



SECTION – 2.24

CIVIL & STRUCTURAL WORKS

1.0 INTRODUCTION

This section covers the requirement scope of civil and structural works for 20MW/160MWh Vanadium Redox Flow Battery Project

1. Scope of Work
2. Codes and Standards
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2.0 SCOPE OF WORK

The scope of work shall include the following.

1. Site-related investigations.
 - a. Topographic survey.
 - b. Geotechnical investigation.
2. Site Development works
 - a. Site Grading includes Soil stabilization and slope protection.
 - b. Green Belt, Landscape development and horticulture including associated water supply system.
 - c. Compound wall with gates.
 - d. Internal roads and Box Culverts.
 - e. Storm water drains and interconnection to outside main drains.
3. Structural Steel works in VRFB Plant.
4. Buildings and Civil Works
 - a. Foundation for all VRFB Plant.
 - b. Security Cabins (if required).
 - c. VRFB Building - Pre-Engineered Building (PEB).
 - d. Local Control room and Main Control room building
 - e. RCC works (Foundations, trenches, etc.) for VRFB Building (PEB) (if required).
 - f. Transformer foundations with soak pit.
 - g. Rail cum road foundations for transformer.
 - h. RCC Fire wall between the transformers (if required).
 - i. Transformer Burnt oil pit.
 - j. RCC Cable trenches.
 - k. Foundation for DG Set.
 - l. Diesel Storage Shed
 - m. Transformer Oil Storage Shed
 - n. Septic tanks and soak pits (if required).
 - o. Service and Potable Water Supply System (if required).
5. Any other civil and structural works, which is not specifically mentioned in this document but required to complete the VRFB Plant as EPC is also included in the scope of work.



3.0 CODES AND STANDARDS

The work to be executed under this specification shall be in accordance with the applicable section of the latest version of the relevant IS standards including amendments, if any, except where modified and / or supplemented by this specification. Some of the applicable standards are listed below:

Structural Design Loads

- IS 875 : Code of practice for design loads
- IS : 1893 : Criteria for earthquake resistant design of structures

Structural works

- 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 : 1161 : Steel tubes for structural purpose.
- IS:808 : Rolled steel beams, channels and angle sections
- IS:813 : Scheme of symbols for welding
- IS:1161 : Steel tubes for structural purposes.
- IS:1367 : Technical Supply Conditions for Threaded Steel Fasteners
- IS : 209 : Zinc Ingot
- IS:1367 : Technical supply conditions for threaded steel fasteners
- IS:1573 : Electroplated coatings for zinc on iron and steel
- IS:1852 : Rolling and cutting tolerances for hot-rolled steel products.
- IS:2016 : Plain washers
- IS:2062 : Steel for general structural purposes
- IS:2633 : Methods of testing uniformity of coating on zinc coated articles
- IS:3063 : Spring washers for bolts, nuts and screws
- IS:4759 : Hot dip zinc coatings on structural steel and other allied products
- IS:6610 : Heavy washers for steel structures
- IS:6639 : Hexagon bolts for steel structures
- IS:7205 : Safety code for erection of structural steel work
- IS:7215 : Tolerances for fabrication of steel structures
- AISC : American Institute of Steel Construction Specification for the Design, Fabrication

Civil Works

- IS : 456 - Codes of Practice for plain and reinforced concrete.
- IS : 1080 - Code of practice for Design and Construction of Simple Spread Foundation.
- IS : 4091 - Code of Practice for Design and Construction of Foundations for transmission line towers and poles.
- IRC:6 - Indian Road Congress — Standard Specification and Code of practice for Road Bridges.
- IRC:37 - Indian Road Congress - Guidelines for the Design of Flexible Pavements
- IS 13920 - Ductile detailing of reinforced concrete structures subjected to seismic forces- Code of Practice (Earthquake)
- NBC :2016 - Guidelines for regulating the building construction activity

Gate & Fencing

- IS:1161 Steel tubes for structural purposes.
- IS:2721 Galvanized steel chain link fabric.



In case any specification for any item of work is not covered, the same shall be executed in accordance with the relevant IS Standards / CPWD Standards, as applicable.

4.0 GENERAL REQUIREMENTS

4.1 Construction Facilities

The Contractor shall provide all temporary offices, sanitary conveniences, store, compounds, parking areas, etc. necessary for the completion of the works. The setting and layout of these shall be in such a manner as to not interfere with the construction and operation of the plant when completed and shall be to the general approval of the Owner. The temporary buildings shall be disposed of as directed by the Owner.

All temporary buildings shall be maintained in a clean condition and operated efficiently. All buildings must always be open to the inspection of the Owner / Government authorities and, the Contractor shall comply with any instruction given by him for the proper cleaning, disinfection, and general maintenance in a sanitary and hygienic condition of the buildings.

In order to enable the Owner for providing the space, the Contractor shall give a layout and the area requirement. The Contractor shall be fully responsible for mobilization and demobilization of the temporary site facilities.

4.2 Plant Levels

It is the contractor's responsibility to make a reference datum and its accuracy shall be maintained throughout the construction period. All levels shall be referred to this datum. Surveying instruments with high quality and one second accuracy and in appropriate quantities shall be used by the Contractor during Construction. The Contractor is fully responsible for the accuracy of the site levels. Latest and validated calibration report of respective equipment used for survey work shall be submitted before carrying out survey work as per manufacturer manuals and instruction.

4.3 Methods of Construction

The Contractor shall submit documents with the details of methodology of construction and the equipment he proposes to utilize for all major structures. The Contractor shall also submit his reports and quality assurance plan to the Owner prior to work and its commencement subjected to owner approval.

4.4 Coordination at Site

The Contractor shall always maintain accesses, facilities without hindrance to others, carry out his work in such a way and in close coordination with other agencies working at the site so that the work proceeds in a systematic and planned way. No stoppage of work due to disputes arising from lack of coordination will be entertained by the Owner.

4.5 Safety

Contractor shall ensure all safety measures are taken at site to avoid accident of his Employees, owner's employee or his co-contractor's employee as per prevailing safety rules. Contractor shall deploy enough safety personnel at project site. Contractor shall make all necessary rigid and temporary design to support permanent ongoing Construction activities.

4.6 Industrial Sign Boards and Safety Signs

The contractor shall install and fix industrial sign boards and safety signs as per relevant safety regulations. Safety signs and boards shall be in fluorescent Acrylic Night glow stick on the door, framed on walls, and hang on false ceiling with Solid 8mm GI rod and Clamps. The contractor



shall submit relevant drawings to owner for approval.

4.7 Foundations

Contractors shall carry out design and detail engineering for all types of foundations. The possibility of rise of water table during monsoon and effect of rainwater shall be accounted in design of foundations. The type of reinforcement bars and cement used in foundations shall be chosen considering the saline condition & seismic zone of the project site and recommendation provided by the soil investigation report. The Plinth level shall be Minimum 1.50m from the NGL for all Buildings.

4.8 Levels

The work includes contouring the entire plot area within the Existing plant boundary as per technical specification.

Land for the project shall be raised above the surrounding areas. After performing the detailed site survey, the plant formation level of the project is proposed above the highest flood level. The finished formation level of the Project area is proposed to be (+) 36.9M above the Mean sea Level, similar to the finished ground level adopted in the existing plant. The areas where a boundary wall is constructed the leveling shall extend at least 2.00 m beyond the outside face of the boundary wall. Afterwards the slopes shall be suitably provided with stone pitching in the slope.

