

SECTION - 3

ENCLOSURES TO THE SPECIFICATION (Customer's Specification)

- 1 Job specification for Bipolar Concrete Penetrating Corrosion Inhibiting Admixture
- 2 Engineering Design Basis Design Philosophy- Structural and Architectural

JOB SPECIFICATION
FOR
BIPOLAR CONCRETE PENETRATING
CORROSION INHIBITING ADMIXTURE
TO
PROTECT EMBEDDED STEEL
REINFORCEMENT IN CONCRETE

PROJECT : DAHEJ PETROCHEMICALS COMPLEX

OWNER : ONGC PETRO additions LTD.

PMC : ENGINEERS INDIA LTD.

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1.0 SCOPE

- 1.1 This specification prescribes the requirements and test methods of physico – chemical characteristics including performance test for evaluating the efficiency of the product in the laboratory for protecting steel reinforcement embedded in concrete from corrosion.
- 1.2 This standard prescribes the requirements and methods of test for the material known as Bipolar Concrete Penetrating Corrosion Inhibiting Admixture (CPCIA). The CPCIA shall be concrete penetrating type which upon addition into the concrete matrix inhibits the corrosion process. It need not be in direct contact with the steel. Its vapours penetrate through fissures, honeycomb structure of concrete, pure water solution added in concrete and seals steel reinforcement at both anodic & cathodic sites, for inhibition. This is due to the bipolar mechanism property of the system. Non-concrete penetrating, nitrite & nitrate corrosion inhibitors are excluded from this scope. The product shall be suitable to protect embedded steel reinforcement bars used in concrete structures from corrosion.

2.0 TERMINOLOGY

- 2.1 For the purpose of this standard the definitions as given in latest versions of ASTM-G1, ASTM-G3, ASTM-G109, ASTM-C 1202, JIS-Z-1535, AASHTO T259, IS:101(Part1/sec.5)-89, IS:456-2000, IS:1202-97, IS:1448-67, IS:1786-85, IS:9103-99 etc. shall apply.
- 2.2 Rounding off, of observed values on different tests shall be in accordance with IS: 2-1960.

3.0 SAMPLING

- 3.1 The representative samples of the material shall be drawn by the purchaser or the Inspecting authority as per the table given below:

Scale of Sampling for CPCIA

No. of containers lot (N)	No. of containers to be selected for sampling (N)
Up to 50	1
51-100	2
101-200	3
201-300	3
301-500	4
501-800	5
801-above	6

4.0 PROPERTIES

- 4.1 The material shall comply with the requirements specified in Clause 5.0, Table-I and Table-II of this specification.
- 4.2 Unless otherwise specified, the following testing conditions shall apply.
- 4.2.1 All the tests shall be conducted at room temperature $27 \pm 2^\circ\text{C}$ and relative humidity at $65 \pm 5\%$ in a well ventilated chamber free from draught and dust.

5.0 REQUIREMENTS

- 5.1 The admixture shall be supplied in one pack.
- 5.2 There are two types of requirements that the material should meet in order to be considered for usage.
- 5.2.1 Properties which can be evaluated in short duration as laid down in Table –I. It can be performed at a laboratory or at sites with proper testing facilities.
- 5.2.2 Properties which can be evaluated by performing long duration tests as laid down in Table–II.
- 5.2.3 All the tests performed under Indian Tropical Conditions mentioned in Table-I & Table-II are mandatory requirement for the approval of product.
- 5.2.4 Approving authorities certificate for long term tests and Suppliers test certificate meeting the short term requirements may be accepted by the purchaser. However, short term tests may be cross checked with NABL accredited laboratory if desired.
- 5.3 The recommended dosage of CPCIA in concrete shall be preferably 1% (w/w of Cement) or as recommended by the manufacturer.
- 5.4 Tests specified in Table II shall be performed in triplicate.

TABLE –I

**REQUIREMENT OF BIPOLAR CONCRETE PENETRATING CORROSION INHIBITING
ADMIXTURE (Short Term Tests)**

Sr. No .	Characteristics	Requirements	Methods of Tests
1.	Appearance	Brownish Liquid free from any visible residual deposits	Visually
2.	Odour	Mild Ammonical Odour	By smell
3.	Skin irritation	No irritation	By applying on reverse of the palm for 05 minutes.
4.	pH i) As in supplied condition ii) 1% dilution ,w/w	i) 9.0-11.0 ii) 9.0-11.0	pH meter / Standard pH paper
5.	Specific Gravity at $27 \pm 2^\circ\text{C}$	1.04-1.06	IS 1448-1967

Sr. No .	Characteristics	Requirements	Methods of Tests
6.	Viscosity of the material as in supplied condition, by Ford cup No 4, at $27 \pm 2^\circ\text{C}$	10 -20 sec.	IS: 101(Pt. 1/Sec.5)1989
7.	Accelerated Corrosion Test, for 21 hrs. i) Raw water without CPCIA ii) ii) Raw water with CPCIA	i) Excessive corrosion spots. ii) There shall not be more than 1-2 corrosion spots.	Modified accelerated corrosion test (Based on Japanese standard JIS Z 1535)

TABLE –II

REQUIREMENT OF BIPOLAR CONCRETE PENETRATING CORROSION INHIBITING
ADMIXTURE (Long Term Tests)

Sr. No .	Characteristics	Requirements	Methods of Tests
1.	Immersion test for 720 hrs. (Rebar weight loss method) i) With out CPCIA* ii) With 1% CPCIA*	i) 40.00 mpy, max. ii) 2.00 mpy, max.	Immersion Test (Rebar weight loss test)[as / ASTM G 1]
2.	Effect of Concrete admixture on compressive strength i) Wth out CPCIA* ii) With 1% CPCIA*	Concrete strength in sample with CPCIA* should be \geq concrete strength in sample without CPCIA*	Test for effect on compressive strength by addition of CPCIA [IS 9103-1999]
3.	Polarization test by Tafel polarization with 3.5% Sodium Chloride, for 20 days i) With out CPCIA* ii) With 1% CPCIA*	Rate of corrosion shall be i) 45 mpy, max. ii) 9 mpy, max.	Electrochemical polarization test conducted on steel rebars embedded in concrete [ASTM-G 3 and IS 9103-1999]
4.	Effect of CPCIA* on corrosion of embedded steel rebars exposed to chloride environments after 09 cycles (14 days wetting and 14 days drying) as per ASTM G109. i) With out CPCIA* ii) With 1% CPCIA*	Rate of corrosion shall be i) 25.00 Coulombs, max. ii) 0.50 Coulombs, max.	Long term corrosion test [ASTM G-109-2005]

Sr. No.	Characteristics	Requirements		Methods of Tests
5.	Chloride Migration profile properties of concrete with & without CPCIA i) Chloride % in concrete at 30 mm depth after 90 days. (For all types of cements e.g. OPC, PPC, PSC, SRC) ii) Ability to resist chloride ion penetration (RCPT) (For all types of cements e.g. OPC, PPC, PSC, SRC) a) Concrete grade M-30, Water cement ratio: 0.45 b) Concrete grade M-40, Water cement ratio: 0.40	With out CPCIA* Chloride % shall be 0.025%, max.	With 1% CPCIA* Nil Resistance to chloride ion penetration shall be 1650 Coulombs, max. 1000 Coulombs, max.	AASHTO T-259 i) Chloride ion penetration (Salt ponding test) [IS:456-2000] ii) Electrical indication of Concrete ability to resist Chloride Ion Penetration (Rapid Chloride Permeability test) [ASTM C-1202 1997]

Note

- 1 CPCIA* : Bipolar Concrete Penetrating Corrosion Inhibiting Admixture. The CPCIA shall be used as 1% w/w of cement or as recommended by the manufacturer for conducting the tests mentioned in Table-II except Immersion test for 720 hrs mentioned at S. No. 1 where it shall be used as 1% w/w of water or as recommended by the manufacturer.
- 2 Wherever required , rebars conforming to IS: 1786-1985 shall be used for testing purposes

6.0 SAFETY TO CONSTRUCTION MATERIAL

CPCIA should not degrade, or damage the construction materials.

- Concrete
- Aggregates
- Steel reinforcement
- Form work/Shuttering

7.0 SAFETY FOR FABRICATION

The CPCIA should not cause harm to personnel by mean of inhalation or skin

contact. All precautionary measures shall be intimated by the manufacturers clearly in writing along with instructions of usages. However final decision about adoption of such measures shall lie with the EIL or client and shall depend upon the conditions prevailing at the site.

8.0 WASTE WATER DISCHARGE

The waste discharge shall be in accordance with the laws of pollution control in force from time to time.

9.0 PACKING

The material shall be packed in suitable air tight polyethylene containers preferably of capacity 20 kg / 200kg or as agreed by purchaser and supplier.

