



GSPC PIPAVAV POWER COMPANY LIMITED

TITLE

700 MW (2 x 350 MW) COMBINED CYCLE POWER PLANT NEAR PIPAVAV ELECTRICAL SYSTEMS - ELEVATORS

SECTION: D3.21

SHEET 3 OF 8

SPEC. NO.
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- 21.3.16 Shafts and axles shall be of forged steel. They shall have sufficient rigidity and bearing surface. Any shaft when stepped, shall be turned to a reasonable radius at the point of reduction in diameter.
- 21.3.17 The elevator shall be provided with suitable counter weights located in the lift shaft. The counter weight shall be designed for smooth and easy operation of the lift and shall be in accordance with Indian Standards referred earlier or equivalent. International Standards. The counter weight shall be provided in the lift shaft. The counter weight shall consist of cast iron weight contained in structural steel frame. it should preferably be equal to that of the car weight plus 40% of the rated load. The traction should be such that no appreciable slip may occur but that slip shall be free to take place upon the landing of either the car or the counter weight.
- 21.3.18 Guide rails for the car and counter weights shall be machined 'T' sections and continuous throughout the entire length and shall be provided with adequate steel brackets or equivalent fixing of such design and spacing that avoid any deflection during the normal operation. Guide rails section shall be adequate to withstand the forces resulting from the application of the safety gear when stopping the counter weights or fully loaded car. The guide shoes or their lining shall be easily renewable, adjustable and self lubricated guides shall be of such length that it shall not be possible for any of the car or the counter weights shoes to run off the guides.
- 21.3.19 Sufficient number of buffers of spring loaded/oil type shall be fitted below lift car and counter weights. The buffers shall be capable of stopping the car or counter-weights without permanent damage or deformation to itself or any part of the lift equipment. The number of buffers shall be so fixed as to ensure proper sharing of the impact loads by all of them.
- 21.3.20 The lift shall be provided with safety device attached to the lift car frame and placed beneath the car. The safety device shall be capable of stopping and sustaining the lift car up at governor tripping speed with full rated load in car. The application of safety device shall not cause the lift platform to become out of level in excess of 3 cm/m measured in any direction. Slack rope switches if necessary, shall also be provided.
- 21.3.21 Contractor to provide a modern advanced electronic drive system of "RESCUING passenger Trapped in an ELEVATOR". This system should be able to rescue during main power failure and elevator control system failure. The system should be fully microprocessor control with latest IGBT power device.

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SECTION: D4.5

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**700 MW (2X350 MW) COMBINED CYCLE POWER
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DESCRIPTION OF BUILDING, STRUCTURES AND
FACILITIES**

SPEC. NO.
TCE.4916A-H-500-001

negative skin friction if any and magnitude of estimated negative skin friction.

- (d) Recommendations for values for modulus of subgrade reaction for foundation design.
- (e) Type of cement to be used for concrete substructures and in stone / brick masonry foundations with reference to the chemical nature of subsoil and ground water.
- (f) Recommendations regarding excavations (shallow & deep), embankment, safe side slopes for excavation and embankment, dewatering, site drainage, etc.
- (g) Recommended soil properties such as density, specific gravity, cohesion, angle of internal friction etc. for design.
- (h) Precautions to be taken for design of lightly loaded structures when expansive soil is encountered with respect to swelling pressure and free swell index values obtained.
- (i) Recommendation for soil improvement if required, to be indicated in the report.

2.3 Site Development Work & Site Grading

2.3.1 The CONTRACTOR has to carryout detailed bathometric survey to ascertain the maximum flood level. The bathometric survey has to be submitted to owner for approval. After obtaining the formal approval, the required grade level of the plant area shall be graded by the Contractor considering the contours, minimum cutting and filling. In no case the grade level shall not be less than 1000mm above maximum flood level of 50 years.

3.0 Fencing

Minimum 3 m high fencing above the toe wall shall be provided around the entire switch yard, transformer yard, auxiliary transformer yard, fuel tank farm, stores etc wherever fencing is necessary due to security / safety / statutory requirements. Fencing shall comprise of 2.4 m high PVC coated galvanised chain link fence of minimum 8 gauge (including PVC coating) with mesh size 75 mm and galvanised barbed wire on inclined member to a height of 600 mm above the chain link fencing. 3 Lines of 12-gauge high tensile spring steel wire shall be provided for the entire length of fencing. Also 50 mm X 6 mm galvanised MS flats shall be provided at every fifth post sandwiching the fencing with post using GI nuts and bolts. Top of toe wall shall be 200 mm above formation level. Toe wall shall be generally of RCC construction and shall extend 150 mm

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below the formation level and the fencing mesh shall be embedded inside toe wall by minimum 75 mm. Fencing post shall be fabricated out of galvanised MS angle section of minimum 75x75x6 mm size and shall be spaced at a maximum spacing of 2.5 m with struts made up of galvanised MS angle at every fifth fencing post in addition to those at bends. Expansion joint shall be provided at every 60 m. Steel entry gates shall be provided for all fenced areas. Gates shall be formed out of tubular section conforming to IS:1161. Removable type of fencing shall be provided at suitable location to permit entry and exit of equipment.

4.0 **ROADS, DRAINS AND CULVERTS:**

4.1 Access roads and vehicular parking areas shall be of flexible pavement type with water bound macadam base and bituminous topping on prepared surface.

4.2 The main access road from the existing asphalt road to the plant boundary shall be four lanes with a refuge of about 2 m wide in between double lane 'up' and 'down' roads. The road shall be designed to cater to the load and needs of construction and maintenance of heavy trucks carrying machinery and heavy cranes.

4.3 All other plant internal roads providing access to buildings / structures / systems for vehicular movement shall be 7.5 m wide. All other minor roads shall be 4 m wide. 1500 mm / 750 mm wide (1500mm for 7.5 M wide Road / 750mm for 4 M wide Road) road shoulder shall be provided on both side of all two lane roads paved with interlocking concrete paving blocks of approved shape/design and colour.

4.4 Road construction shall be as per IRC standards. However the minimum requirement for the roads shall be; 200 mm thick (consolidated thickness) sub base course laid in two layers of 100 mm each and 150 mm thick (consolidated thickness) water bound macadam base course laid in two layers of 75 mm each and topped with 50 mm thick semi-dense bituminous carpet. The minimum thickness of black topping shall be 50 mm. Bituminous topping of all plant roads shall be taken up after all the major construction activities are completed.

4.4 On either side of the roads covered drains shall be provided. Minimum clear width of the drain shall be 600 mm. The drains shall be designed and built using RCC. Drainage lines and other under ground services shall be located at least 1 m clear from the edge of the road. All service and utility lines crossing the roads shall be taken up through NP3 class RCC pipe designed for impact loading. All culverts carrying storm water shall be cast-in-place RCC box culverts.

5.0 **STORM WATER DRAINAGE:**

5.1 Run off coefficient for paved and unpaved areas shall be taken as 0.9 and 0.6 respectively.

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PART A – GENERAL REQUIREMENTS

- 10.4 Bricks having minimum 35 kg/sqcm compressive strength shall be used for non load bearing super structure brick work. Cement sand mortar 1:6 for one brick thick wall and 1:4 for half brick thick wall shall be used. For half brick walls, RCC transoms and mullions shall be provided. Transoms shall be provided at lintel/door height. The spacing of the mullions shall not exceed 2000 mm center to center. The size of transoms/mullions shall be minimum 115 mm square with 4nos., 8 mm dia. bars and 6mm stirrups at 150 mm centers.
- 10.5 Type, thickness and height of external wall, facing the transformer yard to take care of fire accidents in transformer yard shall be according to the requirements of Tariff Advisory Committee.
- 10.6 Even where metal cladding is specified, for initial 3 m height from the ground level, minimum one brick thick masonry wall shall be provided.
- 10.7 All upstands and parapet walls on roof shall be of RCC construction, minimum height of parapet walls shall be 750 mm and thickness 125 mm.
- 11.0 **DRAINAGE**
- 11.1 **Floor drainage**
- 11.1.1 For all buildings and areas, suitable arrangement for draining out water collected from equipment blowdowns, leakage, floor washing, fire fighting, etc. shall be provided on each floor. Gully traps, inspection pits, collecting pits etc. shall be located suitably and designed considering flow volume, easy access, maintenance and safety.
- 11.1.2 All drains inside the building shall have minimum 40 mm thick galvanised grating covers. In areas where heavy equipment loads would be coming, precast RCC covers shall be provided in place of grating. These drains shall lead the water to drain sump.
- 11.1.3 Garland drains shall be provided around all buildings to receive the drainage water from roof and floor and lead them to the plant storm water drainage system.
- 11.2 **Roof drainage**



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natural frequency in all modes including coupled modes and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down by the relevant codes or machine manufacturers shall be satisfied. In case frequency or amplitude criteria of IS: 2974 cannot be satisfied, vibration isolation system (VIS) with springs and viscous dampers shall be provided. Minimum reinforcement shall be governed by IS 2974 and IS 456.

- 2.3.8 For framed type foundations which support any major rotary equipment, the criteria specified in clause 2.3.4 & clause 2.3.5 for TG foundation shall be followed.
- 2.3.9 In the case of variable speed machines, one or more natural frequencies of the foundation may coincide with the operating frequency of the machine. If it is not possible to satisfy the codal frequency or amplitude criteria VIS with springs and viscous dampers shall be provided. It shall be ensured that not more than 5% of the dynamic loads are transmitted to the substructure. Necessary provisions of DIN 4024 shall be adhered to while designing the substructure. Substructure shall be designed for static loads. The vibration isolation system shall consist of helical spring units and viscous dampers supporting the RCC inertia block which support the machine. The spring units shall conform to DIN 2089 and DIN 2096. The static and dynamic analysis shall be carried out as specified in clause 2.3.4 & clause 2.3.5 above except that the analysis can be based on a plate model/Three dimensional solid finite element model. The frequency and amplitudes shall be checked as per relevant applicable code of practices or as per manufacturer's requirements. The permissible amplitude of vibration shall be as specified by the manufacturer and shall be in "satisfactory" range as per VDI 2056, whichever is more stringent.
- 2.3.10 For the foundations supporting minor equipment weighing less than one ton or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structures, floors, etc. suitable vibration isolation shall be provided by means of springs, neoprene pads, etc. and such vibration isolation system (VIS) shall be designed suitably.
- 2.3.11 All such foundation shall be separated from adjoining part of building and other foundations. Joints at floor / slab shall be suitably sealed. All appendages to such foundations shall be reinforced suitable to ensure integral action.
- 2.3.12 The Vibration Isolation system supplied should be of proven make. The Contractor / their associates for the supply of this system should have designed spring supported machine foundations, manufactured, supplied and installed vibration isolation systems consisting of steel helical spring units (Conforming to DIN 2096 & DIN 2089) and viscous dampers

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(Providing damping resistance in all three planes) for not less than 25 (twenty five) machine foundations of heavy rotating machine systems, such as Turbine generators, Boiler feed pumps, ID/ PA / SA fans etc., All the foundation systems be in successful operation (without replacement) for at least 3(three) years as on the date of bid opening.

2.4 Increase in Stresses

- 2.4.1 Where stresses due to wind (or seismic) and temperature are combined with those due to other loads, the allowable stresses in concrete and reinforcement steel shall be increased by 33.33% in case of working stress design.
- 2.4.2 Bearing capacity of the soil shall be allowed to increase by 25% under seismic/ wind load condition.
- 2.4.3 Permissible stresses for different load combinations shall be taken as per relevant IS codes.

3.0 STABILITY OF STRUCTURES

- 3.1 Design shall be checked against buoyancy due to the ground water during construction and maintenance stages for structures like under ground storage tanks, pits, trenches, basements, etc. Minimum factor of safety of 1.2 against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loading. For purpose of calculating downward load due to any overburden, only the mass located vertically above the projected area of the base slab shall be taken in to consideration.
- 3.2 All building sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads. Factor of safety for these cases shall be taken as mentioned in IS: 456 and other latest relevant IS codes. However following minimum factor of safety shall be followed:
 - a) Factor of safety against overturning due to wind, seismic or other lateral load shall be 1.5 minimum
 - b) Factor of safety against sliding shall be 1.5 minimum
 - c) Factor of safety against uplift due to hydrostatic forces shall be 1.2 and due to any other loads shall be 1.5.
- 3.3 Stability of the structure shall also be investigated for loading conditions during construction, repair or other temporary measures. Lower factor of safety may be used for such loading conditions as per relevant IS codes.

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

4.0 **MIN. THICKNESS OF CONCRETE STRUCTURAL ELEMENTS**

4.1 The following minimum thickness shall be followed:

- a) Suspended floor / slab / walkways /canopy slabs, etc. : 125mm
- b) Ground floor slab (non-suspended) : 150mm
- c) Water Retaining slabs / walls : 200mm
- d) Cable/pipe trenches/underground pits/
Laundry walls and base slab : 125mm
- e) All footings (including raft foundations) : 300mm
- f) Parapets : 125mm
- g) Sunshades : 75mm at edge
- h) precast louvers / fins : 50mm
- i) Precast trench cover slabs / floor slabs / louvers : 75mm
- l) Basement walls and base slab : 200mm
- k) Pile caps : 300mm
- l) Underground reservoir
Below ground water table : 200mm
Above ground water table : 150mm

4.2 From fire resistance point of view minimum thickness of reinforced concrete members shall be as per fig.1 of IS: 456. Minimum fire rating of 2 hours shall be considered where fire hazard is expected.

5.0 **MINIMUM HEIGHTS FOR PEDESTALS OF STEEL COLUMNS**

5.1 Pedestals to Steel Columns for building structures shall be:

Top of RCC foundations (pedestals) shall normally be kept at a lower level so that the column base plates together with gussets and stiffeners remain below finished floor level (FFL) unless specified otherwise. Foundation

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levels for columns shall be decided to accommodate underground services, pits, trenches, etc.

5.2 Stair and ladder pedestal shall be kept 200 mm above the finished floor level.

5.3 Pedestals to Steel Columns for Equipment structures:

- a) Equipment in open area : as required (300mm min)
- b) Equipment in covered area : as required (150mm min)
- c) Structures and equipment : as per vendor's data subject to
supplied by vendor minimum as specified above.

6.0 **MINIMUM HEIGHTS FOR ENCASEMENT OF STEEL COLUMNS**

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

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

7.0 **CONCRETE MIX**

The following minimum grades of concrete as per IS: 456 shall generally be used for the type of structures noted against each grade. Ordinary Portland Cement (OPC) shall be used except for under ground structures wherein sulphate-resisting cement shall be used. Grade of cement shall be minimum 43 grade or 53 grade as per IS. For super structure of cooling towers richer mix may be used as per the design requirement. However requirement of table 4 & 5 of IS 456 shall be satisfied depending on the exposure condition. The environmental exposure condition of "Severe" shall be considered for all design condition.

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|----|--------------|--|
| a) | Mix (1:5:10) | Fill concrete |
| b) | Mix (1:4:8) | Foundation below brick wall, blinding layer below foundations, trenches and underground structures, minimum thickness of the layer shall be 75 mm. |
| c) | Grade M20 | Base plate encasement, pavement around building including plinth protection work, encasement of structural steel work. |
| d) | Grade M30 | All other RCC members except where other grades are specified as above |

Intermixing of different grades of concrete in the same structure shall not be allowed in a particular structural element.

The minimum cement content shall be governed by the requirement of IS 456 for normal concrete structure and IS 2911 for piles.

However higher grade of concrete may also be used than the minimum specified to satisfy the design requirement for TG foundations, BFP Foundations, under ground structures etc.

The minimum water cement ration shall be as per IS 456

Clear cover to reinforcement shall be for 2-hour fire rating as per IS 456.

8.0 **REINFORCEMENTS**

8.1 Reinforcement bars shall be as per the following codes:

High Yield Strength Deformed bars : IS:1786

Mild steel bars : Grade I of IS:432

Welded wire fabric : IS:1566

8.2 CONTRACTOR shall supply to the Owner copies of all manufacturer's test certificates for reinforcement bar delivered to site. The certificate shall show the results of tests necessary to prove that the reinforcement complies in respects with the relevant Indian Standards.

8.3 All reinforcement shall be free of all loose mill scale and thoroughly cleaned to remove all loose rust, oil, grease or other harmful matter.

