

## **SECTION - 3**

### **ENCLOSURES TO THE SPECIFICATION**

#### **(i) PGCIL Specification**

**(Page No. 65, 73, 74, 85, 86, 91 to 94, 112, 129 to 138, 140 to 145)**

#### **(ii) PGCIL Field Quality Plan**

**PGCIL Technical Specification for Civil Works**  
(Page No. 65, 73, 74, 85, 86, 91 to 94, 112, 129 to 138, 140 to 145)

## **SECTION 8: CIVIL WORKS**

### **8.1 GENERAL**

The civil works to be provided by the Contractor, in accordance with the Specification, shall include the design & construction of all the items required, in each of the converter stations, including site and general services; buildings; foundations; structures; noise, fire and blast walls etc. The supply of steel and cement required for the civil works shall also be in the scope of the Contractor.

All civil works shall satisfy the requirements specified in other Sections of this Specification and as detailed below. They shall be designed to the required service conditions/loads as specified elsewhere in this Specification and implied as per national/international Standards.

All civil works shall be carried out as per applicable Indian Laws, Standards and Codes. The Contractor shall furnish all design, drawings, labour, tools, equipment, materials, temporary works, constructional plant, fuel supply, transportation and all other incidental items not shown or specified but as may be required for complete performance of the Works in accordance with approved drawings, specifications and directions of the Employer.

All the Works shall be carried out according to the design/drawings to be developed by the Contractor, and approved by the Employer. For all buildings, structures, foundations etc. necessary layout and details shall be developed by the Contractor keeping in view the functional requirement of the plant and facilities and providing enough space and access for operation, use and maintenance. Certain minimum requirements are indicated in this Specification for guidance purpose only; however, the Contractor shall provide according to the complete requirements.

All quality standards, fabrication and erection check lists, welding standards and other technical requirements as covered in the Specification shall be strictly adhered to by the Contractor.

### **8.2 CIVIL WORKS DESIGN BASIS**

#### **8.2.1 GENERAL**

The Contractor shall design and construct all civil works to meet the requirements of the Specification and to be suitable for the intended use at the specified locations. In particular the Contractor shall be responsible for obtaining all data not specifically detailed herein which is required to ensure compliance with the Specification.

## SECTION 8: CIVIL WORKS

~~viii) In case of foundation in rocky strata, type of foundation and recommendation regarding rock anchoring etc. should also be given.~~

### 8.3 SITE PREPARATION

The layout and levels of all structure etc shall be made by the Contractor at his own cost from the general grids of the plot and benchmarks set by the Contractor and approved by the Employer. The Contractor shall give all help in instruments, materials and personnel to the Employer for checking the detailed layout and shall be solely responsible for the correctness of the layout and levels.

#### 8.3.1 SCOPE

This clause covers the design and execution of the work for site preparation, such as clearing of the site, the supply and compaction of fill material, excavation and compaction of backfill for foundation, road construction, drainage, trenches and final topping by stone (broken hard stone).

#### 8.3.2 GENERAL

- .1 The Contractor shall develop the site area to meet the requirement of the intended purpose. The site preparation shall conform to the requirements of relevant sections of this specification or as per stipulations of standard specifications.
- .2 If fill material is required, the fill material shall be suitable for the above requirement. The fill shall be such a material and the site so designed as to prevent the erosion by wind and water of material from its final compacted position or the in-situ position of undisturbed soil.
- .3 Backfill material around foundations or other works shall be suitable for the purpose for which it is used and compacted to the density described under Compaction. Excavated material not suitable or not required for backfill shall be disposed off in areas as directed by Employer upto a maximum lead of 2 km.

#### 8.3.3 EXCAVATION AND BACKFILL

- .1 Excavation and backfill for foundations shall be in accordance with the relevant code.
- .2 Whenever water table is met during the excavation, it shall be dewatered and water table shall be maintained below the bottom

## **SECTION 8: CIVIL WORKS**

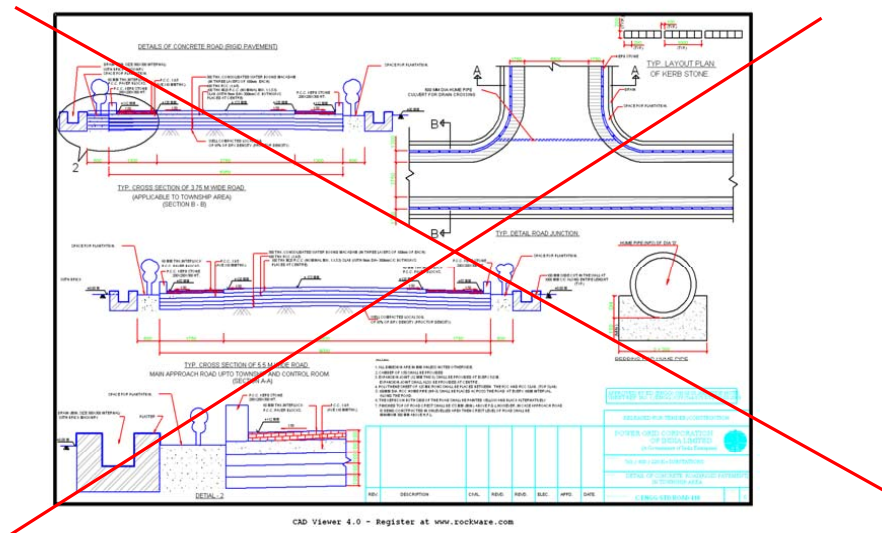
of the excavation level during excavation, concreting and backfilling.

- .3 When embankments are to be constructed on slopes of 15% or greater, benches or steps with horizontal and vertical faces shall be cut in the original slope prior to placement of embankment material. Vertical faces shall measure not more than 1 m in height.
- .4 Embankments adjacent to abutments, culverts, retaining walls and similar structures shall be constructed by compacting the material in successive uniform horizontal layers (not exceeding 15 cm in thickness). (of Loose material before compaction). Each layer shall be compacted as required by means of mechanical tampers approved by the Employer. Rocks larger than 10 cm in any direction shall not be placed in embankment adjacent to structures.
- .5 Earth embankments of roadways and site areas adjacent to buildings shall be placed in successive uniform horizontal layers not exceeding 20 cm in thickness in loose stage measurement and compacted to the full width specified. The upper surface of the embankment shall be shaped so as to provide complete drainage of surface water at all times.