10.0 MARKING

10.1 Each container shall be legibly and indelibly marked with the following:

- a) Name of the material
- b) Name of the manufacturer
- c) Volume / weight of material
- d) Specification number
- e) Batch No. or Lot No. in code or otherwise
- f) Month and year of manufacture

11.0 INSPECTION

11.1 At the time of initial approval of the product or firm, full testing as mentioned in clause 5.2.3, shall be carried out.

11.2 In case of acceptance testing, Inspecting Authority shall draw the sample as per clause 3.1, from the batch under consideration and the material shall be tested for the tests stipulated in Table-I.

11.2.1 Long duration tests need substantial amount of time. The testing facilities for these tests may not be available in each and every laboratory, therefore, Approving authority's certificate for long term tests as stipulated in Table-II & Supplier's test certificate/NABL accredited laboratory test certificate meeting the short term tests as stipulated in Table-I may be accepted by the Purchaser for the acceptance of the material. However if desired by the purchaser, long term tests may also be organized to be carried out at any IITs/NABL accredited laboratory.

ENGINEERING DESIGN BASIS DESIGN PHILOSOPHY

6.6 STRUCTURAL & ARCHITECTURAL

REV. 1 - Cl. 4.1 e Wind Load revised.

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PART – I : STRUCTURAL

(FROM PAGE 3 TO 20)

PART –II : ARCHITECTURAL

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PART-I: STRUCTURAL

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1.0 REFERENCED STANDARDS & PUBLICATIONS

(BIS codes of Practice shall be applicable)

S.No.	CODES	
1.	Code of practice for plain & reinforced concrete	IS: 456
2.	Code of practice for general construction in steel	IS: 800
3.	Code of practice for use of cold formed light gauge steel structural members in general building construction	IS:801
4.	Code of practice for use of structural steel in overhead transmission line towers	IS:802
5.	Code of practice for use of steel tubes in general building construction	IS:806
6.	Indian Standard on Dimension s of Hot Rolled Steel Beams, Columns, Channel and Angles	IS: 808
7.	Scheme of Symbols for Welding	IS: 813
8.	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel	IS:814
9.	Code of practice for use of metal arc welding for general construction	IS:816
10.	Code of practice for design loads	IS: 875
11.	Common burnt clay building bricks-specification	IS: 1077
12.	Steel tubes for structural purposes-specifications	IS: 1161
13.	Technical Supply Conditions for Threaded Steel Fasteners	IS: 1367
14.	Code of practice for construction of stone masonry	IS: 1597
15.	Fillers for expansion joints	IS: 1838
16.	Criteria for earthquake resistant design of Structures	IS: 1893 (Part -1& 4)
17.	Code of practice for design & construction of Foundations in soils	IS: 1904
18.	Code of practice for structural use of unreinforced masonry	IS:1905
19.	Steel for General Structural Purposes- Specification.	IS: 2062
20.	Recommended practice for hot dipped galvanising on iron and steel	IS:2629
21.	Methods for testing uniformity of coating of zinc coated articles	IS:2633
22.	Code of practice for Design and construction of Pile foundations	IS:2911
23.	Code of practice for design & construction of raft foundations	IS:2950
24.	Code of practice for design & construction of machine foundations	IS:2974

25.	Code of practice for concrete structures for storage of liquids	IS:3370
26.	Steel Chequered Plates – Specification	IS: 3502
27.	Code of practice for design and construction of foundation for transmission line towers and poles	IS:4091
28.	Code of practice for earthquake resistant design and construction of buildings	IS:4326
29.	Criteria for blast resistant design of structures for explosions above ground	IS:4991
30.	Criteria for design of RCC chimneys	IS: 4998
31.	Method of test for determination of dynamic property of soil	IS: 5249
32.	Code of practice for anti-termite measures in buildings	IS: 6313
33.	Code of practice for determination of bearing capacity of shallow foundations	IS: 6403
34.	Code of practice for design & construction of steel chimney	IS:6533
35.	Method for determination of mass of zinc coating	IS: 6745
36.	Code of practice for calculation of settlement of foundations	IS: 8009
37.	Chlorpyrifos emulsifiable concentrates	IS: 8944
38.	Recommendations for metal arc welding of carbon and carbon manganese steel	IS:9595
39.	Two parts polysulphide based sealants	IS: 12118
40.	Indian Standard on Hot Rolled Parallel Flanged Steel sections for Beams, Columns and Bearing Piles	IS:12778
41.	Pulverized fuel ash-lime bricks-specification	IS: 12894
42.	Code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces	IS:13920
43.	Control Room Safety (a publication of Oil Industry Safety Directorate)	OISD-STD-163
44.	Fire Proofing in Oil and Gas Industry (a publication of Oil Industry Safety Directorate)	OISD-STD-164
45.	Fire Protection System for Electrical Installations	OISD-STD-173

Note The above list is suggestive and not exhaustive. Apart from these basic codes any other related codes shall also be followed wherever required.

2.0 GENERAL

- 2.1 This specification defines the design criteria and loads that shall be taken in to account for the design of all industrial plant and non-plant structures and buildings for a pipeline project. The design considerations given hereunder establish the minimum basic requirements of reinforced concrete structures, structural steel works and masonry structures. However, all structures shall be designed for the satisfactory performance of the functions for which the same are to be constructed.

3.0 MATERIALS OF CONSTRUCTION

- 3.1 All shed type structures such as Compressor house, Ware house etc. shall be in structural steel.
- 3.2 Pipe supports, cross over, access way, service platform shall completely be of steel construction. All other buildings shall be as per Architectural Design Basis.
- 3.3 All buildings shall be of RCC Frame type construction with brick masonry walls.
- 3.4 Boundary wall shall be of Stone masonry.
- 3.5 Bricks for masonry works shall be of the class conforming to IS: 1077 which is locally available.

4.0 DESIGN LOADS

- 4.1 These loadings shall be applicable to all structures irrespective of the material employed for construction.

a. DEAD LOADS

The weight of all permanent construction including walls, fire proofing, floors, roofs, partitions, stairways and fixed service and other equipments excluding their content.

b. EQUIPMENT LOADS

The empty weight of process equipment including all fixtures, platforms, ladders and attached piping but excluding contents shall be considered. If piping weight is not indicated separately or included in the weight of the equipment, the same shall be taken as 10% of the weight of the equipment.

For horizontal equipments the weight on two supports shall be calculated based on the total weight and C.G. of the equipment.

c. LIVE LOADS

Live loads shall, in general, be as per IS: 875. However, the following minimum live loads shall be considered in the design of structures to account for maintenance and erection as well.

i.	<u>Process Building/Technological Structure (Open/Enclosed type)</u>		
	Operating area	-	5.0 kN/m ² (including 2.0 kN/m ² for Piping)
	Maintenance area	-	7.5 kN/m ²
ii.	<u>Compressor House/TG house</u>		
	Operating area	-	7.5 kN/m ²
	Maintenance area	-	7.5 kN/m ² (or as specified by machine vendor)
iii.	<u>Service Platform</u>		
	Vessel/Tower	-	3.0 kN/m ²
	Isolated platform (for valve operation)	-	2.5 kN/m ²
	Access way	-	2.5 kN/m ²
	Cross over	-	2.0 kN/m ²
iv.	<u>Substation/Control Room</u>		
	Panel floor	-	10.0 kN/m ²
	Partitions	-	1.0 kN/m ²
v.	<u>Office building</u>		
	Office area	-	3.0 kN/m ²
	Lobby	-	5.0 kN/m ²
	Exit way	-	5.0 kN/m ²
	Partitions	-	1.0 kN/m ²
vi.	<u>Laboratory</u>		
	Upper floors	-	4.0 kN/m ²
vii.	<u>Staircase</u>		
	Office	-	5.0 kN/m ²
	Substation/Control Room	-	3.0 kN/m ²
	Laboratory	-	3.0 kN/m ²
	Service platform	-	2.5 kN/m ²

vi. Walkway


Gantry girder - 3.0 kN/m²

Live load on various types of roofs shall be as per the requirements given in IS: 875.

d. **OPERATING LOADS**

Operating loads shall include the maximum designed equipment inventory in the operating cycle of the plant.

e. **WIND LOADS**


 Wind loads shall generally be as per IS: 875. The basic wind speed for all the stations/terminals shall be taken as 44 m/sec.

Values of coefficients k_1 , k_2 , k_3 shall be as:

k_1 (Probability factor, risk coefficient) = 1.00 for permanent structures and
 = 0.90 for temporary structures
 = 0.70 for barricading structures/ Boundary Wall

k_2 (Terrain, height & structure size factor) = this shall be taken for relevant class of structure with **category 2** terrain w.r.t. actual height of the structure

k_3 (Topography factor) = As per site

The design life span of all structures shall be taken as 50 years. Temporary structures shall be designed for a design life span of 25 years. Design life span for boundary wall/barricading structure shall be as per IS: 875.

