - charge. (Cement will be supplied by BHEL as per TCC free of cost).				
79.0	1201	Providing 18mm thick plaster in two layers outside the building/boundary wall in cement mortar 1:6 on walls, finished to a smooth finish including providing 3mmx3mm size grooves at junctions of two dissimilar materials all complete.	SQM	19268		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
80.0	1202	Providing 12mm thick plaster inside the building/boundary wall in cement mortar 1:6 on walls finished to a smooth finish as per specification all complete.	SQM	19394		
81.0	1204	Providing 6mm thick plaster on ceiling in cement mortar 1:4 finished to a smooth all complete.	SQM	822		
82.0	1205	Providing 12mm thick plaster in walls, drains/culverts with a paste of neat cement @ 1kg/sqm and rubbed smooth with trowel etc. all complete.	SQM	131375		
83.0	1206	Providing and making decorative plaster of all types and design on walls, ceilings, arcs, columns with various thickness upto 18 mm including finishing all complete.	SQM	20		
	1300	FINISHES TO CONCRETE / PLASTERED SURFACES				
		Finishes, painting to concrete, plastered surfaces including all labour, material, equipment, surface preparation, scaffolding etc. at any level as per specification, drawings and as directed by engineer - in - charge. (PAINTS OF REPUTED BRAND OF REPUTED MANUFACTURER LIKE ICI/BURGER/ASIAN PAINTS OR EQUIVALENT)				
84.0	1303	Providing and applying two or more coats of oil bound destemper as per IS 428 of approved brand, shade and manufacture to give smooth, hard, durable & glossy finish over a coat of primer over prepared plaster surface as per manufacturers guideline.	SQM	1550		
85.0	1305	Providing and applying two or more coats of acrylic emulsion paint as per IS 5411 of approved brand, shade and manufacture to give smooth, hard, durable & glossy finish over a coat of primer over prepared plaster surface as per manufacturers guideline.	SQM	110		
86.0	A1306	Providing and applying 2 or more coats of Chlorinated Rubber acid/alkali resistant paint of approved brand and colour to floors, walls and ceiling including preparation of surface to receive paint, providing and applying chlorinated rubber zinc phosphate primer conforming to IS 158 complete all as per manufacturer's recommendations and as approved by engineer, at all heights above or below grade level, inclusive of intermediate coat of Titanium dioxide / micaceous iron oxide complete as per specifications.	SQM	20		
87.0	A1310	Providing and applying 2 coats of water proof cement paint of approved make and color on exterior surface at all heights including material, labour, scaffolding, curing etc including primer coat complete as per specification.	SQM	36085		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
88.0	A1311	Providing and applying 2.5mm thick resin and polymer bonded granular textured finish, for external applications shall consist of crushed stone/quartz chips of .5 mm to 2.5 mm size and of approved natural color/shade and bonded with synthetic resins, adhesives and additives altogether in a single pack mix, applied on cured and dried plaster surface with a dry film thickness of minimum 2 mm. The final finish shall have UV resistance, fungus, bacterial resistance properties all complete with grooves filled with poly sulfide sealant of matching color and shade as per specification/drawing/approval of engineer in charge.	SQM	1180		
89.0	1312	Providing and applying 2 mm thick plaster of paris punning on walls including preparation of surface, staging, etc. to achieve a smooth even surface all complete as per specification and as directed by Engineer.	SQM	110		
	1400	FLOORING AND SKIRTING				
		Flooring and skirting at any level including base layer, labour, material, equipments, transportation, handling, curing, polishing etc. at any level as per specification, drawings and as directed by engineer - in - charge. (Under bed concrete will be paid seperately under relevant item). (Cement will be supplied by BHEL as per TCC free of cost).				
90.0	1401	Providing and laying 50 mm thick heavy duty cement concrete in flooring with metallic hardener pigmented topping 12mm thick uniform graded treated iron paricles in flooring. Under layer of 38mm thick cement concrete mix 1:2:4 (1 cement: 2 sand : 4 stone aggregates 12.5mm well graded) and top layer of 12mm thick metallic concrete of mix 1:2 (1 cement hardner mix with approved quality metallic hardening compound :2 stone aggregate 6mm nominal size) by volume including cement slurry, rounding off edges, aluminium strips etc. all complete for following (Quoted item rate shall be inclusive of providing glass joint strips):	SQM	279		
91.0	1402	Providing and laying 25 mm thick heavy duty cement concrete mix 1:2:4 (1 cement: 2 sand : 4 stone aggregates) flooring with metallic hardener pigmented topping of 10 mm thick uniform graded treated iron particles in skirting and dado complete as per specification.	SQM	20		
92.0	1404	Providing and laying interlocking M30 Grade concrete blocks in paving with approved colour and pattern and should be laid on the subbase and bedding as per specifications and recommendations of manufacturer.				
92.1	a	60mm	SQM	450		
92.2	b	75mm	SQM	325		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
93.0	1406	Providing and laying polished Kota stone 18mm to 20mm thk in flooring . Under bed shall average 30mm thk of 1 cement : 2 sand : 4 stone aggregates by volume and brought to proper level. The kota stone slabs/tiles laid over under bed, pressed and tapped down with wooden mallet to the proper level, lifted and pressed again with thick cement slurry spread over the surface with fine joint finished including pigments, curing, grinding, granite polishing etc. all complete.	SQM	45		
94.0	1408	Providing polished Kota stone 18mm to 20mm thk in skirting projecting 6mm from adjacent plaster including cutting brickwall upto the required depth, edging, finishing etc. all complete.	SQM	11		
95.0	1410	Marble stone Flooring laid in 50mm overall thickness with 18-20mm thick marble slabs (grade -1) with minium 30mm thick underbed of 1 cement : 2 sand : 4 stone aggregate by volume and brought to proper level.The marbel slabs/tiles laid over underbed with mortar 1:3, pressed and tapped down with wooden mallet to the proper level, lifted and pressed again with thick cement slurry spread over the surface with fine joint finished including pigments, curing, grinding, granite polishing etc. all complete.	SQM	45		
96.0	1412	Providing and laying 18-20mm thick polished Granite stone of approved color and texture in flooring with brass/ stainless steel strips. Under bed shall average 30mm thk of 1 cement : 2 sand : 4 stone aggregate by volume and brought to proper level. The granite stone slabs/tiles laid over under bed, pressed and tapped down with wooden mallet to the proper level, lifted and pressed again with thick cement slurry spread over the surface with fine joint finished including pigments, curing, grinding, granite polishing etc. all complete.	SQM	51		
97.0	1414	Providing and laying polished Granite stone 18-20mm thk in skirting and dado with 6mm thick projection from adjacent plaster including mortar, cement slurry, pigments, curing, grinding,moulding, granite polishing etc. all complete.	SQM	11		
98.0	A1416	Providing and laying vitrified ceramic tiles of polished variety of size 750x750 from reputed / approved manufacturer, complete including underbed of cement mortar 1:3 with neat cement slurry etc. such that total floor thickness including underbed is 50mm all complete for following				
98.1	b	10mm thick tiles In flooring	SQM	70		
98.2	d	10mm thick tiles In skirting and dado upto specific height	SQM	13		
99.0	A1417	Providing and laying vitrified ceramic tiles of matt finish of size 600x600mm from reputed / approved manufacturer including underbed of cement mortar 1:3 with neat cement slurry etc. such that total floor thickness including underbed is 50mm all complete for following.				
99.1	a	7mm thick tiles In flooring	SQM	20		
99.2	b	10mm thick tiles In flooring	SQM	70		
99.3	c	7mm thick tiles In skirting and dado upto specific height	SQM	9		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
99.4	d	10mm thick tiles In skirting and dado upto specific height	SQM	13		
100.0	1422	Providing & fixing Acid / Alkali resistant (Chemical resistant) tiles confirming to IS:4457 in flooring/Dado and shall be laid over bitumastic lining of min 12mm thick (to be laid in layers of 6mm each). The tiles shall be applied with 6mm thick Potassium Silicate bedding mortar as per IS:4441, 4443 & 4832 and including preparation of surface, application of bitumen primer, curing etc. all complete for following thicknesses. The tiles should be abrasion resistant & durable.				
100.1	a	20mm thick	SQM	15		
101.0	1425	Providing and laying polished Marble slabs (Aranga white or equivalent approved shade/color /design) 20 mm thk in staircase landing/skirting and corridors over minimum 20 mm thick underbed of 1 cement : 2 sand : 4 stone aggregates by volume mixed with sufficient water to form a stiff workable mass. The marble slabs shall be laid over under-bed, pressed and tapped down with wooden mallet to the proper level, lifted and pressed again with thick cement slurry spread over the surface with fine joint finished including moulded marbel nosing, pigments, curing, grinding, making corners, granite polishing etc. complete.	SQM	85		
102.0	1426	Providing and laying marble skirting /dado (Aranga white or approved shade/color /design) equivalent of minimum 20mm thickness projecting 6mm from adjacent plaster all complete including underbed cement mortar 1:3, scaffolding etc. all complete.	SQM	18		
103.0	1429	Providing and fixing removable type flooring system consisting of fire resistant particle board of size 600X600X35 mm with 0.05 mm thick aluminium foil lining at bottom and with 2 mm thick anti static PVC topping including proprietary floor supporting system complete as per specification.	SQM	25		
104.0	1430	Providing and fixing dividing strips in joints of cast in situ floorings at various elevations, finishing, all labour, material etc. complete as per drawing, specification and instructions of engineer in charge.				
104.1	a	Glass strips 40 mm wide and minimum 6 mm thick.	RM	350		
104.2	b	Aluminium strips 40 mm wide and minimum 3 mm thick	RM	400		
104.3	c	Brass strips 20 mm wide and minimum 4 mm thick.	RM	90		
	1500	ROOFING / SIDE CLADDING				
		Roofing / side cladding work including all labour, material, equipment, transportation, handling, scaffolding, laps, hooks, washers, corner pieces etc. at any level as per specification, drawings and as directed by engineer - in - charge.				

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
105.0	1501	Designing, providing and fixing permanently color coated galvanised MS troughed metal sheet decking plate of approved colour and conforming to class3 of IS 14246 over roof purlins for cast-in-situ roof slab as per relevant IS code and specification. Bare metal thickness of deck plate shall be minimum 0.7mm with minimum trough depth of 44 mm having minimum yield strength of 250 MPa and shall serve as permanent shuttering to the roof slab 100mm thick measured over crest of metal decking & shall have adequate strength to support weight of green concrete and imposed loads of min 150 kg/sqm during construction between purlins as per manufacturer's recommendations/ calculations/ test certificates for approval including fixing of plates to purlins, side lapping, end lapping etc. all complete for below mentioned spans. The sheet shall be permanently coated with silicon modified polyester paint of minimum 20 micron DFT on exposed surface (facing operating floor) and minimum 7 micron on other face over epoxy primer applied over hot dipped galvanising @ 275 gm/sqm including fixing of sheet to purlin with self drilling white zinc plated heat treated carbon steel screws of minimum 5.6 mm dia @ 260mm c/c in the trough and stich screws between two adjacent sheets and sealing with epoxy sealant. Measurement of profile sheeting shall be of the plan area of roof covered by MS trough metal decking. Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.				
105.1	a	Span Upto 1800mm	SQM	700		
106.0	1502	Providing and fixing shear connectors of mild steel studs having 16mm dia and minimum 75 mm projected length above purlin passing through metal decking as per relevant IS codes and specification.	QUINTAL	40		
107.0	1504	Designing, providing and fixing External sheet of Permanent colour coated metal cladding with high strength tensile steel sheet 0.5mm bare metal thickness having minimum yield strength 350 MPa and zinc-aluminium alloy coating not less than 275 gm/sqm total on both sides including fixing to supports / rails by concealed fixing system, corrosion resistant self tapping / self drilling type fasteners with suitable cap, flashing etc. all complete. The exposed face of the sheet shall be permanently colour coated with Polyfluro Vinyl Coating (PVF2) of minimum dry film thickness (DFT) 20 microns over suitable primer. Inner face of the sheet shall be provided with suitable pre-coating of minimum DFT 7 microns over suitable primer. The permanent colour coated sheet shall meet the general requirements of IS : 14246 and shall conform to class 3 for the durability. Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	SQM	2000		
108.0	1508	Providing and installing under deck insulation using minimum 0.05 mm thick aluminium foil on exposed surface followed by 0.56 mm dia and 25 mm mesh GI wire netting, fixed at various elevations with rawl plugs including clips but excluding cost of insulation.	SQM	50		
	1600	FALSE CEILING				

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
		False ceiling including all labour, material, equipment, transportation, handling, suspension system etc at any level as per specification, drawings and as directed by engineer - in - charge.				
109.0	A1604	Providing, fixing and laying permanently colour coated aluminium false ceiling of approved colour with stove enamel finish of approved make in LINEAR and SQUARE type with corrosion resistance aluminium alloys panels of minimum thickness 0.6mm including 50mm thick mineral wool insulation (as per IS:8183) bound in polythene bags on top of panels. Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures. A.C. ducts etc. suitable M.S. channel (minimum MC 75) grid 1200 c/c maximum shall also be provided above the false ceiling level for movement of personnel to facilitate maintenance of lighting fixtures, AC ducts etc.The work to be complete as per specifications, drawings and direction of engineer.(Materials for structural platform grid for movement made up of MS Channels/ Beams / Angles shall be supplied by BHEL and shall be paid under ST No 2301) Payment terms - a) On receipt of aluminium false ceiling at site - 50%; b) On completion of erection & fixing - 50%.	SQM	40		
	1700	RAIN WATER DOWN TAKE PIPES				
		Rain water down take pipes including all labour, material, transportation, 2 coats of approved paint over one primary coat, fixtures, accessories etc at any level as per specification, drawings and as directed by engineer - in - charge.				
110.0	1702	Providing and fixing galvanised MS down take pipes of 100 mm dia- Medium quality as per IS:1239(part-I) / IS:3589 all complete.	RM	47		
111.0	1704	Providing and fixing galvanised MS down take pipes of 150 mm dia- Medium quality as per IS:1239(part-I) all complete.	RM	27		
112.0	A1708	Providing and fixing ERW steel down take pipes conforming to IS:4984 as per specification of following diameters.				
112.1	a	200 mm Dia	RM	10		
112.2	b	250 mm Dia	RM	15		
	1800	MISCELLANEOUS WORKS				
		Miscellaneous works including all labour, material, equipment etc. at any level unless otherwise specified as per specification, drawings and as directed by engineer - in - charge.				