8.4 Bars shall not be bent or straightened in a manner that will damage the bar
Reinforcement shall be bent cold.

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- 8.5 All reinforcement shall be accurately fixed by approved means and maintained in correct position as shown in the drawings by use of blocks, spacers and chairs as per IS 2502 to prevent displacement during placing and compaction of concrete.
- 8.6 No metal part of any device shall be used for connecting bars or for maintaining reinforcement in the correct position with in the specified minimum concrete cover to the reinforcement.
- 8.7 Welding of reinforcement shall not be carried out without the permission of the Owner.
- 8.8 Projecting reinforcement or dowel bars for future connection of the structural works shall be protected by cement paint, if they are to be left exposed for a long time.
- 8.9 All the reinforcement bars used shall be of fusion bond epoxy coating as per IS 13620.
- 8.10 Reinforcement detailing shall be as per IS 13920, SP 34.
- 8.11 Two layers of reinforcement (on both inner and outer faces) shall be provided for RCC wall sections having thickness 150 mm or more.
- 9.0 **GROUTING**
- 9.1 Non-shrink flowable grout shall be used for under pinning work below base plate of columns. Non-shrink cum plasticiser admixture shall be added in the grout. For grouting of base of machine foundation high strength ready mixed non-shrink flowable grout shall be used.
- 9.2 Type and grade of grouting for structural columns and equipment bases shall be indicated. Crushing strength of the grout shall generally be one grade higher than the base concrete. Minimum grade of grout shall be M 30.
- 9.3 Nominal thickness of grouting shall be at least 50mm for building columns and pedestals of major equipment. For secondary posts, stair and ladder base, etc. grouting shall not be less than 25mm thick.
- 10.0 **MINIMUM COVER TO FOUNDATION BOLTS**
- Minimum distance from the centre line of foundation / anchor bolt to edge of pedestal shall be the maximum of the following:
- a) Clear distance from the edge of base plate / base frames to the outer edge of the pedestal shall be minimum 50mm.

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b) Clear distance from the face of pocket to the outer edge of pedestal shall be 75mm.

c) Clear distance from the edge of sleeve or anchor plate to the edge of pedestal shall be 75mm.

11.0 MISCELLANEOUS REQUIREMENT

11.1 Fillets at the junction of roof and vertical walls shall be provided with cast in situ cement concrete 1:2:4 (nominal mix) followed by 12mm thick 1:4 cement mortar.

11.2 A screed layer not less than 100 mm thick of cast in situ concrete of nominal mix 1:3:6 shall be provided below all water retaining structures. A sliding layer of craft paper or bitumen paper shall be provided over the screed layer to destroy the bond between screed and base slab.

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

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

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

11.6 Unless specified 20 mm and down graded aggregates shall be used for all structural concrete works. However 40 mm and down graded aggregates may also be used under special conditions for foundation. with prior approval from OWNER.

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

12.0 MAJOR EQUIPMENT FOUNDATIONS

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

12.1 Coarse Aggregates

12.1.1 Sound and durable crushed stone aggregates shall be used. All aggregates shall be tested for alkali aggregate reaction. Materials, which

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

12.1.2 The course and fine aggregate shall be naturally occurring sand gravel or stone, crushed or uncrushed. They shall be obtained from an approved source and shall be hard, strong, durable, clear and shall not contain any harmful material not to affect adversely the concrete quality.

12.1.3 Only coarse and fine aggregates from the approved quarries and conforming to IS: 383 shall be used on the work.

12.2 Temperature Control of Concrete

The temperature of fresh concrete shall not exceed 23⁰ C when placed. For maintaining the temperature of 23⁰ C in the top deck of machine foundations, crushed ice shall be used in mixing water.

12.3 Admixture

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

GTG/STG Foundations	: 150mm to 200mm
BFP	: 100mm to 150mm
Block foundation	: 100mm to 150mm
Column	: 100mm to 150mm

12.4 Form work

12.4.1 No metal part of any device for maintaining formwork in the correct location shall remain permanently within the specified concrete cover to the reinforcement.

12.4.2 In watertight construction, methods of fixing formwork, which result in holes through the concrete section when the formwork is removed, shall not be used. All wall ties shall have water baffles and wall kickers shall be cast monolithically with the base slab.

12.4.3 Approval for the size, type and position of any holes, insert or fixing required by CONTRACTOR shall be obtained before work proceeds.

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Unless otherwise specified or approved all holes shall be formed and all inserts cast in at the time of pouring No part of the concrete works shall be drilled or cut away without approval.

- 12.4.4 Formwork panels shall be stiff enough to prevent damage to the concrete surface caused by excessive movements of the panel during vibration of the concrete.
- 12.4.5 Damaged and used formwork shall not be re used without repairing.
- 12.4.6 All joints in form work and joints between the form works shall be sufficiently tight to prevent loss of liquid from the concrete through these joints.
- 12.4.7 The part of the ties shall be capable of being removed, so that no part remaining embedded in the concrete shall be nearer the surface of the concrete than the specified thickness of cover to the reinforcement. Holes left after the removal of ties shall be filled with concrete or mortar of approved composition.
- 12.4.8 Formwork props shall be positioned between permanent supports so that all members are supported at not more than 3 meters centre in both directions.
- 12.4.9 The props shall be in the form of space frames, composite or single members with sufficient stiffness or bracing so that props will neither sway nor buckle under loads which they are designed to carry.
- 12.4.10 The formwork or the false work shall not be removed from a structural component until CONTRACTOR ensure that the concrete has attained sufficient strength.
- 12.4.11 The concrete is to be regarded as sufficiently hardened when the component has attained such strength that it can resist all loads acting at the time of removal of the formwork.
- 12.4.12 Particular care shall be taken with components which have to carry virtually the full design load directly upon removal of the false work (e.g. in the case of roofs, or floor slabs which have to support loading from floors above them which have not yet hardened)
- 12.4.13 Props shall remain in position for as long a period a possible, particularly for structural components, which are subjected to a major proportion of their design loading as soon as the formwork has been removed.
- 12.4.14 No superimposed load shall be allowed on any part of the concrete work prior to the removal of the forms and props.

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12.4.15 Film faced plywood formwork shall be used for the top decks of all machine foundations.

12.4.16 **Scheme for Concreting**

Weigh batching plants shall be mobilized for all machine foundations. Concrete pump shall be mobilized for GTG/STG foundations, BFP foundations. Arrangements for stand-by Plant and Equipments shall also be made.

12.5 **Placing of Concrete**

12.5.1 Before each concreting CONTRACTOR shall give sufficient notice to the Owner as directed such that an inspection will be made before the concreting.

12.5.2 The concrete shall be mixed in the mixer of adequate capacity having a power elevated loading hopper. The mixer shall be equipped with an automatic water-measuring tank filled with a device for locking the discharge setting. The Mixing shall continue until there is a uniform distribution of the materials and the mass is uniform in colour and consistency.

12.5.3 Any concrete surplus to immediate requirements shall be thrown away. In no case circumstances may the surplus be used later.

12.5.4 The volume of mixed materials in each batch shall comply with the mixer manufacturer's written recommendations.

12.5.5 Concrete shall be transported as quickly as possible from the mixer to its final position without segregation or loss of any of the ingredients.

12.5.6 All equipment to be used for transporting material shall be kept clean; all containers used for transporting concrete shall be thoroughly washed out whenever mixing ceases.

12.5.7 Concrete shall be placed continuously up to construction joints while it is still sufficiently plastic for adequate compaction.

12.5.8 At all times when reinforced concrete is being placed a competent steel fitter shall be in continuous attendance. CONTRACTOR shall adjust and correct the position of any reinforcement, which may be displaced.

12.5.9 CONTRACTOR shall keep on site a complete record of the works showing the time and date when concrete is placed in each part of the work.

12.5.10 Concrete shall be thoroughly compacted by suitable mechanical vibrators during placing and shall be carefully worked around all reinforcement and embedded fixtures and in to the side and corners of the formwork.

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TITLE 700 MW (2X350 MW) COMBINED CYCLE POWER PLANT NEAR PIPAVAV PART C – REINFORCED CONCRETE STRUCTURES AND FOUNDATION

SECTION: D4.6c

SHEET 14 OF 14

SPEC. NO.
TCE.4916A-H-500-001

- 12.5.11 For top surfaces of slab and other surfaces for which formwork is not provided a smooth finish shall be provided with a wooden float after compaction.
- 12.5.12 Whenever, concrete is being vibrated at least one spare vibrator of each type in use shall be available in case of breakdown.
- 12.5.13 Compaction shall start as soon as there is sufficient concrete within the formwork to immerse the vibrator and vibration shall continue during the placing operation so that at no time shall there be a large volume of un compacted concrete in the form work.
- 12.5.14 The concrete shall not be placed directly against a vertical form face but shall be placed to flow to this surface during the compaction process. Care shall be taken to avoid the form face being splashed with mortar during the placing operation.
- 12.5.15 Exposed surfaces, immediately after final set, shall be protected from the sun. All concrete shall be well watered after it has been set and shall be kept continuously damp until thoroughly cured. Provision shall be made for adequate water distribution to all parts of the work so that if required this treatment can be continued sufficiently throughout the whole period of construction. In order to keep the concrete continuously damp, all exposed surface shall be covered with continuously damped gunny bags or shall have water compounded on them, for full period of curing.
- 12.5.16 On exposed concrete surfaces in high sun temperatures and /or strong drying wind conditions CONTRACTOR shall use curing method, which also shields the concrete, and this shall be placed in position not later than half an hour after final tamping. Base mat as well as top deck of machine Foundations shall be cast in a single pour.

12.6 Ultrasonic Testing

Ultrasonic pulse velocity test shall be carried out for the top deck of all machine foundations and TG substructure to ascertain the homogeneity and integrity of concrete. In addition, additional cubes (at the rate of one cube per 150 cum of concrete subject to a minimum of six cubes) shall be taken to carry out Ultrasonic Pulse velocity (UPV) testing on the cubes to serve as reference UPV values. Testing shall be done as per IS: 13311 (Part-1). In case of any defects, the CONTRACTOR shall rectify the defects suitably using cement / epoxy grout etc.

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700 MW(2X350 MW) COMBINED CYCLE POWER PLANT NEAR PIPAVAV PART D – STEEL STRUCTURES

SECTION: D4.6d

SHEET 1 OF 15

SPEC. NO.
TCE.4916A-H-500-001

1.0 GENERAL

1.1 Design of structural steel work shall include generally but not be limited to the steel constructions listed below :

- i) Steel building structure and open structure
This shall include beams, columns, bracings, supporting structures for floors, roof slabs, cladding etc.
- ii) Crane, gantry girder, monorails etc.
- iii) Large diameter storage tanks
- iv) Cooling Water Conduits
- v) Steel stack
- vi) Galvanised latticed structures for switchyard
- vii) Pipe and cable racks
- viii) Platforms and walkways
- ix) Ladders, staircases, handrails etc.

2.0 FRAMING

2.1 All steel framed structures shall be either “rigid frame” or “simple space frames” or a combination of the two.

2.1.1 Lateral forces shall be resisted by stiff jointed moment connections in rigid frame design. The column bases shall generally be fixed to concrete foundation pedestal by providing moment resistant base detail.

2.1.2 Simple space frame design utilises single-span beam systems, vertical diagonal bracing at main column lines and horizontal bracing at the roof and major floor levels. Most of steel buildings shall be designed as simple space frame structures.

2.2 The STG/GTG building design shall be a combination of rigid frame in transverse direction and simple frame in longitudinal direction.

2.3 Pipe rack shall consist of rigid main frame in transverse direction spaced longitudinally as required. In longitudinal direction, pipe rack shall be divided into sections of suitable length with an anchor bay. The main transverse frames shall be connected with longitudinal beams, which will transmit horizontal forces to braced anchor bays. The pipe and cable rack bridge structure shall be adequately rigid to carry the forces from pipelines at anchor points without undue deflection so that pipelines are really anchored at the anchor points.

2.4 Concrete floors shall be considered to provide continuous lateral support to the top (compression) flange of the support beams. However where large cut outs are provided in the floor slabs horizontal floor bracing shall be provided. Grating / chequered plate floor shall neither be considered to provide lateral support to the top flange of supporting beams nor to provide

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a shear diaphragm. Adequate lateral support and horizontal bracing shall be provided as required in such cases.

2.5 Floors for vibrating machines of all kind together with supporting framework shall be adequately braced in both horizontal and vertical planes. Floors or structure supporting mechanical equipment shall be designed to minimise vibration, avoid resonance and maintain alignment and level.

2.6 Columns shall be designed to support the load combination, which produces the maximum interaction ratio. Exterior columns shall be designed to resist wind moments between braced elevation as appropriate. Columns shall also be designed to resist moments caused by discontinuous vertical bracing or non-concentric bracing work points.

3.0 MATERIALS

3.1 Structural steel shall conform to Grade A of IS: 2062 for rolled steel members or plates up to 20 mm thickness. For plates above 20 mm thickness or welded construction, steel conforming to Grade B (Killed) of IS: 2062 shall be used except for crane girders where Grade C (IS:2062) steel shall be used.

3.3 Chequered plates shall conform to IS:3502. All gratings shall be pressure locked type (preferably electro-forged) manufactured in accordance with applicable Indian Standard Codes. All chequered plates and gratings shall be galvanised. Pipes for handrail shall be as per medium grade of IS:1161 and shall be galvanised. Crane rails shall conform to IS:3443.

3.4 Materials used in flues shall be as per Clauses 6.37 of Section 6

4.0 CONNECTIONS

4.1 Welding shall be used for shop fabrication and joints. For site connections, welding or high strength friction grip (HSFG) type bolts shall be used, except in few cases for shear connections of lighter members or removable beam connections where bolted joints may be adopted e.g. purlins, side girts etc. Minimum two bolts of diameter not less than 16 mm per connection shall be used.

4.2 IS:814, IS: 816 IS:1024, IS:4353 and IS: 9595 shall be followed for welding of structures.

4.3 For high strength friction grip bolt connections IS:4000 shall be followed. High strength friction grip bolts shall be of property class 6.6 or 8.8 and shall conform to IS: 3757 and shall not be less than 20 mm in diameter unless designated otherwise. High strength bolts shall be installed as bearing type joint except where loads are reversible.

4.4 All bolted connections shall have bolts of minimum 16 mm diameter. The connections of stairs and handrails shall be made with 20 mm diameter

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threaded fasteners conforming to IS:1363. Erection bolts shall be black bolts of minimum 12 mm diameter.