To account for surface area of piping, platforms and other attachments fixed to the equipment the surface area of the equipment (vessel/column) exposed to wind shall be increased by 20% or as specified in the mechanical data sheet of the equipment.

f. **SEISMIC LOADS**

Seismic forces shall be as per site specific seismic spectra 6987-00-16-54-DB-01 for Seismic Zone III.

g. **IMPACT & VIBRATORY LOADS**

Structures subjected to impact or vibratory loads shall be designed as per the provisions of IS: 875 & IS: 2974.

h. **BLAST FORCES**

Blast resistant control room or any other specified structure subjected to blast forces generated due to accidental blasts from hydrocarbon ignitions shall be designed to withstand all such forces. Design blast loads and blast resistant construction shall conform to OISD-STD-163.

i. **BUNDLE PULL**

Bundle pull for different types of Exchangers shall be taken for design of their supports unless it is made clear that bundle extractor is to be used.

Total Bundle Pull shall be considered on fixed pedestal alone.

j. **OTHER LOADS**

Apart from the specified live loads, any other equipment load or possible overloading during construction/hydro-test/ maintenance/erection shall also be considered in the design. Under hydro test condition the wind force shall be taken as 25% of normal loading.

Design of all structures shall also consider any other relevant and consequential load/stress imparted to the structure.

All liquid retaining/storage structures shall be designed assuming liquid up to the full height of wall irrespective of provision of any over flow arrangement. Pressure relief valves or similar pressure relieving devices shall not be made in underground water retaining/storage RCC structures.

All buildings/structures shall be designed to resist the worst combination of the above loads. However wind loads shall not be considered in combination with loads due to maintenance cranes in workshop, comp. House etc.

5.0 SOIL AND HYDROSTATIC PRESSURE

Pressure on basement walls: - In design of basement walls and similar approximately vertical structure below grade, provision shall be made for the lateral pressure of adjacent soil. Due allowance shall be made for possible surcharge from fixed or moving loads. When a portion or whole of adjacent soil is below free water surface, computations shall be based on the weight of the soil diminished by buoyancy (submerged weight of soil) plus full hydrostatic pressure.

Uplift on floor: - In the design of basement floor and a similar approximately horizontal construction below grade, the upward pressure of water, if any, shall be taken as the full hydrostatic pressure applied over the entire area. The Hydrostatic head shall be measured from the underside of construction. Factor of safety against uplift shall be 1.2. For the purpose of calculating downward load due to over burden; the weight for the same shall be calculated for volume over projected plan area only.

6.0 FOUNDATION DESIGN

6.1 Minimum Requirements

Foundation design shall be as per Geo-Technical Data as specified in bid document.

6.1.1 Minimum depth of foundation for all structures shall be as per Geo-Technical Data. Factors of safety against overturning and sliding shall be as per values given in Table-1. Component of soil backfill weight over foundation slab shall be appropriately covered as foundation dead load. For stability checks the weight of soil as overburden shall be as per Table-1.

6.1.2 The design ground water level shall be as per the Geo-Technical Data and the hydrostatic pressure shall be adequately accounted for in design.

6.1.3 Allowable net bearing capacity of soil shall be based on the following settlement criteria for dead plus imposed load conditions:

- | | |
|--|------------------|
| - Foundations in unit areas, utility areas
and foundations for Plant buildings. | 25mm settlement. |
| - Non Plant buildings. | 40mm settlement. |
| - Raft Foundations | 40mm settlement |

For transient loadings, e.g. wind/seismic, settlement shall not be the design criteria and the SBC (safe bearing capacity) based on shear criteria shall be considered.

6.1.4 Permissible increase in SBC/Pile capacities (for compressive, shear and uplift/tension) shall be as per the Geo-Technical Data.

6.1.5 Under blast (due to hydrocarbon explosion load combinations the design bearing pressure of soil shall not exceed 2 (two) times the allowable static bearing pressure of soil. Pile capacity shall be similarly increased in blast condition to 1.5 times the permissible capacity under compression, tension and shear modes.

6.1.6 Grade of concrete to be used shall in general be as per the philosophy adopted for the entire project. However, minimum cement content, type of cement & any remedial actions required for foundation due to aggressiveness of sub soil water shall be as per the Geo-Technical Data.

6.2 Anti Termite Treatment

No anti termite treatment shall be provided inside the unit areas. All buildings shall be provided with anti termite treatment as per IS: 8944 and IS: 6313.

6.3 Minimum Cover to Foundation Bolts

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

- i) Clear distance from the edge of the base plate/base frame to the outer edge of the pedestal shall be minimum 50mm.

- ii) Clear distance from the face of pocket to the outer edge of the pedestal shall be 100mm.
- iii) Clear distance from the edge of the sleeve or anchor plate to the edge of pedestal shall be 100mm.

6.4 Height of Pedestals

The minimum projection of pedestals supporting any steel structure/stanchion bases shall be 300/150mm above the high point of pavement/ finished grade/finished floor level whichever is higher, for outdoor and indoor located pedestals respectively. The maximum projection of pedestals for staircase/ladder shall be 200mm.

6.5 Grouting & Minimum Grout Thickness

The minimum thickness of grout shall be **25 mm** and not more than 50mm.

All anchor bolt sleeves/pockets and spaces under column bases, shoe plates etc. shall be grouted with free flow, non shrink (premix type) grout with 28-day minimum cube crushing strength of 40N/mm². Ordinary cement sand (1:2) grout shall only be used under the base plates of cross-overs, short pipe supports (not exceeding 1.5 m height) and small operating platforms (not exceeding 2 m height) not supporting any equipment.

Grouting requirement for machines and equipments are not covered here. The same shall be governed by equipment vendor's requirement.

7.0 FLOORING DETAILS FOR BUILDINGS & SHEDS

The specifications given hereunder shall be adopted for the non-suspended ground floor slabs for buildings & sheds as categorised in Table-2 only.

For outdoor pavements, Design basis of Gen. Civil shall be referred.

8.0 SPECIAL CONSIDERATIONS FOR RCC STRUCTURES

8.1 General/Design Methods

- a) All buildings, structures, foundations, machine/equipment foundations, liquid retaining/storage structures, trenches, pits etc. shall be of RCC and designed based on the following IS Codes (latest revision with all amendments issued there to) in general and other relevant IS Codes applicable: IS: 456, 875, 1893, 1904, 2911, 2950, 2974, 3370, 4091, 4326, 4995, 4991, 4998, 5249, 6403, 8009, 13920.
- b) Only limit state method as per IS: 456 shall be followed in the design unless otherwise specified elsewhere in this document for special structures.
- c) Where the specified design depth of groundwater table so warrants all underground pits, tunnels, basements etc. (excluding appurtenances of storm water/effluent collection system, cable trench, pipe trench) shall be of leak-proof RCC construction using waterproofing compounds.
- d) All liquid retaining/storage RCC structures shall be leak-proof and designed as uncracked section as per IS: 3370. However, the parts of such structures not

coming in contact with the liquid shall be designed according to IS:456 except ribs of beams of suspended floor slabs & counter forts of walls (located on the side remote from the liquid) and roof which shall be designed as uncracked section. No increase in permissible stresses in concrete and reinforcement shall be made under wind or seismic conditions for such structures.

- e) The walls and base slabs of liquid retaining/storage structures shall be provided with reinforcement on both faces for thickness greater than or equal to 150mm. In all liquid retaining structures, PVC water bars (minimum size 230mm wide, 5mm thick) shall be provided at each construction joint.
- f) Hot/cold water basin and other primary framing members of Cooling towers or similar liquid retaining structures which remain constantly in contact with water (stored/sprayed) shall be designed as uncracked sections.

8.2 REINFORCEMENT BARS

High Strength Deformed TMT steel bars of grade Fe 500 (with corrosion inhibitors in concrete) conforming to IS: 1786 shall be used for all structures.

8.3 CONCRETE

Minimum grade of reinforced cement concrete to be used for different structures and foundations shall be **M30**. From Durability considerations the minimum cement content and maximum water-cement ratio shall be as under. However, the maximum cement content shall not exceed 450 kg/m³.

For all stations/terminals

Type of cement	Plain concrete (M20)		Reinforced concrete (M30)		Exposure Condition
	Minimum cement content (kg/m ³)	Maximum water-cement ratio	Minimum cement content (kg/m ³)	Maximum water-cement ratio	
OPC/Fly ash based PPC/SRC(*)	250	0.50	320	0.45	Severe

OPC: Ordinary Portland cement, PPC: Portland Pozzalana Cement

*SRC: Sulphate Resistant Cement (if required as per soil recommendation for respective site)

75mm thick lean concrete of grade 1:5:10 shall be provided under all RCC foundations except under base slab of liquid retaining structures where **100 thick** concrete of mix 1:3:6 shall be used. The lean concrete shall extend **50mm** beyond the foundation for normal foundations and **75mm** under liquid retaining structures.