### **8.3.4 COMPACTION**

- .1 The density to which fill materials shall be compacted shall be as per relevant IS and as per direction of Employer. All compacted sand filling shall be confined as far as practicable. Backfilled earth shall be compacted to minimum 95% of the Standard Proctor's density at OMC. The sub grade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor's density at OMC. Cohesion less material sub grade shall be compacted to 70% relative density (minimum).
- .2 At all times unfinished construction shall have adequate drainage. Upon completion of the road's surface course, adjacent shoulders shall be given a final shaping, true alignment and grade.
- .3 Each layer of earth embankment when compacted shall be as close to optimum moisture content as practicable. Embankment material which does not contain sufficient moisture to obtain proper compaction shall be wetted. If the material contains any excess moisture, then it shall be allowed to dry before rolling. The rolling shall begin at the edges overlapping half the width of the roller each time and progress to the centre of the road or

## SECTION 8: CIVIL WORKS



### 8.4 FOUNDATIONS AND OTHER RCC CONSTRUCTIONS

#### 8.4.1 GENERAL

Amendment III SI No 96 (Add)

- .1 Work covered under this Clause comprises the design, supply and construction of foundations and other RCC constructions for switchyard structures, equipment supports, trenches, drains, jacking pad, pulling block, fencing, boundary wall, control cubicles, bus supports, transformers, reactors, marshalling kiosks, auxiliary equipments & systems, buildings, tanks, rail tracks or for any other equipment or service and any other foundation/RCC construction required to complete the work. This clause is as well applicable to the other RCC constructions.

*PPC (ordinary Portland cement) shall not be used for RCC works*

Amendment II SI No 178

- .2 ~~Concrete shall conform to the requirements mentioned in CPWD specification and all the tests shall be conducted as mentioned in Standard field quality plan appended with the specification.~~

~~A minimum grade of M20 concrete shall be used for all structural/load bearing members. Nominal mix by volume 1:1.5:3 (1cement: 1.5 coarse sand: 3stone aggregate 20mm nominal size) shall be used for all RCC works. Higher grades of concrete can be allowed if Contractor carries out mix design and installs a batching plant or arranges the concrete from a approved ready mix concrete supplier.~~

## SECTION 8: CIVIL WORKS

*Reinforced Concrete shall conform to the requirements mentioned in IS 456 (latest version).*

*A minimum grade of M 25 concrete shall be used for all structural/load bearing members for all RCC works in the terminal stations. Only weigh batching shall be allowed for design mix concretes.*

*ADD:*

*All the tests shall be conducted as mentioned in the IS 456 for design mix concretes and will supersede the relevant sections of Standard field quality plan appended with the specification. In case of repeater stations where the concrete volume is very small nominal mix conforming to CPWD specification may be used.*

Amendment II SI No 179

- ~~.3 Where the site is inclined, the foundation height shall be adjusted to maintain the exact level of the top of structures to compensate such slopes.~~

Amendment II SI No 180

- ~~.4 The switchyard foundations plinth and building plinth shall be minimum 300 mm and 500 mm above finished ground level respectively.~~

*The switchyard foundations plinth and building plinth shall be minimum 300 mm and 750 mm above finished ground level respectively*

- .5 Minimum 75 mm thick lean concrete 1:4:8 ( 1 cement : 4 coarse sand : 8 stone aggregate 40mm nominal size) shall be provided below all underground structures, foundations, trenches etc. to provide a base for construction.

Amendment II SI No 181

- ~~.6 Concrete made with ordinary Portland cement shall be carefully cured and special importance shall be given during the placing of concrete and removal of shuttering. Portland pozzolone / slag cement can be used, however 53 grade cement shall be used with specific approval of Employer.~~

*Concrete made with Portland Pozzolana or slag cements cement shall be carefully cured and special importance shall be given during the placing of concrete and removal of shuttering. In case of encountering of aggressive soils and sub soil water OPC/PPC Sulphate resisting cement shall be used for foundations as per the provisions of IS 456*

## SECTION 8: CIVIL WORKS

maximum GWT. Intermediate dividing piers of such enclosure shall be designed considering water in one pump sump only and the other pump sump being empty e.g. for maintenance.

- .19 The foundations shall be proportioned so that the estimated total and differential movements of the foundations are not greater than the movements that the structure or equipment is designed to accommodate. Foundation settlements shall, in no case, exceed the permissible limits specified in relevant Indian Standard Specification.
- .20 All machine foundations shall be designed in accordance with the provisions of the relevant parts of IS-2974, IS-456 and IS-2911. The provisions of DIN-4024 (latest) shall also be followed.

For the foundations of rotating machines, detailed static and dynamic analysis shall be done. A fatigue factor of at least 2.0 shall be considered for dynamic forces. Minimum reinforcement shall be governed by IS-2974 as well as IS-456. RCC design shall be done by working stress method.

For the foundations supporting minor equipments weighing less than one ton or if the mass of the rotating parts is less than one-hundredth of the mass of the foundation, dynamic analysis is not must. However, if such minor equipment is to be supported on building structures, floors etc. suitable vibration isolation shall be provided by means of springs, neoprene pads etc. and such vibration isolation system shall be designed suitably.
- .21 All other foundations shall be designed in accordance with the provisions of the relevant parts IS-2911 and IS-456.
- .22 The gantry/tower foundations shall be designed for factor of safety of 2.2 for normal and broken wire condition and 1.65 for combined short circuit and broken wire condition.
- .23 Minimum two piles shall be provided in any pile group.

Amendment II SI No 184

Add

- 24. Equipment foundations shall be designed for a factor of safety of 2.2 for normal and 1.65 for short circuit condition

### 8.4.3 ADMIXTURES & ADDITIVES

- .1 Only approved admixtures shall be used in the concrete for the Works. When more than one admixture is to be used, each admixture shall be batched in its own batch and added to the mixing water separately before discharging into the mixer.

#### **SECTION 8: CIVIL WORKS**

Admixtures shall be delivered in suitably labelled containers to enable identification.

## **SECTION 8: CIVIL WORKS**

- .2 Admixtures in concrete shall conform to IS-9103. The water proofing cement additives shall conform to IS-2645. Concrete Admixtures/Additives shall be approved by the Employer.
- .3 The Contractor shall use an approved neutralized vinsol resin or air-entraining agent in concrete. The Air-entraining agent shall be supplied and batched as a solution with a solid content not exceeding 15% by weight with suitable, stable and consistent pH. Air- entraining requirements shall be in accordance with CP 100 Part I.
- .4 The Contractor can propose and the Employer, at his discretion, may approve the use of a water-reducing set retarding admixture in some of the concrete. The use of such an admixture shall not be approved to overcome problems associated with inadequate concrete plant capacity or improperly planned placing operations and shall only be approved as an aid overcoming unusual circumstances and placing conditions.
- .5 The water-reducing set-retarding admixture shall be an approved brand of ligno-sulphonate type admixture.
- .6 The water proofing cement additives shall be used only after approval of the Employer.