- 4.5 All bolts and nuts shall have property class compatible to each other. For bolts carrying dynamic or fluctuating loads and those in direct tension shall be provided with an additional double coil helical spring washer conforming to IS:6755. The threaded portion of the bolt shall project through the nut at least by one thread.
- 4.6 Where a steel beam or member is to be connected on RCC structure, it shall be connected using an insert plate and preferably through shear connection.
- 4.7 For crane girders, welding between web and flange plates shall be carried out by submerged arc welding process. Full penetration of weld between web plate and top flange shall be ensured. Intermediate stiffeners shall be connected with top flange plate by full penetration butt weld. Welding across tension flange will not be permitted. Bearing edges of crane girders shall be machined.
- 4.8 The working point of the bracing connection shall be the centre of column and girder to which it connects. The connections of gusset plates to column and girders shall be made to include provisions for eccentricity in connection. The double angle back-to-back with gusset plate in between shall not be used in dust laden areas. Where double angles are not adequate, beam sections with web in the plane of bracing shall be used.
- 4.9 Horizontal bracings shall be of angle / tee section located at the bottom of framing beams. Field welding of bracing at the underside of beam as required to meet slenderness requirement of bracing member shall be indicated on the drawings. Horizontal bracing shall be arranged to avoid framing into the beams at column locations.
- 4.10 For Major columns of main building, column splices shall be designed to resist the greater of the design axial tension load and moments or an axial tension load of 45 t plus 50% of the member capacity in bending in either major or minor axis, whichever produces the greatest number of bolts.
- 4.11 Minimum size of fillet weld shall be 5 mm. No intermittent weld is allowed.
- 4.12 Efficiency of site welds to be considered shall be as follows:
a) Butt weld above 25 m from ground --- 50%
b) Others --- 80%

5.0 DESIGN METHODOLOGY

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- 5.1 The Design of steel structures shall be done by working stress method, in accordance with the provisions of IS: 800 and other relevant IS codes as applicable to specific structures.
- 5.2 All buildings / structures shall be framed structure. Basic consideration for structural framing shall be stability, rigidity, building usage, ease of fabrication / erection and overall economy. Additional bracings / moment connections shall be used to assure stability of structures. Structure shall be designed such that the surfaces of all parts shall be accessible for inspection, cleaning, painting and maintenance.
- 5.3 Crane gantry girders shall be single web plate girders of welded construction with bearing and intermediate stiffeners. Crane girder shall be designed as simply supported and of single span length. Chequered plate shall be used for gantry girder walkway flooring. For lifting / monorails beams ISMB sections shall be preferred and the bottom flange of all beams shall be checked separately for distortion and reinforced suitably if required.
- 5.4 Permissible stresses for different members shall not be allowed to exceed by 33.33% under wind and seismic conditions. However, members which are designed primarily to resist wind load such as bracing members, no increase in permissible stresses will be permitted. However, permissible stresses in bolts and welds shall be allowed to exceed up to 25 % only.
- 5.5 For design which requires the use of the minimum column load (such as, uplift on anchor bolts, column axial tension, etc.) the following criteria shall be used in determining minimum load. Use 90% of the column dead load, No live load is to be used, Uplift forces from vertical bracing are included where applicable and Wind uplift on the roof is included where applicable.
- 5.6 Base plates shall be placed on foundation pedestal with grouting. For large base plates necessary grout holes shall be provided. All anchor bolts for fastening steel columns on foundation shall be embedded in foundation during concreting itself. No anchor pockets in foundation shall be allowed.
- 6.0 **PERMISSIBLE DEFLECTIONS**
- 6.1 The permissible deflections of various steel members under normal loading conditions shall be as specified below. For calculation of deflections in structures and individual members dynamic effects shall not be considered, unless specified otherwise. Also, no increase in deflection limits shall be allowed when wind or seismic loads are acting concurrent with normal loading conditions.
- 6.1.1 Vertical Deflection:

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- a) For beams supporting dynamic equipment : Span / 500
- b) For beams supporting floors / masonry : Span / 325
- c) For beams supporting pipes (pipe racks) : Span / 400
- d) For roofing and cladding components : Span / 250
- e) For gratings and chequered plates : Span / 200
subject to a
maximum of 6 mm
- f) Coal conveyor gallery bridges : Span / 450

6.1.2 For crane gantries or any member subjected to working loads, the maximum deflection under dead load and live load excluding impact shall not exceed the following values:

- a) For manually operated cranes and monorails : Span / 500
- b) For electric overhead cranes
 - i) up to 50 t capacity : Span / 750
 - ii) over 50 t capacity : Span / 1000

6.2 Horizontal deflections

The permissible horizontal deflections shall be as per following unless specified otherwise:

- a) Single storey building (without crane load) : Height / 325
- b) Multistoried building (without crane load) : Height / 500
- c) Pipe rack columns : Height / 200
- d) Open Structures : Height / 200
- e) Crane gantry girder due to surge : Span / 2000 limited
to maximum of 15 mm
- f) Building main columns at crane rail : Height / 2500 limited to
level due to action of crane surge load only maximum of 10 mm
- g) Open gantry columns at crane rail level : Height / 4000 limited to
due to action of crane surge load only maximum of 10 mm
- h) Coal handling trestles : Height / 1000

6.3 Provisions of IS: 800 and relevant latest IS Codes shall be followed for limiting deflections of structural elements not listed above.

7.0 MINIMUM THICKNESS AND SIZES OF STEEL ELEMENTS

7.1 Minimum Thickness

The minimum thickness of various components of a structure and hot rolled sections shall be as follows. The minimum thickness of rolled shapes shall mean flange thickness regardless of web thickness. Structural steel members exposed to significantly corrosive environment shall be increased suitably in thickness or suitably protected otherwise as per good practice and sound engineering judgement in each instance.

- a) Trusses, purlins, girts and bracing : 6 mm
- b) Columns and beams : 8 mm
- c) Gussets : 8 mm

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- d) Stiffeners : 8 mm
- e) Base plates : 10 mm & above
- f) Chequered plates : 6mm o/p & above
- g) Grating flats : 5 mm
- h) Minimum thickness of structural members other than gratings and chequered plate directly exposed to weather and inaccessible for painting and maintenance shall be 8 mm.

7.2 Minimum Sizes

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

8.0 SLENDERNESS AND DEPTH RATIO

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

8.2 The following limiting ratios of depth to span shall be considered as a general guide.

- a) Truss 1 / 10
- b) Rolled beams and girders for Ordinary floors and rafters 1 / 24
- c) Supporting floor beams for vibrating Machines / equipments 1 / 15
- d) Roof purlins and girts 1 / 45
- e) Gable columns 1 / 30

9.0 FABRICATION AND ERECTION

9.1 CONTRACTOR shall prepare detailed fabrication drawings and erection scheme based on the design drawings approved by OWNER. Fabrication drawings are not to be submitted to OWNER for approval as the responsibility for correct detailing rests exclusively on the CONTRACTOR. However these drawings shall be furnished to OWNER for their reference to effect payment. Fabrication shall commence only on the basis of the fabrication drawings approved by the CONTRACTOR'S Consultant.

- (a) Fabrication shall in general follow the provisions of IS:800, and good engineering practice where provisions of IS:800 are not clear.
- (b) Tolerance in fabricated steel work shall be as per IS: 7215.
- (c) Erection of fabricated steel components shall be as per erection drawings prepared by CONTRACTOR and approved by his CONSULTANT.
- (d) Tolerance for erected steel structures shall be as per IS:12843.

**700 MW(2X350 MW) COMBINED CYCLE POWER PLANT
NEAR PIPAVAV
PART D – STEEL STRUCTURES****9.2 Inspection of Welding**

The extent of quality control in respect of welds for structural elements shall be as follows.

9.3 Visual Examination

9.3.1 All welds shall be 100% visually inspected to check the following:

- i) Presence of undercuts
- ii) Surface cracks in both welds and base metals.
- iii) Unfilled craters
- iv) Improper weld profile and size
- v) Excessive reinforcement in weld
- vi) Surface porosity

9.3.2 Before inspection, the surface of weld metal shall be cleaned of all slag, spatter matter, scales etc. by using wire brush or chisel.

9.4 Dye Penetration Test (DPT)

9.4.1 This test shall be carried out for all important fillet welds and groove welds to check the following:

- i) Surface cracks
- ii) Surface porosities

9.4.2 Dye Penetration Test shall be carried out in accordance with American National Standard ASTM E165.

9.5 Ultrasonic test

9.5.1 Ultrasonic test shall be conducted for all groove welds and heat affected zone in dynamically loaded structures and for other important load bearing butt welds in statically loaded structures as desired by OWNER to detect the following:

- i) Cracks
- ii) Lack of fusion
- iii) Slag inclusions
- iv) Gas porosity

9.5.2 Ultrasonic testing shall be carried out in accordance with American National Standard ANSI / AWS D1.1-92 Chapter 6 : Part C.

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9.5.3 Before Ultrasonic test is carried out, any surface irregularity like undercuts, sharp ridges etc. shall be rectified. Material surface to be used for scanning by probes must allow free movement of probes. For this purpose, surface shall be prepared to make it suitable for carrying out ultrasonic examination.

9.6 Radiographic Testing (X – ray and Gamma – ray Examination)

9.6.1 This test shall be limited to 2% of length of welds for welds made by manual or semi-automatic welding and 1% of length of weld if made by automatic welding machines. The location and extent of weld to be tested by this method shall be decided by OWNER to detect the following defects:

- i) gas porosity
- ii) slag inclusions
- iii) lack of penetration
- iv) lack of fusion
- v) cracks

9.6.2 Radiographic testing shall be conducted in accordance with American National Standard ANSI / AWS D1.1-92.

9.6.3 Any surface irregularity like undercuts, craters, pits, etc. shall be removed before conducting radiographic test. The length of weld to be tested shall not be more than $0.75 \times$ focal distance. The width of the radiographic film shall be width of the welded joint plus 20 mm on either side of the weld.

9.7 CONTRACTOR shall provide testing equipment for conducting non-destructive tests for confirming the integrity of welding wherever necessary as directed by the OWNER.

9.8 Acceptable Limits of Defects of Weld

9.8.1 Limits of Acceptability of welding defects shall be as follows.

- i) Visual inspection and Dye Penetration Test

The limits of acceptability of defects detected during visual inspection and Dye Penetration Test shall be in accordance with clauses 8.15.1 and clauses 9.25.3 of American National Standard ANSI / AWS D1.1-92 respectively, for statically and dynamically loaded structures.

- ii) Ultrasonic Testing



The limits of acceptability of defects detected during ultrasonic testing shall be in accordance with clause 8.15.4 and clause 9.25.3 of American National Standard ANSI / AWS D1.1-92 respectively, for statically and dynamically loaded structures.

iii) Radiographic Testing:

The limits of acceptability of defects detected during Radiographic testing shall be in accordance with clause 8.15.3 and 9.25.2 of American National Standard ANSI / AWS D1.1-92 respectively for statically and dynamically loaded structures.

9.9 **Rectification of Defects in Welds**

9.9.1 In case of detection of defects in welds, the rectification of the same shall be done as follows:

- i) All craters in the weld and breaks in the weld run shall be thoroughly filled with weld
- ii) Undercuts, beyond acceptable limits, shall be repaired with dressing so as to provide smooth transition of weld to parent metal.
- iii) Welds with cracks and also welds with incomplete penetration, porosity, slag inclusion etc. exceeding permissible limits shall be rectified by removing the length of weld at the location of such defects plus 10 mm from both ends of defective weld and shall be re-welded. Defective weld shall be removed by chipping hammer gouging torch or grinding wheel. Care shall be taken not to damage the adjacent material.

10.0 **PAINTING**

10.1 All steel structures shall receive two primer coats and two finish coats of painting. First coat of primer shall be given in shop after fabrication but before dispatch to erect at site after surface preparation as described below. The second coat of primer shall be applied after erection and final alignment of the erected structures. Two finish coats shall also be applied after erection.

10.2 Steel surface, which is to be painted, shall be cleaned of dust and grease and the heavier layers of rust shall be removed by chipping prior to actual surface preparation. The surface shall be cleaned to grade ST-2 as per SIS05-5900 or as per IS:1477 (part -I). Surface preparation shall be done by means of sand blasting, which shall conform to IS Standard.

10.3 Primer coat shall consist of one coat of epoxy resin based zinc phosphate primer having minimum DFT of 100 microns. All paints shall be of approved brand and shade as per the OWNER'S requirement.

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- 10.4 Intermediate coat (or under coat) shall consist of epoxy resin based paint pigmented with Titanium dioxide with min. DFT of 100 microns.
- 10.5 Top coat shall consist of one coat of epoxy paint suitably pigmented of approved shade and color with glossy finish and DFT of 75 microns. Additionally finishing coat of polyurethane of minimum DFT of 25 microns shall be provided.
- 10.6 The paint may be applied in one coat, in case high built paint is used, otherwise two coats shall be applied.
- 10.7 Total DFT shall not be less than 300 microns.
- 10.8 Intermediate / top / finishing coat paints shall be from the same manufacture and the paints shall have compatibility with one another. Applications shall be as per manufactures recommendations.
- 10.8 All other steel members like doors, rolling shutters, pipe supports etc. shall be painted as per the details as above
- 10.9 Joints to be site welded shall have no paint applied within 100 mm of welding zone. Similarly where friction grip fasteners are to be used no painting shall be provided. On completion of the joint the surfaces shall receive the paint as specified.
- 10.10 Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly. Surfaces inaccessible after erection including top surfaces of floor beams supporting gratings or chequered plate shall receive one additional coat of finish paint over and above number of coats specified before erection. Portion of steel member embedded / to be encased in concrete shall not be painted.

11.0 REQUIREMENTS FOR SPECIFIC STRUCTURES

11.1 Switchyard Structures

- 11.1.1 All switchyard structures comprising of towers, gantries, lightning masts, lighting towers, equipment structures etc. shall be galvanised steel with bolted site connection.
- 11.1.2 Three dimensional analysis shall be carried out for structures like towers and gantries whereas two dimensional approach may be followed for equipment support structures.
- 11.1.3 All structural steel shall be of tested quality and shall conform to IS:2062. Steel tubes where used for equipment support structures shall conform to IS:1161.

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11.1.4 All bolts and nuts shall be galvanised. In addition to heavy washers conforming to IS: 6610, spring washers conforming to IS:3063 shall be provided at all bolted connections. Bolts shall conform to IS:12427.

11.1.5 Fabrication and erection shall generally be as per IS:802 and IS:800; wherever there is a contradiction between two codes the provision in IS:802 shall govern.

11.1.6 **Galvanising**

11.1.6 Galvanising of the towers shall be as per IS:4759 and IS: 2633 and as given in the following paras.

11.1.6.1 Before galvanising, the steel shall be thoroughly cleaned of any paint, grease, rust, scale, acid or alkali or such other foreign matters as are likely to interfere with the galvanising process.

11.1.6.2 The acceptable values of the coating of zinc on the steel materials shall be in accordance with Table below:

KIND OF MATERIAL

COATING

	<u>Average value</u>	<u>Minimum value</u>
Structural steel members except bolts,nuts and washers	Over 750 gm/sq.m	610 gm/sq.m
For bolts, nuts and washers	Over 550 gm/sq.m	500 gm/sq.m

11.1.6.3 The galvanised surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth, and shall be free from defects like discoloured patches, bare spots, globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

11.1.6.4 There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanised steel member shall withstand minimum four number of one minute successive dips in copper sulphate solution as per IS:2633 unless specified otherwise.

11.1.6.5 All galvanised members shall be treated with sodium dichromate solution or an approved equivalent after galvanising, so as to prevent white storage stains.

11.1.6.6 Wherever galvanised bolts, nuts, washers, accessories, etc. are specified these shall be hot-dip galvanised. Spring washers shall be electro-galvanised. Readily available GI nuts, bolts and washers conforming to galvanising requirements may also be used.

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11.1.6.7 CONTRACTOR shall ensure that galvanising is not damaged in transit. In the event of occurrence of any damage, CONTRACTOR shall at his own cost adopt scrapping and regalanising the member to satisfy the specific requirements.

11.2 STEEL CHIMNEY

11.2.1 The design and construction of chimney shall generally conform to IS:6533 and IS:800. Design and construction shall conform in every respect to Boiler and Factory Inspector's regulations, as well as Civil aviation authorities requirements. The basic dimension of the chimney such as clear diameter, height etc. shall be decided based on the temperature, composition and quantity of flue gases, draft requirements, pollution control regulation etc.

11.2.2 The stack shall be designed to resist stresses due to the following loadings and load combinations as specified in clause 6.5 of IS:6533.

- i) Self weight of the stack along with permanent fixture
- ii) Weight of lining
- iii) Wind loading – both static and dynamic as per IS:6533 and IS:875
- iv) Earthquake load as per IS:1893
- v) Effect of temperature.
- vi) A live load of 300 kg/sq.m on each platform.

11.2.3 Steel used shall be as per IS:2062 grade A for sections and plates less than 20 mm in thickness and IS:2062 grade B for thicker sections and plates. The stack shall be so designed that stresses do not exceed those maximum permissible stress as specified in IS:6533 modified to take into account temperature effect.

11.2.4 Minimum thickness of the stack shall be the calculated thickness obtained from stress and deflection consideration plus allowance for corrosion as per table 1 of IS:6533 considering design life as 20 years. Minimum thickness shall not be less than 6 mm. Maximum deflection of the stack due to static wind loading shall not exceed 1/200 of the unsupported height of the stack.

11.2.5 The base plates and holding down bolts shall be adequate to take the load, moments and reactions between the shell and foundations generally satisfying requirements of IS:800. Anchor bolt shall be made 3 mm larger in diameter than computed dimension to satisfy stress levels. Helical strakes shall be provided for the top 1/3 portion of the unsupported height as explained in clause A.2.2 of IS:6533.

11.2.6 Stability of the structure and foundations as a whole or any part of it shall be checked as per IS:6533.

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11.2.7 Upto a height of 2.5 m from the base, and at every platform level the Chimney shall be insulated externally with mineral wool.

11.2.8 Accessories shall be generally as per IS:6533.

11.2.9 Painting

11.2.9.1 Internal surface of the chimney shall be given two coats of heat resistant aluminium paint conforming to IS : 13183 over two coat of red oxide zinc chromate primer. External surfaces shall be given two coat of red oxide zinc chromate primer and one finish coat of heat resistant aluminium paint conforming to IS:13183 before erection. Top portion to a height of two times the diameter of the flue shall be given two coats of acid resistant paint conforming to IS:158 both inside and outside. Balance external surface shall be provided with two coats of synthetic enamel paint conforming IS:2932 with alternate bands of orange and white shades.

11.2.10 Construction Tolerance

The difference between maximum and minimum internal diameter of the shell measured at any cross section shall not exceed 1% of the nominal diameter. After erection, the deviation of the stack from the vertical at any level shall not exceed 1/1000 of the height at that particular section.