Plain Cement Concrete (PCC) of grade M15 of minimum 150mm thickness shall be provided under all masonry wall foundations.

Plain cement concrete of grade M20 of minimum 40mm thickness shall be provided as damp proof course at plinth level of all masonry walls and to be coated with 3mm thick bitumen emulsion.

8.4 MINIMUM COVER TO MAIN REINFORCEMENT

The following minimum clear cover shall be provided for RCC works.

-	Slab (roof & floor), Canopy, Cantilever, Waist slab	45mm
-	Beam (roof, floor & tie), lintel	45mm
-	Column, Pedestal	50mm
-	Retaining Wall, Basement and Pit Wall.	
	a) Face in contact with earth	50mm
	b) Free face	45mm
-	Liquid retaining structure	
	a) Face in contact with liquid	45mm
	b) Face away from liquid but in contact with earth	50mm
	c) Free face	45mm
-	Foundation slab, base slab, plinth beam	50mm
-	Pile Cap	
	a) Bottom face	100mm
	b) Top face	50mm

8.5 MINIMUM THICKNESS OF STRUCTURAL CONCRETE ELEMENTS

The following minimum thickness shall be followed:

-	Footings (All types, with or without beams)	300mm
	(Note: Tapered footings shall not have thickness less than 150mm at the edges. Minimum average thickness shall not be less than 300mm)	
-	Pile Cap	500mm
-	Basement	
	a) Walls	150mm
	b) Base slab with beams	200mm

c)	Base slab without beams	300mm
-	Slab thickness in Raft foundations with beam & slab construction	150mm
-	Floor/Roof Slab, Walkway, Canopy Slab	120mm
-	Cable/Pipe Trench/Launder Walls & Base Slab	125mm
-	Parapet	75mm
-	Louvre / Fin.	100mm
-	Precast Trench Cover/Precast Floor Slab	125mm
-	Louvre (in contact with liquid)	125mm
-	Liquid Retaining / Leak proof Structure	
a)	Walls	150mm
b)	Base slab with beams	200mm
c)	Base slab without beams	300mm
-	Underground Pit	
a)	Walls	150mm
b)	Base slab with beams	200mm
c)	Base slab without beams	300mm
-	Blast resistant construction	AS/OISD-STD-163

9.0 SPECIAL CONSIDERATIONS FOR STEEL STRUCTURES

9.1 General/design methods

- a) Design, fabrication and erection of the above work shall be carried out in accordance with the following IS Codes as applicable to the specific structures, viz. IS: 800, 801, 802, 806, 814, 816, 875, 1893, 9178, 9595, 6533, etc. Basic consideration of structural frame work shall primarily be stability, ease of fabrication/erection and overall economy satisfying relevant Indian Standard Codes of Practice. Simple and fully rigid design as per IS: 800 shall be used. Where fully rigid joints are adopted they shall generally be confined to the major axis of the column member
- b) Structural elements continuously exposed to temperatures above 200⁰ C shall be designed for reduced stress as per IS:800.
- c) Crane gantry girders shall generally be of welded construction and of single span length. Chequered plate shall be used for gantry girder walkway flooring.
- d) Steel staircases for main approaches to operating platforms shall have channels provided as stringers with minimum clear width of 750mm and slope of app. 41 degree. The vertical height between successive landings shall not be less than 2.6m

nor exceed 4.0 meters. Treads shall be minimum 230mm wide made of grating (with suitable nosing) spaced equally so as to restrict the rise to maximum 200mm.

- e) Hand rails, 1000mm high, shall be provided to all walkways, platforms, staircases. Toe plate (100mmx5mm) shall be provided for all hand railing (except for staircases). Spacing of uprights shall be 1500mm (maximum). Two types of hand railing shall be provided.
 - i) For Tech. structures, walkways, platforms (except platform around/on circular/horizontal vessels), and staircases: Top rail, mid-rail and upright shall be 32mm dia (NB) galvanised MS tubes.
 - ii) For platforms around circular vessels: Top rail shall be 32mm dia (NB) galvanised MS tubes but mid rail and upright shall be of structural steel.
- f) Electro-forged hot dip galvanised MS Gratings shall be minimum 25 deep. The maximum size of voids in the grating shall be limited to 30mm x 100mm. The minimum thickness of galvanising shall be 120 microns.
- g) Welded connections shall be adopted as far as practicable except for the removable members where bolted connections are required viz. (Galvanised) electrical switchyard structures and transmission towers. Structural connections shall have minimum two bolts of 16mm dia. unless otherwise limited by the size of members.
- h) Minimum two nuts shall be used for all anchor bolts except for ladder, stair and handrail.
- i) Structural section shall be conforming to IS:808 and/or IS:12778. RHS/SHS section conforming to IS:4923 shall be used. CHS section shall be conforming to IS:1161.

9.2 GRADE OF STEEL

Structural steel shall be of yield stress of 250 MPa conforming to grade A of IS: 2062. RHS/SHS/CHS shall conform to Yst 310/240.

9.3 FIREPROOFING OF STEEL STRUCTURES

Fire proofing of steel structures shall be by concrete (for structures supporting transfer line & two phase flow line above 6" diameter) and vermiculite (for other structures), wherever required as per OISD-STD-164 and shall be done for 2 hours fire rating as per EIL specification or as required as per TAC rules. Guniting method of fire proofing shall be applied for equipment skirts

9.4 Limiting permissible Stresses

- Permissible stresses in structural members shall be as specified in:

IS: 800	Hot rolled sections (excluding transmission towers and switchyard structures).
IS: 801	Cold formed light gauge sections
IS: 802	Code of practice for use of structural steel in overhead Transmission line towers & switchyard structures
IS: 806	Tubular structures

- Permissible stresses in bolts shall be as specified in:

IS: 800	Hot rolled sections
IS: 801	Cold formed light gauge sections.
IS: 802	Transmission towers & switchyard structures.

- Permissible stresses in welds shall be as specified in:

IS: 801	Cold formed light gauge sections.
IS: 816	Metal Arc Welding

9.5 Limiting Deflection

- a) The limiting permissible vertical deflection for structural steel members shall be as specified below:

- Gantry girder for electric overhead crane (Capacity up to 50T)	: L/750
- Gantry girder for electric over head crane (Capacity over 50T)	: L/1000
- Gantry girder for manually operated crane	: L/500
- Girder/beam for supporting dynamic equipment/hoist	: L/450
- Grating/Chequered plate	: L/200 or 6mm whichever is minimum
- Purlins supporting any type of roofing material under (dead load+live load) or (dead load+wind load) conditions	: L/200
- Other structures/structural components	: As specified in Relevant IS Codes

Where 'L' represents the span.

- b) The limiting permissible horizontal deflection for multi storied steel structure/ building including flare stack shall be Height/325.

9.6 Minimum Thickness

The minimum thickness of various structural components (Hot rolled sections) shall be as given:

a) General Construction:	
Trusses, purlins, side girts & bracings	6mm
Columns, beams	7mm
Gussets in trusses & girders	
i) upto and including 12m span	8mm
ii) above 12m span	10mm
Stiffeners	8mm
Base plates	10mm

Chequered plate
Grating

6mm (on plain)
3mm

Structural members exposed to marked corrosive action shall be increased in thickness or otherwise suitably protected against corrosion.

The minimum thickness of structural components (except gratings & chequered plates) which are directly exposed to weather and inaccessible for repainting shall be 8mm.

b) Transmission Towers & Switchyard Structures:

The minimum thickness of various structural components shall be as per IS: 802.

The minimum thickness for rolled beams and channels shall be mean flange thickness regardless of the web thickness.

The minimum thickness of tubes shall be as specified in IS: 806.

9.7 PAINTING

Painting including shop primer to Structural Steel shall be as per painting specification attached elsewhere.

10.0 SPECIAL CONSIDERATIONS FOR MASONRY WORKS

10.1 General

Masonry works shall be of the class which is locally available in accordance with IS: 1077, IS: 1905, IS: 1597, IS: 12894 and other relevant IS Codes as applicable. All external brick masonry walls shall be of minimum 230mm thickness except for fire walls.

10.2 Cement Mortar

All masonry work shall be constructed in cement sand mortar 1:6 except half brick partition walls which shall be constructed in 1:4 cement sand mortar with two numbers of 6mm diameter MS bars provided at every fourth course properly anchored with cross walls or pillars.