### **8.4.4 HOT WEATHER REQUIREMENTS**

- .1 During hot weather all necessary precautions, as per relevant Codes, shall be taken to avoid premature stiffening of the fresh mix and to reduce water absorption and evaporation losses and when the temperature of the surrounding air is higher than 30°C. The following shall apply unless otherwise approved by the Employer:
  - a) The formwork shall be continuously sprayed with cold water in advance of concreting and excess water shall be removed from inside the forms immediately prior to placement of concrete.
  - b) The reinforcement and the formwork (if metal forms are used), shall be protected from the effects of hot winds and direct sunlight.
  - c) Suitable barriers shall be provided to protect the freshly placed concrete from wind until the concrete is sufficiently hard to allow it to be covered according to (e) below.

## SECTION 8: CIVIL WORKS

- d) The concrete when placed shall be maintained at a temperature of less than 30 degree C by the use of chilled mixing water or by spraying the aggregate with cold water.
  - e) The concrete shall be mixed, transported, placed and consolidated, as rapidly as possible and shall then be covered with an impervious membrane or wet Hessian until moist curing beings.
- .2 Curing compounds shall not be used as an alternative to the requirements of Clause 8.4.3.
- .3 During hot weather (atmospheric temperature above 40 deg C) or cold weather (atmospheric temperature at & below 5 deg C) the concreting shall be done as per the procedure set out in IS-7861 (Part I & II).

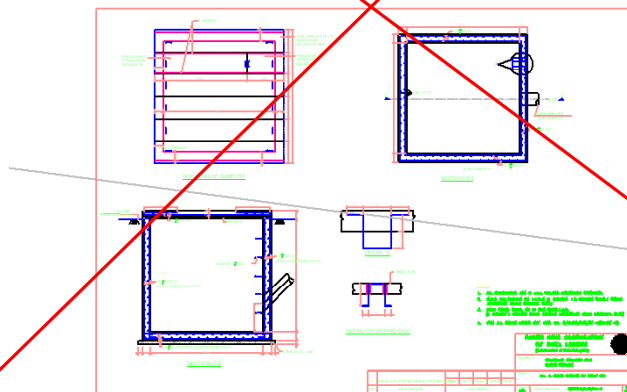
### 8.5 CABLE & PIPE TRENCHES

Amendment II SI No 185 (Add)

- .1 RCC trenches and pre-cast removable concrete covers (with lifting arrangement) shall be designed to withstand *surcharge* loads of 1000 kg/m<sup>2</sup> from maintenance trucks and a concentrated load of 200 kg at mid span of cover. Cable trenches shall also be designed with water pressure along with earth pressure.

Amendment II SI No 186

- .2 Trenches shall be of reinforced cement concrete, having minimum ~~M-20~~ grade *M-25* grade of concrete. The standard / typical trench drawing is indicated below:



## **SECTION 8: CIVIL WORKS**

### **8.10 BUILDINGS**

#### **8.10.1 GENERAL**

##### **8.10.1.1 DIMENSIONS**

The building design shall take into consideration the layout of the panels, equipments, etc, in order to allow enough area for maintenance.

## SECTION 8: CIVIL WORKS

### 8.10.3 AUXILIARY BUILDINGS

Amendment I SI No. 18

~~These buildings shall be located at suitable locations but away from converter building.~~

***These buildings shall be located at suitable locations considering aesthetics and the layout of the converter station.***

#### 8.10.3.1 VALVE COOLING EQUIPMENT BUILDING

~~These buildings shall be provided on per pole basis and shall contain the required cooling equipment for the valves. The dimensions shall be as required to suit the equipment. The cooling towers may be located outside the room. This building shall be located adjacent to respective valve hall. The flooring of the valve cooling building shall be epoxy painted.~~

#### 8.10.3.2 VALVE HALL VENTILATION BUILDING

~~This building shall be located adjacent to the valve halls and house all equipment pertaining to valve hall ventilation system. The rooms shall have ample space for maintenance, removal of equipment etc. The Contractor may use a double storied building to house both the valve cooling and valve hall ventilation equipment.~~

#### 8.10.3.3 PUMP HOUSE

~~The water pumps for the service/domestic water system as well as for fire protection shall be housed in a pump house. A separate pump house shall be located, if required for station drainage system. The raw water tank(s) also may be located next to this pump house. The pump foundations shall be vibration free and independent of building foundation. Suitable ventilation & exhaust shall be provided.~~

#### 8.10.3.4 GUARD HUT

~~A guard hut with lockable door, aluminium windows and attached toilet shall be located near the main entrance to each station. Provision of operating the main gate electrically from the guard hut also shall be provided.~~

#### 8.10.3.5 INDOOR DC YARD (AT AGRA)

Amendment II SI No 197

## SECTION 8: CIVIL WORKS

~~A RCC framed DC yard building shall be built adjacent to the valve halls. The indoor DC yard shall be a ventilated hall containing DC yard equipments, such as smoothing reactors, high speed parallel / de-parallel switch, line isolator, DCCT, Voltage divider, DC filters etc. The ventilated indoor DC yard shall have a pressure at least 5mm of water column over the atmospheric pressure. The air shall be suitably filtered before being supplied to the indoor DC yard and shall have a relative humidity less than 60%. The air shall be suitably filtered before being supplied to the indoor DC yard. The size of the building shall be decided by the Contractor based on the requirements of the equipment to be supplied. Suitable lifting and shifting arrangement of smoothing reactor on permanent or portable basis inside the building shall be made available. Provision shall be made in the indoor DC yard building for installation of wall bushing and connection for parallel converter block by Employer. The floor of the indoor DC yard shall have a heavy duty floor slab with ironite flooring suitable for movement of cranes, trailers, etc.~~

*The indoor DC yard building shall be built adjacent to the valve hall. Suitable lifting and shifting arrangements for equipments shall be made available inside the building. The floor of the indoor DC yard shall have a heavy duty floor slab suitable for movement of heavy equipment*

Amendment III SI No. 98 (Add)

*The indoor DC yard shall be a ventilated hall containing DC yard equipments **connected to 800 KV HV pole bus** such as smoothing reactors, high speed parallel/ de-parallel switch, line isolator, DCCT, voltage divider, DC filters **at least including HV capacitors** etc.*

Amendment III SI No. 99

### 8.10.3.6 **Diesel/ CNG engine generator house:**

~~The generator shall be installed in a separate building. The generator shall be independent of the building foundations and floor slabs and shall be vibration free. Door opening shall be dimensioned to allow removal of engines and generators. Suitable ventilation exhausts shall be provided.~~