11.3 Storage Tanks

11.3.1 Design, fabrication and erection of the cylindrical welded storage tank shall follow the provisions of IS:803. The stresses in the tank shall be computed on the assumption that tank is filled with water. Tension in each course shall be computed at 30 cm above the centreline of lower horizontal joint of the course under consideration.

11.3.2 Wind and internal vacuum loads shall be considered together to check the stability of tank.

11.3.3 Joint efficiency factor shall be taken as 0.85 for butt joints to determine the minimum thickness of shell plates provided all the vertical and horizontal butt welds are spot radiographed. Where welds are not inspected by radiography joint efficiency factor of 0.7 shall be used. However it is recommended that all butt welded joints shall be radiographed.

11.3.4 Minimum thickness of shell plate shall be as given in clause 6.3.3.2 of IS:803 to which corrosion allowance shall be added. Maximum thickness of shell plate shall not exceed 40 mm. Width of shell plate shall not be less than 1500 mm.

11.3.5 Bottom plate uniformly resting on the substructure shall have a minimum thickness of 6 mm for tank upto 10 m in diameter and 8 mm for higher

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diameter. Bottom plate shall project at least 25 mm allround beyond the outer edge of weld attaching the bottom to the shell plate.

- 11.3.6 For large diameter tanks supported cone roof shall be provided. Arrangement of columns and rafters shall in general be as per fig 9 and 10 of IS:803. Roof plates shall have a minimum thickness of 6 mm and shall not be attached to the supporting member. A curb angle shall be provided at the top of the shell in line with clause 6.3.6.2 of IS:803. Roof plates shall be attached to the curb angle with a continuous fillet weld on the top side only. Minimum slope of roof shall be 1 in 16.
- 11.3.7 Rafter clips for the outer row of rafters shall be welded to the shell. Columns shall not be rigidly attached to the bottom plates guide. Clips shall be welded to the tank bottom to prevent lateral movement.
- 11.3.8 Roof supporting columns shall made from structural shapes or pipe or built up section. Suitable base frames or reinforcing pads shall be provided at the column base to distribute loads coming on the tank bottom.
- 11.3.9 Appurtenances and mountings covered under section 7 of IS:803 shall be provided in addition to any other appurtenance which the BIDDER considers essential for the safe and smooth operation of the fuel oil storage and oil handling system.
- 11.3.10 After erection and inspection of the tank, the tanks shall be tested as per clause 12 of IS:803. Leakage, if any noticed shall be repaired to the satisfaction of the OWNER and the tank retested to satisfy acceptance criteria.
- 11.3.11 Tanks shall be provided with two coats of epoxy coating for internal surfaces over two coats of compatible primer. External surfaces shall be provided with two coats of synthetic enamel paint over two coats of red oxide zinc chromate primer.

11.4 Cooling Water Conduits

Design, installation and testing of the pipe shall in general follow the provision of “Steel pipe - A guide for design and installation” – AWWA Manual M11 – published by American Water Works Association. Steel used shall conform to IS:2062. Minimum earth cover over the pipe shall be 1500 mm. Internal surface shall be provided with epoxy coating and the external surface shall be provided with coal tar enamel wrapping. Bedding shall be of sand. Thrust blocks shall be provided at all bends. Internal design pressure shall be the shut off head as furnished by the pump vendor, 1.5 times the pump working head or maximum surge pressure computed from surge analysis whichever is greater. However for surge pressure the allowable stresses can be increased by 25%. External pressure due to earth pressure, surcharge pressure of 2 t/sq.m

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and at road crossings pressure due to vehicles shall be considered. In addition a vacuum pressure of 9 m water column shall be considered while checking against buckling. All site joints shall be inspected by radiography. Internal surface of the conduit shall be provided two coats of epoxy paint over two coats of compatible primer.

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1.0 **DRAINAGE AND SEWERAGE**

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

1.1 **Surface Drainage**

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

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

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

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

1.1.5 The rectangular drains shall be minimum 450mm wide of RCC construction. The pipes for water drainage system shall be of RCC class NP2 conforming to IS:458 with minimum size of 150 mm NB. However for road crossings etc. pipe of class NP3 shall be provided. For rail crossings, pipes conforming to railway loading standards shall be provided. If sufficient clearance cannot be provided between the top of the pipe and road top, the pipes shall be encased in RCC.

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

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

1.1.8 Garland drains, minimum 300 mm wide shall be provided allround the building to lead away roof drainage to plant drainage system. Plinth protection in PCC grade M 15 shall be provided between building wall and drain with appropriate slope.

1.2 **Storm Water Drainage System**

1.2.1 The plant storm water drainage system shall take into account the topography of the plant area, area drainage patterns and intensity of rainfall etc. The

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drainage system shall be designed for a precipitation intensity equal to hourly rainfall for a return period of 1 in 50 years. However, storm frequency of 100 years return period shall be applied for coal storage area.

- 1.2.2 All storm water drainage shall preferably be conveyed through storm water drains provided on both sides of the roads and shall be designed to drain the appropriate catchment area including road surface, open and covered area etc. The drains shall be minimum 450 mm wide at the base. Drain top cover shall be covered with RC precast slab. Grating shall be planned at every 4mts for easy maintenance of drains.
- 1.2.3 In the main plant area all open drains rectangular in cross section shall be in RCC of grade M 30. The thickness of side and bottom shall be minimum 125 mm or as per design considerations whichever is higher.
- 1.2.4 The pipes for water drainage system shall be of concrete of class NP2 conforming to IS:458. However for road crossings etc. higher strength pipe of class NP3 shall be provided. Diameter of pipes used for drainage / culverts shall be between 300 mm to 600 mm. Beyond 600 mm, box drains / culverts shall be provided.
- 1.2.6 Surface drains shall normally have a bed slope not milder than 1 in 1000 along longitudinal direction and RCC pipes shall have such slopes so as to have effective discharge. The maximum velocity for pipe drains and open drains shall be limited to 2.4 m/sec and 1.8 m/sec respectively. However, minimum velocity for self cleaning of 0.6 m/sec shall be ensured at peak flow condition (i.e. 3 times average flow) for pipes flowing at half full.
- 1.2.7 Suitable manholes shall be provided to pipe drainage lines at every 30 m intervals, at junctions and at change of gradient, alignment and diameter of pipe and shall be of RCC construction. Minimum size of manholes shall be 1.0m x 1.0m. All manholes shall be designed considering maintenance, inspection and cleaning of pipes. Easy accessibility and safety shall also be given due consideration.
- 1.2.8 The cushion over the pipes for storm culverts shall be minimum 600 mm. Where less cushion is available, pipe shall be encased in RCC M 20. Suitable RCC structures shall be provided at drops / falls to prevent scouring or damage to surface.
- 1.2.9 Invert of drainage pipe / drain shall be decided in such a way that the water can easily be discharged above the high water level in water course outside the plant boundary to which the storm water is to be led.

1.3 Plant Effluent Drainage (Oily Waste / Process Waster Drainage)

- 1.3.1 The oily / process waste shall be drained / collected through a separate sewer system consisting of underground (over ground if required) cast iron pipes of Class – LA conforming to IS : 1536. Catch pits shall be provided at

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the source location and they shall be interconnected by buried pipes. No bends and branches shall be provided in the pipe line. Manholes shall be provided at all junctions of pipes. Catchpits shall have a minimum internal dimension of 600 mm x 600 mm. They shall be of RCC construction and provided with CI grills.

- 1.3.2 The main and branch connection pipes shall be sized for the expected maximum discharge subject to a minimum of 250 mm NB and 100 mm NB respectively. The pipes shall be adequately sloped for drainage and shall carry flow to neutralisation pit / ETP / Oil water separator as required.

1.4 Sewage System

- 1.4.1 Cast Iron Pipes of Class – LA conforming to IS : 1536 shall be used below ground level for sewage disposal. Pipes connecting toilet facilities to manholes shall be minimum 100 mm diameter NB. Pipes connecting various manholes shall be minimum 150 mm diameter NB.

- 1.4.2 Sewers shall have such slopes so as to have effective discharge. Sewers shall be designed for a minimum self cleaning velocity of 0.75 m/sec for peak flow condition (assumed as 3 times the average flow) and pipes flowing half full. The maximum velocity shall not exceed 2.4 m/sec.

- 1.4.3 Suitable manholes shall be provided to pipe sewage lines at every 30 m intervals, at junctions and at change of gradient, alignment and diameter of pipe and shall be of RCC construction. Details of manholes shall be as per IS:4111 (Part-I). Minimum size of manholes shall be 1.0m x 1.0 m. All manholes shall be designed considering maintenance, inspection and cleaning of pipes. Easy accessibility and safety shall also be given due consideration.

- 1.4.4 Not used

- 1.4.5 Manual on Sewerage and Sewage treatment (published by Central Public Health Environment Engineering Organisation, Government of India) shall be followed for design purpose.

2.0 INTER PLANT TRENCHES

- 2.1 All cable and pipe trenches shall be of RCC with minimum M20 grade. Trenches located outside the buildings shall project at least 150 mm above finished formation level to avoid entry of storm water into the trenches. The bottom of trench shall be provided with suitable slope for draining out collected water into a sump pit.

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

3.0 Roads & Parking areas

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Roads & Parking areas shall be of flexible pavement type and shall be designed in accordance with the provision of the relevant IRC Codes of Practices.

- 3.1 Roads shall be designed as per IRC-37:1984 "Guidelines for the design of flexible pavements". California Bearing Ratio (CBR) method shall be adopted for the design of roads.
- 3.2 Sub base shall be of granular material i.e. laterites, moorum, natural sand, gravel, crushed stone (grading-1) or combination thereof laid over well compacted subgrade. Granular base shall be of water bound macadam course (WBM) construction. The wearing coarse shall be bituminous macadam binder course with open graded premix carpet laid over it. Shoulder provided on either sides shall be in murrum construction of 150 mm compacted thickness. Kerbs of PCC or stone shall be provided to distinguish carriage way.
- 3.3 The geometric design of roads shall be done in accordance with IRC-73. Road widths and curves shall have adequate space for manoeuvring of vehicles. Transverse camber of 1 in 60 shall be provided for the black topping of roads and a slope of 1 in 40 shall be provided on shoulders. Finished top (crest) of roads shall be 250 mm above the surrounding grade level.
- 3.4 Minimum radius of curvature along the inner side of the carriageway shall be generally 15m. However for minor roads this shall be reduced suitably as per layout requirements and site conditions. Road width and turning radii shall also be checked for to take largest foreseeable vehicles and equipment, which can reasonably be expected.
- 3.5 All service and utility lines crossing under roads shall be taken through concrete pipes / ducts and designed for imposed loading. Number of such crossings shall however be kept to a minimum.

4.0 **PAVING**

4.1 **R C C Paving**

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

- (i) Entire backside of the main turbine building up to the farther edge of chimney. The paving shall extend to a minimum of 5 m on either side from the outer most face of equipment structures in the other direction.
- (ii) 5 m wide corridor all around Power House.

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- 4.1.2 The underbed shall consist of well compacted ground supporting dry rubble soling of compacted thickness 225 mm with interstices properly filled with grits, followed by a layer of PCC of M 7.5, 50 mm thick.
- 4.1.3 Paving in crane corridor shall be designed for the maximum load due to movement of crane.
- 4.2 P C C Paving
- 4.2.1 PCC paving of nominal mix of grade M15, 150 mm thick laid over 150 mm thick compacted rubble soling shall be provided around all building as plinth protection to a width of 750 mm or the distance between the brick wall to the garland drain.
- a) Complete Transformer Yard, covering area between turbines building up to the fencing of the Transformer yard.
 - b) Plinth protection around all building to a width of 1000 mm or the distance between the brick wall to the garland drain whichever is higher.
- 4.3 Stone Aggregate Paving
- 4.3.1 Entire switchyard area and main transformer yard area shall be provided with 75 mm thick paving of 40 mm size stone aggregate on top and 75 mm thick paving of 20 mm stone aggregate below. Before laying the paving, the ground surface shall be treated with antiweed chemicals as per manufacturer recommendations.
- 4.3.2 For auxiliary transformer yard, paving of stone aggregate of 75 mm thick using 20 mm size aggregate shall be provided after compacting the under bed and treating with anti-weed chemicals.

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**FINISHES**

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

1.0 FLOORING

The nominal total thickness of floor finish shall be 50 mm including under bed and topping. The flooring shall be laid on already matured concrete base. Generally the under bed for floors shall consist of cement concrete 1:2:4 with stone chips 12.5 mm down graded as coarse aggregates. The under bed shall be provided appropriate slope towards catch pit for floor drainage.

1.1 False Flooring System

Removable type false flooring system shall be provided in computer rooms and control rooms as required. RCC floor slab will be sunk to a depth 600 mm which shall be height of the false floor system. The flooring shall consist of fire resistant phenol formaldehyde bonded particle board panels 600x600x35 mm size, mounted on steel pedestals of adjustable height and supporting steel grid system to provide under floor space. 2 mm thick flexible anti-static PVC topping on top and PVC strip edging on sides of each panel shall be provided.

1.2 PVC Floor Finish

Two mm thick PVC tile as per IS:3462 and laid as per IS:5318 over concrete under bed of 48 mm shall be provided in all control rooms unless specified otherwise. PVC tiles shall ensure anti static surface.

1.3 Epoxy coating

This shall be provided for Steam Turbine building operating floor as per the manufacturers requirement.

1.4 CARBORANDUM TILES

This shall be provided for steam and Gas/steam turbine building floor area. Polished heavy duty cement concrete tiles (carborandum) of 300x300x22 mm thick manufactured as per IS: 1237 using colouring pigment and hard chips like carborandum, quartz etc shall be laid as per IS: 1443 over concrete under bed to result in overall thickness of 50 mm.

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

1.6 Polished Granite Flooring

This shall be provided in areas such as Administration building office area, corridor, staircase etc. Tiles shall be of 25mm thick hard polished granite laid over cement base mortar on concrete bedding.

1.7 IPS flooring

IPS (cement concrete flooring) with metallic floor hardener topping 12 mm thick with a total thickness of 50 mm shall be provided in maintenance and unloading area of turbine building, warehouse floors, operating floor of pump house, warehouse & stores and other plant building areas where heavy duty flooring is required.

IPS flooring with non-metallic floor hardener shall be provided in all MCC and switchgear rooms, which are not air-conditioned.

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

1.6 Granolithic Flooring

1.6.1 Granolithic flooring (cement concrete flooring in 1:1:2) with non-metallic floor hardener topping 12 mm thick with a total thickness of 50 mm shall be provided in maintenance and unloading area of GTG/STG building, permanent stores, and other areas where heavy duty flooring is required.

1.5.2 The other areas of station building, MCC and Switch gear rooms, AC plant rooms, chlorination rooms, relay rooms, DG house, Pump house floors etc., shall be provided with Granolithic Flooring without floor hardener.

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

1.6 Heavy Duty Ceramic Tiles

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

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1.7 Acid / Alkali Resisting Tiles

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

1.8 Integral Floor Finish

For cable vault rooms, mill and bunker bay floors, and floors of wagon tippler shed, reclaim hopper shed, crusher house, junction towers, pent house, elevator machine room shall be provided with floor finish integral to the concrete base as per IS : 2571.

1.9 Cast-in-situ Terrazo

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

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

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

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

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

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

- i) The structures shall be tested for water tightness.

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- ii) Surface on which lining is to be applied shall be prepared as per IS:2395.
- iii) Joints between acid resistant bricks / tiles shall be filled with resin type mortar conforming to IS:4832 (Part II). Seal coat of ready made epoxy paint shall be provided at the joints to cover up any porosity.
- iv) Acid resistant bricks shall be laid with 6 mm wide and 20 mm deep pointing. Pointing shall be with epoxy / furane / CNSL as per the requirement of the agency guaranteeing the performance of lining.
- v) Under side of neutralising pit roof slab, all precast slabs / steel covers over effluent drains shall be given two coats of epoxy coating, each coat of 150 microns thick.
- vi) Acid / alkali resistant treatment shall extend at least 1 metre on all sides from the outermost periphery of pedestals / saddles for indoor installations and 2 metres allround for outdoor installations.

1.11 Polished Vitrified Tiles

Polished vitrified tiles shall be provided in main control building. The tiles shall be of 400 x 400 or 600 x 600, 7.5mm in size and shall be of approved shade, brand and colour.

1.12 MISCELLANEOUS

1.12.1 PVC nosing shall be provided for edge protection of R.C.C. stair treads.

1.12.2 Angles 50x50x6 mm (minimum) with lugs shall be provided for edge protection of cut outs / openings in floor slabs, edge of drains covering gratings, edge of R.C.C cable / pipe trenches of any other place where breakage of edges / corners is expected.