5.0 SITE RELATED INVESTIGATIONS

5.1 Topographical survey

The Contractor shall carryout additional topographic survey at no additional cost to owner. Detailed Topographical survey of these areas indicating the spot levels, contours and permanent features shall be carried out at the site.

The site is generally even and hence minimum cutting and filling is required to suit the layout requirements. The plot area will be generally grade to 36.9m above MSL from the existing level of around 36.3m above MSL and the finished floor level of Station building will be about

37.2 above MSL. Further, the option will be given to EPC Contractor to optimize the final grade levels at various plant areas after giving considerations to layout requirements like easy accessibility, storm water drain system, aesthetic, etc.

5.2 Geotechnical Investigation

Preliminary soil investigation has been carried out by the Owner and the same is available for information. Typical data from bore logs and test results are available in the report. The Contractor shall carryout detailed Geotechnical investigation for the proposed project area to finalize the foundation design parameters at no additional cost to owner.

Credentials of the Geotechnical investigation agency shall be submitted for owner's review and approval.

Layout and number of boreholes shall be decided based on final approved plot plan and the same shall be submitted for Owner review and approval before start of Soil Investigation work.

Type of foundations — pile, raft or open foundations, shall be decided based on the recommendations of the final Geotechnical Report.

The thickness of layers and varying depths at different locations and the rock layer shall be



furnished on completion of Geo-technical investigation indicating the borehole termination with depths.

The cost estimate is based on the assumption raft/Isolated footing foundation as required shall be provided for the major plant and equipment of the project.

However, during project implementation, detailed geo-technical investigations shall be carried out to obtain all data necessary like ground water quality and recommendations of cement and reinforcement for foundation design and engineering.

6.0 SITE DEVELOPMENT WORKS

6.1 Site Grading

The land is almost flat and will be handed over to the Contractor as it is basis and as per HFL.

6.2 Green Belt

1.5 m wide green belt made of bushes shall be developed inside the boundary, all around the plant as shown in proposed Layout of Plant, which is part of this tender document.

6.3 Landscaping

Landscaping shall be developed at entry to Plant.

6.4 Compound Wall

Compound wall of 2.2 m height above FGL, with 600 mm dia barbed wire concertina wire above, shall be provided around entire plant. Material of construction for compound wall shall be either precast wall panels or masonry with plastering. Wall shall be resting on grade beam which in turn will be resting on columns and foundations. Coping wall shall be provided at top. Both surfaces (internal and external) shall be painted with weather proof paint.

6.5 Gates

Number of gates and wicket gates shall be as per proposed Layout of Plant, which is part of this tender document.

Gates shall be double swing gates of adequate size, 2.2 m height and 6.0 m wide (or maximum width of objects to be brought in plus 1.0 m free space on either side). Wicket gate shall be of 1.5 m wide single leaf. Necessary locking arrangements shall be provided for gates, but gates should not be self-locking.

Gate shall be fabricated out of tubular sections conforming to IS : 1161 and shall be hot dipped galvanized. Outer frame shall be 65 NB (medium) tube and diagonal 50 NB (medium) tube 50 mm sq. Welded mesh with 4 mm dia GI wire fabric shall be welded to 25 mm x 6 mm thick GI flat which in turn shall be welded to the outer tubular frame. The gate shall be provided with 20 mm wide x 80 mm dia flat M.S. roller at the bottom. The gate frame shall be fixed to GI tubular post or RCC post.

6.6 Storm water Drain Network

Storm water drainage networks shall be provided for the entire plant area and the same shall be discharging to main storm water network of the solar park near the approach road.

Rain water for the plant areas shall be collected through a network of drains, which shall finally discharge, into the natural discharge available outside the plant boundary. Surface drains shall be open drains of either RCC rectangular drains or brick lined drains trapezoidal in section. All



drains in the power plant area and around Buildings shall be covered drains. Storm water drain shall be directly lead into the natural drainage streams/nallahs for ultimate disposal.

The drain shall be of RCC construction. The drawings shall indicate the basic drainage plan from the various units within the Plant. Invert level of drainage network and at outfall point shall be decided in such a way that water can easily be discharged outside the station Boundary. The maximum velocity and non-silting velocity shall be ensured.

The Recommendation as per the Hydrology report shall also be taken into account during detailed design.

6.7 Roads

Road network consisting of two approach roads from the solar park main road, internal peripheral road and access roads to all facilities as per approved plot plan shall be provided.

The width of main roads in the plant shall be 4.0 m with 1.0 m wide shoulders on both sides. All roads shall be of RCC construction.

All internal plant roads (Double lane roads) shall be 7.0 m wide black topping with 2.5 m wide shoulders on both sides of the road. Single lane roads shall be of 3.75 m wide black topping with 1.0 m wide shoulders on both sides of the road. Access roads to building/facilities (not shown on Plot plan) shall generally be single lane roads without shoulders. All culverts shall be designed for the Class –AA loading conditions.

Adequate turning space for vehicles and Crane shall be provided and turning radius shall be set accordingly. Road to the Transformer / reactors shall be as short as straight. Crane position for lifting transformers shall be as short as to lift the heavy object / parts / equipment's and can load and unload easily for replacement or maintenance any failed unit.

6.8 Walkway / footpath

Footpath with concrete or light weight paving blocks shall be provided as per requirements.

6.9 Car parking

Aesthetically pleasant car parking shed shall be provided, suitable to park four wheelers and two wheelers suitable location to be decided during detail Engineering. The orientation of Roof and steel structure shall be in such a way to install roof Mounted Solar panels in future.

6.10 Chain Link Fence

PVC coated Galvanized Chain link fence shall be provided wherever necessary like transformer / reactor, capacitor bank, diesel generator, transformer oil storage shed and diesel storage shed etc.

7.0 OUTDOOR STEEL STRUCTURES

The major steel structures in the plant shall be latticed construction using angle sections.

7.1 Design Requirements

The loading for the design of Plant structures shall be as per IS: 875 (all parts). The following loads shall be considered:

a) Dead load due to equipment and structure.



- b) Wind load on Structure calculated as per IS: 875.
- c) Construction and maintenance loads.
- d) Seismic loads as per IS:1893-2002.
- e) Corrosion class as per ISO 12944 C4-M.

All steel structure for the Plant shall be hot double dip galvanized structure with welded / bolted connection at shop and bolted connection at site. All bolts and nuts shall also be galvanized. Minimum strength of Bolts shall be as per relevant IS code. Fabrication and shop report shall be submitted to owner for review and approval.

7.2 Dead Loads

Dead loads consist of the weights of the complete structure and equipment, conductors, insulators strings, bus bars etc. The unit weight of structural steel shall be considered as 78.5 kN / cum for computation of loads. Unit weight given in IS:875 (part-I) shall be made use for other materials.

7.3 Imposed Loads

Imposed loads in different areas shall include live loads, dust loads, minor equipment loads, cable tray loads, erection loads, operation / maintenance loads etc. The loads considered shall not be less than that specified in IS:875 (Part II). The loads listed hereunder are the minimum loads for the areas involved. The specific minimum floor live loads are listed below

- a) Chequered plate / gratings : 5 kN / sqm
- b) Walkways : 3 kN / sqm

7.4 Seismic Load

The proposed plant is in Zone III as per IS:1893-2005. Seismic forces shall be as per IS:1893 : 2016. Particular attention is drawn to calculation of the design base shear as per relevant clause of the code while using response spectrum method. The important factor for all major structures and minor structures shall be as per IS:1893: 2016.

7.5 Equipment Load

Static loads of major equipment shall be based on the manufacturer's data of the specified equipment and shall be considered in design in addition to the live load.