11.0 DESIGN REQUIREMENTS FOR SPECIFIC APPLICATIONS

11.1 PIPE RACK & PIPE SUPPORTS

Design of pipe rack & pipe supports shall be as per document no. 8-76-0020

11.2 MACHINE FOUNDATIONS

Machine foundations shall satisfy the requirements of IS: 2974 and any other parameter as per machine vendor.

12.0 SPECIFIC REQUIREMENT

Maintenance platform below Coolers shall be full RCC platform.

Sand Filling for Ring Wall foundation shall be either by river sand or crushed Stone Sand.

TABLE-1

FOUNDATION DESIGN - FACTORS OF SAFETY

Type Of Structure	Minimum Factor Of Safety Against Overturning		Minimum Factor Of Safety Against Sliding		% Weight Of Overburden Over Projected Plan Area Of Footing
	With Wind Or Seismic	Without Wind Or Seismic	With Wind Or Seismic	Without Wind Or Seismic	
All Buildings/ Structures/Eqpts. in Units	1.5	2.0	1.5	1.5	100
Pipe Rack (Offsite)	1.5	2.0	1.5	1.5	50 ^{\$}
Flood Light Mast	1.5	-	1.5	-	50 ^{\$}
Retaining Wall	1.5	2.0	1.5	1.75	100
Over Head water Tank	1.5* / 2.0	-	1.5	-	50 ^{\$}
Flare Supporting Structure	1.5	-	1.5	-	50 ^{\$}
Blast Resistant Structures	1.5	2.0/1.2#	1.5	1.5/1.5#	100

* Empty condition

With blast pressure

\$ In case area is paved, overburden shall be based on NGL (for area under filling) or 600mm below HPP whichever is lower. In case of unpaved area, it shall be w.r.t. FGL.

Minimum Factor of safety against UPLIFT shall be 1.2 for all structures. (Note: In case of sumps, lining weight shall not be included)

TABLE – 2

FLOORING DETAILS FOR BUILDINGS & SHEDS

S No	Description		Flooring Type		
			I	II	III
1(a)	Sub Grade	Earth fill base compacted to 95% dry density.	✓	✓	✓
1(b)		Compacted layer of sand/boulder packing over thoroughly compacted Earth fill (in mm)	200 THK.	200 THK.	150 THK.
2(a)	Strl Grade Slab	Lean concrete 1:5:10 over sand layer (in mm)	50 THK.	50 THK.	50 THK.
		Strl. non suspended slab in M20 Grade concrete (Reinforced with 8mm dia bars @200 c/c both ways) over lean concrete.	150 THK.	150 THK.	100 THK.
2(b)		R/F placement	R/F placed centrally	R/F placed in two layers at top & bottom	No R/F required.
3	Finish	Floor finish	As per Arch Detail	As per Arch Detail	As per Arch Detail

Type I: Plant Buildings such as Sub-Stations, Control Rooms, Pump Houses, Utility Compressor Houses, Parking Areas, Stores, Porches.

Type II: Ware Houses, Workshops, Cement Godowns, Fire Stations, Process Compressor Houses.

Type III: Non Plant Buildings (viz. Administration, Laboratory, Canteen, Time Office, Gate House, Training Centre, Guest House, Residential buildings).

Notes:

- 1) Reinforcement steel shall be as per clause 8.2.
- 2) For Ware Houses & Work shops non suspended ground floor slabs with above specifications shall be provided using vacuum dewatering concrete system.

PART –II : ARCHITECTURAL

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ENGINEERING DESIGN BASIS

1.0 REFERENCED PUBLICATIONS

1. National Building Code of India
2. Factory Law
3. Local Municipality or any other Authority's Bye-laws as applicable.
4. TAC (Tariff Advisory Committee) Rules.
5. Bye-laws of Town & Country Planning Organisation
6. OISD Norms
7. BPE Norms
8. BIS Codes
9. Indian Electricity Rules
10. Any other applicable Law, Rules, Standard as referred in respective clause.

1.1 STANDARD SPECIFICATIONS CODES & PRACTICES

EIL Engineering design incorporates Codes and Standards as referred in the design philosophy of respective engineering disciplines as well as applicable EIL standards specifications.

2.0 DESIGN PHILOSOPHY/ CRITERIA

2.1 ARCHITECTURAL DESIGN

Architectural design of the buildings shall be in accordance with this design basis and references as stated above to meet the functional requirements.

2.2 BUILDING REQUIREMENTS

2.2.1 List of buildings:

Following buildings are envisaged in this project.

2.2.1.1 Non-Plant Buildings

1. Security Barracks and Guard Houses
2. Product Ware House
3. Central Ware House
4. Guest House
5. Construction Office Building
6. Canteen Building
7. Emergency DG House
8. Health Centre
9. Administrative/Training/ Medical centre
10. Central Laboratory Building
11. Polymer Service Building
12. NCU/GCU Service Building
13. Central Workshop
14. Central Warehouse
15. Weigh Bridge
16. Chemical Storage Building

17. Gate Houses

The above list of Non Plant Building is subjected to finalization during detail engineering

Spatial requirement for non-plant buildings. shall be finalized looking into the functional requirements and its occupancy which shall be governed by Owner's specific requirement. Design shall be in accordance with Factory Act, NBC etc.

Requirement of services/utilities such as air conditioning, LAN etc. shall be finalized as per Owner's specific requirement.

2.2.1.2 Plant Buildings

1. Main Control Room
2. Satellite Rack Room
- 3 Sub Stations

The above lists of Plant Buildings are subjected to finalization during detail engineering.

Spatial requirements of these Plant Buildings shall mainly be decided based on the equipment/panel layout, activities to be performed in the building and consequent occupancy pattern. Sizes of various type of spaces shall be decided based on occupancy/ equipment/Panel layout, clearances, maintenance & safety requirements. The objective of spatial arrangement shall be to satisfy functional requirements, physical comfort, and safety regulations as well as aesthetics.

- (a) Control Room Buildings & Satellite Rack Rooms for Process Units shall be designed as per OISD-STD 163, TAC building bye-laws and Factory Act. Control Room Buildings shall be centrally air-conditioned, single storied construction, designed to fully meet the Instrumentation, Electrical, HVAC, safety and other requirements.

Control Room Buildings shall broadly consist of Console Room, Rack Room, EC/ PLC Room, Computer Room, UPS Room, Battery Room, Operators' Rooms, Shift-in-Charge Rooms, Supervisor's Office accommodation, Instruments Calibration Room, Operators' Check and Change Room, Toilets (Ladies & Gents), A.C. Plant/ AHU Rooms, Clean Agent Storage Room etc.

Satellite Rack Rooms shall broadly consist of Rack Room, Room, UPS Room, Battery Room, A.C. Plant/ AHU Rooms, Clean Agent Storage Room etc. Operators' Rooms, Toilets (Ladies & Gents) may be provided if required.

Requirement of Blast resistant design and construction shall be finalized during detail engineering stage.

- (b) Sub-Station buildings shall be designed as per OSID –STD 149; 173; IEA;IER; TAC building bye-laws, Factory Acts etc. Sub Stations shall be double storied having Cable Cellar at ground floor or single storied (having trenches for the cables) as per the Electrical requirements and Electrical Design Basis. Sub Station Buildings shall broadly consist of Switchgear Room, Operator's Room, Battery Room, Other Electrical Panels' Room, Pressurization Room etc. as per functional requirements and Electrical design basis. Toilets shall be provided as per requirement.

2.2.1.3 Units

1. Process buildings/ sheds of DFCU unit (plant/equipment sheds, analyzer room etc. As required)
2. Process buildings/ sheds of PGHU unit (plant/equipment sheds, analyzer room etc. As required)
3. Process buildings/ sheds of BzEU unit (plant/equipment sheds, analyzer room etc. As required)
4. Process buildings/ sheds of BdEU unit (plant/equipment sheds, analyzer room etc. As required)
5. Process buildings/ sheds of LLDPE unit (additive house, extruder house, Bagging & palletization building, catalyst storage, teal house, storages, Analyzer room etc. As required)
6. Process buildings/sheds of HDPE unit (additive house, bagging building, extruder house, analyzer room, etc. As required)
7. Process buildings/ sheds of PP unit (polymerization building, catalyst/ mineral oil storage, extruder house, bagging/palletization & bulk loading building, warehouse, valve house, analyzer room etc. As required)
8. Process buildings/ sheds of BUTENE -1 unit (plant/equipment sheds, analyzer room etc. As required)

The above lists of buildings/sheds are subjected to finalization during detail engineering.

Buildings/ Sheds of Process Units shall be designed as per Factory Act & NBC incorporating special requirements of Licensors if any.

Ventilation and day-lighting shall be ensured by means of louvers/ window & ventilators and roof monitors. Necessary lifting devices shall be provided.

