

SECTION - 1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & QUANTITIES

1.1.0 SCOPE

1.1.1 The scope of work under this specification is Balance Civil Works of 400 kV Switchyard for 2x800 MW YERAMARUS TPS by BHARAT HEAVY ELECTRICALS LTD. The Customer is RAICHUR POWER CORPORATION LTD.

1.1.2 The Civil Works shall generally include, *but not limited to*, following:

- (i) Roads
- (ii) Control room building.
- (iii) Fencing and gates
- (iv) Site levelling
- (v) Any other work required for the project.

1.1.3 The works to be performed in the above construction includes preparation of bar bending schedules, based on the drawings released for construction and getting the same approved by the Engineer-in-charge plus the execution of the work including providing of all labour, supervision, materials, scaffolding, power, fuel, construction equipments, tools and plants, supplies, transportation, all incidental items necessary for successful completion of the work including contractor's supervision and in strict accordance with the drawings and specifications and with inspection and testing standards. The nature of work shall generally involve excavation in all type of soil and rock including dewatering, shoring, strutting, and filling under and around structures, backfilling with available excavated earth around completed structures, cable trenches with covers, disposal of surplus soil, formwork, providing necessary steel embedments and other inserts, drainage work, stone spreading (including antiweed treatment), Surface dressing, concreting, brickwork, plastering as per technical specifications and other works in switchyard all complete as per detailed specification, drawings and directions of Engineer-in-charge.

1.2.0 SPECIFIC TECHNICAL REQUIREMENT

1.2.1 The specific technical requirements for the execution of civil works shall be as per Customer Technical Specification/IS. In case of any conflict between Standard Code and Technical Specifications, the provisions of Technical Specification shall prevail.

1.3.0 BILL OF QUANTITIES

- 1.3.1 The Bill of Quantity shall be as per pages from 1.3 to 1.6
- 1.3.2 The quantities indicated in the 'Bill of Quantity' are indicative and can vary to any extent. Contractor shall not be entitled for any claim for any such variation in the quantities.
- 1.3.3 The provision of Bill of Quantity, specifications and drawings shall be read in conjunction with each other and in case of conflict amongst them, the clarification shall be obtained from the Engineer-in-charge whose decision shall be final and binding.
- 1.3.4 Method of measurement:
- 1.3.4.1 Excavation shall be measured in cubic meters. The lateral dimensions to be considered for working out excavation quantity shall be the PCC dimension below the footing as per approved drawing. Nothing extra shall be paid for slope cutting, etc. Backfilling & disposal quantities shall be worked out based on the above dimensions only.

For other items, unless otherwise described the method of measurement as described in 'Method of Measurement of Building and Civil Engineering Works'-IS 1200(Part I to XXV) latest edition of BIS shall be followed.

SECTION - 2

STANDARD TECHNICAL SPECIFICATION
(N.A.)

SECTION -3

ENCLOSURES TO THE SPECIFICATION

(a) Customer Specification

(b) Standard Drawing

- | | |
|---|--------------------|
| 1. DETAIL OF ROAD – | TB-3-332-607-612 |
| 2. DETAIL OF CHAIN LINK FENCING & GATE- | TB-1-332-607-614 |
| 3. GROUND FLOOR PLAN FOR CONTROL ROOM- | TB-1-332-607-626-1 |
| 4. TERRACE PLAN FOR CONTROL ROOM - | TB-1-332-607-626-5 |
| 5. FINISHING SCHEDULE FOR CONTROL ROOM- | TB-1-332-607-626-6 |
| 6. DETAILS OF DOORS & WINDOWS FOR CONTROL ROOM- | TB-1-332-607-626-8 |



RAICHUR POWER CORPORATION LTD.

(A JOINT VENTURE OF KPCL AND BHEL)

No. 22/ 23, Sudarshan Complex, Sheshadri Road, Bangalore – 560009

2x800MW YERAMARUS TPS

BTG Package, Agreed BOP & associated Civil Works

CONTRACT DOCUMENT – SERVICES

VOLUME C – 2 – V

CIVIL WORKS



Bharat Heavy Electricals Ltd.

Power Sector – Marketing

BHEL House, Sirifort, New Delhi - 110 049



RAICHUR POWER CORPORATION LIMITED

YERAMARUS TPS - 2x800 MW

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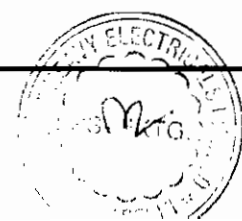
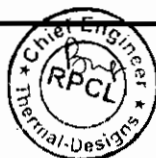
**RAICHUR POWER CORPORATION LIMITED****YERAMARUS TPS - 2x800 MW****GENERAL**

SECTION : D 4.1

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1. This Contract is to cover design, preparation of general arrangement, construction as well as Fabrication drawings, supply of all labour as well as materials and construction of all civil, structural and architectural work on Services contract basis for the 2 x 800 MW, Unit 1 & 2, Yermarus Thermal Power Project being set up at Yermarus village, Raichur District, promoted by M/s Raichur Power Corporation limited (RPCL), a joint venture company between KPCL and BHEL, in the state of Karnataka.
2. Description of various items of work under this contract and nature of work in detail are given hereinafter. The complete work under this scope is referred to as CIVIL WORKS. List of various civil works covered under the scope is given in Section D4.2.
3. The work to be performed under this contract consists of design, engineering as well as providing all labour, materials, consumables, equipment, temporary works, temporary labour and staff colony, constructional plant, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the plant, all in strict accordance with the specifications and including revisions and amendments thereto as may be required during the execution of the work.
4. All materials including cement, reinforcement steel, structural steel etc. shall be arranged by the CONTRACTOR.
5. The scope shall also include setting up by the CONTRACTOR a complete testing laboratory in the field to carry out all relevant tests as per BIS or other international standards required for the civil works for the project.
6. The work shall be carried out according to the design/drawings to be developed by the CONTRACTOR and approved by the OWNER. For all buildings and structures, foundations, etc., necessary layout and details are to be developed by the CONTRACTOR keeping in view the statutory & functional requirements of the plant & facilities and providing enough space & access for operation, use & maintenance. Certain minimum requirements are indicated in this specification for guidance purpose only. However, the CONTRACTOR's offer shall cover the complete requirements as per the best prevailing practice and to the complete satisfaction of the OWNER.
7. Wherever excavation is to be carried out in the vicinity of existing structures care shall be taken for the safety of the structures by resorting to controlled blasting.
8. CONTRACTOR shall inspect the site, examine and obtain all information required and satisfy himself regarding matters and things such as access to site, communications, transport, right of way, the type and number of equipment and facilities required for the work, availability of local labour, materials, water etc., and their rates, local working conditions, weather, flood levels, subsoil conditions, natural drainage, etc. Ignorance of the site conditions shall not be accepted by the Owner as basis for any claim for compensation or extension of time. The submission of the offer by the CONTRACTOR will be construed as evidence that, such an examination was made and any later claims / disputes in this regard to rates / lumpsum amount quoted shall not be entertained or considered by the OWNER.





9.0 GEO-TECHNICAL INVESTIGATION

9.1 A detailed Geotechnical investigation was carried out at the site by the OWNER and the report has been made available to the CONTRACTOR. However, this shall be considered by the CONTRACTOR for reference only.

The CONTRACTOR has to carryout detailed Geotechnical investigation after the award of contract, through some approved / reputed agency and submit Geotechnical investigation report with recommendation for OWNER'S review and approval. The recommendation given in approved final report becomes binding on the contractor. The CONTRACTOR is not eligible to increase his cost or demand any extension of time because the final report is in variance from earlier report available with RPCL or recommendations in the final report are in variance with the actual site conditions during execution of works

9.2 From the preliminary report, it is observed that all major structures like Station building, TG foundation, Boiler foundations, etc. and all other heavily loaded structures can be founded on Shallow foundation. The shallow foundations may be isolated or combined footings or raft foundation depending upon the type and requirement of structures as well as loads, spacing and construction of columns. The foundation depth and safe bearing capacity of the foundations shall be as per approved Geotechnical Investigation report. Effect of uplift and reduction in bearing capacity due to underground water table shall also be considered as per relevant IS codes. For load bearing walls, or filler walls spread foundation can be adopted.

10.0 SURVEY DATA

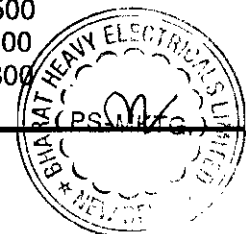
The OWNER has carried out a detailed survey of the plant area and drawings indicating the survey detail along with contour are furnished to the CONTRACTOR. The same shall be treated as for reference only. It is the responsibility of the CONTRACTOR, to verify the various features on his own, before submission of the offer. The OWNER does not take any responsibility for correctness of various features / contour shown on the drawing. The CONTRACTOR is not eligible for any extra cost or any extension of time, if the results from his detailed survey and actual conditions at site are at variance to any extent from the ground levels derived from the drawing furnished by the owner.

11.0 It is the Contractor's responsibility to fix the grade levels at various locations of the plot considering the following.

- (a) Highest flood level at the site during the last 50 years.
Based on the catchment area and rainfall, the CONTRACTOR has to compute the HFL.
- (b) Efficient disposal of storm water by gravity to the nearest water course even during high water.

The grade levels for different areas shall be as follows:

- a) Main Plant
 - i) Station building RL 361.500
 - ii) Transformer Yard RL 361.400
 - iii) Boiler/ESP RL 361.300



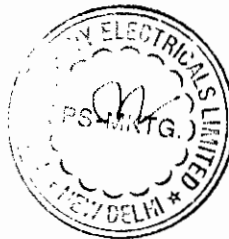


- b) Water system RL 361.500
- c) Cooling tower area, CW Pump house & fore-bay RL 366.500
- d) Switch yard RL 365.000
- e) Fuel handling & Dyke area RL 361.500

12.0 STATUTORY REQUIREMENT

CONTRACTOR shall comply with all the applicable statutory rules pertaining to Factory act, Fire safety rule of Tariff Advisory Committee, Water act for Pollution control Board, Explosives act etc. Provisions of Safety, health and welfare according to Factories act shall also be complied with. Statutory clearances and norms of State Pollution Control Board shall be followed. CONTRACTOR shall obtain approval of Civil / Architectural drawings from concerned authorities before taking up the construction work.

13.0 In case the contractor fails to achieve the targeted progress as stipulated due to non-procurement / arrangement of materials like Steel (Reinforcement / Structural), Aggregates, Cement, Centering & shuttering , Machinery , Labour (Skilled / Unskilled) etc., RPCL reserves the right to arrange for the above at the risk and cost of the contractor.



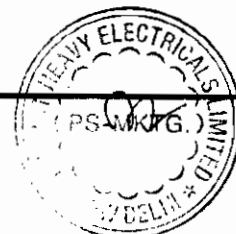
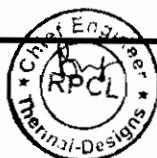


1.0. SCOPE OF CIVIL WORKS:

The scope of Civil Works include Civil, Structural and Architectural works of Power Plant inside plant boundary for the buildings/structures mentioned below and includes collection of all site related data, detailed engineering, preparation of drawing, supply of materials, equipment, labour and tools, supervision, testing, inspection, erection crane, scaffolding including Geotechnical investigation as required for execution of scope of work as per contract. The civil works shall include those required for installation, commissioning, testing, operation and maintenance of the power plant for BHEL scope of works.

The scope will cover but not limited to the following areas/ structures / buildings/ systems/ facilities etc., within the battery limit mentioned elsewhere:

1. Topographical surveying
2. Site leveling and grading
3. Geotechnical Investigation
4. Steam Turbine Generator Building
5. TG Deck, Deck supporting structure and Foundation
6. Mill & Bunker Bay
7. Coal Bunkers
8. Mill foundations and trenches for mill reject system.
9. Boiler Foundations
10. Elevator shaft
11. ESP Foundation
12. ESP Control Room
13. Foundations for BFP, CEP, ID/PA/FD/Seal Air Fans
14. VIS for BFP
15. Condensate Storage Tank Foundation
16. Pipe Trenches, Cable Trenches/Ducts within BTG Battery Area / up to buildings in the BHEL scope of work
17. Pipe & cable racks in BTG area / up to buildings in the BHEL scope of work
18. Foundations for Transformer yard structures
19. RCC Paving in BTG Area and in other areas of BHEL scope
20. Plant Roads, drains and cross drainage works including diversion of nalas within BTG area and in other areas of BHEL scope,
21. Approach roads to buildings in areas of BHEL scope





RAICHUR POWER CORPORATION LIMITED

YERAMARUS TPS - 2x800 MW

SCOPE OF WORK

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22. Service / Technical building
23. Chain link / barbed wire fencing wherever required
24. Air washer system
25. DG building
26. Compressor house
27. CW system
28. ACW system
29. Fuel Oil system-Unloading, storage and Transfer Pump houses
30. Laboratory-Chemical, C&I & Electrical inside Service building.
31. Chlorination plant for CW system
32. DM plant and DM water storage tank.
33. Duct supporting systems.
34. Switch yard structures & foundations
35. Civil works of Mill reject handling system in mill area.
36. Any other structure/building within or outside the BTG area for housing of BHEL supplied equipment.
37. Rail track inside the maintenance building and transformer track in transformer yard and switch yard.