### 8.10.4 **FINISH SCHEDULE**

Amendment III SI No. 100

~~The preliminary indicative finishing schedule is given below. However, at the time of detailed engineering, the Employer reserves~~

## SECTION 8: CIVIL WORKS

~~the right to alter the finishing schedule and specifications and such changes shall have no additional financial implication whatsoever to the Employer.~~

*The preliminary indicative finishing schedule is given below.*

### 8.10.4.1 FLOORING

- .1 The nominal total thickness of floor finish shall be 50 mm.
- .2 Wherever cables are required to be run under the floor (like VPS room) suitable cable raceways shall be provided below the flooring.
- .3 Control room shall be provided with false flooring as specified. The floor of entrance lobby, staircase, control room, VPS room, visitor area and conference room shall have mirror polished 20mm thick granite stone slab flooring over 20mm thick base of cement mortar 1:4 (1 cement : 4 coarse sand). Office areas and electronic workshop shall be provided with vitrified tiles of size 600x 600mm laid over 20mm thick base of cement mortar 1:4 (1 cement : 4 coarse sand).  
  
The floors of rooms having heavy mechanical equipment like Air Conditioning and Valve Cooling shall have Ironite floor finish. The floor shall be further coated with Epoxy/PU.
- .4 The floors of building/room other than those mentioned above shall have vitrified tiles 600 X 600 mm size.

## SECTION 8: CIVIL WORKS

- .5 Risers and treads of stair-cases shall be provided with 20mm thick mirror polished granite stone slab except external staircases leading to roofs of buildings. Steel staircases shall have grating or chequered plates as per the requirement.

Amendment II SI No 198

- .6 Entire area around the Converter Buildings (including transformer & reactor area) shall be provided with PCC (1:2:4) paving of minimum 100 mm thick over a sand/moorum suitably consolidated/compacted cushion of minimum 150 mm, starting from the building edge upto 2 m clear distance for the full length of the building. All other buildings shall be provided with 750 mm wide plinth protection all around with plain cement concrete of 1:2:4 over under bed arrangements as specified above.

Minimum 10 m wide strip as approach to the converter building from both sides shall be paved with RCC. ~~The above specified RCC approach shall be with M15 grade~~

*The above specified RCC approach shall be with M 25 grade*

concrete over suitable under bed having 100 mm thick PCC (1:4:8) over a sand/moorum suitably consolidated/compacted cushion of minimum 150 mm.

### 8.10.4.2 ROOF

- .1 The valve hall roofs are described in clause 8.10.2.5.
- .2 Roofs of other buildings shall consist of cast-in-situ RCC slab.
- .3 The roofs of valve hall and service building shall be provided with 30 mm thick polyurethane foam for thermal insulation and 1.5 mm thick layer of isothane elastomeric membrane 'EMA' with polyurethane primer as water proofing treatment. A wearing course of 25 mm thick PCC(1:2:4) laid in panel of 1.2X1.2 metre with 0.56 mm dia galvanised chicken wire mesh interposed shall also be provided over elastomeric membrane.
- .4 For sufficient disposal of rain water, the run off gradient for the roof shall not be less than 1:100. Screed concrete 1:2:4 or cement sand mortar 1:3 shall be used to provide the gradient.
- .5 The water proofing treatment of roof of buildings except service building and valve hall shall consist of the following operations:
- a) Applying and grouting a slurry coat of neat cement using 2.75 kg/m<sup>2</sup> of cement admixed with proprietary water proofing

**SECTION 8: CIVIL WORKS**

compounds conforming to IS: 2645 over the RCC slab including cleaning the surface before treatment.

## SECTION 8: CIVIL WORKS

- b) Laying cement concrete using broken bricks/brick bats 25mm to 100mm size with 50% of cement mortar 1:5 (1 cement: 5 coarse sand) admixed with proprietary water proofing compound conforming to IS: 2645 over 20mm thick layer of cement mortar of min 1:5 (Cement: 5 coarse sand) admixed with proprietary water proofing compound conforming to IS: 2645 to required slope and treating similarly the adjoining walls upto 300mm height including rounding of junctions of walls and slabs.
- c) After two days of proper curing applying a second coat of cement slurry admixed with proprietary water proofing compound conforming to IS: 2645.
- d) Finishing the surface with 20mm thick joint less cement mortar of mix 1:4 (1 cement : 4 coarse sand) admixed with proprietary water proofing compound conforming to IS: 2645 and finally finishing the surface with trowel with neat cement slurry and making of 300 x 300 mm square.
- e) The whole terrace so finished shall be flooded with water for a minimum period of two weeks for curing and for final test. All above operations to be done in order and as directed and specified by the Engineer-in-charge.

### 8.10.4.3 WALLS

- .1 All buildings shall have framed super-structure. All walls shall be non-load bearing in filled panel walls.
- .2 External walls of all buildings shall either be with solid concrete block masonry (minimum 200 mm thick) or with brick masonry (minimum 230 mm thick) in cement sand mortar 1:6.
- .3 All internal walls shall be either with solid concrete block masonry (minimum 200 mm thick except the internal partition walls for office area and toilets which shall be 100 mm thick) or with brick masonry  
(Minimum 230 mm thick including internal partition walls for office area and toilets) in cement sand mortar 1:6.
- .4 All half brick masonry walls shall be provided with reinforcement consisting of 2 nos. of 6 mm diameter bars every fourth layer.
- .5 A 50 mm thick DPC shall be provided at plinth level before starting the masonry work.

## SECTION 8: CIVIL WORKS

Amendment II Sl No. 199

- .6 For converter building, the external wall upto a height of minimum 6.0m from plant's zero level on the side facing the oil filled equipments e.g. oil filled reactor and transformer to take care of fire accidents and upto a height of 2.5 m on other sides shall be with ~~RCC pre-cast units of minimum M-20 grade as per IS-456.~~ *RCC pre-cast units of minimum M-25 grade as per IS-456.*
- .7 The service building entrance lobby, staircase, control room(VPS), visitor area and conference room shall have wall cladding of 1mm laminate over 12mm ply along with 9mm MDF for necessary grooves and pattern.

### 8.10.4.4 PLASTERING

- .1 External surface of buildings shall have 18mm thick plaster in two layers, with under layer 12mm thick 1:5 cement sand (coarse) plaster and top layer 6mm thick 1:6 cement sand plaster. Inside wall surfaces at all locations shall have 12/15 mm thick cemented sand plaster. Rough surface shall have 15mm and smooth surface shall be provided with 12mm thick cement sand plaster (1:4).
- .2 Inside surface of all walls shall be provided with plaster of Paris punning over the plastered surface except for areas where wall panelling is provided.
- .3 All RCC ceilings shall be provided with 6 mm thick cement sand plaster (1:4) except areas with false ceiling.