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
113.0	1801	Providing and Filling in trenches, plinths, area paving and other underground structures with graded stone aggregate of size range 63 mm to 45 mm in layers not exceeding 230 mm in thickness including breaking of stone boulders to required sizes, filling the interstices with selected sand and compacting to 85 % of original volume of stone stack for all lifts etc. all complete. Payment shall be made for the measurement of the volume of the compacted fill.	CUM	55		
114.0	1802	Providing and mixing approved Bipolar Concrete penetrating Corrosion inhibiting admixture in concrete as per detail specification of manufacturer etc. all complete.	Kg	56500		
114.1	A1802	Providing and mixing approved sodium nitrate based Concrete penetrating Corrosion inhibiting admixture in concrete as per detail specification of manufacturer etc. all complete.	Kg	113000		
115.0	1808	Providing and fixing 300 mm wide Stainless steel strips over expansion joints with minimum lap of 50mm length including stainless steel screws, rawl plugs etc. all complete.	Kg	20		
116.0	1809	Providing Chemical injection grouting with pressure pump for water retaining concrete structures conforming to IS:6494, including fixing nozzles, cost of approved cement, admixture, curing etc. all complete . Payment shall be made as per the consumption of chemical grout.	Kg	150		
117.0	1811	Providing and fixing weep holes in Drains consisting of 100 mm dia HDPE pipe sleeves with single side covering for the pipe mouth with galvanised welded wire fabric of 20 mm sq. opening covered with 40 mm downgraded aggregates in 300 X 300 mm sq. and 300 mm deep size all complete.	EACH	2000		
118.0	1815	Providing and fixing GI rungs in concrete/brick walls having zinc coating of minimum 900 g/sqm etc. all complete.	Kg	400		
119.0	1819	Design, supply, fabrication, erection of stoplog gates in CW Pumps with embedments required, lifting beams, special tools & plants, spare parts for three years, machining, casting, all materials such as structural steel, cast steel, stainless steel, brass used for seals, rubber seals, gears, ball and roller bearing, branch bushings, greasing, bolts, nuts, lugs, threaded fastners etc., cleaning, sand blasting, hot double dip galvanised with minimum coating of zinc 750 gms/sqm., following by an application of etching primer and dipping in black bitumen as per B.S. 3416, erection along with a second stage concreting to true plumb and levels, submission of drawings / fabrication drawings for engineers approval etc all complete. The leakage through rubber seal shall not be more than 5 lit/min/metre length of seal under maximum head.(only weight of structural steel including embedments shall be considered for payment purpose) (SS component shall be measured separately for payment)	MT	4		
120.0	1820	SS component mentioned under ST No. 1819.	MT	1		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
121.0	1821	Supplying, fabricating, erecting in position and testing / examining bolted and / or welded structural steel work for stationary screens made out of rolled sections and / or plates including cutting, straightening if required, edge preparation, bolting / welding of joints, cleaning, sand blasting, hot double dip galvanised with minimum coating of zinc as 750 gms./sqm. followed by application of an etching primer and dipping in black bitumen as per BS 3416 etc all complete.	MT	14		
122.0	1831	Sprinkling of water by water tanker fitted with perforated GI pipe (portable tanker minimum 3000 litre capacity) for roads and miscellaneous area within plant boundary, for dust suppression and reduction of suspended material at site for day to day work, as directed by BHEL site engineer (water for this purpose shall be provided by BHEL free of cost and utilisation of machine will be in terms of Tank-hour put in actual use for water sprinkling).	TANK-HR	1000		
	2000	FENCING AND GATES				
		Fencing and gates including all labour, material, equipment etc at any level as per specification, drawings and as directed by engineer - in - charge.				
123.0	2006	Supplying and fixing 600mm high concertina on top of boundary wall including GI tension wires, clips, anchors, accessories etc. all complete. Concertinal shall be from tensile serrated galvanised wire (HTSW) made with wire diameter of 2.5 mm which will be stretched to 6m and attached on two strands of galvanised HTSSW (high tensile spring steel wire) of 2.5mm dia by means of clips at 1m interval. These two HTSSW strands will be attached to the fence posts/ angles with 12 mm security fasteners. (Structural post shall be separately under ST No. 2007)	RM	7500		
124.0	2010	Supply, fabrication and installing in position and testing MS Gates out of channels, joists, angles, flats, plates, pipes, welded steel wire mesh & sheets including stiffners, bracings, fabricated hinges, MS Aldrops with locking arrangement, tempered steel pivot, guide track of MS Tee, bronze aluminium ball bearing arrangements, castor wheels, painting as per specification etc. all complete.	MT	5		
124.1	A2010	Supply, fabrication and installing in position and testing motorised sliding MS Gates out of channels, joists, angles, flats, plates, pipes, welded steel wire mesh & sheets including electrical fittings, sliding mechanism, stiffners, bracings, fabricated hinges, MS Aldrops with locking arrangement, tempered steel pivot, guide track of MS Tee, bronze aluminium ball bearing arrangements, castor wheels, painting as per specification etc. in complete working conditions all complete.	MT	5		
	2100	WATER SUPPLY				
		Water supply work including men, material, equipment etc. at any level as per specification, drawings and as directed by engineer - in - charge.				
125.0	2101	Providing and fixing in position tested heavy duty type chromium plated (CP) brass long neck bib cocks including sockets, union, nuts etc all complete - 15mm nominal bore.	EACH	4		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
126.0	2102	Providing and fixing in position heavy duty brass stop cock of approved quality including all specials etc all complete - 15mm nominal bore.	EACH	10		
127.0	2103	Providing and fixing in position heavy duty brass full way valve with wheel of approved quality including all specials etc all complete for following sizes:				
127.1	a	25mm nominal bore.	EACH	10		
128.0	2104	Providing and fixing GI pipes class B medium class conforming to IS:1239 pipes shall be concealed and painted with anticorrosive paint, complete for internal works with GI sockets, unions, elbows, tees, nipples etc and clamps including cutting and making good the walls etc all complete for following sizes:				
128.1	a	15 mm nominal bore.	RM	80		
128.2	b	20 mm nominal bore.	RM	24		
128.3	c	25 mm nominal bore.	RM	16		
129.0	2105	Providing and fixing GI pipes class B complete for external work with GI sockets, unions, elbows, tees, nipples etc including trenching & refilling, anti-corrosive paint etc all complete for following sizes:				
129.1	a	15 mm nominal bore.	RM	16		
129.2	b	20 mm nominal bore.	RM	190		
129.3	c	25 mm nominal bore.	RM	60		
129.4	d	50 mm nominal bore.	RM	8		
130.0	2106	Providing and fixing 610mmx453mmx6mm thk mirror from reputed mirror manufacturer. Mirror shall be mounted with glass adjustable revolving CP brackets with CP screws etc all complete.	EACH	4		
131.0	2107	Providing and fixing 610mmx127mmx6mm thk clear glass with C.P Guard rails and mounted on C.P. brackets etc all complete.	EACH	2		
132.0	2108	Providing and fixing 25 mm diameter stainless steel towel rails (600mm X 25mm) all complete.	EACH	2		
133.0	2109	Providing and fixing 20mm dia chromium plated M.S. pipes wall mounted towel rod with C.P. Brackets etc all complete.	EACH	2		
134.0	2110	Providing and fixing C.P. soap holder mounted with C.P. screws etc all complete.	EACH	2		
135.0	2111	Providing and fixing stainless steel / C.P. liquid soap dispenser . Dispenser shall be round and easily revolving with removable threaded nozzle and mounted on C.P. brackets etc all complete.	EACH	2		
136.0	2112	Providing and fixing glazed vitreous wall mounted paper holder with suitable cover cum cutter fitted with CP screws etc. sll complete.	EACH	2		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
137.0	2113	Providing and fixing chromium plated brass shower rose with 15 or 20 mm inlet all complete.	EACH	2		
138.0	2114	Providing & fixing in position P.V.C. water tank of Syntex or approved equivalent including making all necessary inlet & outlet pipes, fixture, ball cocks, valves etc all complete for following capacities. GI pipes shall be paid separately under ST No. 2105.				
138.1	a	1000 litres capacity	EACH	2		
138.2	b	2000 litres capacity	EACH	2		
138.3	c	5000 litres capacity	EACH	2		
138.4	Ad	500 litres capacity	EACH	2		
139.0	2115	Providing and fixing approved stainless steel sink with integrated drainboard as per IS:13983 of size 915x460x178mm with CI brackets, stainless steel chain with rubber plug 40mm, cp brass waste trap with necessary union complete including painting the fittings, cutting and making good the wall where required etc. all complete.	EACH	2		
	2200	SANITARY WORKS				
		Sanitary work including all labour, material, equipment etc. at any level as per specification, drawings and as directed by engineer - in - charge.				
140.0	2201	Supply and fixing glazed vitreous china Wash Basin conforming to IS:2556 part 4 of oval shape with R.S. or C.I. brackets painted white, 15mm chromium plated brass hot & cold faucets with nylon washers, chromium plated brass chain with rubber plug, 32mm chromium plated brass bottle trap and waste of standard pattern, 32mm dia chromium plated brass trap unions, plastic connection pipe with chromium plated nuts, fittings, cutting and making good the walls where required etc all complete.				
140.1	a	White	EACH	2		
140.2	b	Colored	EACH	2		
141.0	2203	Providing and fixing stainless steel kitchen sink of size 610x510x200mm conforming to IS: 13983 including all fittings etc. all complete.	EACH	1		
142.0	2204	Providing and fixing colour glazed vitreous china European type water closet conforming to IS:2556 with siphon, open front solid plastic seat and plastic cover, low level 12.5 litre PVC flushing cistern (same colour as WC) with valveless fittings, necessary C.P connections etc all complete.				
142.1	a	Floor mounted	EACH	1		
142.2	b	Wall mounted	EACH	1		
143.0	2205	Providing and fixing colour glazed vitreous indian type Orissa pattern (580x440mm) water closet conforming to IS:2556 part 3 with all fittings including foot rests, low level 12.5 litre PVC flushing cistern with valveless fittings, necessary C.P connections etc all complete.	EACH	1		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
144.0	2206	Providing and fixing white flat back glazed vitreous china urinals of size 440x265x355 mm with photo voltaic control flushing system as per IS:2556 (part 6, section 1) with flush pipes, lead pipes, gratings, traps and necessary C.P. fittings etc. all complete.	EACH	2		
145.0	2207	Supply, laying and jointing UPVC pipes of class 3 as per IS:4985 including bends, branches and all other necessary fittings, M.S holder bats/clamps, cutting and making good the walls and floors, jointing, testing etc all complete for following.				
145.1	a	75mm dia pipes	RM	25		
145.2	b	110mm dia pipes	RM	15		
145.3	c	160mm dia pipes	RM	10		
146.0	2208	Providing, laying light duty non pressure NP3 class RCC pipes with collars jointed with stiff mixture of cement mortar 1:2 including testing of joints etc all complete for following.				
146.1	a	200mm dia	RM	15		
146.2	b	300mm dia	RM	15		
146.3	c	450mm dia	RM	10		
147.0	2209	Providing, laying light duty non pressure NP2 class RCC pipes with collars jointed with stiff mixture of cement mortar 1:2 including testing of joints etc complete for following.				
147.1	a	150mm dia	RM	15		
147.2	b	250mm dia	RM	15		
147.3	c	300mm dia	RM	10		
148.0	2210	Providing, laying light duty non pressure NP4 class RCC pipes with collars jointed with stiff mixture of cement mortar 1:2 including testing of joints etc complete for following:				
148.1	a	450mm dia	RM	10		
148.2	b	600mm dia	RM	5		
149.0	2211	Providing and fixing C.I Manhole heavy duty cover of size 600mmx450mm including frame from reputed manufacture etc. all complete.	EACH	4		
150.0	2212	Providing and fixing circular heavy duty C.I. manhole cover of 600 mm dia with frame etc. all complete.	EACH	3		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
151.0	2213	Providing and fixing square mouth S.W Gully trap grade 'A' complete with CI grating, brick masonry chamber and water tight CI cover with 300x300mm (inside). The weight of cover to be not less than 4.53 Kg and frame to be not less than 2.72 Kg etc all complete for following sizes:				
151.1	a	100x100mm P or S Type.	EACH	4		
151.2	b	150x100mm P or S Type.	EACH	4		
151.3	c	150x150mm P or S Type.	EACH	4		
152.0	2214	Providing and fixing square mouth S.W Gully trap grade 'A' complete with CI grating, brick masonry chamber and water tight CI cover with 300x300mm (inside). The weight of cover to be not less than 4.53 Kg and frame to be not less than 2.72 Kg etc all complete for following sizes:				
152.1	a	100x100mm P or S Type.	EACH	4		
152.2	b	150x100mm P or S Type.	EACH	6		
152.3	c	150x150mm P or S Type.	EACH	4		
153.0	2215	Providing and fixing C.I. floor traps with C.P jalli all complete.	EACH	10		
154.0	2216	Providing and fixing heavy duty UPVC floor traps with C.P jalli all complete.	EACH	4		
155.0	2217	Providing and installing approved brand single tap water cooler of 80 L cooling capacity all complete.	EACH	2		
156.0	2218	Providing and installing approved brand single tap water cooler of 150 L cooling capacity all complete.	EACH	2		
157.0	2219	Providing and fixing white vitreous urinal partitions of size 675x325x85mm all complete.	EACH	6		
158.0	2220	Providing and fixing eye and face drinking water fountain (combined unit with receptacle conforming to IS: 10592) all complete as per specification.	EACH	2		
	2300	STRUCTURAL STEEL				
		Structural steel works including all labour, material, equipments, transportation, handling etc. at any level as per specification, drawings and as directed by engineer - in - charge.				