Weight of equipment, ducts, conduits, etc. supported by structure shall include maximum possible loading conditions i.e. flood conditions and associated impacts, test loading, anchorages and constraint effects.

7.6 Wind Loads

Wind load shall be in accordance with IS: 875 (Part 1 / Sec1). For arriving at the design wind speed as per the code, the following values shall be adopted for the different factors,

Basic Wind Speed = 41.667 m / s

The wind shall be assumed to blow in any direction and most unfavorable condition shall be considered for design. Wind shall always be assumed to act perpendicular to the Conductor / Rigid bus for structural analysis purposes.



Diagonal wind / inclined wind shall be considered for isolated self-supporting structures like lighting and lightning masts, poles only. Plant structures, which are interconnected either by beams or rigid buses, need not be analyzed for inclined wind loading.

7.7 Detailing Requirements

Permissible stresses, slenderness ratios of members, minimum thickness of steel members, net sectional area of tension members and bolting and framing shall be as per IS: 800.

All structures shall be designed for the worst combination of dead loads, live loads, wind loads and thermal loads as per IS : 800 (latest), Seismic forces as per IS : 1893 (latest).

Wind & Seismic forces shall not be considered simultaneously in any load combination.

Three-dimensional analysis shall be carried out for structures like Steel Structures while two-dimensional analysis may be adopted for equipment support structures, using standard software package like STAADPro. Any non-standard software used shall be validated with manual calculations and shall be used only with the approval of Owner.

For materials and permissible stress IS:800. However, additional requirements given in the following paragraphs shall be also considered.

a) Minimum thickness of galvanized lower member shall be as follows:

Members	Minimum thickness (mm)
Leg members, ground wire peak members / main members	5
Other members	4
Redundant members	4

b) Maximum slenderness ratio for leg members, other stressed members and redundant members for compression force shall be as per IS:800.

c) Minimum distance from hole center to edge shall be 1.5 x bolt diameter. Minimum distance between center to center of holes shall be 2.5 x bolt diameter.

d) The minimum bolt diameter shall be 16 mm or higher as per design requirement.

e) The fabrication and erection works shall be carried out generally in accordance with IS:800. All materials shall be completely shop fabricated and finished with proper connection, materials and erection marks for ready assembly in the field.

f) Foundation bolts for the supporting structures and elsewhere shall be embedded in first stage concrete while the foundation is cast. The Contractor shall ensure the proper alignment of these bolts to match the holes in the base plate. HDG 8.8 grade foundation bolts with hot-dip galvanizing shall be provided for the erection of structures.

8.0 BUILDINGS AND CIVIL WORKS

It shall cover design and constructional requirements for all civil works such as foundation for buildings, equipment and equipment support structures, cable trenches, paving, drains, etc.

8.1 Foundation for VFRB Plant

The type of foundation system, i.e. pile foundation, isolated, strip, or raft to be adopted shall be decided based on the structure, loading arrangement, load intensity and soil strata based on the soil investigation report recommendation. Design of foundations at various levels shall be dependent upon the soil bearing capacity at that level.



All foundations shall be designed for the most critical load combination of dead loads, live loads, inertia forces, wind and seismic loads and secondary effects such as shrinkage, rise and fall in temperature, swelling and shrinking pressure of soil etc and other relevant loading from service conditions arrived based on detailed structural analysis of the equipment and superstructures etc.

For structure foundations, anchor bolt with mechanical anchorage will be provided along with foundation concrete. Bolts in pocket shall not be adopted. All foundation bolts shall be fully galvanized. The min. thickness of galvanizing shall be 180µm All foundation bolts and its material shall confirm relevant Indian Standards codes (IS codes) / International standards. All foundation bolts shall be provided with two standard nuts, one check nut, one plain washer and MS plate at the bottom of foundation bolt.

The stability of the foundations shall be checked against overturning, bearing on soil, uplifting, sliding etc.

The pedestal provided for the VRFB Structure shall be designed for combined action of axial forces viz. compression and tension and bending moments due to horizontal shears in both the longitudinal and transverse directions. A minimum of 4 numbers 16 mm diameter bars or 0.15% of cross section area of the pedestal, whichever is more shall be provided and spacing of the main bar shall not be more than 300 mm.

The centroidal axis of the tower leg shall coincide with the axis of the pedestal. The design of the foundation shall take into consideration the additional forces resulting from eccentricity introduced due to any reason.

The bottom raft / pad shall be designed both for bearing pressure as well as dead load of foundation and overweight of earth. The actual soil pressure under the footing shall be considered to calculate the maximum moments and shears at various sections.

The presence of surface / sub soil water shall be considered in the design of all foundations and underground faculties.

Depending on ground water table the crack width calculation shall also be prepared accordingly.

8.2 SECURITY CABIN

Suitable weatherproof security cabins of 3.0m x 3.0m size, prefab type, resting on concrete foundation or block masonry building with RCC frame shall be provided near the two main entry gates. Suitable numbers of chairs and desk, fan and lightings shall be provided.

8.3 VRFB HALL - Pre-Engineered Building (PEB)

The building shall be sized meeting all requirements of equipment. 3D drawing shall be submitted to owner with Architect view during Engineering and subsequent project phases.

This building shall be pre-engineered building (PEB) with sandwich metal sheet cladding and roofing.

Suitably sized motor geared rolling shutter shall be provided. Dimension of rolling shutter and RCC made ramp with proper gradient shall be such a way to accommodate, entry, exit and hauling of truck / forklift with carrying maximum size of loaded equipment.

EOT crane for Plant of suitable capacity shall be provided for erection and maintenance of largest/heaviest components/assembly. The crane shall consist of all special requirements for erection and maintenance of equipment.



Minimum hook height shall be 9.0 meters or, as per actual requirement whichever is higher. Contractor shall completely service the entire crane before taking over certificate is issued. Contractor has to carry out demonstration and necessary tests:

- Running, hauling,
- No-load test,
- Load test as per site condition and maximum designed and required capacity

Crane shall be capable of lifting and accurately positioning all loads ranging from crane full rated capacity to at least 10 % rated capacity.

Crane shall be designed under following variable speeds through VVVF drive at full Load:

- Hoisting -0.3 – 3 Meters per Minute
- Cross travel - 1.6 – 16 Meters per Minute
- Long travel - 2.0 – 20 Meters per Minute

EOT crane shall be provide with safety features like walkways and platform. It shall be along the bride rail and on the crab of EOT crane for cleaning and maintenance of Crane.

Vertical cage ladder and platform shall be provided to have access to EOT crane.

Contractor shall submit the capacity calculation of the crane for the hall considering a factor of safety of rope as at least 5.

Provision of EOT crane arrangements for future extension of hall shall be provided.

Crane hook approaches shall be of the minimum possible dimensions to ensure maximum coverage of the building area.

The building shall be provided with a 230 mm thick brick wall for with 3.0 height from floor level and sandwich cladding for the rest of the height.

All openings after installation of electrical ducts shall be closed water tight and fire proof.

Adequate number of fixed glazed windows shall be provided for natural lighting.

8.4 Main Control Room Building

- 1) The Main Control Room (MCR) with shall be aesthetically designed with proper facilities for personnel to carry out plant operations and maintenance and for housing equipment.
- 2) CONTRACTOR shall submit the architectural and construction drawings and design of the MCR to the OWNER for approval before start of construction. The buildings and allied works shall be designed to meet the National Building Code requirements and CPWD.
- 3) The MCR shall be constructed with conventional RCC framed structure with brick/concrete masonry partitions / Pre-Engineered Building (PEB) or containerized system or PEB shed with roof accessibility ladder, illumination, water drain arrangement etc.
- 4) Finished Floor Level (FFL) of all buildings shall be at a minimum of 1.50m above the Natural Ground Level (NGL). Clear head room shall be higher of 4.0 m and equipment clearance requirement.