### 8.10.4.5 PAINTING

- .1 Outside face of all buildings and pump houses shall have Novalux exterior paint as per manufacturer's specification.
- .2 Acrylic emulsion paint shall be provided for all rooms except for areas where wall panelling is provided.
- .3 All ceilings shall have oil bound distemper
- .4 Fire resisting transparent paint shall be provided on all wood work over French polish or flat oil paint.
- .5 All fire exits shall be painted in fire red colour shade, which shall not be used anywhere else except to indicate emergency or safety measure.

## SECTION 8: CIVIL WORKS

### 8.10.4.6 DOORS & WINDOWS

Amendment II SI No. 200

- ~~.1 All the doors, windows and ventilators of buildings and windows/ventilators provided on the outer face shall be of aluminium.~~

*All the doors, windows and ventilators of buildings and windows/ventilators provided on the outer face shall be of heavy duty aluminium sections*

Main entrance shall have aluminium framework with glazing or frameless as required during approval of architectural drawings.

Doors shall be of double swing type. Glazed wall panels with aluminium frame shall be provided between control room and adjacent two rooms behind the operator seat to have a clear view. Glazing shall have fire rating of minimum 1 hour.

- .2 WC/toilets shall have wooden panel doors. Doors for office area and in air conditioned areas shall be wooden flush doors.
- .3 All other doors shall be steel doors consisting of double plate flush door shutters, the cavities filled with mineral wool as per specification.

Amendment II SI No. 201

- ~~.4 All windows shall be of aluminium frame.~~

*All windows shall be of heavy duty aluminium frame*

- .5 Rollingshutters with suitableoperating arrangement (manual/mechanical gear operated or electrical according to size shall be provided in buildings to facilitate handling and transportation of equipment.
- .6 All doors/shutters/windows shall be provided with all standard accessories such as handles, tower bolts, locks, stoppers, floor mounted spring type door closure etc. of best quality as approved by the Employer.
- .7 Fire-proof doors shall be provided at all fire exit points as per the recommendations of Tariff Advisory Committee. These shall be as per IS-3614 with minimum 1 hour fire rating.
- .8 Automatic fire proof sliding doors shall be provided wherever required for segregating and preventing the spread of fire.
- .9 Generally no door shall be more than 2.5 m in height. If still a bigger door is required, considering type & size of equipment, then the door shall be made in two parts.

## SECTION 8: CIVIL WORKS

Amendment V SI No. 15

*.10 Fire doors for valve halls shall be rated for 3 hours according to BS 476 Part 22 / IS 3614 Part 2.*

### 8.10.4.7 GLAZING

- .1 Minimum thickness of glazing shall be 5.5 mm.
- .2 Glazing between air-conditioned (A/C) and non-A/C areas shall be provided with hermetically sealed double glazing having glass of minimum 6.0 mm thickness for thermal insulation & clear view. Doors shall be provided with 6.0mm thick single glazing only.

## SECTION 8: CIVIL WORKS

- .3 Ground glass of minimum 5.5 mm thickness shall be used in toilets.
- .4 Fire prone area shall be provided with wired glass with minimum 6 mm thickness.

### 8.10.4.8 FALSE CEILING

The control room and all other air conditioned areas shall have a closed aluminium ceiling system comprising 84mm wide, 12.5mm deep panels of approved colour with a recessed flange of 23.9mm roll formed out of 0.5mm thick aluminium alloy AA 5050 /5052/3003 chromatised and stove enamelled on both sides. The panels shall be fixed on roll formed carriers 32mm wide, 39mm deep made out of minimum 0.9mm thick aluminium alloy strip with cut outs to hold panels in a module of 100mm minimum at 1.6 m c/c maximum. The carrier will be suspended from roof by 4mm diameter galvanised steel wire rod hangers with special height adjustment springs/clips made out of spring steel at maximum spacing of 1.5m c/c hangers. 25mm thick resin bonded mineral wool of approved quality encased in 100 micron black polythene shall be laid over the top of the placed panels.

### 8.10.4.9 FALSE FLOORING

The false floor system to be installed shall provide a maximum finished floor height of 750mm from the existing floor level. The system shall provide for suitable pedestal and under structure design to withstand various static loads and rolling loads. The entire access floor system shall provide for adequate fire resistance, acoustic barrier and air leakage resistance. The system shall be able to accept an independent floor covering i.e. antistatic PVC/ Laminate with PVC beading. The under structure should be able to withstand a UDL of 1080 Kg/m<sup>2</sup> and a point load of 360kg. The under structure should be able to accept a pedestal axial load of 2200kg. Panels should be made from steel. The bottom of panel shall be embossed in hemispherical shape to give strength and flexural rigidity. The top sheet shall be plain and resistant welded at various locations after the top and bottom sheets have been degreased and phosphated. The above hollow panel shall have an infill of light weight cementitious material. The entire panel shall be coated with epoxy coating on the exposed surface. The surface shall have factory laminated anti - static PVC/ Laminate with PVC beading on all sides for edge protection. Panel shall provide for impact resistance top surface minimal deflection, corrosion

## SECTION 8: CIVIL WORKS

### 8.10.6 ~~BUILDING STORM WATER DRAINAGE~~

~~The building design shall provide for the collection of storm water from the roofs. This water shall be drained to the main drainage system of the station.~~

~~Cast Iron rain water down comers conforming to IS-1230 with water tight lead joints or medium class galvanized mild steel pipes conforming to IS-1239/IS-3589 shall be provided to drain off the rain water from the roof. These shall be suitable concealed with masonry work of cement concrete or cladding material. The number and size of down comers shall be governed by IS-1742 and IS-2527.~~

~~All drains inside the buildings shall have minimum 40 mm thick grating covers and in areas where heavy equipment loads would be coming, pre-cast RCC covers shall be provided in place of steel grating.~~

~~For all buildings, suitable arrangement for draining out water collected from equipment blow downs, leakages, floor washings, fire fighting etc. shall be provided for each floor.~~

### 8.11 MISCELLANEOUS GENERAL REQUIREMENTS

Amendment II SI No 202

- ~~1. Dense concrete with controlled water cement ratio preferably 0.45 shall be used~~

*Dense concrete with controlled water cement ratio preferably 0.45 (As per IS 456) shall be used for all underground concrete structures such as pump-house, tanks, water retaining structures, cable and pipe trenches etc. for achieving water-tightness.*