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
159.0	A2301	<p>Supply, fabrication and erection of structural steel with mild steel rolled section / built up section / combination of both conforming to IS:2062, pipes conforming to IS:1161/ IS:1239, chequered plate conforming to IS: 3052, mild steel rounds, monorails, stays, safety chains, ladders, MS grating etc. in columns, beams, gantry girders, bunkers, silos, hoppers, roof trusses, portals, laced purlins, space frames, hangers, struts, monorails, galleries, stiffeners, wall beams, sheeting runners, brackets, stub columns, bracings, cleats, trestles, base plates, splice plates, chequered plate flooring, decking and seal plates, steel frame grid over false ceiling, walkway platforms, ladders, stairs, stringers, treads, landings, hand-rails etc including 2 coats of organic zinc-silicate primer of min 75micron DFT(one coat at shop and one coat after erection), connection design & preparation of fabrication drgs, collection of steel from stores, fabrication, straightening, cutting, bending, rolling, grinding, machining, drilling, welding, electrodes and other consumables, alignment, erection bolts & nuts (weight of erection bolts, nuts and welds not payable), assembly, edge preparation, preheating (min preheat and interpass temperature of 20° C for welding over 20 mm and upto 40 mm & 66° C for welding over 40 mm and upto 63 mm & 110° C for thickness over 63 mm & use of low hydrogen/ radiogenic electrodes), post heating, testing of welders, inspection of welds, visual inspection, non destructive and special testing, rectification and correction of defective welding works, production test plate, inspection and testing, erection scheme, protection against damage in transit, stability of structures, installation of temporary structures, setting column bases, surface preparation by means of manual or mechanical power tools as per IS:1477 part 1, touch-up painting, rectification, dismantling and removal of all temporary structures (weight of temporary structures not payable), return of surplus / waste steel materials to store etc all complete. Including appointment of a seperate agency, approved by BHEL, for review and approval of fabrication drgs, in consultation with BHEL.and all other activities required for completion of the work including return of surplus/ waste steel materials to store etc. as per specification, drawings and instructions of the Engineer.</p> <p>Approval of fabrication drawings does not relieve the bidder from the responsibility of its correctness and accuracy. Payments terms - a). Fabrication - 65%; b) Erection - 25%; c) Alignment - 10%.</p>	MT	175		
160.0	A2302	Extra over ST NO. A2301 for blast cleaning of steel structures to near white metal surface(Sa 2 1/2) before applying the primer all complete.	MT	175		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
161.0	A2305	Providing and applying intermediate coat of epoxy based Titanium dioxide(TiO2) or Micaceous iron oxide (MIO)of minimum 75micron DFT on steel surfaces already having primer coats, topped with two coats of epoxy based colour finish paint with minimum 70 micron total dry film thickness (DFT) of approved make and shade to achieve an even shade including further finishing with top coat of UV resistant (minimum 30 micron DFT) polyurethane of approved shade including protection and cleaning, scaffolding etc. all complete.	MT	175		
162.0	2307	Supplying, fabrication, erection and alignment of factory made electroforged galvanised grating units with mild steel (having minimum galvanisation of 610 g/sqm) conforming to IS:2062 in flooring, platforms, drain and trench covers, walk-ways, passages, staircases with edge binding strips and anti-skid nosing in treads etc. including fixing clamps, fittings, fixtures, all taxes, duties, packing, grinding, drilling, welding, edge preparation, etc. all complete. Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	MT	2		
163.0	A2307	Supplying, fabrication, erection and alignment of factory made electroforged galvanised grating units with mild steel (having minimum galvanisation of 900 g/sqm) conforming to IS:2062 in flooring, platforms, drain and trench covers, walk-ways, passages, staircases with edge binding strips and anti-skid nosing in treads etc. including fixing clamps, fittings, fixtures, all taxes, duties, packing, grinding, drilling, welding, edge preparation, etc. all complete. Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	MT	2		
164.0	A2309	Extra over above ST NO. 2301/2307 for finishing the grating units/bolts/inserts with Cold galvanisation @ 610 gm/sqm over blast cleaned steel surfaces instead of painting with two coats of primer all complete.	MT	3		
165.0	2310	Providing and fixing in position of permanent mild steel bolts (class 4.6 as per IS : 1367 and grade `C' as per IS: 1363) and nuts, washers etc. up to and inclusive of 39 mm diameter and upto 300mm long for structural steel work etc all complete.	Quintal	3		
166.0	2311	Providing and fixing in positing of high strength structural bolts (of property class 8.8 and product grade `C' as per IS: 1367) and conforming to IS: 3757 and high strength structural hardened and tempered nuts (of property class `8' as per IS:1367) conforming to IS:6623 with hardened and tempered washers as per IS:6649 etc. up to and inclusive of 39 mm diameter and upto 300 mm long for structural steel work etc all complete.	Quintal	3		
167.0	2312	Dismantling of steel structure , lowering of material and carriage of the dismantled material up to field fabrication shop / projects storage including temporary dismantling, cutting, re-welding, supporting, and restoring to correct position all temporarily dismantled members, re-alignment of all adjacent connected members to their correct positions (weight of such adjacent members and temporarily dismantled members not payable), scaffolding, staging, tools & tackles, gas cutting, welding, consumables etc all complete.	MT	4		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
168.0	2314	Re-erection of dismantled fabricated structural steel members including carriage of modified "Erection Marks" from the field fabrication shop to erection site, lifting to required position, aligning in position, tack welding, final welding and touch up painting including temporary dismantling and re-erection of temporarily dismantled members, cutting, rewelding, supporting and restoring to the correct position of all temporarily dismantled members, re-alignment of adjacent connected members (weight of such temporarily dismantled members and adjacent members not payable), scaffolding, staging, tools & tackles, gas cutting, welding, consumables etc all complete.	MT	3		
169.0	2320	Supply, fabrication and fixing of GI pipe hand railing (900 mm high) of 32 mm/40 mm dia (Medium Grade) including transportation, loading/unloading, painting etc. all complete. Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%..	MT	5		
170.0	2321	Conducting radiography test on welds wherever specified including equipments, measuring devices, gauges, test report etc. all complete.	RM	25		
171.0	2322	Conducting ultrasonic test on welds wherever specified including equipments, measuring devices, gauges, test report etc. all complete.	RM	20		
172.0	2323	Conducting ultrasonic test on steel plates as per ASTM-A435 or equivalent wherever specified including equipments, measuring devices, gauges, test report etc. all complete.	SQM	50		
173.0	2324	Conducting magnetic particle test on welds wherever specified including equipments, measuring devices, gauges, test report etc. all complete.	RM	20		
174.0	2325	Conducting dye penetration test on welds wherever specified by the engineer including provision of necessary equipments, measuring devices, gauges etc. all complete (over and above the work already specified in the specifications.)	RM	10		
	2400	ROAD WORKS				
		Providing Road Work including necessary material, labour, machinery, transportation etc as per specification, drawing, relevant IRC & IS codes and as directed by the Engineer-in-charge for the following.				
175.0	2401	Preparation of sub grade by excavating earth to required depth for all types of soil/ rock, dressing to camber and consolidating the base including making good the undulation etc and disposal of surplus earth within a lead upto 1 km etc. all complete.	CUM	82280		
176.0	2402	Supplying and filling with selected good earth of approved quality in layers not exceeding 300 mm loose thickness using borrowed soil (borrowed soil to be arranged by the bidder) and compacted so as to achieve at least 95 % maximum dry density as per IS-2720 (Part-VII) including royalty/seignorage fee (if any), sorting, spreading, breaking clods, watering, ramming/compaction by manual/mechanical means, dressing, finishing to required lines, grades and slopes, testing etc all complete.	CUM	7501		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
177.0	2403	Providing, stacking & laying granular morrum for shoulder including watering, compaction with road roller to required camber etc all complete.	CUM	8085		
178.0	2404	Providing & laying water bound macadam sub base course in layers of required thickness with crushed stone aggregates 90 to 40 mm down size, stone screening & blinding material including screening, sorting, spreading to template & consolidation with road roller including carriage, spreading & consolidation of blinding material moorum etc all complete.	CUM	21450		
179.0	2405	Providing & laying water bound macadam base course in layers of required thickness with stone aggregate 63mm to 40mm size, stone screening and blinding material including screening sorting, spreading to template and consolidation with road roller including carriage, spreading and consolidation of blinding material moorum etc all complete.	CUM	14300		
180.0	2406	Laying water bound macadam base course with stone aggregate 50mm to 20mm size stone screening & binding material including screening, sorting, spreading to template & consolidation with road roller including carriage spreading & consolidation of blinding material moorum etc all complete.	CUM	14300		
181.0	2407	Providing & applying tack coat of low viscosity liquid bitumen of grade 80/100 conforming to IS 73, 217 or 454 as applicable @10 kg/ 10 sqm for untreated WBM surface including scraping, cleaning with compressed air etc all complete.	SQM	71500		
182.0	2409	Providing, mixing & laying of bituminous macadam course of specified thickness using bitumen of grade 60/70 conforming to IS 73, aggregates and binder material including hot mixing, hot laying, rolling etc all complete for the following.				
182.1	2409.b	50mm compacted thickness	SQM	71500		
183.0	2410	Providing, mixing & laying 20 mm compacted thick premix carpet in a single course composed of suitable small size aggregate premixed with bituminous binder using medium setting grade bitumen on a prepared base including mixing, applying, rolling etc all complete.	SQM	71500		
184.0	2411	Providing and applying liquid seal coat comprising of an application of a layer of bituminous binder using medium setting grade bitumen at the rate of 9.8kg/10sqm followed by a cover of stone chips at the rate of 0.09 cum/10sqm including rolling etc all complete.	SQM	71500		
185.0	2412	Supplying and laying 400mmx150mmx350mm deep precast concrete kerb stone of grade M-20 with 20 mm nominal size stone aggregate and of shape as per detailed drawing including fixing with cement mortar (1:2) in 13mm thick joints, finishing of joints with neat cement paste, making drainage opening where required etc all complete. (Cement will be supplied by BHEL as per SCC free of cost).	RM	23600		
186.0	2413	Providing & laying edge protection on both edges of black topping using brick on edge (bricks with crushing strength of 75 kg/cm ²) with full brick width (230 mm) etc all complete.	RM	5000		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
187.0	2414	Supply and laying 150mm dia R.C.C NP-2 type Hume pipe in raised shoulders as rain water drains as per detailed drawing including fixing with cement mortar (1:2) in 13mm thick joints, finishing of joints with neat cement paste etc all complete. (Cement will be supplied by BHEL as per SCC free of cost).	RM	3300		
188.0	2415	Dismantling of existing road consisting of premix carpet, kerb stone/ brick on edge, bitumen macadem course, WBM, preparing subgrade to receive new WBM including camber consolidation including disposal of debris within a lead of 1 km etc all complete.	SQM	197		
189.0	2416	Providing 20mm compacted thick premix carpet on existing/damaged road surfaces in a single course composed of suitable small size aggregate premixed with a bituminous binder using medium setting grade bitumen on the existing base including tack coat, cleaning of existing surface, mixing, applying, rolling etc all complete.	SQM	987		
2600 LEVELING & GRADING						
190.0	2601 A	Clearing jungle including uprooting of rank vegetation, grass, brushwood, trees & sapling of girth upto 30 cm measured at a height of 1 m above ground level and Stripping of top soil average 200mm depth and removal of rubbish upto a distance of 50 m outside the working area cleared.designated area of disposal will be shown by BHEL.	SQM	150000		
191.0	2601B	DELETED				
192.0	2601 C	Felling trees of the girth (measured at a height of 1 m above ground level) including cutting of trunks & branches, removing the roots and stacking of seviceable material and disposal of material at a maximum distance 900 meter. All measurment to be recorded in the register.				
192.1	a	Beyond 30 cm girth upto and including 60 cm girth	EACH	1000		
192.2	b	Beyond 60 cm girth upto and including 120 cm girth	EACH	1000		
192.3	c	Beyond 120 cm girth upto and including 240 cm girth	EACH	10000		
192.4	d	Beyond 240 cm girth	EACH	8000		
193.0	2601 D	Removing scrap, debris, trees etc. From project/ work site to a designated place within 5 KM range with all manpowe, T & P etc. including loading & unloading as directed by BHEL engineer.				
193.1	a	Disposal through truck of 5 Cum capacity	EACH	2000		
194.0	2602	Earth work in stripping of top soil upto a maximum depth of 0.30m below ground level so as to exclude all debris, grass, vegetation, bushes, trees having girth upto 300mm including roots and organic materials etc for leveling and grading including dressing to specified levels & grades and compacting the graded/stripped surface by manual/mechanical means, disposal of stripped materials within a lead upto 1km etc all complete as per specification, drawing and as directed by the engineer-in-charge.	Sq.m	631750		
195.0	2603	Earth work in excavation upto any depth below ground level in all types of soil including moorum, ash which can be excavated by any means for grading including setting out, levelling, dewatering (wherever required), dressing the sides & bottom, levelling to grade, all lifts, ramming/compacting the excavated bottom/graded surface, stacking/disposal of surplus excavated materials within a lead upto 1km , spreading/levelling of disposed materials etc all complete as per specification, drawing and as directed by the engineer-in-charge.	CUM	2575902		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
196.0	2608	Earth work in filling upto any depth below ground level for grading to proper grade and level in layers not exceeding 300mm loose thickness with selected approved soil directly from excavation and compacted as specified including dewatering if required, sorting, spreading, breaking clods, watering, ramming/compaction by manual/mechanical means, dressing, finishing to required lines, grades and slopes, tesing etc all complete as per specification, drawing and as directed by the engineer for the following. (Backfilling is from selected materials directly from excavation i.e. without any intermediate stacking. Hence no lead is considered in this item).				
196.1	a	Each layer compacted so as to achieve at least 95% maximum dry density as per IS-2720 (Part-VII)	CUM	52120		
196.2	Ac	Each layer compacted so as to achieve at least 90% maximum dry density as per IS-2720 (Part-VII)	CUM	52120		
196.3	Ad	Each layer compacted so as to achieve at least 85% relative density as per IS-2720 part XIV in case of sandy soils.	CUM	728160		
197.0	2609	Earth work in filling upto any depth below ground level for grading to proper grade and level in layers not exceeding 300mm loose thickness with selected approved soil from compulsorily excavated soil available within a lead upto 1km and compacted as specified including re-excavation of stacked earth, all lifts, sorting, spreading, breaking clods, watering, ramming/compaction by manual/mechanical means, dressing, finishing to required lines, grades and slopes, tesing etc all complete as per specification, drawing and as directed by the engineer for the following.				
197.1	a	Each layer compacted so as to achieve at least 95% maximum dry density as per IS-2720 (Part-VII)	CUM	22230		
197.2	Ac	Each layer compacted so as to achieve at least 90% maximum dry density as per IS-2720 (Part-VII)	CUM	22230		
197.3	Ad	Each layer compacted so as to achieve at least 85% relative density as per IS-2720 part XIV in case of sandy soils.	CUM	300140		
198.0	2610	Extra over ST No. 2602, 2603 & 2609 for carriage of unserviceable material/earth for every 1 KM or part thereof beyond an initial lead of 1KM	CUM	1642600		
A198	A2611	Earth work in filling upto any depth below ground level for grading to proper grade and level in layers not exceeding 300 mm loose thickness with approved borrowed soil (borrowed soil to be arranged by the bidder) and compacted as specified including supplying borrowed soil, royalty/seignorage fee (if any), sorting, spreading, breaking clods, watering, ramming/compaction by manual/mechanical means, dressing, finishing to required lines, grades and slopes, testing, all lead and lifts etc all complete as per specification, drawing and as directed by the engineer for the following.				
A198.1	a	Each layer compacted so as to achieve at least 95% maximum dry density as per IS-2720 (Part-VII) (other than sandy soil)	Cum	110000		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
B198	B2611	Earth work in filling for levelling and grading using fly ash or ash from ash pond including excavation/ collection, loading, transportation from a lead of 7-10 km on prepared surface obtained by compacting by vibratory roller/ heavy compacting equipment including setting out, filling in horizontal layers 250mm, spreading, sorting, watering, compaction with proper moisture content, to achieve a 90% maximum dry density (as per IS2720 Part-VII), dewatering (if required), testing, approaches, finishing to required lines, grades and slopes, levelling etc complete as per specification, drawing and as directed by engineer.	Cum	200000		
199.0	A2612	Providing and laying 300mm thick stone pitching on the slopes of earth fill/cut with approved quality of rock fragments conforming to IS 8237 including materials, testing, necessary excavations if any, compaction etc all complete as per specification, drawing and as directed by the engineer.	SQM	68550		
2700 EARTHEN RAW WATER RESERVOIR						
200.0	2701	Earth work in stripping of top soil upto a maximum depth of 300 mm below ground level so as to exclude all debris, grass, vegetation, bushes, trees having girth upto 300mm including roots and organic materials etc including dressing to specified levels & grades and compacting the graded/stripped surface by manual/mechanical means, disposal of stripped materials within a lead upto 1km etc all complete as per specification, drawing and as directed by the engineer-in-charge.	SQM	85200		
201.0	2702	Earth work in excavation upto any depth below ground level in all types of soil including moorum, ash which can be excavated by any means inside reservoir/ash pond area and for foundation of reservoir/ash pond embankment and cut-off trench including site clearance, setting out, levelling, dewatering (wherever required), shoring & strutting (wherever required), dressing the sides & bottom, levelling to grade, all lifts, ramming/compacting the excavated bottom, stacking/disposal of surplus excavated materials within a lead upto 1km , spreading/levelling of disposed materials etc all complete as per specification, drawing and as directed by the engineer-in-charge.	CUM	69215		
202.0	2703	Earth work in embankment filling/bed filling upto any level below/above ground level in layers not exceeding 300 mm loose thickness with selected approved soil directly from excavation and compacted so as to achieve atleast 95% of maximum dry density (Standard Proctor Test) as per IS:2720, Part-7 including setting out, sorting, handling, spreading, breaking clods, watering, ramming/compaction by manual/mechanical means, dressing, finishing to required lines, grades and slopes, tesing, dewatering if required, all lifts etc all complete as per specification, drawing and as directed by the engineer-in-charge. (Backfilling is from selected materials directly from excavation i.e. without any intermediate stacking. Hence no lead is considered in this item).	CUM	10195		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
203.0	2704	Earth work in embankment filling/bed filling upto any level below/above ground level in layers not exceeding 300 mm loose thickness with selected approved soil from compulsorily excavated soil available within a lead upto 1km and compacted so as to achieve atleast 95% of maximum dry density (Standard Proctor Test) as per IS:2720, Part-7 including setting out, re-excavation of stacked earth, sorting, handling, spreading, breaking clods, watering, ramming/compaction by manual/mechanical means, dressing, finishing to required lines, grades and slopes, tesing, dewatering if required, all lifts etc all complete as per specification, drawing and as directed by the engineer-in-charge.	CUM	91450		
204.0	2705	Extra over ST No. 2701, 2702 and 2704 for carriage of soil/excavated materials for every 1 km or part thereof beyond an initial lead of 1km.	CUM	105295		
205.0	2707	Earth work in bed filling upto any level in layers not exceeding 300 mm loose thickness with selected approved borrowed soil (borrowed soil shall be CL/CI type and shall be arranged by the bidder) and compacted so as to achieve atleast 95% of maximum dry density (Standard Proctor Test) as per IS:2720, Part-7, including setting out, supplying borrowed soil, royalty/seignorage fee (if any), sorting, handling, spreading, breaking clods, watering, ramming/compaction by manual/mechanical means, dressing, finishing to required lines, grades and slopes, tesing, dewatering if required, all leads and lifts etc all complete as per specification, drawing and as directed by the engineer-in-charge.	CUM	20000		
206.0	A2707	Earth work in embankment/bed filling up to any level in layers not exceeding 300 mm loose thickness with selected approved borrowed soil (borrowed soil shall be CL/CI/ML-CL type and shall be arranged by the bidder) and compacted so as to achieve at least 95% of maximum dry density (Standard Proctor Test) as per IS:2720, Part-7, including setting out, supplying borrowed soil, royalty/seignorage fee (if any), sorting, handling, spreading, breaking clods, watering, ramming/compaction by manual/mechanical means, dressing, finishing to required lines, grades and slopes, testing, dewatering if required, all leads and lifts etc all complete as per specification, drawing and as directed by the engineer-in-charge.	CUM	155100		
207.0	2708	Supplying, stacking and laying sand of approved quality as sand blanket/cushion over base/bed and on slopes of embankment including screening, washing (wherever required), watering, compaction, dressing, necessary trimming if any including all leads and lifts etc all complete as per specification and as directed by the engineer-in-charge.	CUM	18155		
208.0	2709	Supplying, stacking and laying sand filter of approved quality inside the body/ slope of embankment including screening, washing (wherever required), watering, compaction, dressing, necessary trimming if any including all leads and lifts etc all complete as per specification and as directed by the engineer-in-charge.	CUM	22855		
209.0	2710	Supplying, stacking and laying 150mm thick graded gravel filter of approved quality below/above rock-toe in slopes, on the embankment including screening, washing (wherever required), watering, compaction, dressing, necessary trimming if any including all leads and lifts etc all complete as per specification and as directed by the engineer-in-charge.	CUM	440		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
210.0	A2711	Providing and placing approved quality of 750 Micron thick heavy duty high density polyethylene liner (HDPE) films manufactured from polyethylene resin in the base/bed of reservoir as well as on side slopes of embankment to prevent seepage including joining with approved method including testing, fixing at the edges in plain cement concrete by providing 400mm wide and 300mm thick plain cement concrete 1:2:4 on the top of embankment (the cost of plain cement concrete 1:2:4 shall be excluded and shall be payable separately) as shown in the drawing etc all complete as per specification and as directed by the engineer-in-charge. Minimum width of HDPE liner shall be 6m.	SQM	121020		
211.0	2712	Providing and placing 300mmx300mm size and 50mm thick precast concrete tiles of grade M-20 over 15mm thick 1cement:4sand mortar on HDPE liner at the bed of reservoir and on side slopes of embankment, filling joints with 1cement : 3sand mortar etc all complete as per specification and as directed by the engineer-in-charge. The rate shall be inclusive of cement sand mortar as well.	SQM	121020		
212.0	2713	Supplying, stacking and laying hand placed rock toe at the down stream side of embankment with approved quality of rock fragments including materials etc all complete as per specification, drawing and as directed by the engineer-in-charge.	CUM	3240		
213.0	2714	Supplying, stacking and laying 300mm thick rip rap on the slopes of embankment with approved quality of rock fragments including materials etc all complete as per drawing, specification and as directed by the engineer-in-charge.	CUM	2990		
214.0	2715	Providing and placing turfing with approved quality of grass on the outer slopes of embankment including materials, transportation, watering etc all complete as per drawing, specification and as directed by the engineer-in-charge.	SQM	9324		
215.0	2716	Providing and laying of 450 mm diameter R.C.C hume pipes of class NP3 conforming to IS:458 with collars, jointing the pipes with 1cement : 1sand mortar and testing of joints etc all complete as per specification and as directed by the engineer-in-charge.	RM	450		
216.0	2717	Providing and fixing of 150mm square and 900mm long guard stones over the top of embankment (cost of PCC grade M10 for encasement will be paid seperately) etc all complete as per drawing, specification and as directed by the engineer-in-charge.	EACH	380		
217.0	2718	Providing and laying Water Bound Macadam (WBM) as per IRC 19 using crushed or broken stone aggregates of size 63mm to 40mm including packing with screenings, binding materials, watering and consolidation/compaction with road roller to make required line, slope and level etc all complete as per drawing, specification and as directed by the engineer-in-charge.	CUM	2200		
218.0	2719	Providing and laying compacted 50mm thick moorum over WBM base course including watering and compaction with road roller to make required line, slope and levels etc all complete as per drawing, specification and as directed by the engineer-in-charge.	CUM	350		
		MISCELLANEOUS				
219.0	A2731	Supply and laying 900 mm diameter MS pipe with 10mm wall thickness including necessary excavation, welding, testing, backfilling etc all complete as per specification and as directed by Engineer-in-charge.	RM	150		
	2800	MISCELLANEOUS 2				