2.0. Battery limit:

Between Switch Yard up to inlet flange of Chimney (excluding Chimney) and first column of Power House Unit No. 1 and last column of Power House Unit No. 2, including peripheral roads of main plant & road between switchyard & transformer yard.

It is not the intent to specify herein all the works in the scope of this contract. All works shall conform to the specification. The works shall conform to high standards of design, engineering and workmanship. Design and construction shall conform in every respect to all local and state regulations governing such works and to stipulations of Indian Standards unless stipulated otherwise in detailed specification.

3.0. EXCLUSIONS:-

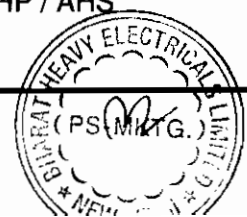
The civil, structural and architectural works of the following areas/structures/buildings within the battery limit and any/all structures/areas/buildings beyond the said battery limit are excluded from BHEL scope of work.

1. Construction Power & construction Water supply
2. Coal handling system
3. Ash handling system
4. Transfer point towers, Trestles and associated structures of CHP / AHS within BTG Area



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YERAMARUS TPS - 2x800 MW

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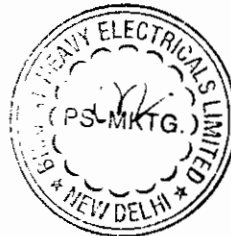
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SCOPE OF WORK

5. Sewage Plant
6. Civil works pertaining to Effluent Treatment plant
7. Chimney
8. NDCT
9. Service Water Overhead Tank
10. Any other structure/building not mentioned in clause 1.0 above
11. VIS for equipment other than BFP

NOTE: Wherever any component is not included in the list of scope of civil works and / or exclusions and also wherever the details are not furnished in their offer, the CONTRACTOR shall carry out the works as per stipulations.

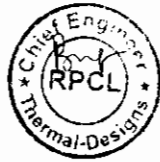




RAICHUR POWER CORPORATION LIMITED
YERAMARUS TPS - 2x800 MW

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RAICHUR POWER CORPORATION LIMITED

YERAMARUS TPS - 2x800 MW

**DOCUMENTS TO BE SUBMITTED DURING DETAILED
ENGINEERING**

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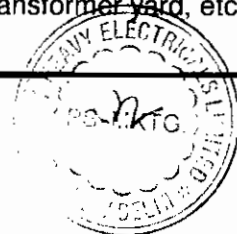
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The following documents are to be submitted for the approval of the OWNER, prior to commencement of fabrication & erection / construction. All drawings shall be of standard sizes (Metric system) and shall be made on AUTOCAD Version 2008/10 and its latest version in executable format.

1. General plant layout drawing with Co-ordinates of roads, boundary wall, watch tower buildings and facilities, piping / cable corridors, pipe and cable trestles, provision of landscaping and green belt development, diversion roads and drains, equipment lay down areas etc.
2. Drawing showing underground facilities with coordinates of these facilities like buried pipes, buried cables, trenches, ducts, sewer, drains, sumps pits, culverts, foundations etc.,
3. Soil investigation report carried out by CONTRACTOR along with foundation recommendation for various buildings/structures/facilities.
4. Topographical survey drawings along with location and details of Bench mark, grid and boundary pillars based on detailed survey conducted after the award of work.
5. Site grading and storm water drainage furnishing levels of various terraces arrangement and details of drains, culverts etc
6. Study note on disposal of effluent from the plant to satisfy the statutory requirement.
7. Design basis memorandum for all buildings, facilities, services and structures. Separate design memorandum reports shall be submitted for all plant buildings / structures including Power house building, mill building, TG foundation, Fan foundations / other block type foundations etc., Designs shall commence only after approval of memorandum.
8. Architectural floor plans, elevations, cross sections and perspective view in colour of all buildings, shall match with existing units.
9. Design calculations and drawings for foundations / substructure and superstructure of all buildings including pump houses and other structures.
10. Design calculations including dynamic analysis and drawings for all foundations subjected to dynamic loads like foundations for TG, BFP, Mill, Fans (PA, FD, ID) etc., Design and drawing of vibration isolation system shall also be furnished.
11. Design calculations and drawings for all facilities and services like roads, culverts, bridges, pavings, road/rail crossings, drains, sewers, water supply, water tank, sumps, trenches, ducts etc.,
12. Drawings of all architectural works including finishing schedule, colour schemes (both internal and external), doors & windows, flooring and false ceiling etc.,
13. Design calculations and drawings for plumbing and building drainage.
14. Design calculations and drawings for switchyard structures, transformer yard, etc.



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RAICHUR POWER CORPORATION LIMITED

YERAMARUS TPS - 2x800 MW

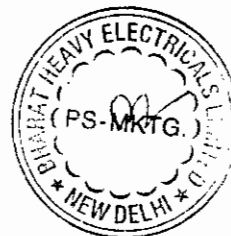
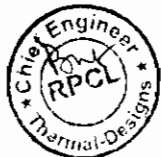
**DOCUMENTS TO BE SUBMITTED DURING DETAILED
ENGINEERING**

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15. Design calculations and drawings for structures pertaining to Cooling Water System.
16. Design calculations and drawings for civil structures/works associated with fuel oil handling system etc.,.
17. All other designs, details/drawings or any other submissions as indicated elsewhere in this specification and as required by the OWNER.
18. Details of corrosion protection measures for all structures.
19. Total quantity of concrete (grade wise), reinforcement steel (diameter wise) and structural steel (section wise) shall be indicated in all construction drawings.
20. All design calculations and drawings for Boiler and ESP structures.
21. Shop drawings/fabrications of all structural steel works (only for reference) and design calculations for important joint connections. Designs for structural steel connections and detailed fabrication drawings to be furnished before commencement of work.
22. Construction and erection procedure for all major structure with specific reference to main plant building, bunker structures, TG foundation and other machine foundations.
23. Write-up on various statutory requirements and their compliance for various buildings and facilities.
24. Quality assurance and Quality Control procedures.
25. Copies of all reports on investigation and studies carried out by the CONTRACTOR as per the scope.
26. Soft copies of all design calculation and drawings shall be submitted for records after approval of the OWNER.
27. Soft copy (executable files) of all STAAD-PRO (or other software) packages used for analysis & design shall be submitted. Also typical hand calculations to validate the computer generated calculations shall be furnished.
28. Standard notes and details for RCC and Structural Steel works.





1. GENERAL

1.1 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. The surrounding area shall be properly micro leveled and graded.

1.2 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 BHEL shall employ a qualified architect / architectural firm to carry out all designs and hold all other architectural responsibilities for the project.

1.3 BHEL 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. BHEL shall provide the drawings and documents for such statutory approvals.

2 ROOF ACCESS

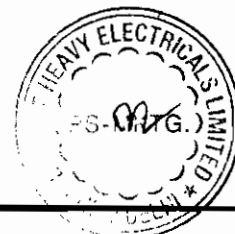
All roofs shall be provided with access thorough a staircase cage ladder. Minimum 1000 mm wide access path shall be provided with tiles to approach equipment on roof.

3 PLATFORMS AND WALKWAYS

3.1 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 the entry shall be atleast 900 mm wide. Platforms located close to each other shall be connected with walkways.

3.2 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 consists 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.

3.3 Continuous walkway at least 500 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.





4 STAIRS & LADDERS

4.1 Steel stairs

All steel staircases shall normally have minimum clear width (back to back of stringer) of 1000 mm and minimum inclination with horizontal of 35.75° . However, in case of space restriction, minimum clear width upto 750 mm and slope upto 45° may be provided. The vertical height between successive landings shall not exceed 5 m. 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).

4.2 Steel Ladders

Ladders shall be provided to platforms, walkways, instruments and equipments 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 dia. MS rungs spaced at 300 mm (maximum). Ladders shall be provided with a safety cage of minimum 750 mm dia. 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.

4.3 RCC stairs

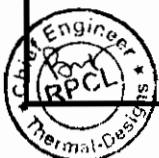
All stairs shall have maximum riser of 180 mm and a minimum tread of 250 mm. However, for public buildings riser shall be limited to 150 mm and tread width of 300 mm. Minimum width of stairs shall be 1500 mm generally. All stairs normally shall have not more than 15 risers in one flight. Aluminum angle nosing with minimum $50 \times 25 \times 3$ angle shall be provided for edge protection of RCC stairs.

5 HANDRAILS

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

5.2 All handrails shall be of 32 mm nominal bore GI pipes (medium class) using 360 gm/sq m of zinc coating as per relevant IS code. 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 center to center of posts. Handrailing shall be shop fabricated for specific locations and field welded or bolted to the erected structural steel.

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





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 corner is expected shall be provided with angles of minimum size L 50x50x6 with lugs for edge protection e.g. around the cut-outs / openings in floor slab, 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.

7 ANCHOR BOLTS AND INSERT PLATES

7.1 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.

7.2 Insert plates shall be designed / checked for shear and bending moment. 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.

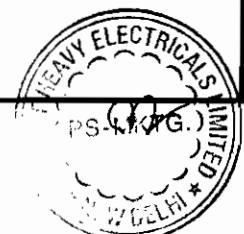
8 VERTICAL HEADROOM

8.1 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
Walkway above false ceiling	1000 mm
Safety cage for ladders	2500 mm
Access for fork lift trucks	2800 mm
Main roads / Railway crossings & crane access	7000 mm
Cable & Pipe rack	3000 mm except at Road / Rail crossings.

9 EXPANSION /CONSTRUCTION JOINTS

9.1 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. At other joints these shall be 150 mm wide.





9.2 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. Pre-formed bitumen impregnated fibre board conforming to IS:1838 shall be used as joint filler.

10 BRICK / STONE MASONRY AND PARAPET WALL

10.1 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 load bearing and non-load bearing walls constructed with solid or concrete blocks or Fly ash bricks shall be in accordance with criteria specified by Section 4 of National Building Code of India Part VI.

10.2 All walls shall be non-load bearing infilled panels walls. External walls of all buildings shall be at least one brick thick. All internal wall 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. Stone masonry / PCC wall / Brick masonry shall be provided as provided in Unit 1.

10.3 50 mm thick DPC (1:1.5:3) with water proofing admixture shall be provided at plinth level before starting masonry work.

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

10.5 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 Tariff Advisory Committee (TAC).

10.6 Even where metal cladding is specified, for initial 3 m height from the ground level, minimum one brick thick masonry wall shall be provided.

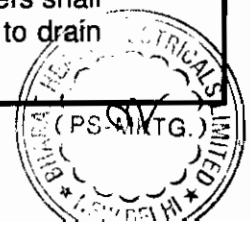
10.7 All upstands and parapet walls on roof shall be of RCC constructions, minimum height of parapet walls shall be 750 mm and thickness 125 mm with aesthetics of architectural designs as approved by the owner.

11 DRAINAGE

11.1 Floor drainage

11.1.1 For all buildings and areas, suitable arrangement for draining out water collected from equipment blowdowns, leakage, floor washing, fire fighting, etc., shall be provided on each floor. Gully traps, inspection pits, collecting pits etc., shall be located suitably and designed considering flow volume, easy access, maintenance and safety.

11.1.2 All drains inside the building shall have minimum 40 mm thick grating covers. In areas where heavy equipment loads would be coming, precast RCC covers shall be provided in place of steel grating. These drains shall lead the water to drain sump.





11.1.3 Garland drains shall be provided around all buildings to receive the drainage water from roof and floor and lead them to the plant storm water drainage system.

11.2 Roof drainage

11.2.1 Roof drainage system shall be provided for quick and efficient draining of rainwater from roof to avoid seepage and damage to roof. The runoff gradient for the roof shall not be less than 1 in 100. Roof drainage system shall consist of roof drain heads, rainwater down corners and fixtures. System shall be designed to handle design rain fall for the specific site and shall be in accordance to stipulations of IS: 1742 and IS: 2527. Roof drains shall conduct water to storm drains through down comers.

11.2.2 Rainwater down comers shall be of HDPE Pipe conforming to IS: 4985.

11.3 Sumps

In case of underground structures, sumps with pumping arrangement shall be provided at suitable location to collect and pump out any incidental water collection to nearest storm water drain.

12 WATER PROOFING OF UNDERGROUND STRUCTURES

12.1 All underground structures like basements, pump houses, water retaining structures etc., shall have plasticiser cum waterproofing cement additives conforming to IS: 9103. In addition, limits on permeability as given in IS: 2545 shall also be met with. The concrete surface of these structures in contact with soil shall be provided with minimum two coats of bituminous painting of grade 85/25 conforming to IS: 9862 @ 1.7 kg/sqm (minimum) for water / 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.

13 ANTI TERMITE TREATMENT

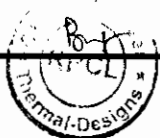
Pre-construction anti termite treatment shall be given to all vulnerable areas susceptible to termite attack and shall include column pits, wall trenches, foundations filling below the floors etc., as per IS: 6313 and other relevant Indian Standards.

14 Plinth level

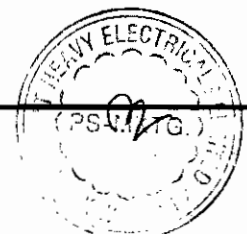
14.1 Finished ground floor level (plinth level) of all buildings and pump houses shall be minimum 500 mm above the formation level / grade level.