1.12.3 Floors of switchgear rooms shall have embedded steel channel suitable for easy movement of breaker panel.

1.12.4 Stairs of control & switchgear building shall have granite finishing with granite wall cladding for a height of 1000 mm from finished step level. The hand rail shall be of stainless steel.

2.0 SKIRTING / DADO

2.1 150 mm skirting matching with floor finish shall be provided in all areas unless specified otherwise elsewhere.

2.2 Toilets and locker rooms shall be provided with dado of 2100 mm high with glazed tiles of minimum 5 mm thickness generally as per IS:777.

2.3 For auxillary Control room and control equipment room minimum 5 mm thick decorative coloured ceramic tiles shall be provided upto false ceiling

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level. For main control room vitrified polished tiles shall be provided up to the false ceiling level.

2.4 For battery room and other areas coming in contact with acid / alkali spillage / fume, dado of acid / alkali resistant tiling as per IS:4457 shall be provided to a height of 2100 mm set in potassium silicate mortar and joints pointed with resin bonded mortar.

2.5 Staircase wall shall be given dado of cast in situ terrazzo to a height of 2100 mm.

2.6 Entrance lobby and lift area shall be provided with granite tile dado.

3.0 METAL CLADDING

3.1 Permanent Colour Coated Sandwiched Insulated Metal Cladding and Roofing System.

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

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

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

3.1.4 Inner sheet shall fixed directly to side runners and Z spacers made of at least 2 mm thick galvanised steel sheet of grade 375 as per IS:277. Inner sheet shall be fixed at the rate not more than 0.75 m centre to centre to hold the insulation and external sheeting.

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

3.1.6 For roof sheeting the specification remains same as that of side cladding except the thickness and galvanisation. The minimum thickness of roof sheeting shall be 0.8mm with galvanisation rate of 275 gm/sqm

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3.1.6 Prefabricated sandwiched polyurethane PUF panel system may also be used for side cladding and roof sheeting			
3.2 <u>Permanent Colour Coated (non-insulated) Metal Cladding System</u>			
3.2.1 Trough zinc-aluminium alloy coated not less than 150 gm/sq.m M.S. sheets having 0.6 mm minimum thickness shall be used for the cladding system. The outside (exposed face) shall be permanently colour coated with PVF2 paint of minimum DFT 20 microns over primer and the inner side (internal face) shall be coated with same paint of minimum DFT 12 microns over primer. These shall be fixed directly to runners. The sheets shall meet the general requirement of IS:14246 and shall conform to class 3 for the durability. For roof sheeting the specification remains same as that of side cladding except the thickness and galvanisation. The minimum thickness of roof sheeting shall be of 0.8mm with galvanisation rate of 275 gms/sqm			
3.3 <u>Flashings, Cap, Trim Clousure etc.</u>			
All flashings, trim closures, caps etc. required for the metal cladding system shall be made out of plain sheets having same material and coating specification as mentioned above for the outer face of the sandwiched metal cladding.			
4.0 <u>PLASTERING</u>			
4.1 For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency.			
4.1 Details furnished below do not include special types of plaster / plaster finishes which may be provided to enhance the architectural appeal. BIDDER may propose such superior plaster finish in his Bid.			
4.1 External face of all walls shall be provided with 18 mm thick cement mortar plastering with an under layer of 12 mm thick in CM 1:6 and top 6 mm thick layer in CM 1:4 with approved water proofing compound.			
4.2 For internal walls 18 thick plaster in CM 1:6 shall be provided on the uneven side of the wall and 12 mm thick plaster in CM 1:6 on the even side of the wall.			
4.3 Inside surfaces of walls shall be provided with 2 mm thick plaster of paris punning over the plastered surfaces in office areas, entrance lobby, corridor, control equipment room and all other air conditioned rooms.			
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4.4 Ceiling plastering of 6 mm thick with CM 1:4 shall be provided for all the buildings except cable vaults.

4.5 All plastering work shall conform to IS:1661.

4.6 Internal plastering on walls shall be done to cover surfaces from skirting level to bottom of roof slab in all areas including areas where false ceiling is provided.

ALL drips, grooves, mouldings, and cornices as shown on drawing or instructed by the owner shall be done with special care to maintain true lines, levels and profiles. After the plastering work is completed, all debris shall be removed and the area left clean.

Neat cement finish: After achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of 1 kg. Per Sq.M. and rubbed smooth with a trowel.

Curing: All plastered surface after laying, shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

5.0 PAINTING

5.1 Details furnished here in below are the minimum acceptable standard for painting. Superior finish if any required by BIDDER to enhance overall appearance will be permitted if such finish meet with the technical requirements.

5.2 Water proof cement based paint as per IS:5410 shall be provided on external faces of walls, sunshades, etc.

5.3 Inside surfaces shall be provided with Oil Bound Distemper for all areas as per IS: 428 except for Control room, Control equipment rooms, and all air conditioned areas for which acrylic emulsion paint shall be provided as per IS: 5411.

5.4 Walls in D.M.Plant shall be provided with chlorinated rubber based paint. Walls above Dado in battery rooms shall also be provided with similar painting.

5.5 All ceilings shall be provided with water bound distemper as per IS:427.

5.6 Oil resistant paint as per IS:161 shall be provided for oil canal and oil equipment room.

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- 5.7 All wood work shall be provided with fire resistant transparent paint as per IS162 over french polish as per IS:348 or flat oil paint as per IS:137.
- 5.8 Painting for structural steel have been specified else where in this document.
- 5.9 Following general instruction for painting shall be followed.
- i) For painting on concrete, masonry and plastered surfaces IS:2395 parts I and II shall be followed.
 - ii) For painting on wood work IS:2338 part I and II shall be followed.
 - iii) All paints shall be of brand and make as per the approval of OWNER.
 - iv) A minimum of two finishing coats of paint over a primer shall be provided to give a smooth uniform finish for the painted surface.
 - v) All painting on masonry or concrete surfaces shall preferably be applied by rollers.
 - vi) Thinner shall not be used with textured paint (sandtex matt etc.) finish.
 - viii) All fire exits shall be painted in Post office red colour shade which shall not be used any where except to indicate emergency or safety measure. In detailing of all buildings, fire safety requirements conforming to IS: 1641 and IS:1642 shall be followed.

6.0 **Roof covering**

All buildings having R.C.C slabs over structural steel framing are provided with troughed metal sheet decking which acts as permanent shuttering. These sheets shall meet the general requirements of IS:14246 and shall conform to class 3 for durability. The sheeting shall be permanently colour coated galvanised MS troughed metal sheet decking of approved profile with minimum base metal thickness of 0.8 mm and minimum trough depth of 38mm. Silicon modified polyester painting shall be used for permanent coating over galvanised surface with minimum rate of galvanising of 180 gm of zinc per sq.m. Dry film thickness of colour coating shall be at least 20 micron.

- 6.1 Roof of other buildings having RCC frame work / structural steel framing shall have cast in situ RCC slab with conventional shuttering.

7.0 **ROOF DRAINAGE AND WATER PROOFING**

- 7.1 For efficient drainage of rainwater, roof concrete shall be given a gradient of a minimum of 1 in 100. The gradient shall preferably provided by sloping the structural framing system itself. Gradient may also be provided

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using screed concrete of grade M20 using 12.5 mm downgraded aggregate. But the average thickness of such screed concrete shall be restricted to about 50 mm.

7.2 All roofs shall be provided with extra heavy duty water proofing treatment comprising of

- i) seven courses as per IS:1346 using 3 layer of glass fibre based felt as per IS:7193
- ii) 50 mm thick foam concrete as per IS:6598 for thermal insulation
- iii) 15 mm thick cement sand plaster 1:4
- iv) chequered cement tiles as per IS:13801 shall be provided over water proofing treatment in areas where movement of personnel is expected. Minimum width of pathway if provided only locally shall be 1000 mm.
- iv) In areas such as roof of control room building etc. where handling of equipment is anticipated, the foam concrete may be replaced by 40 mm screed concrete of grade M 20.

7.3 All roof waterproofing shall be provided using high solid content liquid applied elastomeric water proofing membrane with separate wearing course as per ASTM C-898. Thickness of the membrane shall be a minimum of 1.5mm. The treatment includes application of polymerised mortar over sloped roof to achieve a smooth surface and a primer coat. Wearing course shall be 40mm screed of 1:2:4 concrete cast in panels of 1.2mx1.2m and reinforced with 0.56mm dia galvanised chicken wire mesh and joints sealed using sealing compound. Accessible roof shall be provided with chequered cement tiles as per IS: 13801 over water proofing treatment in areas where movement of personnel is expected. Minimum width of pathway if provided locally shall be 1000 mm. China mosaic tile flooring shall be laid over the water proofing layer to protect against heat over all building roofs.

7.4 Number and size of rain water down take pipe shall be decided based on the provisions of IS:1742 and IS:2527. The pipes shall be UPVC pipe conforming to class-3 of IS: 4985. It is recommended that the minimum diameter of the pipe shall be kept as 160 mm and there shall be a minimum of two pipes provided on each gutter. The down comer pipes shall be suitably concealed with masonry work, cement concrete or sheeting to match with the exterior finish.

8.0 FALSE CEILING AND UNDER DECK INSULATION

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

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8.2	Main Control room shall be provided with Aluminium false ceiling system (LUXALON). This shall comprise of 84 mm wide 12.5 mm deep closed type plain panels of approved colour, roll formed out of 0.5 mm thick corrosion resistant aluminium alloy AA 5050 fixed on roll formed carriers. Additional hangers and height adjustment clips shall be provided for return air grills, supply air diffusers, light fixtures, AC ducts etc.		
8.3	All air conditioned areas and other control rooms shall be provided with Gypboard false ceiling modular system. This shall consist of 600x600x12.5 mm gypboard with one coat of primer and two or more coats of acrylic emulsion paint. The suspension system shall consist of 6 mm diameter galvanised steel rods suspended from ceiling supporting aluminium grid of 38x25x1.5 mm and cross tie of 25x25x1.5 mm and aluminium angle of 25x25x1.5 mm.		
8.4	Suitable M.S channel (minimum ISMC100) grid shall be provided above false ceiling for movement of personnel to facilitate maintenance of lighting fixtures, AC ducts etc.		
8.5	CONTRACTOR shall prepare a layout of the false ceiling system incorporating light fixtures, supply air diffuser, return air grills, fire detectors, fire protection sprinklers etc. such that the ceiling looks aesthetically pleasing. Work shall commence only after the OWNER approves the layout.		
8.6	Under deck insulation shall comprise of 50 mm thick resin bonded mineral wool insulation mat conforming to IS:8183. This mat shall be backed with 0.05 mm thick aluminium foil and 24 Gx25 mm wire mesh netting. These shall be fixed to ceiling or wall as the case may be with 100x50x6 mm slotted mild steel plate welded to M.S. plate inserts embedded at the soffit of the slab at 600 mm c/c and 14 G steel wire drawn through slots and fixed to wire netting.		
9.0	<u>DOORS & WINDOWS</u>		
9.1	Unless specified all doors, windows and ventilators of air conditioned areas, entrance lobby of all buildings and windows/ventilators provided on the outer face of all buildings shall have, powder coated coated aluminium framework with glazing. All other doors (unless otherwise specified) shall be of flushed steel type and windows and ventilators shall be of glazed steel type.		
9.2	Main entrance of the control room building and control equipment room shall be provided with air-locked lobby with provision of double doors of aluminium frame work with glazing. Doors shall be of double swing type or sliding type.		
9.3	For common control building, double glazed wall panels with aluminium frame shall be provided between air-conditioned and non air-conditioned		
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areas and on the side of control room and control equipment room(s) facing the operating floor to have a clear view.

9.4 Single glazed panels with aluminium frame work shall be provided as partition between two air-conditioned areas wherever clear view is necessary.

9.5 All steel doors shall consist of double plate flush door shutters. The door shutter shall be 45 mm thick with two outer sheets of 18 G rigidly connected with continuous vertical 20 G stiffeners at the rate of 150 mm centre to centre. Side, top and bottom edges of shutters shall be reinforced by continuous pressed steel channel with minimum 18 G. The door shall be made sound proof by filling the inside void with mineral wool. Doors shall be provided with all hardware and fixtures like door closer, tower bolts, handles, stoppers, aldrops, etc. Steel windows and ventilators shall be as per IS: 1038.

9.6 Wherever functionally required rolling shutters with suitable operating arrangement manual / Electric shall be provided to facilitate smooth operations. Rolling shutters shall conform to IS:6248.

9.8 All windows and ventilators on ground floor of all buildings located in isolated areas shall be provided with suitable anodised aluminium grill.

9.9 Fireproof doors with panic devices shall be provided at all fire exit points as per the recommendations of Tariff Advisory Committee (TAC). These doors shall generally be as per IS:3614 (Part I and Part II). Fire rating of the doors shall be as per TAC requirements. However minimum rating shall be 2 hours. These doors shall be double cover plated type with mineral wool insulation.

9.10 Hollow extruded section of minimum 3 mm wall thickness as manufactured by INDAL or equivalent shall be used for all aluminium doors, windows and ventilators.

9.11 For common control building, double glazed wall panel with aluminium frame shall be provided between air-conditioned and non air-conditioned areas.

Number, type, make and shade of all Hardware's and fixture used shall be of shall be provided as per owner's selection.

10.0 Glazing

10.1 All ventilators and windows on external face of building shall be provided with light tinted sheet glass of minimum 6 mm thickness.

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- 10.2 Where specified, double glazing shall consist of two 6 mm thick clear toughened light tinted safety glass conforming to IS:2553, hermetically sealed and separated by 12 mm thick gap for thermal insulation.
- 10.3 For single glazed aluminium partitions and doors, Float glass or flat transparent light tinted sheet glass of minimum 6 mm thickness shall be used.
- 10.4 Ground glass / frosted glass of minimum 4 mm thickness with light tint shall be used for all windows / ventilators in toilets.
- 10.5 Unless specified otherwise in this specification minimum thickness of plain sheet glass used for windows/ventilators shall be 4 mm.
- 10.6 Float glass or flat transparent sheet glass shall conform to IS:2835.
- 10.7 All glazing work shall conform to IS:1083 and IS:3548.

11.0 **WATER SUPPLY AND SANITATION**

- 11.1 Roof water tank of adequate capacity depending on the number of users and 8 hours requirement shall be provided for each building and pump house. Polyethylene water storage tank conforming to IS:12701 shall be used. The tank shall be complete with all fittings including float valve, stop cock etc.
- 11.2 Galvanised M.S. pipe of medium class conforming to IS:1239 shall be used for internal piping works for potable water supply.
- 11.3 Sand C.I pipes with lead joints conforming to IS1239 / UPVC pipes conforming to Class-3 of IS: 4985 shall be used for sanitary works above ground level and for below ground level Cast Iron shall be used.
- 11.4 Minimum one toilet block with all the facilities shall be provided on each floor of main plant building. One toilet shall be provided in the boiler area. All other buildings where toilet is specified shall have one toilet block . The facilities provided in the toilet block shall depend on the number of users. However, minimum facilities to be provided shall be as stipulated below. IS:1172 shall be followed for working out the basic requirements for water supply, drainage and sanitation. In addition, IS:2064 and IS:2065 shall also be followed.
- 11.5 Each toilet block shall have the following minimum facilities. Unless specified all the fittings shall be of chromium plated brass (fancy type).
- i) WC (Indian type) Orissa pattern (580x440mm) as per IS:2556 (Part-3) with all fittings including flushing arrangement of appropriate capacity and type – 1no.

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- ii) WC western type 390 mm high as per IS:2556 (part 2) with toilet paper roll holder and all fittings including flushing system of appropriate capacity and type – 1 no.
- iii) Urinal with all fittings with photo voltaic control flushing system as per IS:2556 (Part-6, Sec.1) – 2 nos.
- iv) Wash basin (oval shape) with all fittings as per IS:2556 to be fixed on concrete platform finished with 12 mm thick polished granite stone – 2 nos.
- v) Wall to wall Bathroom mirror (5.5 mm thick float glass) with bevelled edges including all fittings – 2 nos.
- vi) Stainless steel towel rail (600 x 20mm) - 2 nos.
- vii) Stainless steel liquid soap holder cum dispenser – 2 nos.
- viii) Janitor room.
- ix) Provision for installation of water cooler outside the toilet.
- x) Provision of ventilation shaft.