2.2.1.4 Utility Facilities

1. Buildings/ sheds for power receiving and distribution system utility package (as required for utility package)
2. Buildings/ sheds for raw water system utility package (as required for utility package)
3. Buildings/ sheds for DM water system utility package (as required for utility package)
4. Buildings/ sheds for cooling water system utility package (as required for utility package)
5. Buildings/ sheds for compressed air (instrument & plant) system utility package (as required for utility package)
6. Buildings/ sheds for fuel gas system utility package (as required for utility package)
7. Buildings/ sheds for Inert gas system utility package (as required for utility package)
8. Buildings/ sheds for Steam generation system utility package (as required for utility package)

9. Buildings/ sheds for condensate & condensate polishing system utility package (as required for utility package)
10. Buildings/ sheds for emergency power system utility package (as required for utility package)
11. Buildings/ sheds for utility & product distribution piping utility package (as required for utility package)

The above lists of buildings/sheds are subjected to finalization during detail engineering.

Buildings/ Sheds of Process Units shall be designed as per Factory Act & NBC incorporating special requirements of Licensors if any.

Ventilation and day-lighting shall be ensured by means of louvers/ window & ventilators and roof monitors. Necessary lifting devices shall be provided.

2.2.1.5 Offsite Facilities

1. Buildings/ sheds for tankage/ storage facility (as required for offsite package)
2. Buildings/ sheds for resin silos and bagging facility (as required for offsite package)
3. Buildings/ sheds for effluent system (as required for offsite package)
4. Buildings/ sheds for chemical storage (as required for offsite package)
5. Buildings/ sheds for catalyst storage (as required for offsite package)
6. Buildings/ sheds for fire fighting system (as required for offsite package)
7. Buildings/ sheds for security & surveillance system (as required for offsite package)
8. Buildings/ sheds for loading and unloading system (as required for offsite package)

The above lists of buildings/sheds are subjected to finalization during detail engineering.

Buildings/ Sheds of Process Units shall be designed as per Factory Act & NBC incorporating special requirements of Licensors if any.

Ventilation and day-lighting shall be ensured by means of louvers/ window & ventilators and roof monitors. Necessary lifting devices shall be provided.

2.2.2 Day Lighting

Established level of illumination shall be maintained for all parts of the buildings by means of windows, ventilators etc. Provision of referenced publications like NBC part-VIII; Section-1; IS-2440-1975; IS-3646 (part II-1996); IS-7662 (part I-1974), Factory rule or other relevant rules etc. shall be adhered to in this regard. Openings shall be provided with shading devices to avoid glare. For the purpose of illumination, day lighting shall also be supplemented by artificial illumination particularly at fire-exit.

2.2.3 Ventilation

2.2.3.1 Natural Ventilation

Established level of ventilation in terms of air changes per hour shall be maintained for all spaces as per the provision of referenced publications like State Factory rules,

NBC part-VIII Section-1, IS:3101-1975 (Industrial building), IS:3362-1975 (Residential buildings), IS:7662 (Part I-1974) or other relevant code/ rules. Natural ventilation shall also be supplemented by mechanical or electrical means of ventilation in all human occupied areas. Sufficient no. of Glazed/Louvered windows/Ventilators shall be provided and supplemented by exhaust fans.

2.2.3.2 Mechanical ventilation

In addition to natural ventilation, if required Mechanical or electrical ventilation is provided depending on the type of building and its use. Refer Design Basis of Packaged Equipment for its requirement and applications.

2.2.4 Safety Requirement

Safety from fire and like emergencies shall be taken into account in building design as per NBC-Part IV; State Factory Rules and other relevant code/ rules. The buildings shall be provided with exits sufficient to permit safe escape of occupants in case of emergency. The exits shall be in terms of doorway, corridors, etc. to internal/ external staircase or to areas having access to the outside.

2.2.5 Site planning & Landscaping

Site planning of building shall take into account aspects like inter-relationship of the buildings with the whole system, movement pattern, traffic and road net-work, safety regulations, service network, fire safety, climatic and environmental aspects, site conditions like site dimension, contour, drainage, noise level, view, future expansion, visual aspects etc.

Main and service/ maintenance entrances of buildings shall be provided with vehicular access. All exit points shall also be provided with footpath/ vehicular access. Truck movement space in accordance with traffic pattern shall be provided for the building as per the location of hoisting bay/loading, unloading platform. Road network and open space around the buildings shall be designed considering movement and functioning of Fire tenders and cranes etc.

Suitable Landscaping treatment shall also be done around the important buildings. Such treatment shall generally consist of lawns, road side plantation and beautification of building entrance areas. Standard landscape elements such as earth contours, pavings, flower beds, hedges, shrubs, ground cover and ornamental trees shall be incorporated in landscape treatment. Necessary water supply/sprinklers shall also be provided.

2.3 BUILDING SERVICES

Following services shall be provided for all buildings as essential services.

2.3.1 Water Supply, Distribution and Drainage, Sanitary Services.

This service is essential for all human occupied buildings. The building shall have toilet and drinking water facility and accordingly water supply, distribution and drainage, sanitary services as per NBC- Part-IX: Section 1&2, Factory rules and or referenced publication. Drinking water provisions shall be provided within an enclosure separated from the toilets. Space for janitor shall be provided in the toilets. All service pipes showing on the external wall shall be suitably concealed or shall be provided within a shaft.

2.3.2 Electrical Services

This service shall be provided as essential service for all the buildings. Electrical services for building shall consist of electrical supply, and distributions, electrical lighting installations, telephone network, fans, exhaust fans, lighting protection system etc., all accessories, cabling etc. including Emergency power supply, all as defined under Engg. Design Basis of Electrical.

2.3.3 Air Conditioning and Heating

Control Room Building, Administration Building, etc. shall be centrally air-conditioned. Accordingly A.C. Plant/ AHU etc. of the require capacity (depending on the requirement) shall be provided and suitably housed. Some designated rooms (as per Electrical requirement) in the Sub Station Buildings may be required to be air-conditioned. For this suitable window/ split/ package type units may be provided as per requirement w.r.to the Design Basis of Packaged Equipment.

2.4 AESTHETICS

Apart from the fulfillment of functional & safety requirement, aesthetic requirement of the building shall be taken care of in the design. Preliminary drawings indicating Architectural scheme shall be submitted for Owner's approval.

Architectural scheme shall be based on general principles of Aesthetics. Building facades shall reflect such principles like symmetry, balance, proportion, rhythm, light and shade etc.

Building Elements like canopies, overhangs & shading devices, gutters, roof projections, parapets, door; window/ ventilator composition, External wall/ facade shall be considered as contributory elements to aesthetics.

Architectural scheme including design of above mentioned elements shall be subjected to Owner/ PMC approval.

Minimum two alternative Architectural scheme of buildings as desired by PMC/ Owner shall be prepared and submitted for approval.

2.5 STRUCTURAL AND CONSTRUCTION ELEMENTS

The structural system shall be as specified in Engineering Design Basis (Structural).

2.6 BUILDING ELEMENTS

2.6.1 Plinth Protection

The building shall be provided with minimum 900 mm wide (100mm high from top of Approach Road Level) plinth protection around the building.

2.6.2 Finished Floor Level (FFL)

In general, FFL of the Building shall be determined with respect to top of approach road or pavement. Following schedule shall be adhered to for FFL of the building:

- A. Control Room Building (Buildings having false flooring):
Top Road level of Approach road + 150 mm + Height of false flooring

- B. Sub Station Buildings:
- (i) Top of approach Road level +300 mm (Cable Cellar floor)
 - (ii) Top of approach Road level +150 mm (Transformer bays) with pebbles
 - (iii) F.G.L. (+) approx. 1000 mm high from top of road (in case of single storey Substation Building with trenches as per electrical requirement.
- C Plant Buildings (Unit area) floors (HPP) shall be maintained as per Design Basis of General Civil.
- D. Other Buildings:
Top of approach Road level +300 mm to 450 mm and or as per functional requirement.

Notes:

1. In case of approaches with different top levels, the highest top level of approach road/ pavement shall be considered.
2. FFL shall be same throughout in a building.
3. FFL of external loading/unloading bays/ platforms, toilet, pantry, and kitchen shall be 10-15 mm lower than that of the building FFL to check ingress/spillage of water.

2.6.3 Steps/ ramps/ Stairs

Steps/ ramps shall be provided for access to the Building for pedestrian/ vehicular, equipment entry as per relevant code. Minimum 1000 mm wide platform shall be provided in between entrance door and steps/ramps. Following dimensions of the steps/ ramps shall be adhered to.