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

14.3 Finished floor levels of Boiler area / transformer area yard paving shall be kept as per Plot plan. (200 mm below main plant FFL)



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15 Backfilling of over excavated area:

Over excavated area / loose soil / pockets shall be backfilled filled with M10 grade of concrete

16 STATUTORY REQUIREMENTS

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

16.2 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 500 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.

16.3 Adequate no. of fire escapes shall be provided in a building. Fire proof doors, no. of staircase, fire separation walls, lath plastering on structural steel member (in fire prone areas) shall be made according to the recommendation of TAC. For fire safety requirements of buildings IS: 1641 and IS: 1642 shall be followed in addition to TAC requirements. All masonry firewalls shall be minimum 345 thick and RCC firewall shall be minimum 200 mm thick.



**PART-B : LOADS AND LOAD COMBINATION****1. GENERAL**

All structures shall be designed for the most critical combinations of dead loads, imposed loads, equipment loads, crane loads, steam piping (static & dynamic) and other piping loads, wind loads, seismic loads, temperature loads and any other loading conditions which can occur during the design life of the facility.

2. DEAD LOADS

2.1 Dead loads consist of the weights of the structure complete with finishes, fixtures, partitions, wall panels and all equipment of semi-permanent nature including tanks, silos, bins, partitions, roofing, piping, cable trays, bus ducts etc. The content of tanks, silo, bins and hoppers etc., shall be measured at full capacity for this purpose.

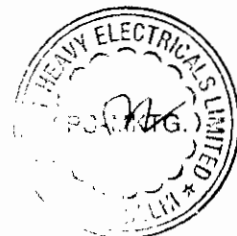
2.2 The piping loads, cable tray loads and the contents of the tank, silos, bins and hoppers shall be listed separately so that they can be excluded from dead load when dead loads are acting as stabilising load for uplift.

2.3 The following unit weight of material shall be considered for computation of loads. Loads given in IS: 875 (part-I) shall be made use of for material not listed below.

Materials	:	Unit weight
Plain cement concrete	:	2.40 t/cum
Reinforced cement concrete	:	2.50 t/cum
Structural steel	:	7.85 t/cum
Brick work	:	1.9 t/cum
Cement plaster	:	2.1 t/cum
Floor Finish	:	2.4 t/cum
Coal	:	1.20 t/cum
Fly Ash	:	1.60 t/cum
Bottom Ash	:	1.60 t/cum

3. IMPOSED LOADS

3.1 Imposed loads in different areas shall include live loads, dust loads, minor equipment loads, cable trays, small pipe racks / hanger, erection loads, operation / maintenance loads, etc. The loads considered shall not be less than that specified in IS: 875 (part II). The loads listed here under are the minimum loads for the areas involved. Special use areas shall be investigated and loads revised upward as necessary. Floors and supporting members which may be subjected to heavy equipment live loads shall be designed on the basis of the weight of equipment or specifically defined live loads, whichever is greater.





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PART – B: LOADS AND LOAD COMBINATION

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3.2 The specific minimum floor live loads are listed below:

3.2.1 **Roofs :**

- (a) Flat Roof : 1.5 kN/sqm for roofs
: 5.0 kN/sqm for accessible roofs with HVAC Equipment etc.
- (b) Sloped Roof : As per IS: 875

3.2.2 Turbine Building

- (a) Ground floor : General area 25 kN/sqm
: Heavy eqpt. Storage area 50 kN/sqm
- (b) Operating Floor : Rotor removal Area 30 kN/sqm
: Eqpt. Laydown Area 30 kN/sqm
: Other areas (Corridors etc.) 15 kN/sqm
: Rotor removal area beams shall also be checked for ½ the rotor load at the center of the beam.
- (c) Heater bay floor : 10 kN/sqm
- (d) Deaerator floor : 10 kN/sqm
- (e) Precast concrete covers : 12 kN/sqm
- (f) Mezzanine floors : 10 kN/sqm
- (g) Platform around deaerator : 10 kN/sq,
- (h) Floor around feed water tank : 20 kN/sqm

3.3 Boiler / Bunker area

- (a) Floor at (+/-) 0.00 : 15 kN/sqm (under operation) or actual loads specified by Boiler manufacturer.
- (b) Feeder / Tripper floor : 20 kN/sqm. Beams however shall be checked for feeder / tripper load.

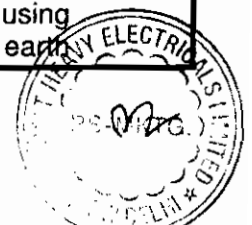
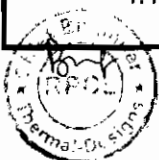
3.4 Main control room/electrical buildings

- (a) Control Room Floor : 10 kN/sqm
- (b) MCC Room : 15 kN/sqm
- (c) Cable vault floor : 5 kN/sqm
- (d) Battery Rooms : 20 kN/sqm





- (e) AHU, AC & ventilation plant : 10 kN/sqm
floors
- (f) Switchgear room : 15 kN/sqm
- (g) PLCC, relay room : 15 kN/sqm
- 3.5 Pump houses
- (a) Operating floor slab : 15 kN/sqm or as required by
equipment supplier whichever
higher.
- 3.6 Workshop : 10 kN/sqm
- 3.7 Other Areas
- (a) RCC floors : 5kN/sqm for offices, laboratories,
conference rooms and general
floors.
- (b) Stairs and balconies : 5 kN/sqm
- (c) Chequered plate/ gratings : 5 kN/sqm
- (d) Walkways : 3 kN/sqm
- (e) Toilet rooms : 2 kN/sqm
- 3.8 Railway supporting bridges such as bridges, culverts etc., shall be
designed as per Railway bridge rules.
- 3.9 Culverts and allied structures including RCC pipes shall be designed for
Class "AA" loading and checked for Class "A" loading as per IRC
standards for two-lane road and above.
- 3.10 Covers for trenches & channels which are not exposed to vehicular traffic
shall be designed for Live load of adjoining area or 2 t/sqm whichever is
higher. Where channels are likely to be exposed to vehicular traffic, the
requirements of Code of practice for road bridges shall be adhered to.
- 3.11 Piping anchor and restraint forces of major piping shall be obtained from
piping analysis results and be considered as live load in the structure
design.
- 3.12 Ponding effects due to framing deflections for roofs, if any shall be
considered.
- 3.13 In addition to the live loads, a minimum of 1.50 kN/sqm shall be
considered as Hung loads for electrical, ventilation & air conditioning. A
load of 2.5 kN/sqm shall be considered as Hung loads for piping where
ever piping is envisaged.
- 3.14 Live loads reduction shall be in accordance with the provisions of IS: 875
& IS: 1893 in case of seismic analysis.
4. **EARTH PRESSURE LOADS**
- 4.1.1 Earth pressure for all underground structures shall be calculated using
coefficients of earth pressure at rest, coefficient of active or passive earth





pressure (whichever is applicable). However, for design of substructure of pump house and under ground liquid storage tanks, earth pressure at rest shall be considered. For design of cold water basin of cooling water and channel, active earth pressure shall be considered

- a) Angle of internal friction for foundation of underground structures for calculation of earth pressure shall be from soil report or 36 degrees whichever is less.
- b) For backfilled soil, angle of internal friction shall be limited to 33 degrees.

4.2 In addition to earth pressure and ground water pressure, etc., a minimum surcharge load of 2.0 t/sqm shall also be considered for the design of all underground structures including channels, sumps, cable & pipe trenches, etc., to take into account the vehicular traffic in the vicinity of the structure.

5. WIND LOAD

5.1 Wind load on structures shall be calculated as per provisions of IS: 875 (part 3). The wind shall be assumed to blow in any direction and most unfavourable condition shall be considered for design.

5.2 In design of structures, wind force on equipment supported on frame including all fixtures, piping, staircase, ladders, etc., shall also be considered.

5.3 Wind loads generally be estimated based on 3 seconds gust wind as per IS 875 (part -3). However, wind loads for slender structure (having height to width ratio exceeding 5) shall be calculated using gust factor method also and higher of the two wind load values shall be considered for analysis.

6. SEISMIC LOADS

6.1 Seismic forces shall be as per zone III of IS:1893 Part IV

6.2 For following structures, the design methods listed below shall be used.

- (a) Turbine Building and Bunker : Response spectrum method
Buildings
- b) All other Buildings : Response spectrum method

6.3 The importance factor for all power plant buildings and structures shall be taken as 1.75 and for other minor structures as per IS:1893 Part IV.

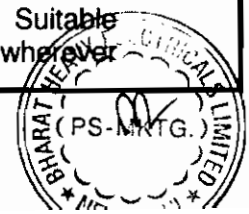
6.4 Ductile detailing in accordance with IS 13920 to be adopted for all concrete structures which is mandatory for Zone – III.

7. TEMPERATURE LOAD

7.1 Expansion and contraction due to changes of temperatures of materials of a structure shall be considered and adequate provisions shall be made for the effects produced (as per provision in relevant IS codes). Suitable expansion joints shall be provided in the longitudinal direction wherever



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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.

7.2 Analysis shall be carried out for ambient temperature variation. The temperature variation shall be considered as 2/3 of 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 temperature during the coldest month of the year and mean of daily maximum temperature during the hottest month of the year. The structure shall be designed to withstand thermal stresses due to 50% of the temperature variation.

7.3 Coefficient of thermal expansion of steel shall be taken as per IS : 800. Coefficient for thermal expansion for concrete shall be taken as per IS: 456.

Ambient Temperature :

Maximum (Average) : 43.3° C

Minimum (Average) : 13.9° C

8 EQUIPMENT LOADS

8.1 Static and dynamic loads of major equipment such as deaerator, heaters, etc., shall be based on the manufacturer's data of the specified equipments and shall be considered in design in addition to the live load. However, where the uniform floor live load adequately accounts for the equipment moving weight, the weight of such equipment as a dead load shall not be considered. Eg: switchgear and control room floors are usually designed for a live load that includes the equipment weight.

8.2 All equipment, tanks and piping design loading shall include hydraulic testing loading. Weight of equipment, ducts, tanks, pipes, conduits, etc., supported by structure shall include maximum possible loading conditions i.e flooded conditions and associated impacts, test loading, anchorages and constraint effects.

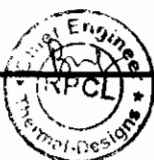
8.3 Air and gas duct loads shall include weight of insulation, duct attachments, dust accumulation loads, seismic, wind and other loads applicable.

9. CRANE, MONORAIL & ELEVATOR LOADS

9.1 Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as per crane vendor's data. All lifting beams and monorails shall have their design loads increased for impact factor as mentioned hereinafter.

9.2 Impact Factor

Loads for cranes, hoists and elevators shall be taken as per IS: 875. The minimum impact factor to be used in design shall be as follows:



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**9.2.1 Crane loads :**

- (a) For vertical force, an impact factor of 25% of the maximum crane wheel load
- (b) A lateral crane surge of 10% of the weight of the trolley plus lifted load applied at the top of each rail divided in proportion to the relative lateral stiffness of the rail support system
- (c) A horizontal surge of 5% of the maximum static wheel loads of the crane applied at the top of the rail in longitudinal direction.

9.2.2 Monorail loads

- (a) Impact factor of 10% of lifted load of hoist for monorail and support design
- (b) Impact factor of 25% of the lifted load for electrical pulley and support design

9.2.3 Elevator

Impact factor of 100% of the lifted load including elevator live load plus the cab weight for the elevator support beams.

9.2.4 Rotating and reciprocating type equipment:-50% of machine weight

10. OTHER LOADS

10.1 Stresses imparted to structures due to variation of water table, erection and maintenance loads shall also be considered in design of all structures.

10.2 In order to allow for unusual loading during steel member erection or during the construction period, all beams on major column lines acting as column struts or ties are designed to withstand an axial force of 45t in combination with the dead load of the beam. End connections on these beams are designed to transfer its axial load. A minimum of 12mm thick connection angles are to be provided unless thicker angles are required by design.

10.3 No part of Roof girders / purlins/ trusses in the service / maintenance bay of Turbine building shall be used for crane erection.

10.4 Columns in turbine building near transformer yard shall also be designed to support tension due to strung conductors and shield wire if the conductors are connected to the Turbine building columns.

11.0 BASIC LOAD CASES

The following basic load cases shall be considered for the analysis:

- (a) Dead load : D
- (b) Self weight of permanent equipment : EL
- (c) Live load on floor / walkway : L





(d)	Live load on roof	:	LR
(e)	Crane load with lift	:	CR1
(f)	Crane load without lift	:	CR2
(g)	Wind load	:	WL
(h)	Seismic load	:	SL
(i)	Load due to soil pressure	:	SP
(j)	Load due to surcharge	:	SCL
(k)	Load due to hydrostatic pressure	:	HP
(l)	Load due to temperature	:	TL
(m)	Special loads	:	SPL

12.0 LOAD COMBINATIONS

12.1 The individual members of the frame shall be designed for worst combination of forces such as bending moment, axial force, shear force and torsion. Permissible stresses for different load combinations shall be taken as per IS: 875 (Part-V) and other relevant IS codes. Wind and seismic forces shall not be considered to act simultaneously.