Amendment II SI No 203

~~For all civil works covered under this specification, nominal mix by volume batching as per CPWD specification is intended.~~

*For all civil works covered under this specification design mix concrete is intended in conformity to IS 456. However, in case of repeater station work where, nominal mix by volume batching as per CPWD specification is intended. The relationship of grade of concrete and ratio of ingredients shall be as below:*

#### SECTION 8: CIVIL WORKS

| S.No. | Mix | Cement | Sand | Coarse Aggregate<br>(As per IS 383) |
|-------|-----|--------|------|-------------------------------------|
| 1.    | M10 | 1      | 3    | 6                                   |
| 2.    | M15 | 1      | 2    | 4                                   |
| 3.    | M20 | 1      | 1.5  | 3                                   |

Amendment II SI No 204

~~The material specification, workmanship and acceptance criteria shall be as per relevant clauses of CPWD specification and approved Field Quality Plan.~~

*The material specification, workmanship and acceptance criteria shall be as per the provisions of IS 456:2000 In case of nominal mixes relevant clauses of CPWD specifications shall be adopted. Approved Field Quality Plan shall be followed for adherence to quality norms.*

## SECTION 8: CIVIL WORKS

2. All joints including construction and expansion joints for the water retaining structures shall be made water tight by using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops shall be used for the base slab and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 6 mm and minimum width shall be 230 mm.

In case the Contractor can demonstrate for adopting a suitable construction technique to avoid seepage of ground water, then the PVC water stops need not be used as specified above.

3. All steel sections and fabricated structures which are required to be transported on sea shall be provided with anti-corrosive paint to take care of sea worthiness.
4. All mild steel parts used in the water retaining structure shall be hot double dip galvanized. The minimum coating of the zinc shall be 750 gm/sq.m. for galvanized structures and shall comply with IS-2629 and IS-2633. Galvanizing shall be checked and tested in accordance with IS-2629. The galvanizing shall be followed by the application of an etching primer and dipping in black bitumen in accordance with BS-3416.
5. A screed of concrete layers not less than 100 mm thick and of grade not weaker than M10 shall be provided below all water retaining structures. A sliding layer of bitumen paper or craft paper shall be provided over the screed layer to destroy the bond between the screed and the base slab concrete of the water retaining structures.
6. Bricks having minimum 75 kg/m<sup>2</sup> compressive strength can only be used for masonry work.
7. Monorails, monorail girders and fixtures shall be provided, wherever required.
8. Doors and windows on external walls of buildings (other than areas provided with insulated metal cladding) shall be provided with RCC sun-shade over the openings with 300 mm projection. Projection of sunshade from the wall shall be minimum 450 mm over window openings and 750 mm over door openings.
9. All stairs shall have a maximum riser height of 150 mm and a minimum tread width of 250 mm. Minimum clear width of stairs shall be 1500 mm.

## SECTION 8: CIVIL WORKS

10. Angles with lugs shall be provided for edge protection all round cut outs/openings in floor slab, edges of drains supporting grating covers, edges of RCC cable/pipe trenches supporting covers, edges of manholes supporting covers, supporting edges of pre-cast covers including cable trench covers and any other place where breakage of corners of concrete is expected.
11. Anti- termite treatment shall be done as per CPWD specification.
12. Hand railing minimum 1200 mm high shall be provided around all floor/roof openings, projections/balconies, walkways, platforms, steel stairs etc. All handrails and ladder pipes shall be 32 mm nominal bore MS pipes (medium class) and shall be galvanized (medium-class as per IS-277). All rungs for ladder shall also be galvanized as per IS-277 medium class.  
  
Stairs within the service building shall be provided with 50mm dia stainless steel hand rail and, 20 mm dia stainless steel balustrades with suitable flats.

Amendment III SI No. 101

13. ~~All shuttering material used shall be of wood only.~~  
*All centering and shuttering materials used shall be of steel only. However, for sides of footings, beams and columns, densified wood may be used.*
14. The proper coordination & execution of all interfacing civil works activities like fixing of conduits in roofs/walls/floors, fixing of foundation bolts, fixing of lighting fixtures, fixing of supports/embedment, provision of cut-outs etc. shall be the sole responsibility of the Contractor. He shall plan all such activities in advance and execute in such a manner that interfacing activities do not become bottlenecks and dismantling, breakage etc. is reduced to minimum.

### 8.12 STATUTORY RULES

1. The Contractor shall comply with all the applicable statutory rules pertaining to Factories Act, Fire Safety Rules of Tariff Advisory Committee, and Water Act for pollution control etc.
2. Provisions for fire proof doors, number of staircases, fire separation wall, lath plastering on structural members (in fire prone areas) etc. shall be made according to the recommendations of Tariff Advisory Committee.
3. Statutory clearance and norms of State Pollution Control Board

#### **SECTION 8: CIVIL WORKS**

shall be followed as per Water Act for effluent quality from plant.

4. Requirement of sulphate resistant cement (SRC) for sub-structural works shall be decided in accordance with the Indian

## **SECTION 8: CIVIL WORKS**

Standards based on the findings of the detailed soil investigation to be carried out by the Bidder/ Contractor.

5. Foundation system adopted by the Contractor shall ensure that relative settlement shall be as per provisions in IS-1904 and other Indian Standards.
6. All water retaining structures designed as un-cracked section shall also be tested for water tightness at full water level as per clause no. 10 of IS-3370 (Part-I).
7. Construction joints at the following locations shall be provided
  - a) At the meeting points of the columns and the raft.
  - b) At the points of contra flexure in the columns.

Additional reinforcements and shear keys shall be provided at the construction joints.

8. All underground concrete structures like pump houses, water retaining structures etc. shall have plasticizer cum water proofing cement additive conforming to IS-9103. In addition, limit on permeability as given in IS-2645 shall also be met with. The concrete surface of these structures in contact with earth shall also be provided with two coats of bituminous painting for water/damp proofing.

In case of water leakage in the above structures, Injection grouting shall be applied for repairing the leakage.

# **PGCIL Field Quality Plan**

(Pages 1 to 20)

# POWERGRID CORPORATION OF INDIA LIMITED

(Quality Assurance & Inspection Deptt.)