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
220.0	2801	Construction of below ground earthing system test pits as per drawing / sketches including concreting, reinforcement, formwork, providing & fixing GI strip etc as per drawing and specification (excavation & backfilling only will be paid under applicable BOQ items).	NO	100		
221.0	2802	Construction of below ground earthing system test links as per drawing/ sketches including concreting, reinforcement, formwork, providing & fixing GI strip etc as per drawing & specification (excavation & backfilling only will be paid under applicable BOQ items).	NO	24		
222.0	2803	Construction of below ground earthing system earth electrodes as per drawing and specification. (Excavation and backfilling only will be paid under applicable BOQ items.)	NO	350		
223.0	2804	Construction of below ground earthing system - Earth connection and riser pig tails as per drawing and specification. (Excavation and backfilling only will be paid under applicable BOQ items.)	NO	1300		
224.0	2806	Sprinkling of water by water tanker fitted with perforated GI Pipe (portable tanker minimum 3000 litre capacity) for roads and miscellaneous area within plant boundary, for dust suppression and reduction of suspended material at site for day to day work, as directed by BHEL Site Engineer (water for this purpose shall be provided by BHEL free of cost and utilisation of machine will be in terms of Tank-hour put in actual use for water sprinkling.	Tank-HR	7440		
	3000	ENABLING WORKS FOR STORES, OFFICE, FIELD HOSTEL, ROADS, RCC SLEEPER, HARD SURFACING, DRAIN AND MISC WORKS. (PROVISION HAS BEEN KEPT FOR CONSTRUCTION OF 5 NOS COVERED STORES WITH ATTACH 10 NOS SEMI COVERED STORE, 3M HIGHT MAIN OFFICE SHED (15Mx 60M), MESS BUILDING (8Mx8M), 20 NOS ROOM FIELD HOSTEL, 5000 NOS RCC SLEEPERS, 4 NOS BORE WELL, 1,10,000 SqM HARD SURFACING, 48,000 SqM TEMPORARY ROADS, DRAINS & CULVERTS, FENCING ETC AND MISCELLENOUS ENABLING CIVIL)				
225.1	EC 1 A	Earthwork in excavation in all kinds of ordinary and hard soil (including slushy soil) up to a depth of 1.5m below ground level and stacking within a lead of 100 M,with necessary shoring, strutting, ramming, trimming and dressing of sides etc., including bailing / pumping out of surface water/rain water/sub soil water, cutting minor vegetation, if any, complete.	CUM	4185		
225.2	EC1 B	Earthwork in excavation in all kinds of ordinary and hard soil (including slushy soil) up to a depth of 1.5m to 3.0m below ground level and stacking within a lead of 100 M,with necessary shoring, strutting, ramming, trimming and dressing of sides etc., including bailing / pumping out of surface water/rain water/sub soil water, cutting minor vegetation, if any, complete.	CUM	780		
226.0	EC 2	Filling using selected excavated materials in trenches, plinths, sides of foundations and other underground structures, pipes, area levelling etc. in layers not exceeding 250 mm thickness including lead of 100m and all lifts and including loading from stock pile, carting, unloading, filling, watering and compacting/ramming each layer, all complete as per specifications, drawings and as directed by the engineer to achieve the following densities with 90% proctor density.	CUM	2080		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
227.0	EC 3	Sand filling (river sand) in plinth in layers not exceeding 15cm as directed by BHEL and consolidating same by thorough saturation with water and ramming complete including the cost of supply of sand (payment to be made on measurement of finished qty).	CUM	1571		
228.0	EC 4	Single brick flat soling of picked jhama bricks including ramming and dressing bed to the proper level and filling the joints with powder earth or local sand including all materials, labour etc. complete.	SQM	11207		
229.0	EC 5	Plain cement Concrete 1 : 3 : 6 (1 cement : 3 sand : 6 graded stone aggregate of 20 mm nominal size) as filling course or lean concrete at any level below foundations, drain, septic tank, floors, hume pipes, materials, labour etc complete. (cement - PPC/OPC/PSC to be supplied by contractor with test certificate from direct manufacturer of CCI / TOPCHEM/ CEMENT MANUFACTURING CO(STAR) /BARRACK VALLEY/ ACC/ BIRLA or equivalent).	CUM	1121		
230.0	EC 6	Reinforced / plain cement concrete 1 : 1.5 : 3 (1 cement : 1.5 sand : 3 graded stone aggregate of 20 mm nominal size) for foundation, columns, beams, chajjas, RCC sleepers, RCC shelf, over head tanks slab, super structure slabs etc excluding cost of shuttering and reinforcement if any but including all materials, labour, curing etc complete all the levels. (cement - PPC/OPC/PSC to be supplied by contractor with test certificate from direct manufacturer of CCI / TOPCHEM/ CEMENT MANUFACTURING CO(STAR) /BARRACK VALLEY/ ACC/ BIRLA or equivalent).	CUM	866		
231.0	EC 7	Reinforced/ plain cement concrete 1:2:4 for RCC floor etc. with approved stone chips 20mm down for floor, drain etc excluding cost of shuttering and reinforcement if any but including all materials, labour, curing etc complete all the levels. (cement - PPC/OPC/PSC to be supplied by contractor with test certificate from direct manufacturer of CCI / TOPCHEM/ CEMENT MANUFACTURING CO(STAR) /BARRACK VALLEY/ ACC/ BIRLA or equivalent).	CUM	890		
232.0	EC 8	Damp Proof Course 40mm thk. 1:1.5:3 concrete (10mm down aggregate) with 2% of approved admixture of water proofing compound. Hot bitumen @ 1.7Kg./sqm shall be applied before & after the DPC as per specification. (cement - PPC/OPC/PSC to be supplied by contractor with test certificate from direct manufacturer of CCI / TOPCHEM/ CEMENT MANUFACTURING CO(STAR) /BARRACK VALLEY/ ACC/ BIRLA or equivalent).	SQM	374		
233.0	EC 9	Supply, transporting, straightening, cutting, bending, placing at any level, binding in position mild steel reinforcements in concrete including cost of reinforcement and binding wire, labour etc complete all as per specifications & drawings (Contractor will provide MS round from SAIL/ TISCO/ IISCO/ SRMB/ SHRICON/ SHYAM STEEL/ ELEGANT/CONCAST etc). Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	MT	3		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
234.0	EC10	Supply, transporting, straightening, cutting, bending, placing at any level, binding in position high yield strength steel reinforcements in concrete including cost of reinforcement and binding wire, labour etc complete all as per specifications & drawings (Contractor will provide TMT bar Fe-415/500 quality from SAIL/ TISCO/ IISCO/ SRMB/ SHRICON/ SHYAM STEEL /CONCAST etc). Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	MT	170		
235.0	EC11	Hire and labour charges for 25 mm thick plank /12mm thick Plywood shuttering for bldg. works for concrete foundations, floor/ roof slabs, beams, lintels, columns, chajja, fins etc including fitting, fixing and striking out carefully after completion of work for below ground and upto 6m height from finished floor level.				
235.1	EC11a	Without vertical props.	SQM	3065		
235.2	EC11b	With vertical props up to (+)6M height.	SQM	307		
236.0	EC12	Brick work in cement mortar (1:6) in foundation, plinth, pier, abutment, wing wlls, water tank, septic tank, drains, culvert etc including all materials, labours, scaffolding and other incidental etc. complete.(cement - PPC/OPC/PSC to be supplied by contractor with test certificate from direct manufacturer of CCI / TOPCHEM/ CEMENT MANUFACTURING CO(STAR) /BARRACK VALLEY/ ACC/ BIRLA or equivalent).				
236.1	EC12a	Ordinary bricks / fly ash bricks, Class designation 75 below plinth lvl.	CUM	447		
236.2	EC12b	Ordinary bricks / fly ash bricks, Class designation 75, above plinth lvl upto 7.0M height.	CUM	665		
237.0	EC13	Half brick work in cement mortar (1 cement :4 sand) in foundation, plinth, pier, abutment, walls, water tank, septic tank, drains, culvert, super structure etc including cost of scaffolding and other incidental work etc. completed. (cement - PPC/OPC/PSC to be supplied by contractor with test certificate from direct manufacturer of CCI / TOPCHEM/ CEMENT MANUFACTURING CO(STAR) /BARRACK VALLEY/ ACC/ BIRLA or equivalent).				
237.1	EC13a	Ordinary bricks / fly ash bricks, Class designation 75, below plinth level.	SQM	850		
237.2	EC13b	Ordinary bricks / fly ash bricks, Class designation 75, above plinth level upto 7 M height.	SQM	1356		
238.0	EC14	Plaster to existing masonry concrete wall, floor, slab soffits, fins, sills etc with sand cement mortar including rounding off or chfenring corners as directed and racking out joints or roughening of concrete surface including chipping & application of cement slury where necessary etc complete as per drawing and direction of engineer. (cement - PPC/OPC/PSC to be supplied by contractor with test certificate from direct manufacturer of CCI / TOPCHEM/ CEMENT MANUFACTURING CO(STAR) /BARRACK VALLEY/ ACC/ BIRLA or equivalent).				