12.2 Criticality of erection / maintenance loads shall also be checked separately in combination with other simultaneously occurring loads for possible design loading.

12.3 For design of main plant structures during seismic conditions, the de-aerator feed water tank shall be considered full up to operating level. However for other load combinations flooded condition shall be assumed.

12.4 "Lifted load" of crane shall not be considered during seismic condition.

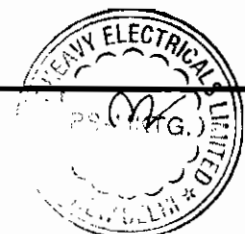
12.5 In case more than one crane is provided and Tandem operation is not envisaged, the load shall be taken as one crane fully loaded and second crane without lifted load but standing idle adjacent to first crane.

13. LOAD COMBINATIONS FOR UNDERGROUND STRUCTURES

Following loading conditions shall be considered in addition to the loading from super structure for the design of sub-structure of pump house, channels, sumps, tanks, reservoirs, trenches and other under ground structures.

13.1 Only liquid pressure from inside and no earth pressure and ground water pressure, and surcharge pressure from outside (applicable only to the structures which are liable to be filled with water or any other liquid).

13.2 Earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.





13.3 Base slab of the pump house shall be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum ground water table at FGL. Intermediate dividing piers of pump sumps and partition walls in channel shall be designed considering water on one side only and the other side being empty for maintenance.

13.4 Design shall also be checked against buoyancy due to ground water during construction and operation stage. Minimum factor of safety as per IS: 3370 against buoyancy shall be ensured considering empty condition ignoring superimposed loads. However in CW forebay and Channel, Pressure release valve may be used to counter the buoyancy effect due to ground water along with sandwich slab of 2500mm thick only, if the thickness of the sandwich slab as per design requirement works out to be more than 2500mm..

14. **SPECIAL STRUCTURES**

For the following structures, additional loading criteria as mentioned below in addition to the criteria discussed above shall be considered:

14.1 **Coal bunkers**

14.1.1 The following densities shall be considered for design of coal bunkers :

- (a) For volume calculations : 800 kg/cum
- (b) For structural design : 1200 kg/cum

14.1.2 The coal bunker will be designed as per criteria outlined in IS:9178 (Part I&II)

14.2 **Switchyard structures :**

14.2.1 The loading for the design of switchyard structures shall be as per IS: 802 Part 1/Sec1-1995 (latest edition). Following loads shall be considered:

- (a) Dead load due to equipment and dead load due to structure
- (b) Wind load on towers, conductors, ground wires and insulator strings calculated as per clause 8 and 9 of IS: 802
- (c) Temperature effects consisting of effect of temperature variation and sag tension as per clause 10 of IS: 802
- (d) Climatic loads as per clause 11.2 of IS: 802
- (e) Anti cascading loads as per clause 11.3.1 of IS:802
- (f) Torsional and longitudinal loads caused by breakage of conductor as per clause 11.3.2 and 16 of IS:802
- (g) Construction and maintenance loads





- (h) Seismic loads as per IS: 1893
- (i) Short circuit forces including “snap effect” in the case of bundled conductors

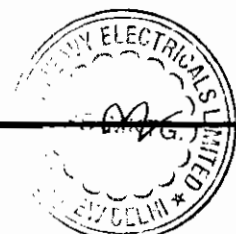
14.2.2 Switchyard structure shall be designed for the worst combination of above loads. The factor of safety for design of members shall be considered as 2 for normal and broken wire conditions and 1.5 for combined short circuit and broken wire conditions. Short circuit forces and wind forces shall not be considered simultaneously.

14.2.3 Foundation shall be designed for a factor of safety 2.2 for normal and broken wire condition and 1.65 for combined short circuit and broken wire conditions. Design of foundation shall be carried out as per IS: 4091.

14.3 Boiler, ESP, Support structures

14.3.1 The supporting structure shall be designed for the following :

- (a) Live / imposed loads
- (b) Dead loads
- (c) Static and dynamic loads of piping, movable equipment and maintenance parts
- (d) Cantilever loads of not less than 2000 kg/metre at a distance of 1200 mm from the external face or the columns, on both sides of the ESP, for cable trays and walkways.
- (e) Cantilever loads of not less than 500 kg/metre at a distance of 1200 mm from the external face or the columns, on both sides of the boiler, for cable trays and walkways.
- (f) Dry ash piping supported from the main columns of ESP structure
- (g) Ash water piping supported on the outermost row of boiler column
- (h) All ESP hoppers filled up with ash upto the top of the hoppers or the bottom of the electrodes (whichever is more) using a bulk density of not less than 1350 kg/cum for the ash, along with additional ash build-up from the end of the third field upto the inlet duct bottom level at a natural repose angle (not less than 30 degree to horizontal in any case)
- (i) Seismic or wind loads as specified elsewhere in the specification
- (j) Temperature variation of ± 25 deg. C for atmospheric temperature variations
- (k) Temperature variations under ESP operating conditions
- (l) **The loads listed above indicate the minimum requirements**





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

14.3.3 Dry ash transportation pipes and supply air pipes shall be supported on the structural members of the ESP.

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

14.3.5 The ESP hopper outlet flanges shall be terminated at a height of 3.5m above finished paved level.

14.3.6 Boiler and ESP support structures shall be checked for differential settlement of foundations which shall be restricted to 1 in 1000 of span or 8 mm whichever is less.

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

14.3.8 Design criteria for foundations and some other facilities / areas are covered separately in this specifications.

15.0 Specific design Requirements:

To account for revisions & additions of new loads likely to occur as the design work progress, the stress ratio / design margin for design of members shall be as follows:

- a. For foundations, the actual to allowable bearing pressure ratio shall not exceed 0.90.
- b. There shall be a margin of 10% on the reinforcement provided as compared to the required reinforcement.
- c. The minimum diameter of bars for main tensile reinforcement for foundation shall be 12 mm.
- d. For column & beams the stress ratio shall not exceed 0.90 for normal loading conditions and not to exceed 1.20 for wind/seismic loading combination.
- e. The design of structural steel plated sections will be done with yield strength of plates as 300 N/mm sq. with 10% additional factor of safety, due to which plated section will be subjected to maximum yield stress of 275 N/ mm sq.



**PART-C REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS****1. GENERAL**

All structures, building foundations, machines / equipments foundation, water retaining structure, trenches, pits, etc., shall be designed as per relevant IS codes in general. Construction in general shall follow provisions of IS: 456 and IS: 3370 for normal and water retaining structures respectively.

2. DESIGN METHODOLOGY**2.1 General**

2.1.1 All designs of RCC structures shall be carried out by limit state method as per IS:456 unless use of working stress method is specifically mentioned. Design strength of materials and design loads shall be calculated using appropriate partial safety factors over characteristic strength and characteristic loads as per IS:456.

2.1.2 For reinforcement detailing IS: 5525 and SP: 34 shall be followed.

2.1.3 The walls shall be provided with reinforcement on both faces for sections 150 mm or more, even if not required from design consideration.

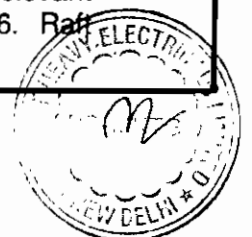
2.2 Foundation and Underground structures**2.2.1 General**

The depth of all the foundations from design consideration shall be reckoned from the NGL (Natural Ground Level) or FGL (Finished Grade Level) whichever is lower. (The minimum depth of the foundations for structures shall be 1.5 m except for minor equipment foundations.)

2.2.1.1 Type of foundation system, i.e., isolated, strip or raft shall be decided based on the loading arrangement, load intensity and soil strata. Design of foundations at various levels shall be dependent upon the soil bearing capacity at that level. For ease of construction and to achieve proper compaction / consolidation of concrete during construction of isolated footings, footing with uniform thickness shall be adopted.

2.2.1.2 Foundation system adopted shall ensure that settlement / relative settlement is as per provision of IS: 1904 and other Indian Standards. However, the settlement shall be restricted to 25 mm & 12 mm respectively in soil & disintegrated rock respectively

2.2.1.3 All foundation including machine / equipment foundations shall be of RCC construction. All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian standards IS: 2974 and IS: 456. Raft foundations shall be designed as per IS: 2950.





2.2.1.4 For design of underground structures, subsoil water level below the formation level shall be based on the recommendations of Geotechnical investigation report. Any variation in such assumptions during the execution shall be to BHEL's account only. All underground pits, tunnels, basements, cable and pipe trenches, etc., shall be leak proof RCC structure. Effects of uplift and reduction in bearing capacity due to underground water table shall also be considered.

2.2.2 **Liquid retaining structures**

2.2.2.1 RCC water retaining structure like storage tanks, reservoirs, cooling tower basin, etc., shall be leak proof and designed as cracked section with limiting crack width of 0.1 mm and limiting steel stresses in accordance with IS: 3370 (part I to IV) by working stress method.

2.2.2.2 Water channels and substructure of pump houses shall be designed as cracked section with limiting crack width of 0.1 mm and limiting steel stresses as per IS: 3370 (part I to IV) by working stress method.

2.2.2.3 All water retaining / storage structures shall be designed assuming liquid upto the height of wall irrespective of provision of any over flow arrangement.

2.2.2.4 In all liquid retaining structures, PVC water bar shall be provided at each construction / expansion joint. The sequence of construction shall also be specified on drawings showing construction joints. At joints fillet shall be provided

2.2.2.4.1 Fillet of size 200 x 200 shall be provided for all water/liquid retaining / conveying structures at the junction of wall and base slab.

2.2.2.5 Where anchors are prescribed to resist uplift, the design of the same shall be based on the recommendation of IS:10270 or the recommendations & parameters furnished below whichever is more critical.

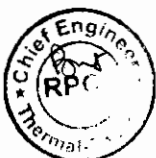
(a) Minimum dia of anchor rod shall be 25 mm and that of anchor hole shall be 75 mm. The dia of anchor hole shall not be less than 2.5 times the dia of the anchor rod.

(b) The anchor hole shall be grouted with cement, sand aggregate (of size 6 mm and down) grout 1:1:2 with non-shrink additive and shall be of strength not less than M30 or one grade higher than the grade of concrete to be used.

(c) Minimum depth of anchor in rock shall be 2 m. Anchor strength in soil layer shall not be accounted. The allowable bond stress between grout & rock shall be 0.2 N/sqmm and 0.5N/sqmm for disintegrated rock and hard rock respectively.

(d) The anchor rod shall be protected by corrosion resistant paint as per IS 10270.

(e) Adequate number of pull-out tests as per IS 11309 shall be conducted to verify the capacity of the anchors both for test and working anchor.





2.3 Machine Foundations

The design of equipment foundation shall be as per IS: 456 and IS: 2974. The provisions of DIN 4024 shall also be followed for machine foundations.

2.3.1 All machine / equipment foundations and structures subject to vibrations shall suitably proportioned so that amplitude and frequency of the foundation / structures are within permissible limits.

2.3.2 All block foundations resting on soil shall be designed using the elastic half space theory. The mass of the RCC block shall not be less than the two and a half (2.5) times mass of the machine. Dynamic analysis shall be carried out to calculate natural frequencies in all modes including coupled modes and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down by the relevant codes or machine manufacturers shall be satisfied. The Minimum reinforcement shall also be governed by IS: 2974 and IS: 456.

2.3.3 For the foundations supporting minor equipment weighing less than one ton or of 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 structures, floors, etc., suitable vibration isolation shall be provided by means of springs, neoprene pads, etc., and such vibration isolation system shall be designed suitably.

2.3.4 Boilers Feed Pumps shall be supported on vibration isolation system. The vibration isolation system shall consist of helical spring units and viscous dampers supporting the RCC deck which support the machine. The spring units shall conform to DIN 2089 and DIN 2096. The whole system is supported on block foundation consisting of common raft and pedestals.

2.3.5 All such foundation shall be separated from adjoining part of building and other foundations. Joints at floor / slab shall be suitably sealed. All appendages to such foundations shall be reinforced suitably to ensure integral action.

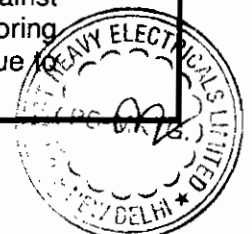
2.4 Increase in Stresses

2.4.1 Where stresses due to wind (or seismic) are combined with those due to other loads, the allowable stresses in concrete, reinforcement steel and structural steel shall be increased by 33.33% in case of working stress design. However, no increase in stresses is permitted for wind predominant structures.

2.4.2 Bearing capacity of the soil shall be allowed to increase by 25% under seismic / wind load condition or as per applicable codal provisions whichever is lower.

3 Stability of structures

3.1 Design shall be checked against buoyancy due to the ground water during construction and maintenance stages for structures like underground tanks, pits trenches, basements, etc. Minimum factor of safety of 1.2 against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loading. For purpose of calculating downward load due to





any overburden, only the mass located vertically above the projected area shall be taken in to consideration.

3.2 All building sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads. Factor of safety for these cases shall be taken as mentioned in IS: 456 and other relevant IS codes. However, following minimum factor of safety shall be followed.

- (a) Factor of safety against overturning due to wind, seismic or other lateral load shall be 1.5 minimum
- (b) Factor of safety against sliding shall be 1.5 minimum
- (c) Factor of safety against uplift due to hydrostatic forces shall be 1.2 and due to any other loads shall be 1.5.