- 5) False ceiling shall be provided for all rooms except Switchgear, Battery and Storerooms.
- 6) The MCR roof shall project from the face of the building by at least 600 mm all around. Parapet for roof shall be with kerb and 750 mm high Brick parapet wall.
- 7) Grade slab shall be provided with reinforcement in both ways.
- 8) The static live load on floor shall be higher of 1000 Kg/Sq.m or actual equipment load. The importance factor for seismic design shall be 1.5.
- 9) For fire safety requirements of buildings, IS:1641 and IS:1642 shall be followed in addition to TAC/NFPA requirements.
- 10) False ceiling shall be of 15 mm thick mineral fibre board in tile form of size 600 x 600 mm, along with galvanised light gauge rolled form supporting system in double web construction, pre painted with steel capping, of approved shade and colour, to give grid of maximum size 1200 x 600 mm as per manufacturer details including supporting grid system, expansion fasteners for suspension arrangement from RCC, providing openings for AC ducts, return air grills, light fixtures, etc. all complete.
- 11) Plinth protection shall be 1000 mm wide and 75 mm thick provided all around the buildings with masonry garland drains of 250 x 250 mm size and shall be connected to nearby drains.

8.5 Transformer Yard Foundations

Transformers shall be founded on RCC foundations with rails on the top and oil soak pits filled with 40mm hard stone aggregate. Jacking pads shall be provided. The size of the soak pit shall be decided based on the transformer details and oil volume.

Material of transformer oil piping shall be suitable for type of oil and applicable temperature resistance.

Fire wall of adequate thickness and height, if required as per TAC regulations shall be provided for transformers.

RCC foundations shall be provided with rail to transport transformers out of transformer yard during maintenance. To facilitate such placing and transportation of transformers, road with suitable width and turning radius shall be provided

Where rails cross the fencing, if required, fencing shall be made of removable type to facilitate transport of transformer.

Suitable RCC foundations for Capacitor Banks shall be provided.

8.6 Transformer Oil Collection Pit

Common burnt oil pit (RCC) shall be provided to collect leaked oil from individual transformer soak pits through heavy duty pipes laid to slope. Inside concrete surface shall be painted with oil resistant paint. FRP manhole cover of (750mm X 750mm) shall be provided. Heavy duty FRP rungs shall be provided at regular spacing for entry / exit to the oil pit. Burn oil pit shall be equipped with portable sump pump or fixed pump of required rating inside pit with power outlet and necessary tubing with discharge point.

Oil collecting pit shall be sized based on volume of oil drained from the biggest transformer with additional 25% capacity.



8.7 Underground Structures

All underground facilities like cable trenches, drains, tanks etc. shall be designed for earth pressure and sub soil water pressure under worst condition. The walls shall withstand a surcharge of 20 kN / m² in addition to the earth pressure. Walls and base slab of shall be designed as cracked section but limiting the steel stresses as per IS:3370. All water retaining / storage structures shall be designed assuming liquid up to the height of wall irrespective of provision of any overflow arrangement. No pressure relieving devices shall be permitted in underground structures.

In Cable trenches the spacing of insert plates for cable tray support angle shall be not more than 1.5 M.

RCC precast cover slabs of cable shall be designed for a live load of 10 kN / sqm.

If any Equipment /Containers supported over the Cover slab shall be designed considering the vendor loading and all other necessary loads.

Box culverts shall be provided at road crossings of cable trenches.

Cable trenches crossing roads shall be designed for Class A loading as per Indian Road Congress – Standard Specification and Code of practice for Road Bridges, IRC-6. Alternatively duct banks (hume pipes) embedded in RCC / PCC may be provided where feasible.

Cable trench inside the buildings shall be covered with 6mm thick galvanized Chequered plate painted with epoxy paint and with stiffeners and lifting hooks. Edges of plate shall be grinded off.

The bed of the tanks/trenches along the length shall be provided with a slope of 1:500 to 1:750 by laying PCC (1:2:4) in second stage to drain out rain / seepage water without compromising the clearance required between the bottom most tray of cable trench and the bed of cable trench.

Suitable expansion joints shall be provided in cable trenches and liquid retaining structures as per IS specification with PVC water stop, bitumen impregnated filler boards, bitumen sealing compound as per specifications or as directed by the Owner. Water proofing cement additive shall be used for the construction of cable trenches to ensure water tightness.

The trench shall be covered with precast R.C.C. cover of suitable thickness and joints shall be pointed with cement mortar 1:3 to prevent entry of rain water from top. The weight of a single RCC cover shall not be more than 75 kg. Suitable lifting hooks shall be provided for easy handling. Depression at lifting hook portion shall be filled with sand-bitumen to avoid rainwater stagnation. The top of the trenches shall be kept 150 mm above FGL. Suitable lugs of reinforcement steel shall be welded to edge protection angles for ensuring fixity in the concrete. Necessary embedded steel plates shall be provided for supporting the cable trays. All cable entry / exit at VRFB shall be watertight, dust and vermin proof.

Sump pumps shall be provide in cable trenches in plants where there is no possibility of gradient flow and exit of water to the nearest drain. Type, capacity and other technical specifications shall be fixed in detail engineering.

8.8 Diesel Generator Area

RCC foundation shall be provided for Diesel Generator. Removable type covered shed shall be provided based on type of Diesel Generator. Other details shall be as per system requirements and applicable standards and regulations.



8.9 Diesel Storage Shed

Diesel storage shed shall be steel structure with single sheet roof and side cladding. Other details shall be as per system requirements and applicable standards and regulations.

8.10 Transformer Oil Storage Shed

Transformer oil storage shed shall be steel structure with single sheet roof and side cladding. Other details shall be as per system requirements and applicable standards and regulations.

8.11 High Mast and Street Lighting Foundations

RCC foundations shall be provided for high mast and street lighting.

9.0 COMMON REQUIREMENTS FOR CIVIL WORKS

9.1 Grading of Concrete

Unless required otherwise, cement used shall be Sulphate Resistant Cement conforming to IS 12330. Special cement, as appropriate, shall be used for structures, or portions of structures, exposed to chemicals. The type of cement shall be as per the soil investigation report. All structural concrete shall be design mixes only. Ready mix concrete may be used where feasible, minimum cement content shall be 350 kg / m³ of concrete unless otherwise specified in the detailed soil investigation report. In addition to that all information to be checked and ensured inline with the recommendations from the soil report.

The following grades of concrete as per IS : 456 shall be adopted for the type of structures noted against each.

M 35 - RCC structures below ground (min).

M 35 - RCC structures above ground (min).

M 35 - Precast trench covers

M15 - PCC

9.2 Clear Cover

Clear cover to reinforcement shall be as follows :

	Top(mm)	Bottom(mm)	Sides(mm)
Footings / Pile caps	50	75	50
Column / Pedestal	40	40	40
Grade Beam	40	40	40
Precast units	25	25	25

Approved quality make and same grade of Concrete spacer block shall be provided as cover in concrete structure.

All reinforcement shall be of high yield strength deformed TMT bars conforming to IS: 1786 Grade of rebar shall be Fe 500D coated with anti-corrosive paint/ Corrosion resistant steel bars.