- | | | |
|----|--------------------------|--|
| A | Stairs width | = 1500mm minimum |
| B. | Tread | = 300 mm minimum |
| C. | Riser | = 150 mm maximum |
| D. | Slope of Ramp | = Not steeper than 1:6 or as per requirement |
| E. | Ratio of Tread & Riser | = 2 Riser + Tread= 600 to 650 mm |
| F. | No. of risers per flight | = 15 Nos. |
| G. | Landing width | = 1500. minimum |

2.6.4 Walls

Following schedule shall be adhered to for wall material and thickness:

- | | | |
|----|---------------------------------|--|
| A. | External, walls | = 230 mm. thk. Brick wall |
| B. | Internal partition wall | = 230/115 mm thk. Brick wall depending on the overall length and height of the wall (refer note below) |
| C. | Transformer Walls | = 200 thk. RCC or 355 thick (including plastering) fire walls as per Electrical requirements. (IER) |
| D. | Concrete wall (Blast resistant) | = As per structure design basis |

Notes:

1. 115 mm thk. brick partition walls (with nominal steel requirement as per structure design) shall be provided with 230 mm thk. brick pillars for stability.
2. Wherever conduits or pipes are required to be concealed within partition wall, the wall thickness shall be increased suitably.
3. Wherever, bricks are not commonly available, suitable alternative material shall be used after obtaining owner's approval.

2.6.5 Doors

Doors shall be provided for access, security and safety at all entry & exits of rooms, functional areas & the buildings. Air tight door shall be provided in pressurized area and in gaseous protection area. Fire check doors shall be with minimum two hours rating as per statutory requirement. Sizes of the doors shall be determined on the basis of the following schedule:

- A. Equipment, Panel area: Size of max. equipment including packing.
- B. Other areas: Volume of movement through door.
- C. W.C., Bath Cubicle Door: 800 mm x 2100mm (wall opening size)
- D. Minimum size of other doors: 1000mm x 2100mm (wall opening)

Notes:

1. Rolling shutters shall be provided for equipment entry for Switchgear Room/ Electrical Room, A.C. Plant Room etc.
2. Motor operated Rolling Shutters shall be provided in the main equipment entry door.

2.6.6 Windows/ ventilators

Windows/ ventilators shall be provided in all areas for natural lighting, ventilation and visibility at working level.

For the purposes of natural ventilation, total openable area of the windows/ventilators shall be as per Factory Act subjected to a minimum of 15% of the floor area to be ventilated.

For the purpose of natural lighting total glass area shall be minimum 15% of the floor area. However, in case of offices, work places etc. windows shall be provided for the full length of walls as per approved Architectural scheme. Areas accommodating panels/eqpts. shall be normally provided with ventilators at high level for unobstructed distributed lighting.

Wherever due to limitation of external wall area or any other reasons, stipulated area of window/ ventilation for ventilation cannot be provided, suitable mechanical devices shall be provided. For Workshop/Warehouse sheds etc. with roof sheeting etc. suitable monitor to be provided for ventilation.

Transparent roof light sheeting shall be provided in roofing of shed type structures for day lighting.

2.6.7 Canopy/ Overhang

Canopy/overhangs shall be provided at all entries & exits for rain & sun protection. Size of the canopy/ porch shall be decided w.r.to utility of the building and other aesthetic. Blast proof Control Rooms shall not have any projections with outer face of its walls except with false treatment for aesthetics of the building.

2.6.8 Shading Devices

Shading devices shall be provided over all windows, openable ventilators for rain & sun protection. These devices shall be in form of horizontal projections, vertical projected fins or combination of both as per building facade treatment. Minimum projection shall be 600 mm.

2.6.9 Parapet

Parapets shall be of RCC for all buildings with minimum 500 mm high for non-approachable roof and 900 mm high for approachable roof.

2.6.10 Roof Gutter

Gutter with rain water pipes or R.C.C. shafts shall be provided for all the building for roof water drainage. Sizing of the gutter shall be based on area to be drained and number of outlets. Gutters shall be of RCC. For Workshop/ Warehouse shed with precoated roof sheeting, precoated sheets gutters may be provided and for big size of workshops/warehouse RCC shaft may be provided at the end of gutter.

2.6.11 Rain Water Pipes, Spouts

Rain water pipes shall be provided for roof water drainage. Number of rain water pipes shall be decided on the basis of roof area, slope and rainfall intensity as per NBC-IX Section 2. Rain water pipes shall be embedded in concrete. RCC or GI spouts may be used for drainage of chajja/small canopies of ground floor.

2.6.12 Air Lock Lobby

This shall be provided for all entries with centrally air-conditioned spaces.

2.6.13 Emergency Exits

Emergency exits shall be provided for the building as per State Factory Rules, NBC-Part IV and for individual functional spaces such as Console area, Electrical room etc. Emergency exits shall be located in such a manner that escape route is direct, unobstructed & without passing through any other functional areas to safe area.

2.6.14 Staircases

Staircases shall be provided for vertical circulation & emergency exits. Number of staircases shall be based on building sizes more than 500 Sq.M ground covered area shall have two stairs (NBC-Part IV). Emergency exit requirements shall be as per safety distance requirement. At least one no. staircase/ladder shall be provided for access to the flat roof top for maintenance.

2.6.15 Railings

Railings shall be provided in stairs, and in all unprotected openings in slabs as a safety device. Steel railings in loading/ unloading bay of shall be of removable type.

2.6.16 False Ceiling

False ceilings shall be provided in the all air-conditioned areas for the purpose of reducing room volume and to hide air conditioned ducting etc. and also to maintain acoustic level inside any space.

2.6.17 False/Cavity flooring

False/ cavity flooring shall be provided to accommodate under floor cabling in Instrumentation areas like Console Room, Rack Room, Computer Room etc. Extent of false/ cavity flooring shall be as per Instrumentation requirements.

2.6.18 Transformer Gate

Steel gate of suitable size in front of transformer bays in substations building may be provided as per electrical requirement.

2.7 SCHEDULE FOR ARCHITECTURAL FINISHES

2.7.1 GENERAL

For the purposes of schedule of Architectural finishes, buildings are categorised into following types. colour Scheme for all Architectural items shall be as approved by the Owner.

Type	Buildings
Type A	Important buildings like Administration Building / Training / Medical centre, Main Gate/ Guard House
Type B	Control Rooms, Satellite Rack Room, Sub Stations
Type C	Non plant buildings like Guest house, Canteen Building, Health Centre, Central Laboratory Building, Gate House (other than main gate/ guard house) etc.
Type D	Non plant buildings like Service Buildings, Security Barracks, Product Ware House, Central Ware House, Construction Office Building, Central Workshop, Central Warehouse, NCU/GCU Service Building, Weigh Bridge, Chemical Storage Building etc. & other non plant buildings not categorized under any other group
Type E	Utility/ storage/ Process Buildings/ Sheds like DG Shed, Pump Houses, Compressor House, Process Building/Sheds, Cement Godown, Storage Shed, Analyzer Room etc.

Note:

In case of conflict between licensor/ process/ safety/ statutory requirement and this schedule of Architectural finishes, the former shall override.

2.7.2 EXTERNAL FINISHES

2.7.2.1 External wall, RCC Surfaces

A. Type "A" Buildings

- Composite Aluminum Panel & structural glazing

B. Type "B" Buildings

- Sand stone cladding

C. Type "C" Buildings

- Plain cement plaster and texture coating ('Heritage' or 'Spectrum')

D. Type "D" Buildings

- Plain cement plaster and Acrylic paint

E. Type "E" Buildings

- Plain cement plaster and waterproof cement paint

2.7.3 INTERNAL FINISHES

2.7.3.1 Floor finishes:

A. Entrance Lobby, Reception, lounge, Waiting area etc :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Granite stone	○ Granite stone	○ Vitrified tiles	○ Kota stone	○ Kota stone

B. Office and associated areas like records/ storage, meeting/ conference room etc.:

Type-A	Type-B	Type-C	Type-D	Type-E
○ Vitrified tiles	○ Vitrified tiles	○ Vitrified tiles	○ Ceramic Tiles	○ Kota stone

C. Circulation area (Corridor, passage, etc.):

Type-A	Type-B	Type-C	Type-D	Type-E
○ Granite stone	○ Granite stone	○ Vitrified Tiles	○ Kota stone	○ Kota stone

D. Kitchen, Pantry & Dining hall etc. :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Vitrified Tiles	○ Vitrified Tiles	○ Vitrified Tiles	○ Ceramic Tiles	○ Kota stone

E. Toilet, Drinking water area etc. :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Granite Stone	○ Granite Stone	○ Vitrified Tiles	○ Ceramic Tiles	○ Ceramic Tiles

Note: In Sub Station building flooring of Toilet/ drinking water shall be of Ceramic Tiles

F. Staircase.

Type-A	Type-B	Type-C	Type-D	Type-E
○ Granite Stone	○ Granite Stone	○ Marble Stone	○ Kota Stone	○ Kota Stone