3.3 Stability of the structure shall also be investigated for loading conditions during construction, repair or other temporary measures. Lower factor of safety may be used for such loading conditions as per relevant IS codes.

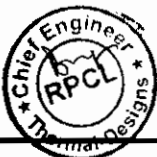
3.4 In case where dead load provides the restoring force, only 0.90 times characteristic dead load shall be considered. Imposed loads shall not be considered as restoring force.

4 MINIMUM THICKNESS OF STRUCTURAL ELEMENTS

The following minimum thickness shall be followed:

a	Suspended floor / slab / walkways / Canopy slabs, etc	150 mm
b	Ground floor slab (non-suspended)	150 mm
c	Water Retaining slabs / walls	200 mm
d	Cable / pipe trenches / underground pits / Launder walls and base slab	150mm
e	All footings (including raft foundations)	300 mm
f	Parapets	125 mm
g	Sunshades	75 mm at stage
h	Precast louvers / fins	50 mm
i	Precast trench cover slabs / floor slabs / louvers	75 mm
j	Paving	100 mm
k	Basement walls and base slab	200 mm
l	Silo / bin walls	150 mm
m	Underground reservoir	
n	i) Below ground water table	200 mm
o	ii) Above ground water table	150 mm

4.1 From fire resistance point of view minimum thickness of reinforced Concrete members shall be as per fig 1 of table 16a of IS 456.





5 MINIMUM HEIGHTS FOR PEDESTALS OF STEEL COLUMNS

- 5.1 Pedestals to Steel Columns for building structures :
Top or RCC foundations (pedestals) shall normally be kept at a lower level so that the column base plates together with gussets and stiffeners remain below finished floor level (FFL) unless specified otherwise. Foundation levels for some columns shall be changed suitably to accommodate underground services, pits trenches, etc.
- 5.2 Stair and ladder pedestal shall be kept 200 mm above the finished floor level.
- 5.3 Pedestals to Steel Columns for Equipment structure :
- | | | |
|-----|---|--|
| (a) | Equipment in open area | : as required (300mm min) |
| (b) | Equipment in covered area | : as required (150 mm min) |
| (c) | Structures and equipment supplied by vendor | : as per vendor's data subject to minimum as specified above |

6 MINIMUM HEIGHTS FOR ENCASEMENT TO STEEL COLUMNS

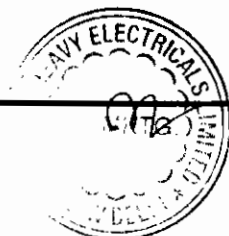
In case the top of pedestal is kept at a lower level so that the column base plate together with gussets and stiffeners remain below finished floor level (FFL) the column bases as well as the column sections shall be encased in concrete above FFL as per following.

- | | | |
|-----|--------------|----------------------------|
| (a) | Open area | : 300 mm above paved level |
| (b) | Covered area | : 150 mm above FFL |

7 CONCRETE MIX

- 7.1 The following minimum grades of concrete as per IS: 456 shall generally be used for the type of structures noted against each grade. Ordinary Portland Cement (OPC) shall generally be used. However in case of scarcity of OPC cement and as directed by owner, Pozzolona Portland Cement (PPC) / fly ash cement can also be used. Grade of OPC cement shall be 43 conforming to IS 8112.

- | | |
|-----------|--|
| M10 | : Backfilling of over excavation. |
| M15 | : Foundation below brick wall, blinding layer below foundations, trenches and underground structures, minimum thickness of the layer shall be 100 mm. |
| Grade M20 | : Base plate encasement, pavement around building including plinth protection work, encasement of structural steel work, etc. |
| Grade M25 | : All RCC members except where other grades are specified e.g. Foundation and super structure, grade beams, pedestals, ground floor slabs, roof slabs, cable and pipe trenches, Precast concrete work, etc.
TG Raft |





Grade M30

Water retaining structures below and above ground, for all Machine foundations including ID, FD, PA except TG top Deck, BFP Top deck and TG Columns.

Grade M 35

For TG Columns, TG top Deck, BFP Top deck

7.2 Minimum cover to the reinforcement shall be as per IS:456 .

7.3 Minimum cement content shall be governed by the requirement of IS:456.

8 REINFORCEMENTS

8.1 Reinforcement bars shall be as per the following codes :

TMT of Grade Fe 500	:	IS 1786
Mild steel bars	:	Grade I of IS: 432
Welded wire fabric	:	IS: 1566

8.2 Intermixing of different grades of rebars or rebars of different material composition in same structure shall not be allowed.

9 GROUTING

9.1 Non-shrink flowable grout shall be used for under pinning work below base plate of columns. Non-shrink cum plasticiser admixture shall be added in the grout. For grouting of base of machine foundation high strength flowable ready mixed non-shrink grout shall be used.

9.2 Type and grade of grouting for structural columns and equipment bases shall be indicated. Crushing strength of the grout shall generally be one grade higher than the base concrete. Minimum grade of grout shall be M25.

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

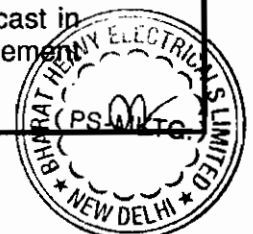
10 MINIMUM COVER TO FOUNDATION BOLTS

Minimum distance from the center line of foundation / anchor bolt to edge of pedestal shall be the maximum of the following:

- (a) Clear distance from the edge of base plate / base frames to the outer edge of the pedestal shall be minimum 50 mm.
- (b) Clear distance from the face of pocket to the outer edge of pedestal shall be 75 mm.
- (c) Clear distance from the edge of sleeve or anchor plate to the outer edge of pedestal shall be 75 mm.

11.0 MISCELLANEOUS REQUIREMENT

11.1 Fillets at the junction of roof and vertical walls shall be provided with cast in situ cement concrete of M15 grade followed by 12 mm thick 1:4 cement mortar.





11.2 A screed layer not less than 100 mm thick of cast in situ concrete of nominal mix Grade M10 shall be provided below all water retaining structures. A sliding layer of craft paper or bitumen paper shall be provided over the screed layer to destroy the bond between screed and base slab.

11.3 All under ground structures such as CW pump house, sumps etc, shall be designed as per IS: 456 limiting the crack width to 0.1 mm. Check for crack width shall be in accordance with BS: 8007/IS: 456. In case of leakage in the above structure injection grouting method shall be applied to repair the structure according to the requirement of IS: 6494.

For switchyard foundations anchor bolt with mechanical anchorage shall be provided and cast along with foundation concrete. Bolts in pockets shall not be adopted. Foundation for all switchyard towers shall be designed as per IS: 4091. Contact between foundation and the soil strata shall be ensured for all conditions and combinations of loading

11.4 Plywood formwork shall be used for all water retaining / conveying structures and for all over ground concrete works. For other areas steel / plywood formwork shall be used.

11.5 Unless specified, 20mm and downgraded aggregates shall be used for all structural concrete works. However 40mm and downgraded aggregates may also be used for mass / deep foundations like coal mill foundations, fan foundations etc., under specific approval from the owner.

11.6 Tolerance for formed and concrete dimension shall be as per IS:456

12.0 MAJOR EQUIPMENT FOUNDATIONS

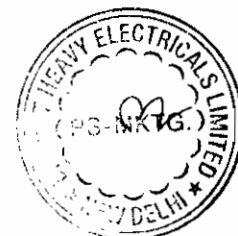
Special requirements for concreting of major equipment foundations like TG, BFPs MILLS and Fans shall be as given below:

12.1 Coarse Aggregates

Sound and durable crushed stone aggregates shall be used. All aggregates shall be tested for alkali aggregate reaction. Materials, which contain high percentage of reactive silica, shall not be used. In exceptional cases of high percentage of reactive silica content, aggregate may be allowed where low alkali cement shall be used. Lime stone aggregate shall not generally be used for foundations which are subjected to high temperature and repeated temperature cycles (like in the case of all machine foundations).

12.2 Temperature Control of Concrete

The temperature of fresh concrete shall not exceed 23 deg. C when placed. For maintaining the temperature of 23 deg. C in the top decks of machine foundations, crushed ice shall be used in mixing water.





12.3 Admixture

Plasticizer cum retarder type admixture shall generally be added to the concrete for promoting workability in addition to retarding the setting time for mass concreting work. The slumps shall generally be in the range given below:

TG Top deck	150mm to 200mm
BFP, ID/PA/FD Fan & Mill deck	100mm to 150mm
Block foundation	100mm to 150mm
Column	100mm to 150mm

12.4 Form work

Plywood formwork shall be used for the top decks of all machine foundations and also for columns of TG foundation

Steel trestles shall be used in staging for concreting of the TG columns / decks.

12.5 Scheme for Concreting

Weigh batching plants shall be mobilized for all machine foundations. Concrete pump shall be mobilized for TG raft, TG Top deck, BFP Deck, PA/FD/ID Fan deck, Mill Deck. Arrangements for stand-by Plant and Equipments shall also be made

12.6 Placing of Concrete

Base mat and top deck of machine Foundations shall be cast in a single pour

12.7 Ultrasonic Testing

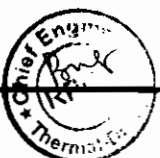
Ultrasonic pulse velocity test shall be carried out for the top decks of all machine foundations and TG substructure to ascertain the homogeneity and integrity of concrete. In addition, additional cubes (at the rate of one cube per 150 cum of concrete subject to a minimum of six cubes) shall be taken to carry out Ultrasonic Pulse velocity (UPV) testing on the cubes to serve as reference UPV values

Testing shall be done as per IS: 13311 (Part-1). In case of any defects, BHEL shall rectify the defects suitably using cement / epoxy grout etc.

SHAKER TEST : M/s RPCL and M/s Evonik desired to conduct Shaker test on TG foundation to correlate the design results of dynamic analysis with the actual foundation.

12.8 Quality Control

Refer Clause 3.5 of Section 4.5 Volume V.



**1. DRAINAGE AND SEWERAGE**

All drainage lines for storm water, sewage and waste drainage etc. shall preferably be laid in service aisles close to the road. Separate network shall be provided for lines of storm water, sewage, and waste drainage.

1.1 Surface Drainage

1.1.1 All the paved and unpaved areas shall be adequately drained. The surface drainage system shall be designed for surface washings and / or rain / fire water as the case may be. Unpaved open areas shall be drained through RCC drains and connected to main storm drains.

1.1.2 The paved area shall be sloped towards the drains with a minimum slope of 1 in 100. The maximum drainage travel extent shall be limited to 10 metres.

1.1.3 The surface drainage from uncontaminated area shall be connected to nearest open storm water drains through rectangular drains. Contaminated area surface drainage shall be collected through separate network.

1.1.4 The interconnecting pipes and rectangular drains shall be sized for carrying the design discharge when running full.

1.1.5 The rectangular drains shall be minimum 600 mm wide of RCC. The pipes for water drainage system shall be of RCC class NP2 conforming to IS:458 with minimum size of 300 mm NB. However, for road crossings etc. pipe of class NP3 shall be provided. For rail crossings, pipes conforming to railway loading standards shall be provided. If sufficient clearance cannot be provided between the top of the pipe and road top, the pipes shall be encased in RCC.

1.1.6 The maximum velocity for pipe drains and open drains shall be limited to 2.4m/sec and 1.8m/sec respectively. However, minimum velocity for self cleansing of 0.6m/sec shall be ensured. Slope of drain shall not be milder than 1 in 1000.

1.1.7 Minimum earth cover of 450 mm shall be provided over drainage pipes in paved areas.

1.1.8 Garland drains minimum 300 mm wide shall be provided allround the building to lead away roof drainage to plant drainage system. Plinth protection in PCC M15 grade shall be provided between brickwall and drain with appropriate slope.

1.2 Storm Water Drainage System

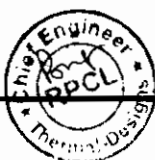
1.2.1 The plant storm water drainage system shall take into account the topography of the plant area, area drainage patterns and intensity of rainfall etc. The drainage system shall be designed for precipitation intensity equal to hourly rainfall for a return period of 1 in 50 years.





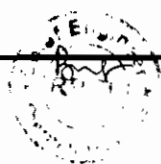
However, storm frequency of 100 years return period shall be applied for Coal Storage area.