9.3 Minimum thickness of structural elements

The following minimum thickness shall be followed:



a)	Ground floor slab (non - suspended)	150 mm
b)	Water Retaining Slab / Walls	200 mm
c)	Cable / Pipe Trenches / Underground pit	125 mm
d)	All footings (including raft foundations)	300 mm
e)	Precast trench cover slabs – indoor	100 mm
f)	Precast trench cover slabs – outdoor	100 mm
g)	RCC Paving	150 mm
h)	RCC Paving with vehicular load	200 mm

9.4 Excavation and Backfilling

Excavation and backfilling shall be accordance to IS standards. Contractor shall carry out deep / shallow excavation by considering safety at side against any collapse. Temporary design against sliding and supports shall be provided by contractor. Backfilling shall be with non-expansive soil. Any organic matter like roots and barks of trees shall be removed, if found at foundation level and surplus excavation shall be filled with PCC 1:4:8.

9.5 Dewatering from construction site

Whenever water table is met during excavation, it is contractor responsibility to dewater and water table shall be maintained below the bottom level of excavation during excavation, concreting and backfilling. Delay due to such cause will not be entertained and at no additional cost to Owner.

9.6 Compaction of soil

Density to which filler material is compacted shall be as per relevant IS codes and as per direction of employer. Backfilling earth shall be compacted to minimum 95% of the standard proctor's density at OMC. Earth material shall be free from lumps and concrete debris.

9.7 Reinforcement Fixing

Reinforcement fixing shall be as per IS 2502. Reinforcement supports shall include all spacers, chairs, ties, slab bolster, clips, chair bars, and other devices for properly assembling, placing, spacing; supporting, and fastening the reinforcement. Spacers shall be cast from concrete of the same quality as that in which they will be embedded. Concrete block spacers shall be cast in metal mould with an approved means of separating blocks and of ensuring that the blocks are of the proper size. Coated binding wire shall be incorporated into the blocks to enable them to be securely attached to vertical or horizontal bars and the contractor shall demonstrate both that the blocks are of the requisite strength and that the means of attachment to the reinforcement are adequate.

9.8 Formwork

Formwork shall be designed and constructed so as to remain sufficiently rigid during placing and compaction of concrete and shall be such as to prevent loss of cement slurry. The face of formwork in contact with concrete shall be cleaned and treated with form release agent. Striping out formwork shall be as per IS:456 standards. Formwork shall be in good condition to have good surface of concrete. Approved quality make and same grade of Concrete spacer block shall be provided as a cover in concrete structure.

9.9 Concrete placement

Concrete shall be placed in the forms as close as possible to its final position in a single operation to the full thickness of slabs and beams and shall be placed in horizontal layers, not exceeding 2.5 m height in a single pour in walls, columns and similar members.



The contractor shall organize the pouring of concrete in such a manner that once concreting of a section has started the operation shall be continuous and each operation shall be completed prior to a stoppage.

The temperature of concrete shall not exceed 40°C measured at discharge into the works.

The maximum allowable temperature of any point within any cast element is 60°C. The maximum allowable temperature differential between any two points in the same element is 15°C. Additional temperature control measures during construction (such as the use of insulated formwork) will be required. Contractor to prepare a process control chart and method statement verifying measures to achieve these requirements. Temperature monitoring of concrete work is required where:

- a) The minimum dimension of any casting is 0.8 metres or more, or
- b) where otherwise instructed by the Owner.

Where specified on the drawings, construction, expansion or contraction joints shall be provided and the concrete shall be poured continuously between two adjacent joints. No other joints than shown on the drawings shall be permitted. Stoppage (cold) joints formed between two concreting operations separated by more than 6 hours time shall be subject to the same treatment as the construction joints.

Concrete shall not be dropped into place from a height exceeding 1.5 metres.

9.10 Compaction and mechanical vibration of concrete

As concrete is being placed it shall be compacted by mechanical vibrators complying with IS:2505, IS:2506, IS:2514 & IS:4656, to obtain a dense material free from honeycombing, free from water and air holes. The contractor shall ensure that the vibrators are used in such a manner that the reinforcement is not displaced, the formwork not damaged and no segregation caused, but complete compaction of the concrete is achieved.

9.11 Finish of concrete

The concrete face shall have the finishes indicated on the drawings or in the present specification. The finished surface of the concrete shall be sound, solid and free from honeycombing, protuberances, air holes or exposed aggregate. No plastering, cement wash, mortar or paint shall be applied to cover defective concrete surfaces.

9.12 Curing

Concrete shall be protected from loss of moisture for not less than 7 days after the concrete is placed. Trowelled surfaces, except those that receive a separate finish or coating, shall be cured with a membrane curing compound. Float finished surfaces, except those that receive a separate finish, may be cured with either a membrane curing compound or with water. Only water curing shall be used if the surface receives a separate finish.

Water curing

Water saturation of concrete surfaces shall begin as quickly as possible after initial set of the concrete. Water curing shall begin within 12 hours in dry weather and within 24 hours in damp weather. The rate of water application shall be regulated to provide complete surface coverage with a minimum of runoff. The application of water may be interrupted for surface rubbing. The concrete surface shall not be permitted to dry. After the rubbing has been completed, rubbed surfaces shall be covered with burlap and kept saturated for the remainder of the curing period.

Membrane curing



Membrane curing compound shall be applied within 30 minutes after final finishing of the surface or as soon as possible after finishing without causing damage to the surface. Membrane curing compound shall be spray applied at a coverage of not more than 7.4 square meters per liter. Membrane curing shall not be used on surfaces that shall be covered at a later date with mortar, concrete, damp—proofing, tile, or any coating. Membrane curing shall not be used on cast-in-place concrete bases for field erected tanks.

9.13 Plumbing and Sanitation

All plumbing work shall be executed to comply with the requirement of the appropriate bye-laws, Rules and regulation of the Local Authority and owner's requirement. Sintex or equivalent make roof water tank of adequate capacity depending on the numbers of users for 24 hours storage shall be provided. However, minimum of 02nos. of 1500 lit capacity shall be provided. Contractor shall provide permanent access and platform to supervise and cleaning of water tanks.

Chlorinated polyvinyl chloride (CPVC) pipes having thermal stability for hot and cold water supply including all CPVC plain and brass threading confirming to relevant IS code.

Sand C.I. pipes with lead joint confirming to relevant IS codes shall be used for sanitary works above ground level and RCC pipes shall be used for sanitary works below ground.

Each toilet shall have the following fittings.

- WC (western type) with toilet paper roll holder and all other fitting.
- Urinals (430mm X 260mm X 350mm in size) with all fittings and built –in sensor for automatic flush after use
- Wash basin (550mm X 450mm) with all fittings.
- Bathroom mirror (600mm X450mm X 6mm) with hard board backing.
- CP brass tower rail (600 mm X 20mm)with CP brass bracket
- Soap holder and liquid soap dispenser.
- Automatic hand dryer.

Water cooler for drinking water with adequate water storage facility shall be provided in kitchen.

Stainless steel kitchen sink (510mm X1040mm X 180mm bowl depth) with drain board for pantry shall be provided.

All fittings, fasteners, gratings shall be chromium plated.

9.14 Septic tank and Soak pit

Contractors shall provide necessary no. of septic tank; soak pit and inspection chambers with adequate capacity to treat the sewage / sullage from the buildings. Septic tank shall be RCC made, and all inner surfaces shall be epoxy painted.

9.15 Water Supply for horticulture and Domestic use in Building

Water storage provision of suitable size and adequate water capacity shall be constructed with necessary power supply, water pipeline network with rated pressure and pump provision for horticulture of landscaping area and green belt.