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
238.1	EC14a	With 1:6 cement mortar average 12 mm thick plaster below GL.	SQM	325		
238.2	EC14b	With 1:6 cement mortar average 12 mm thick plaster above GL.	SQM	6693		
238.3	EC14c	Outside plaster with 1:4 cement mortar average 15 mm thick above GL at all levels.	SQM	4659		
239.0	EC19	Supply, fabrication, erection and painting of structural steel work in columns, beams, wind ties, etc with simple rolled structural members connected to one with another with brackets gusset cleats, bolts & nuts or welding etc as per design & direction complete including fabrication, hoisting & erection including all materials, labour etc complete with one coat of primer & two coats of synthetic enamel painting (Contractor will provide structural steel from JINDAL/ SAIL/ TISCO/ IISCO/ SRMB/ SHRICON/ SHYAM STEEL/ RINL etc with test certificate). Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	MT	50		
240.0	EC20	Supply, fabrication, erection and painting of steel work with tubular sections as per IS 1161& 1239 for roof truss, purlin etc including all materials conforming to relevant IS codes, labour etc as per drawing, specification and direction of engineer with one coat of primer and two coats of synthetic enamel painting (Contractor will provide structural steel from JINDAL /BANSAL/ TATA/ SHYAM STEEL/ RINL etc). Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	MT	175		
241.0	EC21	Providing & fixing corrugated galvanised iron sheet (CGI) 0.5mm thick for roofing of TATA/SAIL/ZINDAL/BANSAL make including galvanised J or L hook, bolts and nuts 8mm dia with bitumen washer 25mmdiax 3mm thick and 1.6 mm thick limpet washer complete with all labour, tools and plants. Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	SQM	12000		
242.0	EC22	Providing and fixing galvanised iron ridge 0.5 mm thick and 230 mm lappings on both sides of TATA /SAIL /ZINDAL /BANSAL make including fixing necessary screws, washers etc complete with all labour and tools and plants.	RM	480		
243.0	EC23	Providing, transporting, fixing of MS foundation/ anchor bolt (Grade-1 of IS:432 & IS:2062) assembly in concrete along with nuts, lock nuts, 25mm dia, 950mm long including furnishing of labour, materials, welding, etc all complete as per specification, drawing and instruction of engineer (Contractor will supply all material). Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	KG	3000		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
244.0	EC24	Supplying, fitting & fixing openable steel window conforming to us IS:1036-1975 & IS:7452-1974 with non-friction projecting type of hinges fitted with revetts or nut bolt system as directed, glazing cleats, lugs, 2 nos MS anodised peg stays & fastner for each window of size 900x1200mm, 4mm thick clear glass pane (each glass max size 450x450mm), including fixing in position, fixing lug in cement concrete 1:2:4 with stone chips 12.5mm down cutting holes & mending good damage, 10mm dia MS round guard bar welded horizontally 125 c/c with each window etc complete with 1 coat of primer and 2 coats of synthetic enamel finish in all respect.	SQM	139		
245.0	EC25	Supplying, fitting and fixing fixed steel windows for store conforming to us IS:1036-1975 and IS:7452-1974 with glazing, cleats, lugs, 4mm thick clear glass pane (each glass max size 450mmx450mm), etc including fixing in position, fixing lugs in cement concrete 1:2:4 with stone chips 19mm down cutting holes & mending goods damages, with 10mm dia MS round guard bar fixed horizontally 125 c/c etc complete with one coat of primer and two coats of synthetic enamel finish in all respect.	SQM	70		
246.0	EC26	Priming one coat to timber or steel or plastered surface or other metal surface with ready mix paint of approved quantity including smoothening of surface by sand papering etc complete.	SQM	195		
247.0	EC27	Painting two coats with best quantity synthetic enamel paint ready mix oil bound paint of approved make and brand including smoothening surface by sand pepering etc including using approved putty etc on the surface if necessary.				
247.1	EC27a	On steel or other metal or wooden surface with super gloss.	SQM	154		
248.0	EC28	3 coats white washing with lime including cleaning and smoothening masonry surface thoroughly to give an even shade.	SQM	325		
249.0	EC29	Providing plaster of paris 2 mm thick punning over finished plaster surface and finished with one coat of acrylic emulsion primer followed by two coats of acrylic emulsion paint inside wall to give smooth and even surface as per specification at all levels.	SQM	7200		
250.0	EC30	Two coats of water proofing cement paint of Seacem or equivalent make & shade applied on external wall including scraping the surface thoroughly on plastered or concrete surface (manufacturers specification to be followed) at all levels including all materials, labours, scaffolding etc complete as per direction of engineer.	SQM	4659		
251.0	EC31	Supply and providing ms/cgl gate sizes 4 M. wide x 5 M height (2 leaves) or 900mm wide x 2400mm height gate made of 0.5 mm C.G.I. sheet framed with 50x50x6mm angle, one diagonal with two posts ISMB 100 & all fittings and fixtures like hinges, hatch bolts, locking arrangements etc. complete as per Drawing, specification and finished with one coats of red oxide primer followed by two coats (Berger) synthetic enamel as directed by Site In-charge.	MT	3		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
252.1	EC32a	Providing Public toilet (GENTS) with following facilities as directed by BHEL: (a) Inside size of toilet 8.0Mx3.6M , (b) 5mm thick white colour ceramic floor tile and inside walls tile upto 1.35 M height from finish floor, (c) four white vitreous wash basin 550x400 mm (Hindustan make or equivalent) with CI bracket, 15 mm cp brass pillar taps, 32 mm PVC waste water pipe, 32mm CP brass waste, two CP towel rail 550mm long, two best quality 550x400mm mirror etc complete, (d) ten WC chamber with Indian type WC Pan with high level 10 lts capacity CI flushing cistern, etc. (e) all inside pipe line shall be 15mm /20mm PVC and concealed pipes, (f) main supply external supply water pipe line shall be 32mm dia PVC of 12 M, (g) one bathroom with one 15 CP tap, one CP shower, complete in all respect. (h) ten nos. Flat back urinal with automatic high level CI flushing system, 5nosX 5 litre capacity each with CP connector, (i) Soil/ drain pipe shall be min 75mm dia CI for below floor inside if any and outside shall be 100mm dia PVC of supreme or equivalent. Masonry, concreting, plastering, CGI roofing with runner etc. will be paid seperately as per respective items.	set	1		
252.2	EC32b	Providing public toilet (LADIES) with following facilities as directed by BHEL: (a) Inside size of toilet 3.6Mx2.5M , (b) 5mm thick white colour ceramic floor tile and inside walls tile upto 1.35 M height from finish floor, (c) two white vitreous wash basin 550x400 mm (Hindustan make or equivalent) with CI bracket, 15 mm cp brass pillar taps, 32 mm PVC waste water pipe, 32mm CP brass waste, two CP towel rail 550mm long, two best quality 550x400mm mirror etc complete, (d) four WC chamber with indian type WC Pan with seat and lid black colour, low level 10 lts capacity white PVC flushing cistern, etc. (e) all inside pipe line shall be 15mm /20mm PVC and concealed pipes, (f) main supply external supply water pipe line shall be 25mm dia PVC of 12 M, (g) one bathroom with one 15 CP tap, one CP shower, complete in all respect.(i) Soil/ drain pipe shall be min 75mm dia CI for below floor inside if any and outside shall be 100mm dia PVC of supreme or equivalent, (j) four nos Squating pan. Masonry, concreting, plastering, CGI roofing with runner etc. will be paid seperately as per respective items.	set	1		
252.3	EC32c	Providing attach toilet for field hostel with following facilities as directed by BHEL: (a) Inside size of toilet 2.0 x 2.5m, (b) 5mm thick white colour ceramic floor tile & inside walls tile upto 1.35m height from finish floor, (c) 1 white vitreous wash basin 450x300mm (Hindustan make or equivalent) with CI bracket, one 15mm CP brass pillar taps, 32mm PVC waste water pipe, 32mm CP brass waste, 1 CP towel rail 550mm long, 1 best quality 550x400mm mirror , 2 nos CP bib cock, one CP shower etc complete, (d) 1 European type WC pan with seat and lid black colour, low level 10 ltr capacity white PVC flushing cistern with connector, etc (e) all inside pipe lines shall be 15mm/ 20mm PVC & concealed pipes, (f) main external supply water pipe line shall be 25mmdia PVC of 6m, complete in all respect including testing, (g) Soil pipe shall be min 75mm dia CI for below floor if any & outside shall be 100mm PVC of supreme or equivalent. Masonry, plastering, concreting, roofing, etc. will be paid as per respective items.	SET	23		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
252.4	EC32d	Providing attach toilet for Office with following facilities as directed by BHEL: (a) Inside size of toilet 2.0m x 2.0m, (b) 5mm thick white colour ceramic floor tile & inside walls tile upto 1.2m height from finish floor, (c) 1 white vitreous wash basin 450x300mm (Hindustan make or equivalent) with CI bracket, 15mm CP brass pillar taps, 32mm PVC waste water pipe, 32mm CP brass waste, 1 CP towel rail 550mm long, 1 best quality 550x400mm mirror etc complete, (d) 1 European type WC pan with seat and lid black colour, low level 10 ltr capacity white PVC flushing cistern, etc (e) all inside pipe lines shall be 15mm/ 20mm PVC & concealed pipes, (f) main external supply water pipe line shall be 25mmdia PVC of 6m, complete in all respect including testing, (g) Soil pipe shall be min 75mm dia CI for below floor if any & outside shall be 100mm PVC of supreme or equivalent. Masonry, concreting, plastering, CGI roofing with runner etc. will be paid seperately as per respective items.	SET	8		
252.5	EC32e	Providing common toilet for Office with following facilities as directed by BHEL: (a) Inside size of toilet 8.0M x 4.0M, (b) 5mm thick white colour ceramic floor tile and inside walls tile upto 1.35 M height from finish floor, (c) three nos. white vitreous wash basin 550x400 mm (Hindustan make or equivalent) with CI bracket, 15 mm cp brass pillar taps, 32 mm PVC waste water pipe, 32mm CP brass waste, two CP towel rail 550mm long, three nos. best quality 550x400mm mirror etc complete, (d) two WC chamber with European type WC Pan with seat and lid black colour, low level 10 lts capacity white PVC flushing cistern, etc (e) all inside pipe line shall be 15mm /20mm PVC and concealed pipes, (f) main supply external supply water pipe line shall be 25mm dia PVC of 12 M, (g) one bathroom with one 15 CP tap, one CP shower, complete in all respect. (h) four nos. Flat back urinal with ceramic partition, with automatic high level CI flushing system , 5 litre capacity with CP connector,(i) Soil/ drain pipe shall be min 75mm dia CI for below floor inside if any and outside shall be 100mm dia PVC of supreme or equivalent. Masonry, concreting, plastering, CGI roofing with runner etc. will be paid seperately as per respective items.	SET	1		
253.0	EC34	Consolidation of subgrade/ existing surface with 12 T power roller or vibromax including making good the undulations with earth and rerolling the subgrade for road, hard surfacing of equipment store, fabrication yard, assembly yard etc as directed by BHEL.	SQM	102700		
254.0	EC35	Providing and laying stone for making erection roads, hard surfacing etc. with specified sizes of approved quality hard rock rubble or hand broken hard metal of sizes ranging from 100mm to 150mm, etc in one layers approximately 200mm total thickness including moorum after compaction, hand packing, filling in interstices with quarry spalls/ moorum and providing a layer of 25mm thickness (consolidated) including watering, thoroughly compacting layer with 12 tonne power roller or vibromax with minimum 8 passes etc all as per the direction of the engineer and as per specification.	CUM	20450		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
255.0	EC36	Providing & laying water bound macadam base for erection roads, hard surfacing of open equipment store, preassembly yard etc in layers of required thickness with stone aggregate 90mm to 45mm size stone screening and binding material including screening, sorting, spreading and consolidation with power road roller 12T including carriage spreading and consolidation of blinding material moorum etc Including cost of material, labour, all complete.	CUM	6600		
256.0	EC37	12 mm thick cement plaster (1:6) with 1mm neat cement punning for drain/septic tank etc complete with all materials (excluding cement), labour etc as directed by BHEL.	SQM	4100		
257.0	EC38	1.2M high fencing with MS angle post of size 40X40X5 mm 1.8 M long post placed every 3M centre to centre embeded in concrete blocks(1:2:4), every 15th post, last but one end post corner post shall be strutted on both sides and post on one side only and provided with 8 horizontal lines and two diagonal sinterwoven with horizontal wires, of barbed wire 9.38 kg per 100 metres (min) between two post fitted and fixed with GI staples turn buckles, angle post shall be embeded in plain cement concrete(1:2:4)size 300x300x600mm deep below ground etc complete including excavation, backfilling, concreting, one coat of primer, two coat of synthetic enamel paint finish. Contractor will supply all materials (excluding cement) , structural steel, paint, labour etc complete.				
257.1	EC38a	For structural angle post with two coats of bitumen based protective coating etc complete.	KG	3253		
257.2	EC38b	Supplying, fitting, fixing galvanised chain link fencing of approved quality 50mmx50mmx8 g, by means of galvanised `C` clips, with fixing of galvinised special clips etc. Contractor to supply all materials. Angle post to be paid separately as per item no 2625 (A). Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	SQM	3120		
257.3	EC38c	For G I barbed with all fixing etc complete. Contractor to supply all materials.	KG	500		
258.1	EC39 a	Providing & laying 200/250 mm wide x 40 mm thick sal wood planks platform over one layer 35 micron thick pvc sheet spreaded over cement floor including all labour,materials,screws, nails, etc. complete.	CUM	36		
258.2	EC39 b	Providing & fixing false ceiling with wooden frame work with 2nd class wooden batten of 50 x 40 mm on shorter span and or 40 x 25 mm on longer span , making grid panel of 1200 x 1200 mm jaming on brick wall with cement concrete(1:2:4) and 4 mm commercial ply to be fixed on wooden frame work for false ceiling, including all labour,materials,screws, nails, 2 mm GI wire for taking supports from roof etc. complete including finished with 2 coats of synthetic enamel paint and one coat primer on false ceiling. All wooden battens to be painted with one coat of Black bituminous paint.	SQM	618		
259.0	EC40	Providing & laying of 600x600x9/10 mm thick vitrified tile locally available best quality to be laid over 30/35 mm thick 1:4 cement sand mortar and 100mm high skirting with all materials & labour etc complete.	SQM	825		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
260.0	EC41	Providing PVC pipe of Supreme or equivalent quality for drinking water system for BHEL office, Field hostel with all fittings and fixtures, labour etc complete for BHEL office.				
260.1	EC41a	For external 32mm dia.	RM	157		
260.2	EC41b	For external 40mm dia.	RM	156		
260.3	EC41c	For external 50mm dia.	RM	163		
261.0	EC43	Providing PVC pipe with fittings and fixtures of Supreme or equivalent make with all materials, labour etc complete for external sewer line/ waste water line connection upto open drain or manhole to manhole/ septic tank/ soak pit for BHEL office, field hostel.				
261.1	EC43a	For external 75mm dia.	RM	118		
261.2	EC43b	For external 100mm dia.	RM	117		
262.0	EC44	Providing & fixing of wooden solid flush door with commercial ply finish, fitted with 3 MS hinges, one 8mm dia 150 mm long aluminium tower bolt, 16x300mm long Al sliding door bolt & 100mm aluminium handle, finished with one coat of primer & two coats of synthetic enamel paint etc complete.				
262.1	EC44a	25 mm thick.	SQM	60		
262.2	EC44b	30 mm thick.	SQM	39		
263.1	EC45a	Providing and fixing of wooden frame work with second class sisoo or equivalent for door frame or partition wall upto ht of 2.7m with wooden batten 65X65mm, 50X25mm, 40X25mm etc. including fixing on wall/floor with MS cleats/ flats and embeded in concrete, finished with one coat of primer & two coats of synthetic enamel paint on exposed surface and bitumenous coat on masonry contact surface, etc complete with all labour & materials.	CUM	3		
263.2	EC45b	Supplying and fixing 4mm thick commercial ply on wooden frame work with both side finished with one coat of primer and two coats of synthetic enamel paint for wall partition as well as roofetc complete.	SQM	164		
264.0	EC46	Suppy, fitting & fixing/ laying of GI pipe as per IS 1239/IS 3589 with all necessary accessories ie socket, bend, tee, union, cross, elbow, nipple, long screw, reducing socket, reducing tee, short piece etc complete for making connection from deep well/source to water tank for construction/ drinking water system including cost of all necessary jointing materials labour etc all complete (payment will be made on center line measurement of total pipeline including all specials).				
264.1	EC46a	50 mm dia nominal bore, medium quality	RM	130		
264.2	EC46b	32 mm nominal bore, meduim quality.	RM	130		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
265.0	EC49	Providing and fixing security kiosk size approx 2Mx2M in plan, front height 3M and back side height 2.9M, made of structural angle frame 65x65x6 all verticals and two horizontals with diagonals, 3 vertical sides and roof shall be covered with CGI sheet 0.5 MM thick with one each side opening 300x300MM for viewing, floor shall be made with 40 MM thick wooden planks (second class treated wood) at an height of 400MM above ground level, one wooden planks 2.0mx450mm size to be provided for sitting arrangement inside kiosk, all angles and planks top side shall be painted with one coat of primer and two coats of synthetic enamel paint finish including all labours and materials etc complete..	SET	9		
266.0	EC50	Providing and laying NP3 class RCC with collars joint with stiff mixture of cement mortar 1:3 with all materials and labour. All excavation, backfilling, concreting if required shall be paid separately as per relevent items.				
266.1	EC50a	300mm dia	RM	147		
266.2	EC50b	400mm dia	RM	143		
	3100	BORE WELLS				
267.0	EC51	Labour for boring through any type of soil for sinking tubewell of required dia. With top enlargement by rig boring system (either by reverse circulation or by direct rotary method) including hire charges and labour for Rig Machine tools and plants, staging force pumping set, and making arrangement for water required for boring etc. complete and lowering of casing pipes , strainers blind pipes etc. complete for 200 mm dia upto 50 mtrs, and 100 mm dia from 50 m to 250 mtrs & beyond from G.L.. Depth of boring to be decided at the time of execution.				
267.1	a)	First 50 (Fifty) Mtrs. From Ground Level	Mtrs.	200		
267.2	b)	Beyond 50 (Fifty) but upto to 100 (Hundred) Mtrs. From Ground Level	Mtrs.	200		
267.3	c)	Beyond 100 (Hundred)but upto to 150 (Hundred fifety) Mtrs. From Ground Level	Mtrs.	200		
267.4	d)	Beyond 150 (Hundred Fifety) From Ground Level (In case good water strata is not available upto 250 M Depth.)	Mtrs.	300		
268.0	EC52	Supplying, fitting, fixing 'ORIPLAST' make or equivalent PVC casing pipes as per IS 12818-1992/ASTM-D-1785 and the following details : (Dia & length of pipe to be decided at site during execution:-				
268.1	a)	150 Nb having wall thickness of 7.5 mm (Min)	Mtrs	200		
268.2	b)	100 Nb having wall thickness of 5.0 mm (Min)	Mtrs.	120		
268.3	c)	80 Nb having wall thickness of 4.0 mm (Min)	Mtrs.	120		
268.4	d)	50 Nb having wall thickness of 4.0 mm (Min)	Mtrs.	120		
269.1	EC53a	Supplying, fitting, fixing of 'ORIPLAST' make or equivalent PVC ribbed screen (strainer) as per IS 12818-1992. 100(Hundred) NB (wall thickness 5.7 mm (Min))	Mtrs	80		
269.2	EC53b	Supplying, fitting, fixing of 'ORIPLAST' make or equivalent PVC ribbed screen (strainer) as per IS 12818-1992. 80 (Eighty). NB (wall thickness 4.0 mm(min))	Mtrs	80		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
269.3	EC53c	Supplying, fitting, fixing of 'ORIPLAST' make or equivalent PVC ribbed screen (strainer) as per IS 12818-1992. 50 (Fifty). NB (wall thickness 4.0 mm (min))	Mtrs	40		
270.1	EC54a	Supplying fitting & fixing reducing socket 100mm x 150 mm	No.	4		
270.2	EC54b	Supplying fitting & fixing reducing socket 100mm x 50 mm	No.	4		
271.0	EC55a	Providing & fixing bottom plug as required upto 100 mm (internal) dia fixed with PVC pipes with necessary fittings.	No.	3		
272.0	EC55b	Providing & fixing bottom plug as required upto 50 mm (internal) dia fixed with PVC pipes with necessary fittings.	No.	1		
273.0	EC56	Supplying fitting & fixing 150 mm Dia MS Housing Clamp.	No.	4		
274.0	EC57	Providing 150 mm Centre Guide for positioning casing pipes.	No.	40		
275.0	EC58	Packing the annular space in the blank bore hole at the bottom, between the outside of the tubewell pipe strainers, casing pipes, and the borehole with pea size gravel of sizes varying between 2mm to 5 mm upto the bottom of the 150 mm dia casing pipes	Mtrs	800		
276.0	EC59	Packing the annular space between the outside of the 150 mm dia casing pipe and the bore hole with puddled clay.	Mtrs	80		
277.0	EC60	Washing and developing tubewell with Air compressor of 150 PSI / 300 CFM for 8 (Eight) hours per day with necessary arrangement for testing the yield in gallons per hour with V notch, including Bacteria removal treatment as necessary.	Hours	288		
278.0	EC61	Collecting sample of water for bacteriological and chemical test from any Govt. approved laboratory. Documentary evidence from Govt. approved laboratory regarding the water quality certifying that the water coming out of the borewell is safe for Human consumption.	No.	4		
279.0	EC62	Supplying fitting & fixing MS Cap at top 150 mm dia including 150 mm dia MS pipe of 1 mtr or less to be fixed with PVC pipes above ground level.	No.	4		
280.0	EC63	Geophysical investigation of the aquifer by electrologging system with all Tools and plants, specialist manpower, etc. as may be necessary, including submission of reports	No.	4		
281.0	EC64A	Supply & delivery of 5 HP KSB make or equivalent submersible pump motor set having duty point capacity of discharging 5 LPS of clear water at a total head of 40 mtr. Along with 50 mm dia GI heavy duty best quality column pipes of total length 35 mtrs & lockable PVC submersible cable clamps of suitable no. and 10 mm dia steel wire rope of suitable length for protecting device with necessary galvanised nuts, bolts, washers for all complete as directed by BHEL	SET	2		
282.0	EC64B	Supply & delivery of 3 HP KSB make or equivalent submersible pump motor set having duty point capacity of discharging 3LPS of clear water at a total head of 40 mtr. Along with 40 mm dia GI heavy duty best quality column pipes of total length 30 mtrs & lockable PVC submersible cable clamps of suitable no. and 10 mm dia steel wire rope of suitable length for protecting device with necessary galvanised nuts, bolts, washers for all complete as directed by BHEL	Set	2		
283.1	EC65a	Supplying & delivery of 400 volts, 30 Amps, ICTPN switch with MRC fuses of make Havels or equivalent. & Suitable starter L&T or Equivalent, MS Angle Frame for mounting etc. complete.	Set	2		
283.2	EC65b	Supplying & delivery of 400 volts, 15 Amps, ICTPN switch with MRC fuses of make Havels or equivalent. & Suitable starter L&T or Equivalent, MS Angle Frame for mounting etc. complete.	Set	2		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
284.0	EC66	Installation of ICTPN switch & Starters of SI No.15a & 15b on MS angle frame on wall.	Set	4		
285.0	EC67	Drawing the double run submersible cable from the tubewell to the starter through suitable dia class - B medium GI protection tubes by supplying & laying the same on underground / under floor / wall, including laying, termination etc. all complete.	Set	4		
286.0	EC68	Supplying & laying 10 Sq. m 1.1 Kv grade 3.5 core PVC armoured ALUMINIUM cable on wall by means of saddles from ICTPN switch to busbars to MCCB, NCCB to starter including all end termination and interconnections etc. complete.	Mtrs	200		
287.1	EC69a	Supplying fitting and fixing GI pipes of TATA medium or equivalent make with all necessary accessories, specials viz. Socket, bend, tee, union, cross, short piece etc.fitted with holder bat	Mtrs	200		
287.2	EC69b	Supplying fitting and fixing GI pipes of TATA medium or equivalent make with all necessary accessories, specials viz. Socket, bend, tee, union, cross, short piece etc.fitted with holder bat clamps, including cutting pipes, making threads, fittings, fixing etc. complete in all respects, including cost of all necessary fittings as required, jointing materials in position above ground. 40 mm dia medium quality	Mtrs	400		
287.3	EC69c	Supplying fitting and fixing GI pipes of TATA medium or equivalent make with all necessary accessories, specials viz. Socket, bend, tee, union, cross, short piece etc.fitted with holder bat clamps, including cutting pipes, making threads, fittings, fixing etc. complete in all respects, including cost of all necessary fittings as required, jointing materials in position above ground. 32 mm dia medium quality	Mtrs	200		
288.1	EC70A	Supplying, fitting, fixing 50mm dia wheel valve, gun metal of approved brand and make tested to 21 Kg/sq.cm as directed by BHEL.	Nos	2		
288.2	EC70B	Supplying, fitting, fixing 40 mm dia wheel valve, gun metal of approved brand and make tested to 21 Kg/sq.cm as directed by BHEL.	Nos	2		
289.0	EC71	Providing manpower, Consumable, T&P et. For running and maintenace without supply of major equipment for all tubewells with pump set.	Man-Months	36		
290.0	EC72	Providing manpower, materials for constructure of brick masonry pump house (inside area around 5 sqM) with brick foundation of 1 M depth from existing GL and Plinth level of Pump House shall be 600 mm from existing GL with 40 mm thick IPS flooring, 250 thick brick wall 2500mm height from PL with plaster finish in inside & outside (12/15 mm thick) all brick work & plaster 1 cement : 6 sand, with one MS angle (50x50x6) framed door with MS sheet of 3 mm thick with locking arrangement,120 mm thick RCC roof concrete grade M-25 with one 150 ISMB fixed on the ceiling of the pump house for maintenance purpose, inside 3 coat of whitewash, out side 3 coats of water proof cement paint finish, the pump house inide to be wired for fixing a CFL lamp of 18W with a switchboard. The necessary supply for this illumination can be tapped from the ICTPN switch supplied for the pump motor set. All cement, steel and other materials, labour etc. required are to be supplied by the bidder	Set	2		
	3200	ELECTRCAL ENABLING ITEMES				
291.0	EA1	Supply & fixing of iron clad main switches TPN/ DP on angle iron frame duly painted/ on wall, with all required materials, hardwares, etc. as per instruction of BHEL Engineer, of Standard make (Havells/crompton/approved make) -				
291.1	EA1a	200 Amps TPN, MSFU(Main switch fuse)	NO.	3		
291.2	EA1b	63 A TPN	NO.	9		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
291.3	EA1c	30/ 32A TPN.	NO.	15		
291.4	EA1d	32A DP.	NO.	10		
291.5	EA1e	16A DP.	NO.	30		
291.6	EA2	Supply & fixing of sheet metal (16SWG) iron clad busbar chamber (W=500mm x D=150mm) on angle iron frame duly painted on wall with 4 Al bars (25mm x 5mm x 600mm) 500V, with adequate nos of holes drilled for connection of incoming & outgoing ckts, bars are fixed on porcelain insulators. Including supply of required hardwares for connection, fitted with DANGER board, all complete as per instruction of BHEL Engineer.	NO.	9		
292.0	EA3	Supply & fixing of metal sheet MCB BOX, as per instruction of BHEL Engineer -				
292.1	EA3a	4 Way	NO.	40		
292.2	EA3b	6 way	NO.	10		
292.3	EA3c	8 way	NO.	10		
293.0	EA4	Supply & fixing of Metal Junction Box with connector Lugs, as per instruction of BHEL Engineer -				
293.1	EA4a	Size (8"X10"X3") to terminate 10 sqmm cable and 4 sqmm cable	NO.	10		
293.2	EA4b	Size (8"X6"X3") to terminate 6 sqmm cable and 2.5 sqmm cable/1sqmm cable	NO.	15		
294.0	EA5	Supply & fixing of composite flush/box mounted type 250 volt 6 Pin 15 Amps Plug socket integral fuse, with single phase motor starter with overload protection, on sheet metal box with bakelite cover and earthing attachment including Switch and Fuse of matching PVC box-make ANCHOR or approved make (Pantry/Kitchen/AC), as per instruction of BHEL Engineer.	NO.	100		
295.0	EA6	Supply & fixing composite flush type 250 volt 5 Pin 5Amps Plug socket integral fuse with 5 Amps piano key type switch on sheet metal box with bakelite cover and earthing attachment including Switch and Fuse of matching PVC box-make ANCHOR /or approved make (for Computers /printers), as per instruction of BHEL Engineer.	NO.	120		
296.0	EA7	Supply and Fixing of Switch Board(10"X14") with flush type 250 volt 6 Pin 15 Amps Plug socket integral fuse with six no.s 15 Amps piano key type switch on sheet metal box with bakelite cover and earthing attachment including Switch and Fuse of matching PVC box-make ANCHOR or approved make, as per instruction of BHEL Engineer.	NO.	60		
297.0	EA8	Supply and installation of switchboard of sheetmetal box with bakelite cover, as per instruction of BHEL Engineer -				
297.1	EA8a	Size 4"X8"	NO.	15		
297.2	EA8b	Size 4"X10"	NO.	40		
297.3	EA8c	Size 4"X4"	NO.	15		
298.0	EA9	Supply and installation of Piano type Switches (5 Amps), as per instruction of BHEL Engineer.	NO.	320		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
299.0	EA10	Supply and installation of 5 Amps socket to be fixed in switchboard, as per instruction of BHEL Engineer.	NO.	50		
300.0	EA11	Supply and Installation of SP MCB for lighting / Power purpose-				
300.1	EA11a	16 Amps	NO.	30		
300.2	EA11b	6 Amps	NO.	35		
301.1	EA12a	Supply of 3.5 core 95 sqmm PVC, armoured Aluminium cable of 1.1 KV grade as per IS-1554.	RM	200		
301.2	EA12b	Laying below ground in excavated trench average depth 800 mm with 8 nos of brick on top of the cable per meter including filling the space between brick & cable and also the trench with shifted soil levelling and restoring the surface duly rammed & compacted, as per instruction of BHEL Engineer.	RM	200		
301.3	EA12c	End termination with double compression gland and lugs.	NO.	20		
302.1	EA13a	Supply of 3.5 core 25 sqmm PVC, armoured Aluminium cable of 1.1 KV grade as per IS-1554.	RM	200		
302.2	EA13b	Laying above ground on wall/ surface with clamps etc, chase cutting on wall/ floor, mending good damages, testing & commissioning of 3.5 core 25 sqmm PVC, Aluminium cable of 1.1 KV grade, as per instruction of BHEL Engineer.	RM	200		
302.3	EA13c	End termination with double compression gland and lugs.	NO.	20		
303.1	EA14a	Supply of 4 core 16 sqmm PVC, armoured Aluminium cable of 1.1 KV grade as per IS-1554.	RM	600		
303.2	EA14b	Laying above ground on wall/ surface with clamps etc, chase cutting on wall/ floor, mending good damages, testing & commissioning of 4 core 16 sqmm PVC, Aluminium cable of 1.1 KV grade, as per instruction of BHEL Engineer.	RM	200		
303.3	EA14c	Laying, below ground in excavated trench average depth 800 mm with 8 nos of brick on top of the cable per meter including filling the space between brick & cable and also the trench with shifted soil levelling and restoring the surface duly rammed & compacted, as per instruction of BHEL Engineer.	RM	400		
303.4	EA14d	End termination with double compression gland and lugs.	NO.	30		
304.0	EA15	Supply, drawing through PVC conduit/casing, termination, testing & commissioning as wiring for lighting, power & earthing of -				
304.1	EA15a	1 core 10 sqmm PVC insulated, stranded Copper wire of 1.1 KV grade	RM	1000		
304.2	EA15b	1 core 6 sqmm PVC insulated, stranded Copper wire of 1.1 KV grade	RM	200		
304.3	EA15c	1 core 4 sqmm PVC insulated, stranded Copper wire of 1.1 KV grade	RM	200		
304.4	EA15d	1 core 2.5 sqmm PVC insulated, stranded Copper wire of 1.1 KV grade	RM	4000		
304.5	EA15e	1 core 1.5/1 sqmm PVC insulated, stranded Copper wire of 1.1 KV grade	RM	6000		
304.6	EA15f	1 core 1 sqmm PVC insulated, Green stranded Copper wire for earthing of inside building	RM	3000		
305.0	EA16	Supply and fixing of PVC conduit with all bends, tees, reducers, rectangular/circular box, clamps, saddles, etc. along with the accessories in surface/ recess in beam/ roof slab/ wall/ false ceiling and making good the same as required, as per instruction of BHEL Engineer.				