Note: In Sub Station building flooring of staircase shall be of Kota stone

G. Battery Room & Chemical Handling areas (All type of Buildings):

- Chemical resistant Epoxy coating

H. Electrical Room, Pressurisation Room, AC Plant, Loading / Unloading bays, Equipment handling areas, Storage areas, Switchgear, MCC, Ware House, Work Shop, Process/ utility Sheds etc. (All type of buildings):

- Heavy duty cement concrete flooring.
(Vacuum dewatering flooring in large Rooms/ areas)

I. Console, Rack room , UPS Room , areas housing instrumentation equipments requiring under-floor cabling (All type of buildings):

- Raised Access/ cavity/ false flooring :
With High pressure laminate finish

2.7.3.2 Internal wall finishes:

A. Entrance Lobby, Reception , lounge, Waiting area etc :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Granite stone cladding	○ Granite stone cladding	○ Marble stone cladding	○ POP punning & Plastic emulsion paint	○ Oil bound distemper

B. Office and associated areas like records/ storage, meeting/ conference room etc.:

Type-A	Type-B	Type-C	Type-D	Type-E
○ POP punning & Plastic emulsion paint	○ POP punning & Plastic emulsion paint	○ POP punning & Plastic emulsion paint	○ POP punning & Plastic emulsion paint	○ Oil bound distemper

C. Circulation area (Corridor, passage, etc.) :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Granite stone cladding up to 1500mm height, POP punning & Plastic emulsion paint above	○ Granite stone cladding up to 1500mm height, POP punning & Plastic emulsion paint above	○ POP punning & Plastic emulsion paint	○ POP punning & Plastic emulsion paint	○ Oil bound distemper

Note : In Sub Station building wall finish of Circulation area shall be Oil bound distemper

D. Kitchen, Pantry & Dining hall etc. :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Ceramic tile dado	○ Ceramic tile dado	○ Ceramic tile dado	○ Ceramic tile dado	○ Ceramic tile dado

E. Toilet, Drinking water area etc. :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Granite stone dado	○ Granite stone dado	○ Ceramic tile dado	○ Ceramic tile dado	○ Ceramic tile dado

Note: In Sub Station building cladding in Toilet etc. shall be of Ceramic Tile dado

F. Staircase.

Type-A	Type-B	Type-C	Type-D	Type-E
○ Textured coating	○ Textured coating	○ Plastic emulsion paint	○ Plastic emulsion paint	○ Oil bound distemper

Note: In Sub Station building Staircase wall finish shall be Oil bound distemper.

G. Battery Room & Chemical Handling areas (All type of Buildings):

- Acid resistant tiles/ epoxy coating over cement plaster up to 2500 height & oil bound distemper above 2500 height.

H. Electrical Room, AC Plant, Loading / Unloading bays, Equipment handling areas, Storage areas, Switchgear, MCC, Ware House, Work Shop, Process/ utility Sheds etc. (All type of buildings):

- Oil bound distemper.

I. Rack room , UPS Room (All type of buildings):

- POP punning with plastic emulsion paint

J. Console Room :

- Granite stone dado

2.7.3.3 Internal ceiling finishes:

A. Entrance Lobby, Reception , lounge, Waiting area etc :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Gypsum board panel false ceiling	○ Aluminum panel/ strip false ceiling	○ Gypsum board panel false ceiling	○ Gypsum board panel false ceiling	○ Oil bound distemper

B. Office and associated areas like records/ storage, meeting/ conference room etc.:

Type-A	Type-B	Type-C	Type-D	Type-E
○ Mineral fibre false ceiling	○ Aluminum panel/ strip false ceiling	○ Mineral fibre false ceiling	○ Mineral fibre false ceiling	○ Oil bound distemper

C. Circulation area (Corridor, passage, etc.) :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Gypsum board panel false ceiling	○ Aluminum panel/ strip false ceiling	○ Gypsum board panel false ceiling	○ Gypsum board panel false ceiling	○ Oil bound distemper

D. Other AC areas etc., where false ceiling required :

- Gypsum board false ceiling

E. Other area not indicated above etc. :

Type-A	Type-B	Type-C	Type-D	Type-E
○ POP punning & Plastic emulsion paint	○ POP punning & Plastic emulsion paint	○ POP punning & Plastic emulsion paint	○ POP punning & Plastic emulsion paint	○ Oil bound distemper

F. Electrical Room, AC Plant, Loading / Unloading bays, Equipment handling areas, Storage areas, Switchgear, MCC, Ware House, Work Shop, Process/ utility Sheds etc. (All type of buildings):

- Oil bound distemper

2.7.4 DOORS

A. Entrance/ exit Doors

Type-A	Type-B	Type-C	Type-D	Type-E
○ Powder coated Aluminium glazed shutter	○ Powder coated Aluminium glazed shutter	○ Powder coated Aluminium glazed shutter	○ Powder coated Aluminium glazed shutter	○ Pressed steel

B. Doors in circulation area of all type of Buildings

- Glazed, powder coated Aluminum door

C. Office area doors

Type-A	Type-B	Type-C	Type-D	Type-E
○ TW frame, block board TW veneer finish flush shutter	○ Powder coated Aluminium glazed shutter	○ Pressed steel frame block board laminated finish flush shutter	○ Pressed steel frame block board laminated finish flush shutter	○ Pressed steel frame block board laminated finish flush shutter

D. All Electrical Room, A.C. Plant Room, Battery Room doors of all type of Buildings

- Pressed steel frame with Pressed steel shutter

E. Toilet doors

Type-A	Type-B	Type-C	Type-D	Type-E
○ TW frame, block board TW veneer finish flush shutter	○ TW frame, block board TW veneer finish flush shutter	○ Pressed steel frame block board laminated finish flush shutter	○ Pressed steel frame block board laminated finish flush shutter	○ Pressed steel frame block board laminated finish flush shutter

F. Fire check/ resistant doors

Irrespective of above schedule, Fire check doors (minimum 2 hours rated) shall be provided wherever required as per OISD/ Statutory requirements.

1. Fire check doors In Control Room / Satellite Rack Room Building
 - A. Main entrance/ entry to Console :
 - Glazed steel Fire check door
 - B. Other Rooms :
 - Solid type steel fire check door (with 300x300 vision panel)
2. Fire check doors In Administration Building
 - A. Main entrance/ entry/ circulation area :
 - Glazed steel Fire check door
 - B. Other Rooms :

- Wooden, TW veneered fire check door (with 300x300 vision panel)

3. Fire check doors In other Buildings

A. Main entrance/ entry/ circulation area :

- Glazed steel Fire check door

B. Other Rooms :

- Solid type steel fire check door (with 300x300 vision panel)

Rolling shutters shall be provided in equipment areas like Switchgear/ MCC Room, Workshop, Ware House etc. where opening size for door exceeds 3000 x 3000mm. Doors/windows/ventilators shall be complete with all fittings & fixtures for easy smooth operation & locking facility.

2.7.5 WINDOWS & VENTILATORS

Type-A	Type-B	Type-C	Type-D	Type-E
○ Glazed, Powder coated Aluminium	○ Glazed, Powder coated Aluminium	○ Glazed, Powder coated Aluminium	○ Glazed, Powder coated Aluminium	○ Glazed, steel

2.7.6 ROOF TREATMENT

- Atactic Polypropylene modified bituminous waterproofing membrane .

2.7.8 ROOFING / CLADDING (sheds/workshop)

- Precoated, profiled colour coated galvanised steel sheet roofing/ cladding

2.7.9 SANITARY FITTINGS & FIXTURES

A. Water Closet (European type) :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Wall hung type, coloured (premium luxury model)	○ Wall hung type, coloured (premium luxury model)	○ Wall hung type, coloured (premium luxury model)	○ Pedestal type, coloured	○ Pedestal type, coloured

B. Wash Basins :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Round, coloured, with electronic sensor over granite counter (premium luxury model)	○ Round, coloured, with electronic sensor over granite counter (premium luxury model)	○ Round, coloured, with electronic sensor over granite counter (premium luxury model)	○ Round, coloured, over granite counter	○ Wall hung type

C. Urinals :

Type-A	Type-B	Type-C	Type-D	Type-E
○ With electronic sensor (premium luxury model)	○ With electronic sensor (premium luxury model)	○ With electronic sensor (premium luxury model)	○ Standard Wall hung type	○ Standard Wall hung type

D. Plumbing fixtures (stop/ bib / pillar cocks, flash valves etc.):

Type-A	Type-B	Type-C	Type-D	Type-E
○ Stainless steel (premium luxury model)	○ Stainless steel (premium luxury model)	○ Stainless steel (premium luxury model)	○ CP Brass	○ CP Brass