Piping work from Control Building water supply network to terminal point at PSS boundary for future connection from external water supply shall be provided.

9.16 Construction / Expansion Joints



All water retaining structure, RCC storm water channel and burnt oil tank shall be watertight with provision of 225mm wide PVC ribbed water stopper at all construction joints and expansion joints.

9.17 Leak test of water retaining structure

Contractor shall perform water leak test or Hydro test as per relevant IS code. In case of water leakage found in structures, contractor shall submit the repair methodology and attend leakages with approved material as per International / IS standards.

9.18 Room Dimensions

Dimension of all rooms shall be based on area covered by electrical / I&C equipment's plus working space plus free space and additionally space reserved and / or required for future installation of equipment's if any.

9.19 Wall and Roof Cladding

Double skin insulated cladding shall be made of (0.6mm base metal thickness) colour pre-coated sheets. Confirm to ASTM 792 M grade 345Bwiminimumyieldstrengthof 345 MPa Cold rolled steel with hot-dip metallic coating of Al- Zn alloy shall be used as substrate. The surface shall be colour coated by oven baked paint system over substrate. Permanent colour coated sheet shall meet the general requirements of IS 14246 and shall conform to Class 3 for durability.

Insulated Panels shall be of required size for roof and walls. Puff density of panel shall be 40+/-2Kg/m³. Thermal conductivity of insulated panels shall meet HVAC design requirements.

Painting shall be done considering high saline C4-M zone as per ISO 12944. RAL shall be decided during engineering phase and shall match with brick work interior / exterior paint.

Roof of buildings shall be suitably sloped to affect proper drainage. No openings shall be permitted on the roof excepting those essential to exercise proper control on air conditioning. The entire roof with gutter shall be tested against water leaking prior to installation of false ceiling and placing of electrical equipments.

Standard fasteners shall be self-tapping Zinc plated metal with EPDM bonded zinc plated washer. All screw shall be colour coated to match roof and wall sheeting.

Sealer shall be applied at all side laps and end laps of roof panels and around self flashing windows. Sealer shall be pressure sensitive elastomeric butyl tapes. Sealer shall be non-asphaltic, non-shrinking, and non-toxic and shall be super adhesive metals, plastic and painted at temperature from 51°C to 104°C.

Solid or closed cell Caulser matching the profile of panels shall be installing along the eaves, Ridge, rake, cutouts and other location specified in drawings and shall be water tight and airTight.

Flashing and / or Trim shall be furnished at the rakes, eaves corners and framed openings and where necessary to provide weather tightness and finish appearance. Colour shall be match with wall sheet.

9.20 Roof gutter and rain water downspout.

Gutter and downspout shall be adequately design to endure proper roof drainage system. Colour of gutter steel sheet and downspout shall be same as the colour of roof and cladding steel sheet. Downspout pipe shall be bringing to the plinth protection with elbow at end and / or 200mm above than storm water / garland drain and / or close to FGL in case of Kiosk. A



100mm dia opening shall be made in gutter at both ends cladding of gutter to avoid flooding / over capacity of gutter in case of chocking of downspout pipes due to dust / debris. Round head pipe holders / clamps of PVC made or equivalent (rust proof) shall be installed at regular interval to keep the downspout in stable position

9.21 Provision for Roof Solar Panel fixing and maintenance

Suitable provision shall be provided on roof for future installation and maintenance of solar panels.

9.22 Roof Access

Galvanized Steel Cage ladder of required size shall be fixed outside for access roof. If the height is more than 3.0 m, then intermediate steel platform shall be provided with steel gratings. Anchoring of ladder shall be with RCC. Cage ladder shall extend to 1.0 m up vertically above the roof level.

Necessary roof anchors shall be provided above roof cladding for fixing safety harness of personnel walking on the roof.

9.23 Doors and Partitions

External doors shall be double leaf glazed aluminum door unless fire rated doors as mandatory required. Fire rating shall be as per applicable standards.

Partition between control room and adjoining rooms shall be of glazed aluminium with 5.5mm thick glass or pre-laminated aluminium board depending upon the location of partition.

All internal doors shall be single leaf glazed aluminum door or Fire rated steel doors as per requirements.

For movements of panels, door shall be suitably sized.

Control room wall up to the false ceiling level shall be of aluminium glazed partition. In other area cladding shall be of brickwork. Sufficient openable and fixed windows / ventilators shall be provided for natural day lighting and ventilation.

These shall be of robust and leak tight construction suitable for the saline environment. The opening and closing mechanism for openable joinery items shall be within easy reach.

9.24 Signage Boards

Contractor shall provide to the owner, detailed specification of sign boards. For switchyard and transformer yard, the sign board shall be made of Aluminium composite sheet. Letters on the board shall be proper illumination arrangement. All sign boards at open area and on road shall be placed on 400 X 400 mm and 600mm deep RCC foundations. Vertical posts shall be 65NB circular GI pipe, painting with epoxy paint with black and white Strip of 300mm with required Dry film thickness. Post shall be in two pieces. Short arm embedded in concrete pedestals and long armed above the ground shall be connected with short arm by bolt and nut connection

Each room shall be provided identification name plate of 2mm thick stainless steel with black letter engraving on it.

9.25 Damp proof Course (DPC)

Contractor shall make provision of Damp proof course to prevent moisture raising by capillary action in block masonry walls as per relevant IS code and approved make by owner.



9.26 Plinth Protection

Plinth protection in 100 mm thick PCC shall be provided, with a width of 1000 mm or the distance between the building outer wall to the RCC garland drain and at suitable expansion joint. It shall be laid over prepared subgrade and base formed with 40mm down rubble stone to a thickness of 150 mm. Grade of concrete shall as specified in section related to Reinforced Concrete Works.

Plinth protection around building and paving in main plant area shall be provided. Paving/hard surface shall be provided for vehicle parking and covered vehicle parking for cycles, scooters and cars/jeeps near service building. Entire area behind the station building shall be paved. The Car parking shall be accommodated in a shed. The shed shall have a sloping roof and shall be open on all sides without side cladding.

9.27 Block masonry

The top layer of brickwork shall be provided with min. 150mm thick x 230mm wide RCC lintel beam with minimum reinforcement, plastered top surface for proper fastening / resting of wall cladding.

Contractor shall use light weight block for ordinary block masonry walls and fire rated blocks for fire wall in building. Surfaces of block shall be rough to achieve good bond with plastering. All blocks shall be well soaked during wall erection. Contractor shall provide Mullions with minimum reinforcement in case the block work span between two columns exceed limit specified in relevant IS standards.

9.28 Plastering

All external surface of masonry shall have 18mm thick plaster in two layers, with the under layer of 12mm thick 1:4 cement –sand plaster and the top layer of 6mm thick 1:6 cement sand plaster. Inside surface shall be 12mm thick 1:6 cement sand plaster. GI chicken mesh shall be fixed at brick / block and concrete joints before plaster.

9.29 Switch Boards and Cable Wiring

Contacto shall provide all required power outlets in each room with some extra provision with concealed wiring.

9.30 Furniture, Fixtures and Cabinets.

Adequate number of furniture, fixtures and cabinets shall be provided in all rooms including pantry.

9.31 External painting

External plastered surfaces of building walls shall be painted with exterior acrylic paint as per manufacturer specification and approval of owner.

9.32 Finishes



The finishes for the buildings be as follows.