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
305.1	EA16a	1" dia rigid	RM	6000		
305.2	EA16b	1" dia flexible	RM	200		
306.0	EA17	Supply and fixing of PVC casing with all bends, tees, reducers, rectangular/circular box, clamps, saddles, etc. along with the accessories in surface/ recess in beam/ roof slab/ wall/ false ceiling and making good the same as required, as per instruction of BHEL Engineer.				
306.1	EA17a	1.5" dia	RM	500		
306.2	EA17b	1" dia	RM	1000		
306.3	EA17c	0.5" dia	RM	200		
307.0	EA18	Supply & fixing of ceiling rose on circular boxes, as per instruction of BHEL Engineer.	NO.	100		
308.1	EA19a	Supply of outdoor luminaires type 1x70 W HPSV lamps in cast aluminium body with acrylic cover along with lamps, control gear, etc including all fixing/ supporting accessories complete. Model: BJMSC-70SV of BAJAJ or equivalent of PHILIPS/ CROMPTON.	NO.	90		
308.2	EA19b	Fixing on wall with 40 mm dia swan neck GI pipe with suitable clamps etc & commissioning of outdoor luminaires suitable for 1x70 W HPSV lamps in cast aluminium body with acrylic cover along with lamps. Including all fixing/ supporting accessories complete and flexible wire for connection between ceiling rose & fitting.	NO.	90		
309.1	EA20a	Supply of Indoor type luminaries 1x150 W medium bay industrial type, model BJMBI-150SV of BAJAJ or equivalent of PHILIPS/ CROMPTON.	NO.	180		
309.2	EA20b	Fixing from roof truss with suitable clamp arrangement, flexible wire for connection between ceiling rose & fitting and commissioning of type HPSV luminaries medium bay industrial type, model BJMBI-150SV of BAJAJ or equivalent of PHILIPS/ CROMPTON.	NO.	180		
310.0	EA21	Supply & Installation of Dual Tube Light (2x36 Watt) Fixture of standard make (Philips or approved make)	NO.	20		
311.0	EA22	Supply and installation of CFL 2x36 W decorative false ceiling type, with box base & mirror type reflectors with fixing/ hanging material/ hardware, of approved make.	NO.	100		
312.0	EA23	Supply and installation of CFL 2x36 watts with box base & vitrious enamelled reflectors with fixing/ hanging material/ hardware, of approved make.	NO.	40		
313.0	EA24	Supply of 230V 12" exhaust fan with external louvre	NO.	10		
314.0	EA25	Supply of local make approved quality Pedestal fan - 16" sweep.	NO.	80		
315.0	EA26	Supply and Installation of earth electrode 40 mm dia 3 metre long GI pipe directly driven into earth including earth excavation if required.	NO.	40		
316.0	EA27	Supplying & installation of 16 SWG GI wire for earthing including supply & termination with lugs as required.	RM	4000		
317.0	EA28	Supplying & installation of 8 SWG GI wire for earthing including supply & termination with lugs as required.	RM	300		
318.0	3300	For items not covered above (from Sl. No.1 to 290.0), quote % above or below the CPWD schedule (DSR-2007).				
318.1	3300.1	Rate of complete item.				