## STANDARD FIELD QUALITY PLAN FOR SWITCHYARD CIVIL WORKS

### Section : FOUNDATION MATERIALS

| Sl. No. | Component/Operation & Description of Test                            | Sampling Plan with basis                                                                                                                                  | Ref. Document & acceptance norm                                          | Testing Agency                                                                                                                  | Remarks                                                                                    | Check |
|---------|----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|-------|
| 1.      | CHECKING OF FOUNDATION MATERIALS                                     |                                                                                                                                                           |                                                                          |                                                                                                                                 |                                                                                            |       |
| A)      | CEMENT                                                               |                                                                                                                                                           |                                                                          |                                                                                                                                 |                                                                                            |       |
| i)      | Fineness                                                             | One sample per lot of 100 MT or part thereof from each source for MTCs and one sample per lot of 200 MT or part thereof from each source for site testing | IS:456, IS:269                                                           | Manufacturer/ POWERGRID approved lab                                                                                            | Review of manufacturers test certificates (MTCs) and laboratory test results by POWERGRID  | B     |
| ii)     | Compressive Strength                                                 |                                                                                                                                                           | IS:8112, IS:12269                                                        |                                                                                                                                 |                                                                                            |       |
| iii)    | Initial & final setting time                                         |                                                                                                                                                           | IS:1489 & POWERGRID specification                                        |                                                                                                                                 |                                                                                            |       |
| iv)     | Soundness                                                            |                                                                                                                                                           |                                                                          |                                                                                                                                 |                                                                                            |       |
| v)      | Heat of Hydration for low heat cement (Not applicable for OPC & PPC) |                                                                                                                                                           |                                                                          |                                                                                                                                 |                                                                                            |       |
| vi)     | Chemical Composition of Cement                                       | One sample per lot of 100 MT or part thereof from each source for MTCs                                                                                    | IS:456, IS:269<br>IS:8112, IS:12269<br>IS:1489 & POWERGRID specification | Manufacturer                                                                                                                    | Review of manufacturers test certificates by POWERGRID                                     | B     |
| B)      | COARSE AGGREGATES                                                    |                                                                                                                                                           |                                                                          |                                                                                                                                 |                                                                                            |       |
| i)      | Determination of Partical size (Sieve Analysis)                      | One sample per lot of 100 cubic meter or part thereof from each source for each size                                                                      | IS:383, IS:2386 and POWERGRID specification                              | POWERGRID approved lab. However, Moisture content test for design mix concrete shall be done on all days of concreting at site. | Each source to be approved by POWERGRID Review and acceptance of test result by POWERGRID. | B     |
| ii)     | Flakiness Index                                                      |                                                                                                                                                           |                                                                          |                                                                                                                                 |                                                                                            |       |
| iii)    | Crushing Value                                                       |                                                                                                                                                           |                                                                          |                                                                                                                                 |                                                                                            |       |
| iv)     | Specific Gravity*                                                    |                                                                                                                                                           |                                                                          |                                                                                                                                 |                                                                                            |       |
| v)      | Bulk Density*                                                        |                                                                                                                                                           |                                                                          |                                                                                                                                 |                                                                                            |       |
| vi)     | Absorption Value*                                                    |                                                                                                                                                           |                                                                          |                                                                                                                                 |                                                                                            |       |
| vii)    | Moisture Content*                                                    |                                                                                                                                                           |                                                                          |                                                                                                                                 |                                                                                            |       |
| viii)   | Soundness of Aggregate**                                             |                                                                                                                                                           |                                                                          |                                                                                                                                 |                                                                                            |       |
| ix)     | Presence of deleterious materials                                    |                                                                                                                                                           |                                                                          |                                                                                                                                 |                                                                                            |       |
|         | * Applicable Design concretes only                                   | ** Applicable to concrete work subject to frost action                                                                                                    |                                                                          |                                                                                                                                 |                                                                                            |       |

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|      |                                                                                                  |                                                                        |                                                                                                                                                                                                |                                                                                                                                |                                                                                            |   |
|------|--------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|---|
| C)   | FINE AGGREGATE                                                                                   |                                                                        |                                                                                                                                                                                                |                                                                                                                                |                                                                                            |   |
| i)   | Gradation/Determination of Particle size (Sieve Analysis)                                        | One sample per lot of 100 cubic meter or part thereof from each source | IS:383,IS:2386,IS:456 and POWERGRID specification                                                                                                                                              | POWERGRID approved lab. However Moisture content test for design mix concrete shall be done on all days of concreting at site. | Each source to be approved by POWERGRID Review and acceptance of test result by POWERGRID. | B |
| ii)  | Specific Gravity and density                                                                     |                                                                        |                                                                                                                                                                                                |                                                                                                                                |                                                                                            |   |
| iii) | Moisture content                                                                                 |                                                                        |                                                                                                                                                                                                |                                                                                                                                |                                                                                            |   |
| iv)  | Absorption Value                                                                                 |                                                                        |                                                                                                                                                                                                |                                                                                                                                |                                                                                            |   |
| v)   | Bulking                                                                                          |                                                                        |                                                                                                                                                                                                |                                                                                                                                |                                                                                            |   |
| vi)  | Silt Content Test                                                                                |                                                                        |                                                                                                                                                                                                |                                                                                                                                |                                                                                            |   |
| vii) | Presence of deleterious materials                                                                |                                                                        |                                                                                                                                                                                                |                                                                                                                                |                                                                                            |   |
| D)   | BRICKS                                                                                           |                                                                        |                                                                                                                                                                                                |                                                                                                                                |                                                                                            |   |
| i)   | Dimensional tolerance                                                                            | As per enclosed Annexure-II                                            | CPWD & POWERGRID specification                                                                                                                                                                 | POWERGRID approved Lab.                                                                                                        | Approved by POWERGRID                                                                      | B |
| ii)  | Compressible Strength                                                                            |                                                                        |                                                                                                                                                                                                |                                                                                                                                |                                                                                            |   |
| iii) | Water Absorption                                                                                 |                                                                        |                                                                                                                                                                                                |                                                                                                                                |                                                                                            |   |
| iv)  | Efflorescence                                                                                    |                                                                        |                                                                                                                                                                                                |                                                                                                                                |                                                                                            |   |
| E)   | WATER                                                                                            |                                                                        |                                                                                                                                                                                                |                                                                                                                                |                                                                                            |   |
| i)   | Cleanliness (Visual Check)                                                                       | Random                                                                 | IS:456, IS:3025 and POWERGRID specification. The water used for mixing concrete shall be fresh, clean and free from oil, acids and alkalies, organic materials, or other deleterious materials | Contractor                                                                                                                     | Each source to be approved by POWERGRID                                                    | B |
| ii)  | Chemical and physical properties of water for checking its suitability for construction purposes | One sample per source                                                  | IS:456, IS:3025 and POWERGRID specification                                                                                                                                                    | Contractor/ POWERGRID Approved Lab                                                                                             | Approved by POWERGRID                                                                      | B |
|      | *Applicable to design mix concretes only                                                         |                                                                        |                                                                                                                                                                                                |                                                                                                                                |                                                                                            |   |