Building Room	Flooring with 150mm skirting	Wall (internal)	Ceiling
VRFB Hall with space for maintenance bay.	Granolithic floor with metallic hardener and two coat of epoxy paint of total DFT of 300 micron over floor. Anti-slip grain to be spread over epoxy paint for slip resistance on designated area of floor walkway.	Premium acrylic emulsion paint with on smooth surface applied with plaster of Paris.	Metal roofing
Kitchen / pantry / Lobby / Corridor	Vitrified tiles of 8mm thick and 600X 600mm	Premium acrylic emulsion paint with on smooth surface applied with plaster of Paris on block wall	Oil bound washable distemper
Toilet	Heavy duty anti skid ceramic tiles	Dado glazed tiles	Oil bound washable distemper
Staircase	Anti-skid and high grade Precast terrazzo tile with nosing.	Handrail- stainless steel of grade 304	
Weather proofing for RC roof slabs	Elastomeric water proofing membrane with foam concrete		

9.33 Maintenance Bay

Maintenance bay shall be equipped with 150mm height x 150mm wide RCC dyke all around the perimeter of required bay space. Shall be equipped with eye-wash shower or water service line with tap and pressurize air system for cleaning of electrical equipment. Floor drainage pit and pipeline to drain the dirty water to the nearest garland drain.

Shades and pattern of all tiles shall be decided during engineering or during project phase. RAL (Colour scheme) of wall internal and external face shall be as per colour of steel sheet cladding. Contractor shall submit all relevant prequalification details and make necessary research of its availability in Indian market.

9.34 Substructure finishing

All substructure or concrete surfaces which are in direct contact of soil and ground water shall be treated as critical and suitable surface protection shall be done to make the concrete durable against effects of acid / alkali soil substances.

9.35 False ceiling and Raised Floor

Approval of owner is subjected that Contractor shall obtain stability certificate for respective manufacturer.

All building material / construction material shall confirm to the best quality specified in the relevant international standards / IS standards.



9.36 Preferred vendors for Building materials

Material / Item	Manufacturer
Cement (SRC/PSC)	ACC, Ultratech, Ambuja, JK laxmi, Sanghi Cement, HI-Bond, Hathi
Reinforcement steelHYSD / TMT-CRS steels bars with Grade Fe500D	SAIL, Tata Tiscon, Jindal Steel,JSW, RINL
Admixtures / water proofing compounds / Hardener	Dr. Fixit, Sika, BASF, Fosroc
Aluminum Sheet	Hindalco, Jindal
Structural steel	Jindal, Tata Steel, SAIL, RNIL, Essar
Steel - Hot Rolled section (Angle / Channel / Beam / Round bar)	Jindal, Tata Steel, SAIL, RNIL, Essar
Steel coil for purlins, girts and cold frame member	JSW, Essar, Tata Blue scope
Foundation Bolts	Power Grid (PGCIL) or GETCO approved
Nut, bolts, washer grade 8.8 / grade 5.6 / grade 10.9	Power Grid (PGCIL) or GETCO approved
Welding Electrodes	ISI marked
Metal cladding puff panel / sandwich panel	King span Jindal, Sintex, ThyssenKrupp Steel, Tata Blue scope
Vitrified tiles / Ceramic tiles	Nitco, Kajaria, Simpolo
Glass	Float Glass : Saint-Gobain, Modi glass
Bricks / light weight block	Approved make by owner
Rolling Shutter	Approved make by owner
Steel doors	Approved make by owner
Door closer	Godrej, Dorver, Yale
Door / window fixates like lock, handle	Godrej, Dorma, Kich
Door Lock	Godrej, Yale
Panic Bar / Push bar with safety sign display sticker	Dorma
Aluminum doors / windows / partition	Hindalco, Jindal
Stainless steel	Tata Steel, Jindal, SAIL
Acrylic and emulsion paint, weather proofing paint	Asian, Indigo, Burger
Putty	Birla, Asian, Burger
Acid / epoxy resistant paint	Asian, Burger
Sealant	Sika, Fosroc, Hilti
No Shrink grout	Fosroc
Water stopper / water bar	Approved make by owner
CI / FRP / RCC Manhole cover	Approved make by owner
False ceiling (gypsum or fiberglass board)	Armstrong / Saint Gobain
Raised floor	Approved make by owner
RCC pipe	Approved manufacturer confirming to B.I.S.standards
GI pipe-class C heavy	Jindal, Tata
GI fittings	Approved make by owner
PVC pipes	Supreme, Prince, Finolex
CPVC pipes	Finolex, Astral
Brass fitting	Approved make by owner
C.P. fitting	Jaguare, Hindware
Plumbing fixtures	Jaquare or Kohler or equivalent make
Sanitary hardware	Hindware, Ceraor equivalent make
Stainless steel sink with drain board	Nirali make



9.37 Aluminum doors / Windows / Ventilators

All aluminum section shall be anodized. Section of door and window frame shall be approved make. Door shutter shall be made out from Aluminum and combination of compact sheet and clear float / wired glass of 5.5mm thick with sun film sheet on it. Rooms shall have adequate size and number of fixed / openable sliding windows and louvers with sun film over it to facilitate adequate ventilation / fresh air circulation. All windows shall have hot dip GI coated MS grill. All windows shall have curtains of approved make and have mosquito / fly net. These nets shall be removable for cleaning purpose. All doors / windows / louvers shall have weather shade. All door / window / ventilators sills shall have 20mm thick granite lining.

9.38 Landscaping

Landscape of the entire plant area including supply of plants maintenance and sprinkling of water through distribution pipe network shall be provided. Landscaped areas shall be irrigated by sprinklers with the treated water from the sewage treatment units

10.0 DESIGN LOADS FOR CIVIL STRUCTURES AND BUILDINGS

10.1 Dead Load

Dead loads consist of the weights of the structure complete with finishes, fixtures, partitions, wall panels and all equipment of semi-permanent nature including partitions, roofing, piping, cable trays, bus ducts etc. The following unit weight of material shall be considered for computation of loads:

Plain Cement Concrete	24 kN / m ³
Reinforced Cement Concrete	25 kN / m ³
Structural Steel	78.5 kN / m ³
Brick work	19 kN / m ³

10.2 Equipment Load

The imposed load generally shall include the panel loads and as explained in clause 7.5.0.

10.3 Earth Pressure Loads

Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest.

In addition to earth pressure and ground water pressure, etc., a minimum surcharge load of 20 kN / sqm shall also be considered for the design of all underground structures including channels, sumps, cable and pipe trenches, etc. to take into account the vehicular traffic in the vicinity of the structure.

10.4 Imposed Load

Imposed loads in different areas shall include live loads, minor equipment loads, cable trays, erection loads, operation / maintenance loads etc. The loads considered shall not be less than that specified in IS : 875 (Part II).

Flat roof : 1.5 kN / m² + Equipment load

10.5 Wind Load



Wind loads 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 unfavorable condition shall be considered.

Basic Wind Speed = 41.667 m / s

The external / internal pressure coefficients shall be as per respective clauses of IS : 875.

10.6 Seismic Load

Seismic forces shall be as per IS:1893-2005. The site falls in Zone-III. IS:13920 shall be followed for detailing. Importance factor shall be taken as per IS: 1893.

10.7 Load Combinations

The individual members of the frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force and torsion. Permissible stress 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. Load factors shall be based on the factors given in the relevant codes of practice – in general all loads which are variable (including earth and ground water pressure) shall be treated as live loads for purpose of determining the load factor.

11.0 FABRICATION AND ERECTION OF STRUCTURAL STEEL

11.1 Structural steel

All structural steel shall be of tested quality. Rolled steel sections and plates shall conform to IS:2062. Steel tubes where used for equipment support structure shall conform to IS:1161.