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
318.2	3300.2	Rate of supply of materials at site only.				
318.3	3300.3	Rate for execution complete excluding supply of materials.				
319.0	3400	OTHER MISCELLANEOUS				
319.1		1 Supply & Installation of remote controlled 1.5 TON WINDOW AC of reputed make "LG/CARRIER/VOLTAS /equivalent"//complete with remote control Unit, MCB & 15 AMP Switch/Socket & Installation	NO.	10		
319.2		2 Supply & Installation of remote controlled 2 TON WINDOW AC of reputed make "LG/CARRIER/VOLTAS /equivalent"//complete with remote control Unit, MCB & 15 AMP Switch/Socket & Installation	NO.	10		
319.3		3 Supply & Installation of remote controlled 1.5 TON SPLIT AC of reputed make "LG/CARRIER/VOLTAS /equivalent"//complete with remote control Unit, MCB & 15 AMP Switch/Socket & Installation	NO.	10		
319.4		4 Supply & Installation of remote controlled 2 TON SPLIT AC of reputed make "LG/CARRIER/VOLTAS /equivalent"//complete with remote control Unit, MCB & 15 AMP Switch/Socket & Installation	NO.	10		
319.5		5 Supply & Installation of PEDASTAL fan (16 inches Sweep) of reputed make "CROMPTON" or equivalent) complete with required and regulator	NO.	15		
319.6		6 Supply & Installation OF conference table U- shape, each longer side length shall be 9 M and width shall be 600mm (total centre line length of table shall be 20.0 M approximate) made of 19 mm to 20 mm thick wooden block board table top, side and intermediate support @ 1.5 M C/C with 20 numbers of Steel framed wooden cained Chairs. Table top shall be 1 mm thick lamination, longer side of vertical face shall be 150mm above ground floor, all vertical supports (long as well as shorter side) visible side shall be 0.8 mm thick lamination, long side of vertical face(inner portion) which is not visible shall be smooth finish with putty, two coat of primer and two coat of synthetic enamel paint matt finish, 19mmx9mm half round moulded beading of 1st class teak wood for both ends of all vertical supports, fixed by screw, nail, metal angle, adhesive, etc. complete including cost of first class/furniture carpenter, all labours, materials, complete.	LUMPSUM	1		
319.7		7 Supply & Installation of Cushioned Chairs with arms matching with Conference Room Table	NO.	50		
319.8		8 Supply & Installation of MS Slotted Angle Rack Size:36inches(L)x18inches(D)x86inches(H) No.Of Shelves(including Top & Bottom)-7 No Of Compartments-6 Distance between each Shelf-14inches Distance between lowest Shelf and Door-2inches MS Slotted Angle specification-40mmx40mmx3mm(Thk) Colour-TA Grey	NO.	15		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
319.9.1	09.(a)	Supply & Installation of Executive Steel writing table with Wooden Top made of Teak Wood & glass having left hand and Right hand Drawers (2 Drawer in left and 3 in right with lock & key) Size (Table)- 66inches x36inches of standard height	NO.	18		
319.9.2	09(b)	Supply & Installation of Wooden Side Table of standard height suiting to above Table of Size:84inchesx24inches of standard heightHaving racks with sliding door	NO.	18		
319.10.1	10. (a)	Supply & Installation of Executive Steel writing table with Wooden Top made of Teak Wood & glass having left hand or Right hand Drawers (3 Drawers) Size (Table)- 48inchesx24inches of standard height	NO.	62		
319.10.2	10(b)	Supply & Installation of Wooden Side Table of height suiting to above Table of Size:60inchesx24inches Having racks with sliding door	NO.	50		
319.11	11	Supply & Installation of Revolving / Adjustable Executive cushioned chair with Arms	NO.	65		
319.12	12	Supply & Installation of Revolving / Adjustable Executive cushioned chair with Arms and high back	NO.	12		
319.13	13	Supply & Installation of steel Canned Chairs with Arms for Visitors	NO.	68		
319.14	14	Supply & Installation of Cushioned Chairs with Arms for Visitors	NO.	15		
319.15	15	Supply & Installation of Wooden cup board Size-47inches(W)x17.5inches(D)x53inches(H) With Double Shutter &two compartments	NO.	20		
319.16	16	Supply & Installation of Steel book case of reputed make Size:33inches(L)x12inches(D)x78inches(H) Compartment-4	NO.	2		
319.17	17	Supply & Installation of Iron Safe- 24 inches(L)x18inches(D)x24inches (H) Having front door, double lock and handle	NO.	2		
319.18	18	Supply & Installation of steel filing cabinet of reputed make (4 drawers) Size -18.5inches(W)x24.5inches(D)x52inches(H)	NO.	60		
319.19	19	Supply & Installation of steel almirah of reputed make Size – 36inches(W)x18inches(D)x78inches(H)	NO.	30		
319.20	20	Supply & Installation of Aqua Guard Water Cooler cum Purifier	NO.	8		
319.21	21	Supply & Installation of wooden cot (single bed Size:6.5 feetx3.5 feet) with mattress, pillow, pillow cover, bed sheet, bed cover, buckets & Mugs	SET	25		