- 1.2.2 All storm water drainage shall preferably be through open storm water drains. These shall be provided on both sides of the roads and shall be designed to drain the appropriate catchment area including road surface, open and covered area etc. The drains shall be minimum 600 mm wide at the base.
- 1.2.3 For open trapezoidal drains, brick masonry lining on sides and bottom shall be provided. Bricks shall be laid in cement mortar and joints pointed flush. The thickness of lining shall be minimum 115 mm. The lining shall be with bricks of class designation 50 laid in cement sand mortar 1:4 and flush pointed with cement sand mortar 1:2. The side slopes upon which lining has to rest shall be made such that no earth pressure is exerted upon lining in any condition. However, the side slope shall not be steeper than 2 vertical to 1 horizontal. Alternatively, open drains trapezoidal in cross section may be provided in PCC lining of M15 grade. The thickness of PCC lining shall be minimum 100 mm or as per design requirements whichever is higher.
- 1.2.4 All open drains rectangular in cross section shall be in RCC. In the main plant block, rectangular section RCC drains in minimum M20 grade concrete shall be provided. The thickness of side and bottom shall be minimum 125 mm or as per design considerations whichever is higher.
- 1.2.5 The pipes for water drainage system shall be concrete pipes of class NP2 conforming to IS:458. However, for road crossings etc. higher strength pipe of class NP3 shall be provided. Diameter of pipes used for drainage / culverts shall be between 300 mm to 600 mm. Beyond 600 mm, box drains / culverts shall be provided.
- 1.2.6 Surface drains shall normally have a bed slope not milder than 1 in 1000 along longitudinal direction and RCC pipes shall have such slopes so as to have effective discharge. The maximum velocity for pipe drains and open drains shall be limited to 2.4 m/sec and 1.8 m/sec respectively. However, minimum velocity for self cleansing of 0.6 m/sec shall be ensured at peak flow condition (i.e. 3 times average flow) for pipes flowing at half full.
- 1.2.7 Suitable manholes shall be provided to piped drainage lines at every 30 m intervals, at junctions and at change of gradient, alignment and diameter of pipe and shall be of masonry or RCC construction. Minimum size of manholes shall be 1.0m x 1.0m or circular manhole of 1 m dia. All manholes shall be designed considering maintenance, inspection and cleaning of pipes. Easy accessibility and safety shall also be given due consideration.
- 1.2.8 The cushion over the pipes for storm water culverts shall be minimum 600 mm. Where less cushion is available, pipe shall be encased in RCC M-20. Suitable RCC or masonry structures shall be provided at drops / falls to prevent scouring or damage to surface.
- 1.2.9 Invert of drainage pipe / drain shall be decided in such a way that the water can easily be discharged above the high water level in water course outside the plant boundary to which the storm water is to be led.

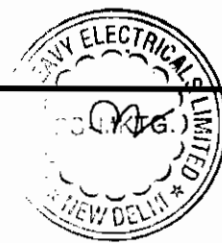




- 1.3 **Plant Effluent Drainage (Oily Waste / Process Waste Drainage)**
- 1.3.1 The oily / process waste shall be led up to the collection sump (sump in RPCL scope). Waste drained / collected through a separate sewer system consisting of underground (overground if required) concrete / cast iron pipes. Catch pits shall be provided at the source location and they shall be interconnected by buried pipes. No bends and branches shall be provided in the pipe line. Manholes shall be provided at all junctions of pipes. Catchpits shall have a minimum internal dimension of 600 mm x 600 mm. They shall be of RCC construction and provided with CI grills.
- 1.3.2 The main and branch connection pipes shall be sized for the expected maximum discharge subject to a minimum of 250 mm NB and 100 mm NB respectively. The pipes shall be adequately sloped for drainage.
- 1.4 **Sewage System**
- 1.4.1 Cement concrete pipes shall be used below ground level for sewage disposal. Pipes connecting toilet facilities to manholes shall be minimum 100 mm NB. Pipes connecting various manholes shall be minimum 150 mm NB. However salt glazed stoneware pipes of diameter not exceeding 150 mm can be used in localised areas not subject to any traffic loads. For main power block below paved area, cast iron spun pipe of Class LA conforming to IS:1536 shall be used.
- 1.4.2 Sewers shall have such slopes so as to have effective discharge. Sewers shall be designed for a minimum self cleansing velocity of 0.75 m/sec for peak flow condition (assumed as 3 times the average flow) and pipes flowing half full. The maximum velocity shall not exceed 2.4 m/sec.
- 1.4.3 Suitable manholes shall be provided to piped sewage lines at every 30 m intervals, at junctions and at change of gradient, alignment & diameter of pipe and shall be of masonry or RCC construction. Details of manholes shall be as per IS: 4111 (Part-I). Minimum size of manholes shall be 1.0m x 1.0 m for square section or 1 m dia for circular. All manholes shall be designed considering maintenance, inspection and cleaning of pipes. Easy accessibility and safety shall also be given due consideration.
- 1.4.4 Separate septic tanks shall be provided at suitable locations for each building block. Sewage from septic tanks shall be connected to the existing common sewerage treatment plant.
- 2 **INTER PLANT TRENCHES**
- 2.1 All cable and pipe trenches shall be of RCC with minimum M20 grade. Trenches located outside buildings shall be projecting at least 150 mm above finished formation level to avoid entry of storm water into the trenches. The bottom of trench shall be provided with suitable slope for draining out collected water into a sump pit.



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RAICHUR POWER CORPORATION LIMITED

YERAMARUS TPS - 2x800 MW

PART E : OUTDOOR CIVIL WORKS

SECTION : D 4.6

VOLUME-V

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2.2 Trenches shall be covered using precast RCC cover of minimum M20 grade, each not weighing more than 65 kg and shall be provided with lifting hooks.

2.3 As far as possible in the open area trenches shall be provided for running cables.

3.0 ROADS & PARKING AREA

Roads and parking areas shall be of flexible type of construction and shall be designed in accordance with the provision of the relevant IRC Codes of Practice. Top level of parking area shall be flushed with crown of the connecting roads with a cross slope.

3.1 Roads shall be designed for class 'E' of traffic i.e. traffic intensity of 450-1500 vehicles per day (heavy vehicles exceeding 3 tonnes laden weight) as per IRC-37:1984 "Guidelines for the design of flexible pavements". California Bearing Ratio (CBR) method shall be adopted for the design of roads.

3.2 Sub-base shall be of granular material i.e. laterite, murrum, natural sand, gravel, crushed stone (grading-1) or combination thereof laid over well compacted subgrade. Granular base shall be of wet mix macadam course (WMM) construction. The wearing coarse shall be bituminous macadam binder course with open graded premix carpet laid over it. Shoulder provided on either sides shall be in murrum construction of 150 mm compacted thickness. Kerbs of PCC or stone shall be provided to distinguish carriage way.

3.3 The geometric design of roads shall be done in accordance with IRC-73. Road widths, curves and parking areas shall have adequate space 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 60 shall be provided for the black topping of roads and a slope of 1 in 40 shall be provided on shoulders. Finished top (crest) of roads shall be 250 mm above the surrounding grade level.

3.4 Minimum radius of curvature along the inner side of the carriage way shall be generally 12m. However for minor roads this shall be reduced suitably as per layout requirements and site conditions. Road width and turning radii shall also be checked for to take largest foreseeable vehicles and equipment which can reasonably be expected.

3.5 All service and utility lines crossing under roads shall be taken through concrete pipes / ducts and designed for imposed loadings. Number of such crossings shall however be kept to a minimum.





4. **PAVING**

4.1 **R.C.C Paving**

4.1.1 R.C.C paving of grade M20, minimum 125 mm thick laid to a slope of 1 in 100 towards the nearest drain, with reinforcement placed 50 mm from the top surface, shall be provided in the following areas.

- (i) Entire backside of the main Turbine building up to the farther edge of Chimney. The paving shall extend to a minimum of 5 m on either side from the outer most face of equipment structures in the other direction.
- (ii) 5 m wide corridor all along the entire width of TG and De-aerator bay at both gable ends.
- (iii) Fuel oil decantation platforms

4.1.2 The under-bed shall consist of well compacted ground supporting dry rubble soling of compacted thickness 230 mm with interstices properly filled with grits, followed by a layer of PCC of grade M15, 75 mm thick.

4.2 **P.C.C. Paving**

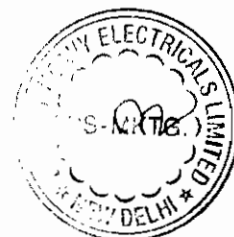
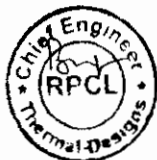
4.2.2 PCC paving of nominal grade M15, 100 mm, laid over 230 mm thick compacted sand and rubble soling shall be provided in the following area.

- i) Complete Transformer Yard, covering area between A-row of the turbine building upto the fencing of the Transformer yard
- ii) Plinth protection around all building to a width of 750 mm or the distance between the brick wall to the garland drain.
- iii) Fuel oil tank farm area, DM water storage tank area and CST farm area for a width of 1 m.

4.3 **Stone Aggregate paving**

4.3.1 Entire switch yard shall be provided with 75 mm paving of 40 mm single size stone aggregate on top and 75 mm paving of 20 mm single size stone aggregate below. Before laying the paving, the ground surface shall be treated with anti weed chemicals as per manufacturer recommendations.

4.3.2 For auxiliary transformer yard, paving of stone aggregate of 75 mm thick using 20 mm single size aggregate shall be provided after compacting the under bed and treating with anti-weed chemicals.





The minimum quality of finishes to be used for various building areas are furnished in this section. However, the Bidder is at liberty to use superior finishes provided all specific requirements for the finish specified herein below are satisfied.

1. **FLOORING**

The nominal total thickness of floor finish shall be 50 mm including under bed and topping. The flooring shall be laid on already matured concrete base. The under bed for floors shall consist of cement concrete M15 with stone chips 12.5 mm down graded as coarse aggregates. The under bed shall be provided with appropriate slope towards catch pit for floor drainage.

1.1 **PVC Floor Finish**

Two mm thick PVC as per IS: 3462 laid as per IS: 5318 over concrete under bed of 48 mm.

1.2 **Kota Stone Flooring**

This shall be provided for Turbine building operating floor. The Kota stone slabs shall be of minimum 20mm thick with approved colour.

1.3 **Terrazo Tiles**

This shall be provided in general circulation areas such as lift entrance area, office area, laboratory etc. Tiles shall generally be of size 250 x 250 x 20 mm laid over concrete bedding to result in an overall thickness of 50 mm.

1.4 **Granolithic flooring**

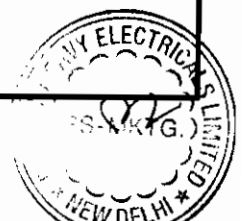
1.4.1 Granolithic flooring (cement concrete flooring in M25 with non metallic floor hardener topping 12 mm thick with a total thickness of 50 mm shall be provided in maintenance and unloading area of Station building, Mill and bunker bay, operating floor of pump house and other plant building areas where heavy duty flooring is required.

1.4.2 Granolithic flooring without floor hardener shall be provided in all MCC and switchgear rooms, which are not air-conditioned.

1.4.3 Granolithic flooring shall also be provided in areas, which are not provided with any special finish. Areas which are likely to be subjected to oil spillage shall be provided with two coats of oil resistant painting over Granolithic flooring.

1.5 **Heavy Duty Ceramic Tiles**

Heavy duty ceramic tiles with matt finish shall be used in toilets, pantry, dining hall of canteen, locker rooms etc. The tiles shall be 300 x 300 x 7 mm of approved shade brand and colour.



**1.6 Acid / Alkali resisting Tiles**

Battery rooms and other areas coming into contact with acid / alkali vapours or fumes shall be given acid / alkali resistant tiles 25 mm thick, jointed with acid / alkali resistant cement slurry. Bedding shall comprise of potassium silicate mortar conforming to IS: 4832 (Part-I) and resin based mortar like epoxy for jointing. Total thickness of flooring shall be 50 mm. Ceramic unglazed vitreous tiles conforming to IS: 4457 with minimum thickness of 20 mm may also be used as acid / alkali resistant tile. The above specification do not apply to D.M. Plant.

1.7 Integral floor finish

For cable vaults floor finish integral to the concrete base shall be provided as per IS: 2571.

1.8 POLISHED VITRIFIED TILES

Polished vitrified tiles of size 600X600X10 mm of approved shade, brand and colour laid with CM 1:3 shall be provided in control rooms.

1.9 Cast-in-situ Terrazo

Risers and treads of staircases shall be provided with cast in situ terrazo. This shall be laid as per IS: 2114, using white cement or cement with colouring pigment. Chequered finish shall be provided for treads. Total thickness of the finish shall be 25 mm.

1.10 Acid / Alkali resistant Tiling / Brick lining in D.M Plant

1.10.1 Bitumen primer followed by 12 mm thick bitumastic layer, 6 mm thick potassium silicate mortar bedding and 38 mm thick alkali / acid resistant bricks as per IS: 4860 shall be provided for CPU regeneration area, Chemical house floor, effluent drains, floors around equipment & chemical handling vessels, chemical storage area for the floor, kerbs and sumps, all as per the acid / alkali proofing specialist Contractor's requirement.

1.10.2 For floor of neutralising pit the finish shall be as follows. Bitumen primer followed by 18 mm thick bitumastic layer, 6 mm thick potassium silicate mortar bedding and 75 mm thick acid / alkali resistant brick as per IS:4860.

1.10.3 For walls of neutralising pit, the same specification as 1.10.2 shall apply except that thickness of the brickwork shall be 115 mm with suitable pilasters at 2000 mm c/c.

1.10.4 Special instruction to be followed for acid resistant lining in neutralising pit shall be as follows.

- i) The structures shall be tested for water tightness.
- ii) Surface on which lining is to be applied shall be prepared as per IS:2395.