11.2 Bolts and nuts

All bolts and nuts shall be galvanized of mild steel and shall conform to IS : 6639. Unless shown or specified all bolts and nuts shall be hexagonal. All nuts shall fit tight. Mechanical properties shall conform to property class 4.6 and 4 of IS: 1367 for bolts and nuts respectively. Bolts of property class 5.6 conforming to IS: 12427 may also be used.

11.3 Washers

Plain washers shall be made of galvanized steel, unless otherwise specified and shall conform to IS: 2016. Spring washers shall be provided for those parts which carry dynamic loads and where black bolts for connections are permitted. Heavy washers shall conform to IS: 6610 and spring washers to IS: 3063.

11.4 Electrodes

Mild steel electrodes shall conform to IS:814 and high tensile steel electrodes to IS:1442. The Contractor shall furnish to the Owner a certificate issued by the manufacturer to the effect that the electrodes supplied are in accordance with the above specifications. For welding in any particular position, the electrodes used shall be those recommended by the manufacturer for use in that position.

11.5 Galvanizing

Galvanizing of VFRB Plant structures shall conform to IS:4759. The min. thickness of galvanizing shall be 180µm at any point of the galvanized structure. Galvanization shall be measured with elcometer or the material can be sent for testing to laboratory as and when required. No averaging is allowed for measuring the thickness of galvanization. All side shall be galvanization with same specification and shall be maintained for any hollow components of



structures. Galvanization shall be considering the high saline zone C4-M as per ISO 12944.

11.6 Other Materials

Other materials used in association with steel work shall comply with the appropriate Indian Standard specifications.

11.7 General Requirements of Materials

Before ordering bought out items, special accessories, equipment etc. and materials of any description, the Contractor and his subcontractors shall submit the names of the proposed manufacturers or suppliers together with the specification of the materials for the approval of the Owner and shall, thereafter, send copies of the orders to the Owner.

In addition to the special provisions made hereafter as to the sampling and testing of materials by particular methods, samples of materials and workmanship proposed to be employed in the execution of the works comprised in this Contract may be called for any time by the Owner and when so called for by the Owner, the same shall be furnished by the Contractor free of cost without delay. The samples, when approved, shall be kept by the Owner who shall reject all materials or workmanship not in conformity with the quality and character of the approved samples. Suitable labeled boxes for the storage of the said samples shall be provided by the Contractor free of cost.

The Contractor shall furnish to the Owner the following certificates, if required, before commencement of fabrication:

- i) A certificate stating the process of manufacture and chemical composition of the steel supplied.
- ii) Test certificates by the manufacturer giving the results of each of the specified mechanical tests applied to the structural steel, bolts, nuts and washers and the chemical composition of the same.

11.8 Workmanship

All workmanship shall be equal to the best practice in modern structural shops. Greatest accuracy shall be observed in the manufacture of every part of the work and all similar parts shall be strictly interchangeable.

Fabrication and erection shall generally be as per IS:2062.

11.9 Templates

Templates used throughout the work shall be all steel, steel bushed in such cases as the Owner may consider necessary. In cases where actual materials have been used as templates for drilling the Owner shall decide whether they are fit to be used as parts of the finished structure.

11.10 Straightening

All materials shall be straight and if necessary, before being worked shall be straightened and / or flattened by pressure unless required to be of curvilinear form and shall be free from twists.

11.11 Clearance

The erection clearances for cleared ends of members connecting steel to steel should preferably be not greater than 2.0 mm at each end. The erection clearance at ends of beams without web cleats should be not more than 3 mm at each end, but where for practical reasons greater clearance is necessary, suitably designed seating should be provided.

11.12 Shearing, Flame Cutting and Planning



- a) Shearing or flame cutting may be used at the Contractor's option provided that a mechanically controlled cutting torch shall be used for the flame cutting and that the resulting edge shall be reasonably clean and straight. Sheared members shall be free from distortion at sheared edges.
- b) The edges and ends of all flange plates and web plates of plate girders and built-up columns of plates forming chords or web members of lattice girders and all cover plates, the ends of all angles, tees, channels and other sections forming the flanges of plate girders and columns and chords and web members of lattice girders shall be planed.
- c) The ends of all stiffeners shall be planed or ground to fit tightly between the main angles or flanges. Care shall be taken to ensure a full bearing of the stiffeners at the supports and at other points where concentrated load is applied. The ends shall not be drawn or caulked.
- d) The butting surfaces at all joints of girders or columns shall be planed so as to butt in close contact throughout the finished joint.
- e) The ends of all built-up girders and of all columns shall be faced. The bearing surfaces of all slabs and plates for caps and bases of columns and for seatings for heavy girders shall be machined.
- f) Unless clean, square and true to shape, all flame cut edges shall be planed.
- g) Cold sawn ends if reasonably clean and flame cut ends of sections not inferior to sawn ends in appearance need not be planned except for butting ends

12.0 CIVIL, STRUCTURAL & ARCHITECTURAL SCOPE

Design & Construction of Facilities:

- 1) Site Investigation: Topography survey and geotechnical investigation.
- 2) Main Control Room (MCR): Pre-Engineered Building (PEB) or containerized system or PEB shed with roof accessibility ladder, illumination, water drain arrangement etc.
- 3) Required overhead cranes/hoists/gantry cranes
- 4) Temporary shed for material storage shed during construction. Permanent spares storage shed with inventory racks, hoists etc. Open yard storage wherever required including preparation of the area/fencing etc.
- 5) Inverter/PCS Rooms: PEB, containerized, or outdoor PCS with canopy structure
- 6) Storeroom and Security Cabin
- 7) Cable trenches / trestles including cable tray support
- 8) All equipment supporting foundations and structures
- 9) Approach roads and internal roads (connection to available approach roads; must ensure O&M accessibility)
- 10) Internal and external drainage system
- 11) Project boundary fencing with gates
- 12) Internal fencing and gates (transformer yard, inverter yard, etc.)
- 13) Kiosk/cubicle type control room with all electrical fittings and furniture, toilets, dining, store room/record room, conference room/common room,

Site Preparation:



- 1) Cutting, clearing, and disposal of vegetation, roots, old structures, foundations etc
- 2) Site grading, slope protection, ground preparation, filling and levelling
- 3) Temporary drainage and dewatering
- 4) Construction power and water supply arrangement

Supply & Pre-commissioning

- 1) Packing, forwarding, and transportation of all equipment to site
- 2) Unloading, storage, and preservation at site
- 3) Site assembly of BESS components
- 4) Obtaining all transport and site permits

Appendix – 1.0 **Key Features of the Project Site**

- | | | | |
|-----|--|---|---|
| 1.0 | Project Site | : | P.O. Petrochemical, Vadodara,
Vadodara District, Gujarat State |
| 2.0 | Approach to site | | |
| | a) Nearest town | : | Vadodara |
| | b) Nearest Railway Station | : | Bajuwa / Ranoli Railway Station of
Western Railway |
| | c) Nearest Sea Port | : | 150 km from Dahej |
| | d) Nearest Airport | : | 220 km from Hazira |
| | e) Access Roads | : | Vadodara |
| 3.0 | Site Elevation | : | 36.9 m above sea level |
| 4.0 | Ambient temperature | | |
| | a) Max. dry bulb temp | : | 44.3°C |
| | b) Min. dry bulb temp | : | 5.6°C |
| | c) Design temperature for electrical
equipment / device | : | 50°C (Max) |
| 5.0 | Relative humidity | | |