SL.NO.	ST. NO	DESCRIPTION	UNIT	QTY	RATE (in Rs.)	AMOUNT(in Rs.)
319.22	22	Supply & Installation of double door 240 litre frost free Refrigerator of reputed make LG/Samsung/Godrej or equivalent with voltage stabiliser (3 star)	NO.	10		
319.23	23	Supply & Installation of Wooden Writing table Size-42inchesx 18inches(Left hand or right hand drawer)	SET	20		
319.24	24	Supply & Installation of wooden Chair for above table under sl.no 23	NO.	20		
319.25	25	Supply & Installation of Cushioned sofa Set of good quality (One 3 seater + Two Nos 2 seaters + 1 No One seater +1 wooden Centre table made of teak wood with glass top)	SET	10		
319.26	26	Supply & Installation of wooden dinning table for 6 persons along with 6 Nos dinning chairs.	SET	10		
319.27	27	Supply & Installation of CEILING fan (48 inches Sweep) of reputed make "CROMPTON" or equivalent complete with required and regulator.	NO.	15		
319.28	28	Supply & Installation of top loading Fully Automatic Washing Machine 6 kg (min) of reputed make LG/Samsung/Hier/Godrej/IFB or equivalent.	NO.	10		
319.29	29	Supply & Installation of Vacuum Cleaner 1400 Watt (min) of reputed make LG/Samsung/Ureka Forbs/ or equivalent.	NO.	10		
TOTAL (except ST No.3300)						

Annexure-1 of TCN-04

14.1.3	<p>The bidder will have to install 2 nos PCs (multimedia PC work station Pentium- core-2 Duo, with a processor of 1 GHz or above, Min 320 GB HDD, 4 GB RAM, 100/1000 MBPS LAN card) of HCL/HP/ZENITH/DELL or equivalent make with Window 7 O/S and required software like MS Office 2010 Professional, AutoCAD 2010 or higher, PageMaker (7.0) etc, ADOBE PDF CREATOR with one no laserjet printer compatible for A3 size printing (ink/ cartridge for which to be supplied as and when required), one no laserjet printer compatible for A4 size printing (ink/ cartridge for which to be supplied as and when required) with power backup at places, as per instruction of BHEL for exclusive use of BHEL. (The vendors may consider about 500 pages of printing per month in order to estimate the consumption of ink/cartridge etc.</p> <p>The bidder will have to provide 2 nos Laptops (G60 or G62 model of HP make with Intel Core I3 Processor <u>M370@2.70</u> GHz ,Minimum 3 GB RAM & 320 GB Hard Disk)with windows 7 OS 64 BIT ,LAN Cards & ATI Mobility Radeon Premium Graphics and multimedia arrangement with Optical Mouse with required softwares MS Office 2007 & 2010 both ,Auto-CAD 2010,Latest version of ADOBE READER,Word to PDF software , Licenced Antivirus (KASPERSKY/AVG),Latest ADOBE Photoshop with 2 Nos. colour All-in-One LaserJet Printer(Printer cum Copier cum Scanner cum FAX (with receiver-optional))of HP make compatible for A4 Size printing (ink/ cartridge for which to be supplied by bidder as and when required).</p> <p>The bidder will have to provide 1 No Photo Copier Machine of CANON make with LAN Printing Facility along with usual copier facility with one operator.</p> <p>These computers/ printers/Photocopier shall remain contractor's property and they will be allowed to take out the same after completion of the site works. The contractor shall provide data / information etc in prescribed formats for periodical updating of the progress reports, material management reports, updating of network pertaining to the contractor's scope of work etc.</p> <p>The contractor shall also provide Two nos Computer Operators, One No. Weighing Machine Operator and six numbers service staff for miscellaneous service for BHEL's use at site/ Kolkata for reconciliation, progress review & day-to-day planning purpose, documentation etc.</p> <p>These facilities are to be provided within 40 days from LOI date till completion of site works or as decided by BHEL. If contractor fails to provide computer/ printer or personnel as per requirement, for a continuous period of fifteen days or more, BHEL shall have the right to deduct the amount as per following rates on prorated basis, from contractor's RA bill or any other dues.</p>
14.1.3.1	<p>@ Rs 12,000/- (Twelve thousand)/ month for each computer operator/ Weighing Machine Operator/ Photo Copier Machine Operator. Or at actuals (rate +30%) if BHEL arranges this facility, whichever is lower.</p>
14.1.3.2	<p>@ Rs 8,000/- (eight thousand)/ month for each computer with printer. Or at actuals (rate +30%) if BHEL arranges entire facility or part of facility, whichever is lower.</p>
14.1.3.3	<p>@ Rs 12000/- ((Twelve thousand)/month for Photo-Copier Machine. Or at actuals (rate +30%) if BHEL arranges this facility, whichever is lower.</p>
14.1.3.4	<p>@ Rs 8,000/- (eight thousand) / month for each service staff. Or at actuals (rate +30%) if BHEL arranges this facility, whichever is lower.</p>
14.1.3.5	<p>In the event of the contract period getting extended beyond the stipulated time for reasons not attributable to the bidder, the bidder will be reimbursed at the above mentioned rate (actual +15%) if the services of computer/operator/staff are being used by BHEL.</p>

NO DEVIATION CERTIFICATE

(To be typed and submitted in the Letter Head of the Company/Firm of Bidder)

To,

(Write Name & Address of Officer of BHEL inviting the Tender)

Dear Sir,

Sub : **No Deviation Certificate**

Ref : 1) Tender no PSER:SCT:VIZ:C1128:10.

2) BHEL's NIT, vide reference no PSER:SCT:VIZ:C1128 Dated:28-09-2010.

3) BHEL's TCN-01,vide reference no PSER: SCT:VIZ:C1128:TCN-01 Dated: 06-10-2010.

4) BHEL's TCN-02, vide reference no PSER: SCT:VIZ:C1128:TCN-02 Dated: 19-10-2010

5) BHEL's TCN-03, vide reference no PSER: SCT:VIZ:C1128:TCN-03 Dated: 22-10-2010

6) BHEL's TCN-04, vide reference no PSER: SCT:VIZ:C1128:TCN-04 Dated: 03-11-2010

7)All other pertinent issues till date.

We hereby confirm that we have not changed/ modified/materially altered any of the tender documents as downloaded from the website/ issued by BHEL and in case of such observance at any stage, it shall be treated as null and void.

We also hereby confirm that we have neither set any Terms and Conditions and nor have we taken any deviation from the Tender conditions together with other references applicable for the above referred NIT/Tender Specification.

We further confirm our unqualified acceptance to all Terms and Conditions, unqualified compliance to Tender Conditions, Integrity Pact (if applicable) and acceptance to Reverse Auctioning process.

In the event of observance of any deviation in any part of our offer at a later date whether implicit or explicit, the deviations shall stand null & void.

We confirm to have submitted offer in accordance with tender instructions and as per aforesaid references.

Thanking you,

Yours faithfully,

(Signature, date & seal of authorized representative of the bidder)

पावर सेक्टर पूर्वी क्षेत्र (मुख्यालय)

POWER SECTOR EASTERN REGION DJ-9/1, SALLAKE CITY, KOLKATA - 700 091

फैक्स/Fax : (033) 23211960 फोन/Phone : बोर्ड/EPABX : 23211691/ 1798