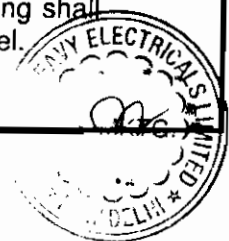
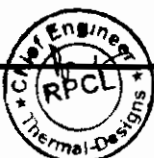
- iii) Joints between acid resistant bricks / tiles shall be filled with resin type mortar conforming to IS:4832 (Part II). Seal coat of ready made epoxy paint shall be provided at the joints to cover up any porosity.
- iv) Acid resistant bricks shall be laid with 6 mm wide and 20 mm deep pointing. Pointing shall be with epoxy / furane / CNSL as per the requirement of the agency guaranteeing the performance of lining.
- v) Under side of all precast slabs / steel covers over effluent drains shall be given two coats of epoxy coating, 150 microns thick.
- vi) Acid / alkali resistant treatment shall extend at least 1 metre on all sides from the outermost periphery of pedestals / saddles for indoor installations and 2 metres around for outdoor installations.

1.11 **Miscellaneous**

- 1.11.1 Aluminium angle nosing with minimum size (50 x 25 x 3) shall be provided for edge protection of R.C.C. stair treads.
- 1.11.2 Angles 50x50x6 mm (min) with lugs shall be provided for edge protection of cut-outs / openings in floor slabs, edge of drains covering gratings, edge of R.C.C cable / pipe trenches and at any other place where breakage of edges / corners is expected.
- 1.11.3 Floors of switchgear rooms shall have embedded steel channel suitable for easy movement of breaker panel.

2. **SKIRTING / DADO**

- 2.1 150 mm skirting matching with floor finish shall be provided in all areas unless specified otherwise elsewhere.
- 2.2 Toilets & locker rooms shall be provided with dado of 2100 mm high with glazed tiles of minimum 5 mm thickness generally as per IS:777.
- 2.3 For main Control room and control equipment room minimum 5 mm thick decorative coloured ceramic tiles shall be provided upto false ceiling level.
- 2.4 For battery room and other areas coming in contact with acid / alkali spillage / fume, dado of acid / alkali resistant tiling as per IS:4457 shall be provided to a height of 2100 mm set in potassium silicate mortar and joints pointed with resin bonded mortar.
- 2.5 Staircase wall shall be given dado of cast in situ terrazo to a height of 2100 mm.
- 2.6 Entrance lobby and lift area in Service building and Admin building shall be provided with granite tile dado to a height upto false ceiling level.



**3. METAL CLADDING****3.1 Permanent colour coated sandwiched insulated metal cladding system**

3.1.1 Troughed zinc-aluminium alloy coated (both sides) M.S. sheet having 0.6 mm minimum thickness (or high tensile steel sheet of 0.5 mm minimum thickness) shall be used on external face (outer face) of cladding system. Weight of coating shall not be less than 150 gm / sq.m. The outer side (exposed face) shall be permanently colour coated with Polyfluro Vinyl Coating (PVF2) of Dry Film Thickness (DFT) 20 microns (min) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns.

3.1.2 Galvanised M.S.sheets of minimum 0.6 mm thickness shall be used as inner liner (internal face) of cladding system. The exposed face shall be permanently colour coated with silicon modified polyester paint of DFT 20 microns (min) over primer. Inner face of external sheet shall be provided with suitable pre-coating of minimum 7 microns. The rate of galvanisation shall not be less than 150 gm / sq.m.

3.1.3 The permanent colour coated sheet shall meet the general requirements of IS: 14246 and shall conform to class 3 for the durability.

3.1.4 Inner sheet shall fixed directly to side runners and Z spacers made of atleast 2 mm thick galvanised steel sheet of grade 375 as per IS:277. Inner sheet shall be fixed at the rate not more than 1.50 m centre to centre to hold the insulation and external sheeting.

3.1.5 The insulation shall be of bonded mineral wool of minimum thickness 50 mm conforming to IS:8183, having a density of 32 kg / cum for glass wool & 48 kg / cum for rock wool.

3.2 Permanent colour coated (non-insulated) metal cladding system

3.2.1 Troughed zinc-aluminium alloy coated not less than 150 gm/sq.m M.S.sheets having 0.6 mm minimum thickness (or High tensile steel sheet of 0.5 mm minimum thickness) shall be used for the cladding system. The outer side (exposed face) shall be permanently colour coated with PVF2 paint of minimum DFT 20 microns over primer and the inner side (internal face) shall be coated with same paint of minimum DFT 10 microns over primer. These shall be fixed directly to runners. The sheets shall meet the general requirement of IS:14246 and shall conform to class 3 for the durability.

3.3 Flashings, caps, trim closures etc

All flashings, trim closures, caps etc. required for the metal cladding system shall be made out of plain sheets having same material and coating specification as mentioned above for the outer face of the sandwiched metal cladding.



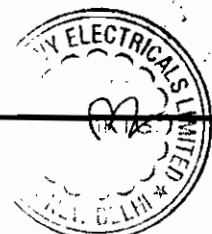


4. **PLASTERING**

- 4.1 Details furnished below does not include special types of plaster / plaster finishes which may be provided to enhance the architectural appeal. CONTRACTOR shall provide such superior plaster finish as indicated in his Bid.
- 4.2 External face of all walls shall be provided with 20 mm thick cement mortar plastering with an under layer 14 mm thick in CM 1:6 and top 6 mm thick layer in CM 1:4 with approved water proofing compound.
- 4.3 For internal walls 18 mm thick plaster in CM 1:6 shall be provided on the uneven side of the wall and 13 mm thick plaster in CM 1:6 on the even side of the wall.
- 4.4 Inside surfaces of walls shall be provided with 2 mm thick plaster of paris punning over the plastered surfaces in office areas, entrance lobby, corridor, control equipment room and all other air conditioned rooms.
- 4.5 Ceiling of all buildings except in cable vaults and over false ceilings shall be given 6 mm thick cement sand plaster 1:4
- 4.6 All plastering work shall conform to IS:1661.

5. **PAINTING**

- 5.1 Details furnished here in below are the minimum acceptable standard for painting. Superior finish if any required by CONTRACTOR to enhance overall appearance will be permitted if such finish meet with the technical requirements.
- 5.2 Water proof cement based paint as per IS:5410 shall be provided on external faces of walls, sunshades, etc.
- 5.3 Inside surfaces shall be provided with Acrylic emulsion paint as per IS:5411 for Control room, Control equipment rooms, all air conditioned areas and all other areas and above dado in buildings like time office, canteen, first aid centre, toilets etc.
- 5.4 Inside surfaces shall be provided with oil bound distemper as per IS:428 for plant buildings like Workshop, Permanent stores, D.G. house, Compressor house, pump houses, Ash handling pump house etc.
- 5.5 Walls in D.M.Plant shall be provided with chlorinated rubber based paint as per IS : 9862 over walls. Walls above Dado in battery rooms shall also be provided with similar painting.
- 5.6 All plastered ceilings shall provided with water bound distemper.
- 5.7 Oil resistant paint as per IS:161 shall be provided for oil canal and oil equipment room.





- 5.8 All wood work shall be provided with fire resistant transparent paint as per IS162 over french polish as per IS:348 or flat oil paint as per IS;137.
- 5.9 Painting for structural steel have been specified else where in this document..
- 5.10 Following general instruction for painting shall be followed.
- i) For painting on concrete, masonry and plastered surfaces IS:2395 parts I and II shall be followed.
 - ii) For painting on wood work IS:2338 part I & II shall be followed.
 - iii) All paints shall be of brand and make to the approval of OWNER.
 - iv) A minimum of two finishing coats of paint over a coat of primer shall be provided to give a smooth uniform finish for the painted surface.
 - v) All painting on masonry or concrete surfaces shall preferably be applied by rollers.
 - vii) Thinner shall not be used with textured paint (sandtex matt etc) finish.
 - viii) All fire exits shall be painted in Post office red colour shade which shall not be used any where except to indicate emergency or safety measure.

6. ROOF

- 6.1 All the buildings having R.C.C slabs over structural steel framing are provided with troughed metal sheet decking which acts as permanent shuttering. These sheets shall meet the general requirements of IS:14246 and shall conform to class 3 for durability. The sheeting shall be permanently colour coated galvanised M.S.troughed metal sheet decking of approved profile with minimum base metal thickness of 0.8 mm and minimum trough depth of 38mm. Silicon modified polyester painting shall be used for permanent coating over galvanised surface with minimum rate of galvanising of 180 gm of zinc per sq.m. Dry film thickness of colour coating shall be at least 20 micron.
- 6.2 Roof of all buildings having R.C.C. frame work shall have cast in situ R.C.C. slab with conventional shuttering.
- 6.3 Roof of steam generator shall be of permanently colour coated galvanised M.S. troughed metal sheet of approved profile. Minimum base metal thickness shall be 0.8 mm. The rate of zinc consumption for galvanising shall be 275 gm/sq.m. The external face shall have permanent colour coating of PVF2 paint of minimum DFT of 20 microns and inner surface shall be coated with silicon modified polyester paint with DFT of 20 microns.





7. ROOF DRAINAGE AND WATER PROOFING

7.1 For efficient drainage of rain water, roof concrete shall be given a gradient of a minimum of 1 in 100. The gradient shall preferably provided by sloping the structural framing system itself. Gradient may also be provided using screed concrete 1:2:4 using 12.5 mm downgraded aggregate. But the average thickness of such screed concrete may be restricted to about 50 mm. In the case of metal roofing system the roof slope shall be 1 vertical: 3 horizontal.

7.2 All Roofs shall be provided with high solid content liquid applied elastomeric water proofing membrane with separate wearing course as per ASTM C-898. Thickness of the membrane shall be a minimum of 1.5 mm. The treatment includes application of polymerised mortar over sloped roof to achieve a smooth surface and a primer coat. Wearing course shall be 40 mm screed of 1:2:4 concrete as above cast in panels of 1.2mx1.2m and reinforced with 0.56 mm dia galvanised chicken wire mesh and joints sealed using sealing compound. Accessible roof shall be provide with chequered cement tiles as above.

7.3 Number and size of rain water down comer pipe shall be decided based on the provisions of IS:1742 and IS:2527. The pipes shall be HDPE pipe conforming to IS:4985. It is recommended that the minimum diameter of the pipe be kept as 150 mm and there shall be a minimum of two pipes provided on each gutter. The down comer pipes shall be suitably concealed with masonry work, cement concrete or sheeting to match with the exterior finish.

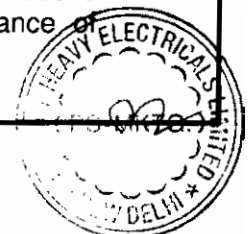
8. FALSE CEILING AND UNDER DECK INSULATION

8.1 All air conditioned areas, entrance lobbies and corridors in Service / Technical building shall be provided with the suspended false ceiling system. Under deck insulation system shall be provided on the under side of the roof / floor slab of the air conditioned areas based on the functional requirement. Ceiling of air washer room also shall be provided with under deck insulation.

8.2 Aluminium false ceiling system shall comprise of Luxalon 84 C grade of approved colour in entrance lobby and conference hall. Additional hangers and height adjustment clips shall be provided for return air grills, supply air diffusers, light fixtures, AC ducts etc.

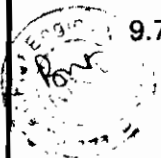
8.3 Gyp board false ceiling system shall consist of 600x600x12.5 mm gyp board with one coat of primer and two or more coats of acrylic emulsion paint. The suspension system shall consist of 6 mm dia galvanised steel rods suspended from ceiling supporting aluminium grid of 38x25x1.5 mm and cross tie of 25x25x1.5 mm and aluminium angle of 25x25x1.5 mm.

8.4 Suitable M.S channel (minimum ISMC100) grid shall be provided above false ceiling for movement of personnel to facilitate maintenance of lighting fixtures, AC ducts etc.



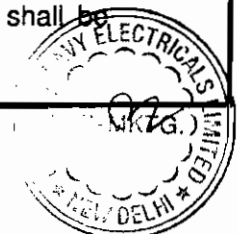


- 8.5 CONTRACTOR shall prepare a layout of the false ceiling system incorporating light fixtures, supply air diffuser, return air grills, fire protection sprinklers etc. such that the ceiling looks aesthetically pleasing. Work shall commence only after the OWNER approves the layout.
- 8.6 Under deck insulation shall comprise of 50 thick resin bonded mineral wool insulation mat conforming to IS:8183. This mat shall be backed with 0.05 mm thick aluminium foil and 24 Gx25 mm wire mesh netting. They shall be fixed to ceiling or wall as the case may be with 100x50x6 slotted mild steel plate welded to M.S. plate inserts embedded at the soffit of the slab at 600 mm c/c and 14 G steel wire drawn through slots and fixed to wire netting.
9. **DOORS & WINDOWS**
- 9.1 Unless specified all doors, windows and ventilators of air conditioned areas, entrance lobby of all buildings and windows/ventilators provided on the outer face of all buildings shall have, electro colour coated (anodised) aluminium framework with glazing. All doors of office areas shall be of factory made pre-laminated particle board (MDF exterior grade). All other doors (unless otherwise specified) shall be of steel.
- 9.2 Main entrance of the control room and control equipment room shall be provided with air-locked lobby with provision of double doors of aluminium frame work with glazing. Doors shall be of double swing type or sliding type.
- 9.3 For common control building, double glazed wall panels with aluminium frame shall be provided between air-conditioned and non air-conditioned areas and on the side of control room and control equipment room(s) facing the operating floor to have a clear view.
- 9.4 Single glazed panels with aluminium frame work shall be provided as partition between two air-conditioned areas wherever clear view is necessary.
- 9.5 All steel doors shall consist of double plate flush door shutters. The door shutter shall be 45 mm thick with two outer sheets of 18 G rigidly connected with continuous vertical 20 G stiffeners at the rate of 150 mm centre to centre. Side, top and bottom edges of shutters shall be reinforced by continuous pressed steel channel with minimum 18 G. The door shall be sound deadened by filling the inside void with mineral wool. Doors shall be complete with all hardware and fixtures like door closer, tower bolts, handles, stoppers, aldrops, etc.
- 9.6 Steel windows and ventilators shall be as per IS:1038.
- 9.7 Wherever functionally required rolling shutters with suitable operating arrangement Manual / Electric shall be provided to facilitate smooth operations. Rolling shutters shall conform to IS:6248.