Unless specified all fittings in the toilets shall have same specification as stipulated above

Attached toilets shall be provided for senior executive rooms and conference rooms shall have 1 WC, 1 urinal, 1 washbasin, 1 mirror, 1 no. Towel rail, 1 liquid soap holder cum dispenser. WC shall be of western type 390 mm high as per IS:2556(Part-2) with toilet paper roll holder and all fittings including flushing valve of appropriate capacity and type.

- 11.6 HRSG area toilet shall have minimum 2 no. WC (Indian type), 4 no. urinals, 4 no. wash basins, 4 no. mirrors, 4 no. towel rails, 4 no. soap holder cum dispenser, 2 no. showers, janitor room and a provision for installation of water cooler.
- 11.7 An eye and face fountain (combined unit with receptable) conforming to IS:10592 shall be provided in battery room, D.M plant and Chlorination plant.
- 11.8 Unless specified all fittings and fixtures in the toilets shall have same specifications as stipulated in Cl.No.11.5.
- 11.9 Stainless steel kitchen sink (750 mm size) for pantry shall be provided. Platform in pantry shall be finished with 12 mm thick polished granite stone.
- 11.10 Laboratory sink shall be of white vitreous china of size 600x400x200 mm conforming to IS:2556(Part-5) in laboratories and in battery room.
- 11.11 In GTG/STG building,, Control room building at least one toilet block shall be provided for ladies.
- 12.0 **MISCELLANEOUS REQUIREMENTS**

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- 12.1 Doors and windows on external walls of buildings shall be provided with RCC sunshade over the openings with 300 mm projection on either side of the opening. Projection of sunshade from the wall shall be minimum 450 mm over window openings and 750 mm over door openings.
- 12.2 Doors and windows on the external walls of buildings with metal cladding shall be fixed by creating recesses in the cladding system.
- 12.3 Duct banks consisting of PVC conduits for cables shall be provided with proper sealing arrangement consisting of fire retardant sealing compound.
- 12.4 All floor openings for cables below electrical panel shall be sealed with fire sealing compound after cables are laid.
- 12.5 All openings in external walls provided for pipes, cables, ducts etc. shall be effectively sealed to prevent water seepage, after the routing of the services are over.
- 12.6 **Natural Lighting & Ventilation**
 - 12.6.1 The area of windows shall be a minimum 15% of the floor area to ensure adequate natural lighting.
 - 12.7.1 Fans shall be provided in general office area as per standard norms.
 - 12.7 Sewerage system shall be provided with adequate ventilation for the pipe work as well as manhole.

Finishes: (Brief details of finishes)

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Building/ area	Brief description				
	Wall (Internal)	Floor	Ceiling	Roof treatment	Wall (External)
STG & GTG building					
Ground floor:	Oil bound distemper	Carborandum tiles	Water bound distemper		Granular finish (Vineratex)
Toilet	Dadoing for 2100mm high + Oil bound distemper	Heavy duty ceramic tiles	Water bound distemper		Granular finish (Vineratex)
Control and Switch gear building					
Central control room	Acrylic emulsion paint	Heavy duty ceramic tiles	Water bound distemper	Elastomeric water proofing treatment	Granular finish (Vineratex)
Switch gear room	Acrylic emulsion paint	IPS with non metallic floor hardner	Water bound distemper		Granular finish (Vineratex)
Battery room	Acid & Alkali tile dadoing for 2100mm high + Chlorinated rubber based paint	Acid / Alkali resistant tiles	Chlorinated rubber based paint		Granular finish (Vineratex)
Office, Common areas & Corridor	Acrylic emulsion paint	Vitrified tile flooring	Water bound distemper		Granular finish (Vineratex)
Cable room	Oil bound distemper	IPS with non metallic floor hardener	Water bound distemper		Granular finish (Vineratex)
Toilet	Dadoing for 2100mm high + Oil bound distemper	Heavy duty ceramic tiles	Water bound distemper		Granular finish (Vineratex)

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Electronic cubicle room & Computer room	Acrylic emulsion paint	Heavy duty ceramic tiles	Water bound distemper		
Laboratory room	Acrylic emulsion paint	Heavy duty ceramic tiles	Water bound distemper		Granular finish (Vineratex)
D M plant building					
Chemical storage room	Chlorinated rubber based paint	Acid / Alkali resistant tiles	Water bound distemper	Elastomeric water proofing treatment	Granular finish (Vineratex)
Office	Acrylic emulsion paint	Heavy duty ceramic tiles	Water bound distemper		Granular finish (Vineratex)
Toilet	Dadoing for 2100mm high + Oil bound distemper	Heavy duty ceramic tiles	Water bound distemper		Granular finish (Vineratex)
Water treatment area	Chlorinated rubber based paint	Acid / Alkali resistant tiles	Water bound distemper		
Laboratory room	Acrylic emulsion paint	Heavy duty ceramic tiles	Water bound distemper		
Control room	Acrylic emulsion paint	Heavy duty ceramic tiles	Water bound distemper		
Clarified Water pump house	Oil bound distemper	IPS flooring with non metallic floor hardener	Water bound distemper	Elastomeric water proofing treatment	Granular finish (Vineratex)
Cooling Water pump house	Oil bound distemper	IPS flooring with non metallic floor hardener	Water bound distemper	Elastomeric water proofing treatment	Granular finish (Vineratex)
Permeate water pump house	Oil bound distemper	IPS flooring with non metallic floor hardener	Water bound distemper	Elastomeric water proofing treatment	Granular finish (Vineratex)

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Sea water pump house	Oil bound distemper	IPS flooring with non metallic floor hardener	Water bound distemper	Elastomeric water proofing treatment	Granular finish (Vineratex) / Water proof cement paint
DG & Compressor house	Oil bound distemper	IPS flooring with non metallic floor hardener	Water bound distemper	Elastomeric water proofing treatment	Granular finish (Vineratex)
BFP Building	Oil bound distemper	IPS flooring with non metallic floor hardener	Water bound distemper	Elastomeric water proofing treatment	Granular finish (Vineratex)
Chlorination Building	Chlorinated rubber based paint	Acid / Alkali resistant tiles	Water bound distemper	Elastomeric water proofing treatment	Granular finish (Vineratex)
Fuel Gas Control Room	Acrylic emulsion paint	Heavy duty ceramic tiles	Water bound distemper	Elastomeric water proofing treatment	Granular finish (Vineratex)

Stores

Chemical Storage Room	Chlorinated rubber based paints	Acid/Alkali resistant tiles	Water bound distemper		
Office	Acrylic emulsion paint	Heavy duty ceramic tiles	Water bound distemper		
Toilet	Acrylic emulsion paint	Heavy duty ceramic tiles	Water bound distemper		

Workshop

Workshop Building	Oil bound distemper	IPS flooring with non metallic floor hardener	Water bound distemper		
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Filter water Pump House

Filter water pump house	Oil bound distemper	IPS flooring with non metallic floor hardener	Water bound distemper	Elastomeric water proofing treatment	Granular finish (Vineratex)
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Door, Window and Ventilator Schedule

Building/Structures	Doors	Windows/Ventilators
Temporary site office	Pressed steel door frame with double plate flush shutters	Pressed steel frame with steel glazed window
GTG / STG building	On external walls: Pressed steel doorframe with double plate flush shutters. For equipment entry: steel sliding type / Rolling shutters Office area: Pressed steel door frame with Pre laminated particle board (MDF exterior grade) shutters Entrance lobby: Electro colour coated (anodised) aluminium framework with glazing. FPD as per TAC requirement	Windows: Sliding type anodised aluminium framework with 6mm thick glass. Ventilators (External faces): Aluminium framed louvers Ventilators (Internal faces): Pressed steel frame with steel ventilators
Control room building	Main entrance: Aluminium glazed double leaf with fixed sheet glass in anodised aluminium frame on either side. Entrance to Control room: Electro colour coated (anodised) aluminium framework with glazing. For equipment entry: steel sliding type / Rolling shutters Office area: Pressed steel frame with Pre laminated particle board (MDF exterior grade) shutters	Control room: Glazed aluminium sliding type windows Switchgear room: Glazed aluminium windows with wire glass Other area: Electro colour coated (anodised) aluminium framework with glazing.
	A/C area: Electro colour coated (anodised) aluminium framework with glazing.	
	Switchgear room: Steel sliding type door.	

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	Battery room: PVC Frame with PVC door, Cabin doors: Single leaf glazed aluminium doors FPD as per TAC requirement.	
DM plant control room & laboratory	Aluminium glazed doors. For equipment entry: steel sliding type / Rolling shutters	Aluminium glazed sliding windows.
Clarified water Pump House	Pressed steel door frame with double plate flush shutters	Pressed steel frame with steel glazed window
Clarified Water Pump House	Pressed steel door frame with double plate flush shutters	Aluminium glazed sliding windows.
Permeate Water Pump House	Pressed steel door frame with double plate flush shutters For equipment entry: steel sliding type / Rolling shutters	Pressed steel frame with steel glazed window
Sea Water Pump House	Pressed steel door frame with double plate flush shutters For equipment entry: steel sliding type / Rolling shutters	Pressed steel frame with steel glazed window
DG & Compressor Building	Pressed steel door frame with double plate flush shutters For equipment entry: Rolling shutters	Steel windows with 6mm thick wire glass and MS grill work
Workshop & Stores	Pressed steel door frames with double plate flush shutters For equipment entry: Steel sliding type/Rolling Shutters Office Area: Prestressed steel frame with pre-laminated particle board (MDF exterior grade) shutters.	Steel windows with 6mm thick wire glass and MS grill work

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Note: Windows facing transformer yard shall be provided with 6mm thick wire glass in addition to specific requirement given above

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SCOPE

The specification covers general requirements of materials, design, Construction and Testing of R.C.C works involved in the construction of Reinforced Concrete Induced Draught Cooling Tower.

2.0

CODES AND STANDARDS

A. Materials

- i. IS:432 Mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
- ii. IS:1785 Plain hard drawn steel wire for prestressed concrete.
- iii. IS:1786 High strength deformed steel bars and wires for concrete reinforcement.
- iv. IS:2062 Steel for general structural purposes.
- v. IS:3589 Seamless or electrically welded steel pipes for water, gas and sewage (168.3mm - 2032 mm)
- vi. IS:8112 43 Grade Ordinary Portland Cement
- vii. IS:12330 Sulphate resisting portland cement.

B. Codes of Practice

- i. IS:456 Code of practice for plain and reinforced concrete.
- ii. IS:800 Code of practice for general construction in steel.
- iii. IS:875 Code of practice for design loads (other than earthquakes for building and structures).
- iv. IS:1080 Code of practice for design and construction of simple spread foundations.
- v. IS:1343 Code of practice for pre-stressed concrete

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|-------|-----------------------|--|---------|
| vi. | IS:1893 | Criteria for earthquake resistant design of structures. | |
| vii. | IS:2309 | Code of practice for the protection of buildings and allied structures against lightning. | |
| viii. | IS:2629 | Recommended practice for hot dip galvanising on iron and steel. | |
| ix. | IS:2950 (part 1) | Code for practice for design and construction of raft foundation. | |
| x. | IS:3043 | Code of practice for earthing. | |
| xi. | IS:3370 (part 1 to 4) | Code of practice for concrete structures for storage of liquids. | |
| xii. | IS:12200 | Code of practice for provision of water stops at transverse contraction joints in and concrete dams. | masonry |
| xiii. | BS:4485 (All parts) | Specification for water cooling towers. | |
| xvi. | BS:8007 | B.S.Code of Practice for design of concrete structures for retaining aqueous liquid. | |

2.1 The applicability of the provisions for conformity to the various codes and standards stipulated shall be in the following order.

- a) Bureau of Indian Standards.
- b) British Standards Institution.

Wherever the above Standards are in conflict with the stipulations of this specification, the latter shall govern.

3.0 GENERAL REQUIREMENTS

3.1 The cooling tower shall be capable of cooling the rated quantity of water through the specified thermal range at the design wet bulb temperature and it shall conform to the other design parameters as stipulated in the Mechanical section of this document.

3.2 The scope of the BIDDER'S work for a cooling tower shall include preparation of detailed designs and construction drawings and execution of

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work including but not limited to supply of all material for foundations, shell, basin, fill with its supporting structure, staircases/walkways/platforms with handrailing, cold water outlet channels including gates, screens with handling arrangement, painting, access doors, water distribution system, aviation warning system, lighting, lightning protection system, with their associated hardware, etc., complete all as required to give satisfactory performance and as stipulated in various clauses in this document.

3.3 CONTRACTOR shall submit detailed design calculations and construction drawings to OWNER for obtaining his approval prior to commencement of work at site.

3.4 In the event, BIDDER has quoted in collaboration with another firm (either Indian or foreign), each and every drawing and design calculations submitted shall bear collaborator's seal and signature indicating their approval. BIDDER shall also furnish, along with the offer, back-up guarantee for the performance of the cooling tower from the collaborator.

4.0 LOADINGS

4.1 Wind loads shall be considered as per IS:875 with appropriate values for K1, K2 and K3.

4.2 Earthquake loads shall be considered as per IS:1893 duly considering the type of soil and foundation system. Importance factor shall be taken as per IS 1893.

4.3 Dead load shall be considered as per IS:875. In addition to all loads, fungus load of 100 kg/m² shall be considered.

4.4

4.5 Live load on staircase, walkways and fan deck shall be taken as 5 KN/sq.m

4.6 Loading brought upon the cooling tower by permanent fixture shall be taken into account.

4.7 Design shall take into account all temporary loading during erection and construction stages.

4.8 Dead loads

Dead loads shall include the weight of structure complete with finishes, fixtures and partitions, false-ceiling and shall be taken as per IS: 875. Dead loads for natural draft cooling towers shall include self weight of structure, weight of fill material, weight due to algae growth, weight of falling water, weight of hot water pipe, weight of water in hot water channel and

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distribution system including the self weight of channel and distribution system, weight of drift eliminators, etc.

- 4.8 Equipment, piping and associated loads
Loads of all equipments like Deaerator, Heater, Feed water Tank, Cooling Equipment, Motors, fan drive pulleys, Pumps, Monorails, Ventilation duct, air inlet & exhaust duct, Electrical control and relay panels, Cable load, Pipe load (static and dynamic), Tanks, AHU, Batteries, Air Washer, etc. shall be considered over and above the imposed loads. Equipment loads shall be considered as given by equipment supplier. Equipment loads which are of permanent nature shall be treated as dead loads.

4.9 **Load Combination for Induced Draught Cooling Tower**

Static Analysis and Design

The following load conditions shall be considered for the design of the Fan supporting structure along with other load combinations as per IS:875.

- i) Machine Load.
 - a. Load case 1 + equalvant static load due to unbalance force of fan corresponds to balance quality grade G 16mm/sec as per IS:1940.
 - b. Load case 1 + unbalance load corresponding to one blade failure load condition.
 - c. The strength design of the Fan supporting structure shall be done for worst loading combinations as stated above.
- ii) Dynamic analysis
 - a) Free vibration analysis

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

Forced response analysis shall be carried out for the fan supporting structure including the intermediate structure supporting the motor, gear box and pillow block to calculate the vibration amplitudes for the following unbalance condition.
 - a) For unbalance load corresponding to balance quality grade Q 16 mm/sec of the fan as per IS 1940.



The amplitude so calculated shall be within the permissible values as specified by the fan manufacturer or IS-2974 whichever is more stringent.

iii) Mid Bearing supporting structure

The intermediate supporting structure for motor, gearbox and pillow block shall be so arranged that it does not cause any torsional moments on the beams/pedestals on which the intermediate support rests. The intermediate supporting structure shall be orthogonal to the grid of beams on which it rests. The motor shall be supported on a base frame.

5.0 **CONCRETE WORKS**

5.1 Cement used shall be OPC complying with IS:8112. Same brand of cement shall be used as far as possible through out the construction of the entire structure to enable to achieve uniform color and surface finish for the superstructure. In locations where chemical analysis of subsoil reveals high sulphate content, sulphate resistant cement shall be used below ground level.

5.2 Minimum grade of concrete for various R C C structural components shall be M30.

5.3 Minimum cement content per cubic meter of concrete shall be as per Table 5 of IS: 456.

5.4 In locations where high sulphate resistant cement has to be used below ground level, minimum cement content shall be as per Table 4 of IS:456.

5.5 Material, design, construction and workmanship in general shall conform to IS:456 in limit state design with a limiting crack width of 0.1mm. For prestressed concrete works, design, construction and workmanship shall be in accordance with IS:1343.

6.0 **REINFORCING STEEL**

6.1 Reinforcement bars shall conforming to IS: 432 grade I quality for mild steel and IS: 1786 for yield strength deformed bars.

6.2 All the reinforcement bars used shall be of fusion bond epoxy coating as per IS 13620.

6.3 Steel wires for prestressing shall conform to IS:1785 (part 1 & 2).

7.0 **STRUCTURAL STEEL**



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13.0 This section defines the technical requirements for surface preparation selection and application of paints on equipment, vessels, machinery, piping, ducts etc. However, manufacturers shall follow their standard procedures for painting their equipment. The Bidder shall submit a detailed painting procedure for approval of Employer / Employer's Representative after the award of contract.

13.1 The following surface and material shall require painting:

- (a) All un-insulated carbon steel and alloy steel equipment like columns, vessels, drums, storage tanks, heat exchangers etc.
- (b) All un-insulated carbon steel and low alloy piping, fitting and valves (including painting of identification marks).
- (c) All pipe structural steel supports, walkways, platforms, hand rails, ladders etc.

13.2 The following surfaces and material shall not require painting:

- (a) Non-ferrous materials
- (b) Austenitic stainless steel
- (c) Plastic and / or plastic coated materials
- (d) Insulated surface of equipment and pipes except colour coating wherever required.
- (e) Painted equipment like blowers, pumps, valves, etc., with finishing coats in good condition and with matching colour-code.

13.3 Codes and Standards

Painting of equipment shall be carried out as per the specifications indicated below and shall conform to the relevant IS specification for the material and workmanship.

The following Indian Standards may be referred to carrying out the painting job.

- IS : 5 : Colours for ready mixed paints and enamels
- IS : 1303 : Glossary of terms relating to paints
- IS : 2379 : Colour code for identification of pipelines.
- IS : 2395 : Code of practice for finishing of concrete, masonry and plaster surfaces (Parts I and II)

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- IS : 2338 : Code of practice for finishing of wood and wood based materials (Parts I & II)
- IS : 158 : Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and heat resisting
- IS : 2074 : Ready mixed paint, air drying, red oxide zinc chrome, and priming.
- IS : 104 : Ready mixed paint, brushing, zinc chrome, priming
- IS : 2932 : Enamel, synthetic, exterior
- (a) undercoating
(b) Finishing.
- SIS : 55900 : Swedish standard for blasting

13.4 Surface Preparation

The surface shall be prepared in a manner suitable for coatings. Chemical derusters or rust converters shall not be applied. Acid cleaning is subject to approval of Purchaser / Purchaser representative.

13.4.1 Blasting

The surface of the part / component shall be blasted before the coating material is applied.

Unless otherwise specified in the documents, the surface shall satisfy the following requirements after blasting:

(a) Blasting according to SIS 055900, Grade Sa-2¹/2.

Depending on production flow, weldable, ethyl zinc silicate shop primer, dry film thickness 15 – 25 microns shall be used.

13.4.2 Manual Rust Removal

Manual rust removal shall be allowed for welded zones and for touching up installed components.

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13.4.3 **Cleaning**

Removal of impurity

Impurity	Removal
(a) Dust, loose deposits	Vacuum-cleaning, brushing
(b) Adhesive deposits	Power brushing
(c) Oils, greasy impurities	Wet blasting, use of detergent additives by agreement
(d) Salt deposits	Rinsing
(e) Markings (e.g., felt tip pen)	Organic solvents to manufacturer's specifications e.g., Trichloro trifluoro ethane and solvents containing acetone (renew solvent and rag frequently).

13.5 **Processing**

13.5.1 **General**

Application Conditions

The primer shall be applied to properly prepared surfaces only. The specifications of the coating material manufacturers shall be observed. The minimum temperature shall be +5°C and the relative humidity shall not exceed 80%. The temperature of the work piece shall be atleast 3 °C above dew point.

13.5.2 **Application Procedure**

The primer shall be applied by means of brush or by spray. The top coats shall be applied by means of brush, roller or by spray.

At points where coating application is interrupted, the individual layers shall be adequately stepped to ensure proper layer sequence when coating operations are resumed.

13.5.3 **Touching Up**

Before each layer is applied, previous coating shall be touched up where necessary by way of rust removal and cleaning, according coating manufacturer's specifications. The final top coat shall be reapplied completely, if required.

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**13.5.4 Uncoated Surfaces**

Moving parts of machines (e.g., stems, shafts, sliding and locating bearings), nameplates, instruments and sealing surface shall not be coated. Welds shall be left free of coating upto a distance of 30 mm on each side of the weld edge until erection and weld examinations, if any, have been completed.

13.5.5 Bond Strength

The pull-off stress determined using the pull-off test method for adhesion shall be not less than 1.5 N/mm², according to ISO 4624.

13.6 Surface Conditions of Coating Surfaces

The coating surface shall have a uniform film thickness, shade and gloss and shall be free from inclusions, sags and wrinkles.

13.7 Coating Systems**13.7.1 General Requirements for Coating Systems**

Coating materials according to SSPC, BS 5493 or DIN 55 928 shall be used. Intermediate coats are to be pigmented with micaceous iron oxide. The materials shall be matched with each other so that they are compatible. Coatings deviating this specification shall be subject to approval. Standards of surface preparation and painting shall give a time to first maintenance of 10 years.

The colour and gloss of top coats shall be in accordance with sub-clause suggested colour codes for painting (Sub-clause 13.10).

13.7.2 Standard Coating System (External Coatings)

(a) For painting of civil structures in general and other steel structures not covered below shall be carried out as specified in the Civil Section D4.3 of the specification

(b) Galvanised iron and steel requiring paint finish at site

(i) At site

Surface Treatment

Mechanical cleaning from contaminants by means of washing or steam jetting and sweep blasting with fine sand or etching (T-Wash).

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SPEC. NO.
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De rusting St 3 and application of high build epoxy primer DFT 80 µm.

Finish coating:

Analogous to standard painting scheme

13.7.3 Painting of indoor components such as valves, pumps, motors, electrical parts, tanks etc.**At works**Surface preparation:

Blasting according to SIS 055900: grade Sa 2 ½. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer dry film thickness 15 – 25 µm, may be used.

Prime coat:

Two (2) layers of zinc phosphate epoxy, total dry film thickness 75 µm.

At site

Thorough cleaning to remove oil, grease, dirt and any other contaminants. Derusting of all mechanical damages according to SIS 055900 Grade ST3. Touch up with 1 pack inorganic ethyl zinc silicate, dry film thickness 50 µm

Finish coat:

Two (2) layers of a 2 pack epoxy polyamide glossy, according to colour specification, dry film thickness 60 µm.

Total system dry film thickness 135 µm.

Remarks:

Equipment coated with a standard application system can be accepted if the quality of this application system is corresponding with the quality of the above mentioned system.

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**13.7.4 Painting of Outdoors equipments (external surfaces) such as piping, valves, pumps, motors, electrical parts, tanks etc.**

Weather exposure, weather resistance, temperature upto 120⁰C as per 13.7.1 and 13.7.3 however.

Surface Preparation:

Blasting according to SIS 055900: grade Sa 2 ½. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer dry film thickness 15-25 µm, may be used.

Prime Coat:

Two (2) layers of zinc phosphate epoxy, total dry film thickness 75 µm.

Intermediate Coat:

One (1) layer 2 pack high build epoxy polyamide Mio, dry film thickness 100 µm.

Finish Coat:

One (1) layer of a 2 pack aliphatic polyurethane glossy minimum dry film thickness 50 µm. Total system dry film thickness 225 µm.

13.7.5 Special Coating System (External Coatings)**(a) Parts exposed to temperatures above 120⁰C, upto 200⁰C, not insulated****(i) At works****Surface Preparation:**

Blasting according standard SIS 55900 Grade Sa 2¹/₂ and ISO 8501-1: 1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer, dry film thickness 15-25 µm, may be used.

Prime coat

Inorganic ethyl zinc silicate, dry film thickness 75 µm.

(i) At site**Pre-treatment:**

Derusting of all mechanical damages, according to ISO 8501-1: 1989, grade St 3 Touch-up with 1 pack inorganic ethyl zinc silicate, dry film thickness 50 µm.

Removal of all decontaminants from prime coat.

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SPEC. NO.
TCE.4916A-H-500-001Intermediate Coat:

1 pack silicon acrylic, dry film thickness 35 μ m.

Final coat :

1 pack silicon acrylic, dry film thickness as 35 μ m.

Total system dry film thickness 145 μ m.

Final coat according to colour code.

(b) **Parts exposed to temperatures above 200°C, upto 400°C, not insulated**

(i) At works

Surface Preparation:

Blasting according to ISO 8501-1: 1988 grade Sa 2^{1/2}. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer, dry film 15-25 μ m, shall be used.

Prime coat:

Inorganic ethyl zinc silicate, dry film of thickness 75 μ m.

(ii) At site

Pre-treatment:

Derusting of all mechanical damages, according standard Sa 2^{1/2} to ISO 8501-1: 1988. Touch-up with coating system according to manufacturer's recommendations.

(c) **Insulated Parts, continuously exposed to condensing water or parts exposed to temperatures**

For parts that are provided with insulation on site.

(i) **Insulated parts, exposed to condensing water**

At works

Surface Preparations:

Blasting according standard Sa 2^{1/2} to ISO 8501-1: 1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer, dry film thickness 15-25 μ m shall be used.

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SPEC. NO.
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Inorganic ethyl zinc silicate, dry film thickness 75µm.

(ii) Insulated parts exposed to temperatures

Parts, exposed to temperatures upto <400⁰C at works

Surface Preparation:

Blasting according to standard Sa 2¹/₂ to ISO 8501-1: 1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer, dry film thickness 15-25 µm shall be used.

Parts, exposed to temperatures above 400⁰C at works (Steam pipes, pressure tubes and parts for the HRSG, such as heating surfaces, heaters and super heaters reheaters, etc.)

Surface preparation:

Blasting according standard Sa 2¹/₂ to ISO 8501-1: 1988.

Temporary primer:

Varnish.

(d) Intermittent exposure due to condensing water / chemicals (Indoors)**(i) At works**Surface Preparation:

Blasting according to standard Sa 2¹/₂ to ISO 8501-1: 1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer, dry film thickness 15-25 µm may be used.

Prime Coat:

Two layers of zinc phosphate epoxy primer total dry film thickness greater than or equal to 75 µm.

(ii) At sitePretreatment:

Derusting of all mechanical damages, according standard Sa 3 to ISO 8501-1: 1988, touch-up with 2 pack high build epoxy with volume solid content of more than 85%, 75 µm.

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Intermediate Coat:

2 pack high build epoxy, dry film thickness 80 μm .

Finish coat:

2 pack epoxy according to colour appearance, dry film thickness of 50 μm .

Total system dry film thickness 205 μm .

When exposed to weathering, weather resistance finish coat shall be applied.

(e) Water exposure

Surfaces permanently or predominantly in contact with water.

(i) At site / worksPretreatment:

Removal of all welding pearls.

Blasting according standard Sa 3 to ISO 8501-1: 1988.

Coat:

4 coats 2 pack coal-tar-epoxy, dry film thickness 125 μm each.

Total system dry film thickness 500 μm .

Touch-up after erection as required.

13.7.6 Buried / underground piping system

(a) Where pipelines are buried, underground protection shall be provided for the piping system as indicated in any one of the methods given below:

- (i) Coal tar primer, coal tar enamel, inner wrap of fibre glass, final outer wrap of enamel impregnated fibre glass. Total thickness of coating shall not be less than 4.0 mm.
- (ii) With anti-corrosive tape of minimum 4 mm thick conforming to IS-10221 and AWWA C 203-93.

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(b) Pipe surfaces shall be cleaned by shot or sand blasting before application.

(c) Tests to be carried out after application

(i) Bond / Adhesion test

(ii) Holiday test

13.8 INTERNAL COATINGS**13.8.1 Tanks (Internal Surfaces) as specified in relevant sections of specification**

Industrial, deionised, demineralised and potable water upto 60°C pH range: 4.5 – 9.5.

Blasting according to ISO 8501-1: 1988, grade Sa 2^{1/2}.

Prime coat:

Two layers of zinc phosphate epoxy primer total DFT greater than or equal to 75 µm.

Pretreatment:

Derusting of all mechanical damages, according to standard Sa 3 to ISO 8501-1:1998, touch up with 2 pack high build epoxy with volume solid content of more than 85%, 75 µm.

Intermediate coat:

2 pack high build epoxy, dry film thickness 80 µm.

Finish coats:

2 pack solvent free epoxy paint dry film thickness 150 µm per coat.

In case of service or potable water tanks, the coating material selected shall not taint the water.

QA / QC procedure, including pinhole inspection, for shall be submitted for approval by Employer / Employer's Representative.

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13.8.2 Rubber Lining of Pipes, Valves and Tanks as specified in relevant sections.

(a) At works

Pretreatment:

Blasting according standard 2¹/₂ to ISO 8501-1 : 1988.

Rubber lining:

Hard-rubber 5mm for DM water applications, thickness greater than or equal to 3 mm for others. In case of failure of rubber lining for both pipes and vessels, the rubber lining shall be replaced by COROCOAT

13.9 Painting for Electrical Items

13.9.1 All the steel work shall be thoroughly cleaned of rust, scale, oil, grease, dirt and swarf by pickling, emulsion cleaning, etc. The sheet steel shall be phosphated / oven dried and then painted with two coats of zinc rich primer paint. After application of the primer, two coats of finishing synthetic enamel paint shall be applied. The colour of the finishing coats inside shall be glossy white and exterior of the treated sheet steel shall be shade 631 of IS-5 / RAL 7032 for all switchboard/MCC/ Distribution boards, control panels, etc.

13.9.2 All electrical equipment shall be given tropical and fungicidal treatment and outdoor equipment shall be provided with rain hood to prevent entry of rain water into the equipment.

13.9.3 Painting and galvanising requirements of switchyard structures are covered in Civil section D4 in Volume - III.

13.10 Suggested Colour Codes for Painting

Sl. No.	Item / Service	Colour	IS-5	Colour (Band)	IS - 5
13.10.1	Structures, platforms, galleries, ladders and handrails.	Dark Admirability Grey	632	-	-
13.10.2	Boiler casing, ducting	Nut Brown	413	-	-
13.10.3	Crane				
(a)	Crane structure	Golden Yellow	356	Black	-
(b)	Trolley and hook	Crimson	540	-	

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13.10.4	Pump motors, compressors	Light Grey	631	-	-
13.10.5	Tanks (without insulation and cladding)				
(a)	Outdoor	Aluminium	-	-	-
(b)	Indoor	Light Grey	631	-	-
13.10.6	Vessels and all other proprietary equipment (without insulation and cladding)	Light Grey	631	-	-
13.10.7	Switchgear	Light Grey	631	-	-
13.10.8	Control and relay panels	Light Grey	631/ 7078 of IS1650	-	-
13.10.9	Turbines	Light Grey	631	-	-
13.10.10	Generators and exciter	Light Grey	631	-	-
13.10.11	Transformers	Aluminium	-	-	-
13.10.12	Machinery guards	Signal red	537	-	-
13.10.13	Piping (Without insulation and cladding)				
(a)	Water System				
(I)	Boiler feed	Sea Green	217	-	-
(ii)	Condensate	Sea Green	217	Light Brown	410
(iii)	DM Water	Sea Green	217	Light Orange	557
(iv)	Soft Water	Sea Green	217	French Blue	166
(v)	Bearing cooling water	Sea Green	217	French Blue	166
(vi)	Potable and filtered water	Sea Green	217	French Blue	166
(vii)	Service and clarified water	Sea Green	217	French Blue	166
(viii)	Cooling water	Sea Green	217	French Blue	166
(ix)	Raw water	Sea Green	217	White	

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(b) Air system					
(i)	Station air	Sky Blue	101	-	-
(ii)	Control air	Sky Blue	101	White	-
(c) Oil system					
(i)	Light oil (HSD)	Light Brown	410	French blue	166
(ii)	Lubricating oil	Light Brown	410	Light grey	631
(iii)	Transformer oil	Light Brown	410	Light Orange	557
(d) Gas system					
(i)	Fuel gas (Regassified LNG)	Canary Yellow			
(ii)	Carbon dioxide	Canary Yellow	309	Light grey	631
(iii)	Hydrogen	Canary Yellow	309	Signal red	537
(e)	Fire Services	Fire red	536	-	-
(f)	Effluent pipes	Black	-	-	-
(g)	Vacuum pipes	Sky Blue	101	Black	-
(h)	Drainage	Black	-	-	-

NOTES

1. This colour code basically refers to IS: 2379 for piping with necessary modifications.
2. Where band colour is specified, same shall be provided at 10 metre intervals on long uninterrupted lines and also adjacent to valves and junctions.