- 9.8 All windows and ventilators on ground floor of all buildings located in isolated areas shall be provided with suitable anodised aluminium grill.
- 9.9 Fire proof doors with panic devices shall be provided at all fire exit points as per the recommendations of Tariff Advisory Committee (TAC). These doors shall generally be as per IS:3614 (Part I and Part II). Fire rating of the doors shall be as per TAC requirements. However minimum rating shall be 2 hours. These doors shall be double cover plated type with mineral wool insulation.
- 9.10 Hollow extruded section of minimum 3 mm wall thickness as manufactured by INDAL or equivalent shall be used for all aluminium doors & partitions. Hollow extruded section of minimum 1.5 mm wall thickness as manufactured by INDAL or equivalent shall be used for all aluminium windows and ventilators.
10. **GLAZING**
- 10.1 All ventilators and windows on external face of turbine building, pump house, compressor house, DG set building, workshop building, fire escape staircase and those buildings located in fire prone areas shall be provided with wired glass of minimum 6 mm thickness conforming IS:5437.
- 10.2 Where specified, double glazing shall consist of two 6 mm thick clear toughened safety glass conforming to IS:2553, hermetically sealed and separated by 12 mm thick gap for thermal insulation.
- 10.3 For single glazed aluminium partitions and doors, Float glass or flat transparent sheet glass of minimum 5.5 mm thickness shall be used.
- 10.4 Ground glass / frosted glass of minimum 4 mm thickness shall be used for all windows / ventilators in toilets.
- 10.5 Unless specified otherwise in this specification minimum thickness of plain sheet glass used for windows/ventilators shall be 4 mm.
- 10.6 Float glass or flat transparent sheet glass shall conform to IS:2835.
- 10.7 All glazing work shall conform to IS:1083 and IS:3548.
- 10.8 For entrance lobby of service / technical building, toughened glass of adequate thickness shall be provided.
11. **WATER SUPPLY AND SANITATION**
- 11.1 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.
- 11.2 Galvanised M.S. pipe of medium class conforming to IS:1239 shall be used for internal piping works for potable water supply.





- 11.3 Sand C.I.pipes with lead joints conforming to IS:1729 shall be used for sanitary works above ground level.
- 11.4 Minimum one toilet block with all the facilities shall be provided on each floor of main plant 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. One toilet shall be provided in the boiler area. 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.
- 11.5 Each toilet block shall have the following minimum facilities. Unless specified all the fittings shall be of chromium plated brass (fancy type).
- i) WC (Indian type) Orissa pattern (580x440mm) as per IS:2556 (Part-3) with all fittings including flushing arrangement of appropriate capacity and type-1 no.
 - ii) WC western type 390 mm high as per IS:2556 (part 2) with toilet paper roll holder and all fittings including flushing system of appropriate capacity and type – 1 no.
 - iii) Urinal with all fittings with photo voltaic control flushing system as per IS:2556 (Part-6, Sec.1) – 2 nos.
 - iv) 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 – 2 nos.
 - v) Wall to wall Bathroom mirror (5.5 mm thick float glass) with bevelled edges including all fittings.
 - vi) Stainless steel towel rail (600 x 20mm) - 2 nos.
 - vii) Stainless steel liquid soap holder cum dispenser – 2 nos.
 - viii) Janitor room.
 - ix) Provision for installation of water cooler.
 - x) Provision of ventilation shaft.
- 11.6 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 390 mm high as per IS:2556(Part-2) with toilet paper roll holder and all fittings including flushing valve of appropriate capacity and type.
- 11.7 Boiler area toilet shall have minimum 2 no. WC (Indian type), 4 no.urinals, 4 no.wash basins, 4 no. mirrors, 4 no.towel rails, 4 no. soap holder cum dispenser, 2 no.Showers, janitor room and a provision for installation of water cooler.
- 11.8 An eye & face fountain (combined unit with receptacle) conforming to IS:10592 shall be provided in battery room, D.M plant and Chlorination plant.

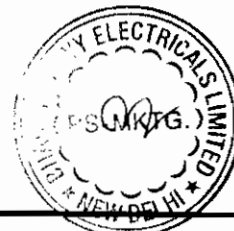
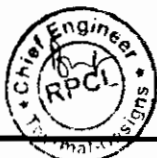




- 11.9 Unless specified all fittings and fixtures in the toilets shall have same specifications as stipulated in Cl.No.11.5
- 11.10 Stainless steel kitchen sink (750 mm size) for pantry shall be provided. Platform in pantry shall be finished with 12 mm thick polished granite stone.
- 11.11 Laboratory sink shall be of white vitreous china of size 600x400x200 mm conforming to IS:2556(Part-5) in laboratories and in Battery room.
- 11.12 In Main Turbine building, Service building / Technical building at least one toilet block shall be provided for ladies.

12. MISCELLANEOUS REQUIREMENTS

- 12.1 Doors and windows on external walls of buildings shall be provided with RCC sunshade over the openings with 300 mm projection on either side of the opening. Projection of sunshade from the wall shall be minimum 450 mm over window openings, 750 mm over door openings and 1200 mm over rolling shutters.
- 12.2 Doors and windows on the external walls of buildings with metal cladding shall be fixed by creating recesses in the cladding system.
- 12.3 No cable trenches shall be provided in TG hall, Boiler/ESP area, fuel oil pump house, etc.
- 12.4 Duct banks consisting of MS/PVC conduits for cables shall be provided with proper sealing arrangement consisting of fire retardant sealing compound.
- 12.5 All floor openings for cables below electrical panel shall be sealed with fire sealing compound after cables are laid.
- 12.6 All openings in external walls provided for pipes, cables, ducts etc. shall be effectively sealed to prevent water seepage, after the routing of the services are completed.
- 12.7 Natural lighting & Ventilation
- 12.7.1 The area of windows shall be a minimum 15 % of the floor area to ensure adequate natural lighting.
- 12.7.2 Fans shall be provided in general office area as per standard norms.
- 12.8 Sewerage system shall be provided with adequate ventilation for the pipe work as well as manhole.





1. **IS CODES & REFERENCES**

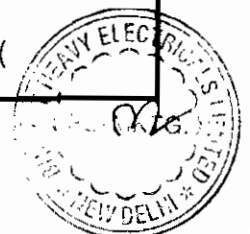
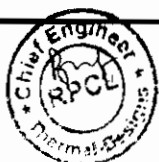
- 1.1 All the Indian Standards referred to shall be the latest revision (including all amendments issued thereto) at the time of execution.
- 1.2 Reference to only some of the codes in this document and various clauses of design criteria shall not limit or restrict the scope or applicability of other relevant codes. It shall be ensured that all other codes relevant to a specific job, in addition to those already mentioned, are followed wherever applicable.
- 1.3 Where British / American / DIN or other codes and standards are referred to in this document, equivalent Indian Standards may be substituted if available.
- 1.4 In case of any deviation / conflict between provisions of IS codes and the design criteria, the provisions that are more stringent shall followed unless specifically directed otherwise.
- 1.5 The Codes and Standards listed below are applicable for the design and construction of structures and buildings in general. Codes and Standards applicable for specific design and construction are listed elsewhere in reference sections.
- 1.6 Specifications for materials supplied from India follow the Indian Standard Specifications.
- 1.7 Field and laboratory testing procedures for materials follow Indian Standard Specifications.
- 1.8 Working stress design can be used as alternative but the approval of OWNER is a prerequisite.

2. **LOADS**

- IS:875 Code of Practice for design loads (other than earthquake)
for Buildings and structure (All parts)
- IS:1911 Schedule of unit weights of building materials
- IS:1893 Criteria for earthquake resistant design of structure

3. **FOUNDATIONS**

- IS:1080 Code of Practice for design and construction of shallow foundations on soils (other than raft, ring and shell)
- IS:1904 Code of Practice for design and construction of foundations in soils general requirement
- IS:2911 Code of Practice for design and construction of pile foundations: (All parts)
- IS:2950 Code of Practice for design and construction of raft foundations
- IS:2974 Code of Practice for design and construction of machine foundations (all parts)
- IS:4091 Code of Practice for design and construction of foundations for transmission line towers and poles
- IS:8009 Code of Practice for calculation of settlement of foundations: (





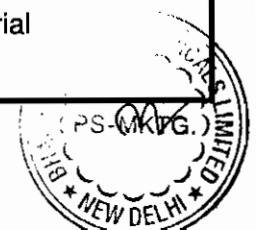
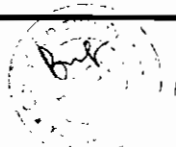
- IS:9556 All parts)
Code of Practice for design and construction of diaphragm walls
- IS:11089 Code of Practice for design and construction of ring foundation
- IS:13301 Guidelines for vibration isolation for machine foundations

4. RCC

- IS:456 Code of Practice for plain and reinforced concrete
- IS:458 Specification for precast concrete pipes
- IS:3370 Code of Practice for concrete structures for the storage of liquids: (All parts)
- IS:3414 Code of Practice for design and installation of joints in buildings
- IS:3935 Code of Practice for composite construction
- IS:4326 Code of Practice for earthquake resistant design and construction of buildings
- IS:4995 Criteria for design of reinforced concrete bins for storage of granular (all parts) and powdery materials
- IS:4998 Criteria for design of reinforced concrete chimneys: (All parts)
- IS:5525 Recommendation for detailing of reinforced concrete works
- IS:1786 Specification for high strength deformed steel bars and wires for concrete reinforcement
- IS:10262 Recommended guidelines for concrete mix design
- IS:11384 Code of Practice for composite construction in structural steel and concrete
- IS:11504 Criteria for structural design of Reinforced concrete Natural Draft Cooling Tower
- IS:11682 Criteria for design of RCC staging for overhead water tanks
- IS:13920 Code of Practice for ductile detailing of reinforced concrete structures subjected to seismic forces.

5. STRUCTURAL STEEL

- IS:800 Code of Practice for general construction in steel
- IS:802 Code of Practice for use of structural steel in overhead transmission line towers: (All parts)
- IS:806 Code of Practice for use of steel tubes in general building construction
- IS:808 Dimensions for hot rolled steel beam, column channel and angle section
- IS:813 Scheme of symbols for welding
- IS:816 Code of Practice for use of metal arc welding for general construction in mild steel
- IS:1024 Code of Practice for use of welding in bridges and structures subjected to dynamic loading
- IS:1161 Steel tubes for structural purposes
- IS:2062 Structural steel (fusion welding quality)
- IS:4000 High Strength bolts in steel structures – Code of Practice
- IS:7215 Tolerances for fabrication of steel structures
- IS:8640 Recommendations for dimensional parameters for industrial building





- IS:9178 Criteria for design of steel bins for storage of bulk material (all parts)
- IS:9595 Recommendation for Metal arc welding of carbon and carbon manganese steel
- IS:12843 Tolerances for erection of steel structures

6. MISCELLANEOUS

- IS:1038 Specification for steel doors, windows and ventilators
- IS:1172 Code of basic requirements for water supply, drainage and sanitation
- IS:1346 Code of Practice for water proofing of roofs with bitumen felts
- IS:1742 Code of Practice for building drainage
- IS:1905 Code of Practice for structural use of unreinforced masonry
- IS:2210 Criteria for design of reinforced concrete shell structures and folded plates
- IS:2470 Code of Practice for installation of septic tank:
- (part 1) Design criteria and construction
 - (part 2) Secondary treatment and disposal of septic tank effluent
- IS:3067 Code of Practice for general design details and preparatory works for damp proofing and water proofing of buildings
- IS:10440 Code of Practice for construction of reinforced brick and reinforced brick concrete floors and roofs
- SP:6 Handbook for structural engineers (all parts)
- SP:7 National Building Code of India
- SP:16 Design Aids for reinforced concrete to IS:456-1978
- SP:20 Handbook on masonry design and construction
- SP:22 Explanatory handbook on codes for earthquake engineering (IS:1982-1975 and IS:4326-1976)
- SP:24 Explanatory handbook on Indian Standard code of Practice for plain and reinforced concrete
- SP:25 Handbook on causes and prevention of cracks in buildings
- SP:32 Handbook on functional requirements of industrial buildings
- SP:34 Handbook of concrete reinforcement and detailing (SCIP)
- IRC:37 Guidelines for design of flexible pavements
- IRC:73 Geometric design of roads Bridge rules of Government of India, Ministry of Railways (Railway Board)
- BS:4485 Structural design of Cooling Towers (part 4)