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SPEC. NO.
TCE.4916A-H-500-001**14.0 General**

14.1 The Contractor shall offer a plant so as to meet the pollution control requirements of statutory authorities. Emissions and discharges of solid, liquid and gaseous effluents from the Power Plant shall fully comply with all requirements and limits specified in Environmental (Protection) Act, 1986, Minimum National Standards (MINAS), along with all latest amendments to all of the above requirements, stipulations of the Central Pollution Control Board (CPCB), Ministry of Environment and Forests (MOEF) and Gujarat Pollution Control Board (GPCB) for the project, and any other central or local statutory requirements regarding environmental pollution and its abatement. The limits for emissions and liquid effluents are indicated in subsequent clauses.

14.2 The Contractor shall be responsible for obtaining all necessary approvals, licenses and permissions, which are related to design, construction, installation and operation of the plant. These shall be obtained at appropriate time to ensure that the construction and commissioning programme can be realised.

14.3 Gaseous and Particulate Emissions

14.3.1 For the fuels specified, the gaseous and particulate emission from the stack shall comply with the requirements stipulated by statutory authorities.

14.3.2 The expected air pollutants are SO_x and NO_x. Based on the minimum sulphur content in the liquid fuel, the HRSG stack height of 70 m is to be provided. For controlling of NO_x, dry low NO_x type hybrid burners shall be provided in the gas turbines to limit the emissions below 25 ppm (v/v at 15% excess oxygen).

Following shall be the maximum allowable limits of the emission pollutants in the exhaust gas at stack.

Total Particulate Matter	---	Less Than 100 mg/Nm ³
Oxides of Nitrogen	---	Less Than 30 ppm
Oxides of Sulphur	---	Less Than 50 ppm
Carbon Dioxide (Co ₂)	---	Less Than 5%.

14.3.3 All the gas lines vents and gas scrubbers vent connections would be led to a cold flare stack of suitable height. Necessary safety zones shall be maintained around the cold flare stack.

14.3.4 The Contractor shall provide continuous monitoring equipment to measure particulate matter (e.g. cross-stack optical density or equivalent), carbon monoxide, sulphur dioxide, nitrogen oxides, temperature and oxygen content of the stack gases. The monitoring instruments must be carefully located to ensure that representative sampling is obtained and sampling should be to a recognised standard.

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14.3.5 The monitoring systems should incorporate the means to record various time averaged values as required by the performance requirements. Monitoring data should be displayed in the control room, with provision of alarms to notify the operator of any deviation from the specified values. The Contractor shall furnish a list of monitoring equipment he intends to provide with their location in the plant.

14.4 Noise control

14.4.1 An integrated approach shall be taken by the Contractor to control noise emission which shall include but not be limited to :

- (a) Design and layout of building to minimise transmission of noise, segregation of particular items of plant and to avoid reverberant areas.
- (b) Specification of permissible noise levels for bought-out items.
- (c) Choice of materials for civil construction
- (d) Acoustic design of building
- (e) Use of lagging with attenuation properties on plant components / installation of sound attenuation panels around the equipment.

14.4.2 Where the requirements stated above are not met within the basic design of the plant they shall be achieved by the supply under the Contract of suitable means of noise control, which shall conform to the following requirements :

- (a) The noise control system shall, as far as possible, be designed to form an integral part of the plant.
- (b) The abatement system shall, wherever practicable, be applied to the source of excessive noise rather than to the entire item or component.
- (c) If above means are not adequate and enclosures are used for noise abatement, close fitting enclosures shall be provided.

14.4.3 Noise in Control Areas

(a) Control Rooms

The noise levels in control rooms must be such that intelligible speech communication is always possible and mental concentration is not hindered.

(b) Other Control Areas

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The noise levels in other control areas must be such that intelligible conversation (telephone and person-to-person) is possible and operator fatigue is minimised.

(c) Station Noise Criterion

The criterion for environmental noise is that the design of the station and its components shall not exceed, in any continuous mode of operation, the level stipulated by MOEF and/ or Pollution Control Board at the nearest plant boundary. Presently the norm is as follows

- (i) Noise level shall not exceed 85 dBA at 1.5 m from the equipment surface
- (ii) Far field noise level at the plant boundary shall not exceed the following values as stipulated in the Environment (Protection) Rules, 1986 :
 - Day Time - 75 dB(A) (6.00 hrs – 22.00 hrs.)
 - Night Time – 70 dB(A) (22.00 hrs – 6.00 hrs)

14.5 Liquid effluent disposal

14.5.1 The cooling tower blow down, HRSG blowdown/ drains, effluent after plant washing, cleaning etc., will be led to the guard pond. Back wash from filters and regeneration effluent from the mixed bed units will be led to the neutralising pit, treated and led to the guard pond.

14.5.2 Plant drains from HRSG / TG areas will be led to a sump, which will also collect oil water from transformer area. The oily effluent has to be treated in an oil water separator for removal of oil traces. The clear water will be led to the guard pond while dirty oil will be disposed off in drums separately.

14.5.3 Network of sewage pipelines of stoneware construction would be provided to carry sewage from the building toilets and other drains to septic tanks. Outflow from septic tank is passed through soak. The sewage from the power plant including the residential colony shall be treated to conform to the following standards:

Biological Oxygen Dispersants 5 Days 20°C < 20 mg/l
Chemical Oxygen Dispersants (COD) < 200 mg/l
Suspended solids < 30 mg/l
Residual chlorine < 0.5 ppm

14.5.4 The water collected in the guard pond will be diluted with water from the permeate water storage tank and treated properly to meet the tolerance limits stipulated by the Gujarat Pollution Control Board and Ministry of Environment and Forests, Government of India before connecting to the main plant drain.

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The effluent discharged from the guard pond shall be treated to the standards prescribed below :

PH - 6.5 to 8.5
Oil & grease < 10 mg/l
Suspended solids < 100 mg/l
Iron (total) < 1 mg/l
Copper (total) < 1 mg/l
Lead (Total - Pb) < 0.5 mg/l
Zinc < 1 mg /l
Chromium (total) < 0.2 mg/l
Chlorine < 0.5 mg/l
Mercury < 0.005 mg/l
Nickel < 3.0 mg/l
Zinc < 5 mg/l
Temperature < 40° C
Phenolic Compound < 3 mg/l
Cyanides (As – CN) < _____
Fluorides (As – F) < 5 mg/l
Sulphides (As – S) < 2 mg/l
Ammonical Nitrogen (As NH₃) < 40 mg/l
Arsenic < 0.1 mg/l
Hexavalant Chromium (As – Cr+6) < 0.5 mg/l
Insecticides / Pesticides - Nil

14.6 **Hazardous area classification**

14.6.1 The Contractor shall take full account of any special requirements concerning the nature, handling and storage of all fuels, flammable gases, chemicals etc. The Contractor shall provide the plant, equipment, buildings and other services and facilities accordingly to ensure the safety of the operating and maintenance personnel.

14.6.2 The Contractor shall furnish drawings to define all the hazardous zones taking into account all the sources of hazards under normal and abnormal operating conditions (regardless of whether or not these areas are specifically listed in the specifications). The zoning philosophy shall be subject to the approval of the Owner and shall meet the suitable code requirements of NFPA.

14.6.3 The Contractor shall ensure that all the electrical equipment installed in any hazardous area is designed and tested to suit the relevant zone classification.

14.7 **Monitoring requirements**

The Contractor shall include continuous monitoring equipment for the following as minimum.

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- (a) Continuous ambient air quality monitoring system for suspended particulate matter, respirable particulate matter, SO_x , NO_x and CO minimum three (3) sets.
- (b) For manual monitoring of ambient air quality – High Volume Sampler with attachment for gaseous sampling and respirable particulate matter sampler – four (4) sets (minimum)
- (c) Stack monitoring kit complete with all accessories as well as NO_x sampling assembly for manual monitoring of stack gases conforming to the requirements laid down by CPCB.
- (d) One completely automatic micro-meteorological data collection and recording station comprising wind-vane, anemometer, thermometer, hygrometer, sunshine recorder, evaporimeter, rain-fall recorder, etc. The stations shall be equipped with arrangement for measurement of ground based inversions using techno-commercially acceptable methods. Alternative means can be proposed for the method of measurement of inversions on hourly basis.

The entire station shall be of automatic recording type connected with logic controller and programmable micro-processor. Continuous recording system with provision for instantaneous display of different parameters including the wind rose shall be provided.
- (e) On line monitoring equipment for continuous monitoring of temperature and other salient parameters like TDS, free chlorine, pH, oil and grease, etc., of treated effluent before re-use shall be provided.
- (f) A full fledged and well equipped modern laboratory with all necessary instrument and facilities shall be provided. The Contractor shall furnish the list of laboratory equipment and appliances including specification and make. The laboratory shall be adequately equipped to test and analyse all parameters laid down in the Standards of discharge of liquid effluents, air emissions, ambient air quality as well as solid wastes applicable in India.

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SPEC. NO.
TCE.4916A-H-500-001**15.1 General**

15.1.1 The Contractor shall offer a plant so as to meet all the safety requirements for the property and personnel at site during construction, testing, commissioning and subsequent operation and maintenance of the plant.

15.1.2 The Contractor shall develop a detailed safety programme and the objective of the safety programme is to prevent damages to properties, injuries and fatalities to personnel at site and to promote maximum efficiency through safe working methods and conditions. This programme shall be applied to all the staff of the Contractor including the staff of the sub Contractors, all staff of the Employer and other agencies at site. Subsequently, the plant shall have all the safety requirements for the operating and maintenance personnel at site.

15.1.3 The safety programme shall conform to suit site conditions and also to local / regional / government and other statutory regulations.

15.2 Safety Guidelines

15.2.1 The Contractor shall appoint a Safety Officer at site during construction and commissioning of the plant and he shall be responsible for implementing the Contractor's safety programme in co-operation with the Contractor's and Sub-Contractor's staff at site. A safety committee comprising of all the representatives from various agencies at site including Employer's representative shall be formed to implement the safety programme.

15.2.2 Contractor shall conduct regular site meetings with all the safety coordinators at site. In addition, mock safety drills, lectures, demonstrations and training programmes on safety aspects shall be regularly conducted at site.

15.2.3 Each employee at site shall be given a copy of the safety booklet and the safety bulletin board should be set up in prominent places at site. Safety practice rules, specific job safety rules, safety posters and other educational material on " Safety" should be posted thereon.

15.2.4 All personnel at site shall be provided with safety gadgets such as helmets, goggles, hand gloves, safety shoes, safety belts, etc. Usage of hoisting belts / safety belts are a must for personnel working at higher elevations.

15.2.5 Sufficient safety signs shall be displayed over the entire plant area. The safety signs shall be provided for such areas which may pose danger such as excavated pits, presence of underground cables, all temporary electrical connections, live wires, all over head electrical lines, existence

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of flammable and explosive material etc. All temporary electrical connections should conform to statutory regulations and shall be maintained by competent and licensed supervisors.

- 15.2.6 Safety zones shall be created and demarcated during hoisting and lifting of equipments, radiography, blasting, pressure testing, etc.
- 15.2.7 The areas of working during night shall be properly illuminated with flood lights and hand lamps as per the demand of the job. Also, adequate lighting facilities shall be provided during erection to ensure safety to the personnel working during night.
- 15.2.8 Adequate medical and first aid facilities shall be provided at site and labour colony by the Contractor. The Contractor shall be responsible for the medical and health requirements of its staff including that of the sub contractors.
- 15.2.9 The Contractor shall ensure that address, telephone numbers of hospitals, doctors, ambulance services are available at site as the same are required during emergencies.
- 15.2.10 The Contractor shall supply and erect sufficiently large safe platforms, galleries, stairways, ladders, access ways, etc, necessary for safe and easy access to all the plant equipments for operation and maintenance.
- 15.2.11 All major equipment shall be arranged to facilitate safe isolation from all hazards for maintenance purpose.
- 15.3 The details furnished above are only guidelines to be considered by the Contractor in developing a detailed safety programme. A detailed safety programme shall be developed by the Contractor and furnished to the Employer for review.
- 15.4 All the systems shall be designed for highest operational safety. Whenever manual intervention provision is provided for controls, an operator guidance instructions shall be available on the operator stations to prevent and to guide the operator for correct operation. Further it shall prevent any operation that will comprise the safety of the equipment / system.
- 15.5 Time sheet/ record of persons working at site shall be always available at time office. Contractor safety department must keep records related to safety.
- 15.6 EPC contractor and subcontractor shall establish and follow good safety standard at site for the safety of manpower, machine and materials. Manpower working at site shall be encouraged to follow safety standards.

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- 15.7 All the lifting tackles like slings, chain pulley blocks, cranes etc. shall be with test certificate and of good quality. General safe lifting procedure shall be ensured by contractors safety department while using these tackles. In no case, lifting with slings the material with sharp edges without sling protection/ packing shall be allowed.
- 15.8 Contractor must ensure availability of first aid kit, ambulance etc. for the emergencies.
- 15.9 Contractor must encourage subcontractors and their manpower for keeping GOOD HOUSE KEEPING at all the places. Necessary actions needs to be taken by contractor for maintaining above requirement.
- 15.10 All the statutory requirements, govt. laws, company acts shall be followed by contractor and its manpower during working at site.
- 15.11 All trenches- excavated areas shall be covered (if possible) and warning signboard shall be kept on the access/ entrance.
- 15.12 All the work carried out inside enclosed areas/ tunnels/ ducts/ vessels shall be carried out by obtaining vessel entry/ confined space entry permits from safety officer. 24 V DC power supply with transformer must only be used inside confined space.
- 15.13 Following Plant Safety Requirements shall be provided and observed by the bidder.
- 15.13.01 Hand rail and toe guard shall be provided at all the areas of human access. It shall be provided at each platforms, walk ways, ladder landings, etc.
- 15.13.02 All the rotating parts of the plant shall be covered with suitable protection covers. All the rotating couplings shall be provided with the removable coupling guard. No shaft shall be left open during any stages of erection, commissioning or operation.
- 15.13.03 All the buildings shall have two entry and exit at diagonally opposite locations as minimum. All the prevailing legal requirements shall be observed during the construction of each building, equipments etc. All the areas of the plant including all buildings, enclosures, platforms etc. shall be covered by the fire detection, fire alarming and fire extinguishing system as per statutory requirements. This shall include the portable fire extinguishers in ample numbers in each required places.

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- 15.13.04 Permanent online Gas leak detectors , with alarming in control room, shall be provided in each hazardous gas handling areas. Additionally portable gas leak detectors shall be provided for each type of hazardous gases handled in the plant, including but not limited to Chlorine, Hydrogen, Methane (Regassified LNG), Carbon Dioxide, Refrigerant used in Air Conditioning, SF6 Gas of HV circuit breaker etc. This is in addition to the portable gas detectors supplied under the I&C calibration and maintenance package.
- 15.13.05 Safety Shower (Whole Body Shower) and eye washing fountains shall be provided in each chemical handling area.
- 15.13.06 Safety Sign Boards and Standard Operation Procedure (SOP) Sign boards shall be provided in each hazardous fluid handling areas.
- 15.13.07 Provision of first aid kits shall be provided by the bidder in the each building of the plant.
- 15.13.08 All the lifting tackles like slings, hooks etc. shall be tested and certified for the suitable weight lifting as per prevailing rules and norms. This shall be observed during the erections and for any other activity on the site.
- 15.13.09 The facility of the pit with the slop, filled with Potassium Hydroxide (KOH) shall be provided at the nearest suitable area for putting the leaking chlorine cylinder to avoid any leakage in the atmosphere. Suitable lifting devices and arrangements shall be provided for shifting the chlorine tonners from the dosing areas to this pit shall be provided.
- 15.13.10 Suitable rubber mats shall be provided at all the switchgears (both back and front side) of the station.
- 15.13.11 Provision of all the safety requirements mentioned in the prevailing laws and suitable international standards shall be provided by the contractor.
- 15.13.12 All the opening in the surface, either on ground or on any platform, shall be provided with removable type of grating. Alternatively the opening shall be provided with the handrail / toe guard arrangement on all four sides. Any other arrangement

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necessary to prevent any “fall down” type of accidents shall be provided for the personal safety.

- 15.13.13 Florescent lamps of all three colours (Eg. Red, Yellow and Blue) shall be provided on each power bus bars running along the crane travel. These shall be provided on both the ends of the busbars. These lamps shall be visible from any section of the building and for this purpose, if required, additional lamps shall also be provided.

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