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| Sl. No.           | Component/Operation & Description of Test                          | Sampling Plan with basis                                                                                                                                                                                                                                                                                                                                   | Ref. Document & acceptance norm                     | Testing Agency                        | Remarks                                                                            | Check |
|-------------------|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|---------------------------------------|------------------------------------------------------------------------------------|-------|
| 1.                | REINFORCEMENT STEEL                                                |                                                                                                                                                                                                                                                                                                                                                            |                                                     |                                       |                                                                                    |       |
| i)                | Identification & size                                              | Random                                                                                                                                                                                                                                                                                                                                                     | IS:432, IS:1139, IS:1786 & POWER GRID specification | Contractor                            | Approved by POWERGRID                                                              | B     |
| ii)               | Chemical Analysis Test                                             | One sample per heat                                                                                                                                                                                                                                                                                                                                        | IS:432, IS:1139, IS:1786 POWERGRID specification    | Manufacturer                          | Review of manufacturers test certificates by POWERGRID                             | B     |
| iii)<br>iv)<br>v) | Tensile Test<br>Yield stress/proof stress<br>Percentage Elongation | One sample per lot of 40 MT or part thereof for each size of steel conforming to IS: 1139 and 5 MT or part thereof for HDS wire for each size of steel as per IS: 432. For steel as per IS:1786 under 10mm 1 sample for each 25 MT or part thereof. 20 mm-16 mm 1 sample for each 35 MT or part thereof. Over 16mm 1 sample for each 45 MT or part thereof | IS:432, IS:1139, IS:1786 POWER GRID specification   | Manufacturers/ POWERGRID approved lab | Review of manufacturers test certificates as well as lab test results by POWERGRID | B     |
| vi)               | Bend/Rebend Test                                                   | One sample per lot of 20 MT or part thereof for each size of steel as per IS:432, IS:1139. For steel as per IS:1786 under 10mm-16mm 1 sample for each 25MT or part thereof 10 mm-16mm 1 sample for each 45 MT or part thereof.                                                                                                                             | IS:432, IS:1139, IS:1786 POWER GRID specification   | Manufacturers/ POWERGRID              | Review of manufacturers test certificates as well as lab test results by POWERGRID | B     |
| vii)              | Reverse Bend Test for HDS wire                                     | One sample per lot of 5 MT or part thereof for each size                                                                                                                                                                                                                                                                                                   | IS:432 POWER GRID specification                     | Manufacturer/ POWERGRID approved lab  | Review of manufacturers test certificates as well as lab test result by POWERGRID  | B     |

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## Section : FOUNDATION

| Sl. No. | Component/Operation & Description of Test                                                 | Sampling Plan with basis                                                                                                               | Ref. Document & acceptance norm                      | Testing Agency                              | Remarks                                                                    | Check |
|---------|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|---------------------------------------------|----------------------------------------------------------------------------|-------|
| C.      | STRUCTURAL STEEL USED IN CABLE TRENCHES & FOUNDATIONS                                     |                                                                                                                                        |                                                      |                                             |                                                                            |       |
| i)      | Dimensional Check                                                                         | Random                                                                                                                                 | POWERGRID Specification & approved drawing           | Contractor                                  | Checklist to be prepared and signed jointly                                | B     |
| ii)     | Visual Check for damages, rusting, Pitting etc.                                           | 100%                                                                                                                                   | POWERGRID Specification & approved drawing           | Contractor                                  | Checklist to be prepared and signed jointly                                | C     |
| iii)    | Visual Check for welding, defects, primer, coating and painting/galvanizing as applicable | Random                                                                                                                                 | POWERGRID specification & approved drawings          | Contractor                                  | Checklist to be prepared and signed jointly                                | C     |
| iv)     | Physical properties of structural steel                                                   | 1 sample per lot of 40 MT or part thereof for tensile tests and 1 sample per lot of 20 MT or part thereof for bend test for each size. | IS:2062, POWERGRID specification & approved drawings | Manufacturer/<br>POWER GRID<br>Approved lab | Review of Mfgs. Test certificates as well as lab test results by POWERGRID | B     |

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| Sl. No. | Component/Operation & Description of Test                        | Sampling Plan with basis | Ref. Document & acceptance norm                              | Testing Agency                                | Remarks                                     | Check |
|---------|------------------------------------------------------------------|--------------------------|--------------------------------------------------------------|-----------------------------------------------|---------------------------------------------|-------|
| 2.      | GANTRY/EQUIPMENT FOUNDATION/ CABLE TRENCH                        |                          |                                                              |                                               |                                             |       |
| A.      | BEFORE EXCAVATION                                                |                          |                                                              |                                               |                                             |       |
| i)      | Checking of pegs condition as per line and alignment             | 100% on each location    | IS:4091, IS:3764 & POWERGRID approved drawings/specification | Contractor                                    | Approval by POWERGRID                       | C     |
| ii)     | Checking of pit making as per drawing & RL                       | 100% on each location    | IS:4091, IS:3764 & POWERGRID approved drawings/specification | Contractor                                    | Approval by POWERGRID                       | C     |
| B.      | EXCAVATION                                                       |                          |                                                              |                                               |                                             |       |
| i)      | Dimensional conformity                                           | Each location            | IS:4091, IS:3764 & POWERGRID approved drawings/specification | Contractor                                    | Approval by POWERGRID (JMC/MB)              | B     |
| ii)     | Verticality/slopes & Squareness of each pit                      | Each location            | IS:4091, IS:3764 & POWERGRID approved drawings/specification | Contractor                                    | Checklist to be prepared and signed jointly | B     |
| iii)    | Verification of classification of foundation wherever applicable | Each location            | IS:4091, IS:3764 & POWERGRID approved drawings/specification | Joint inspection by POWER GRID and contractor | Approval by POWERGRID                       | B     |
| C.      | FOUNDATION BOLTS/METALLIC INSERTS                                |                          |                                                              |                                               |                                             |       |
| i)      | Check for proper                                                 | 100%                     | POWERGRID                                                    | Contractor                                    | Checklist to be                             | C     |

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|      |                                                                                                |                     |                                                                   |                                               |                                             |   |
|------|------------------------------------------------------------------------------------------------|---------------------|-------------------------------------------------------------------|-----------------------------------------------|---------------------------------------------|---|
|      | identification foundation bolts w.r.t type of foundation                                       |                     | specification & approved drgs.                                    |                                               | prepared and signed jointly                 |   |
| ii)  | Visual check for mechanical damage and galvanising/ painting if applicable for metallic insert | 100%                | POWERGRID specification & approved drgs.                          | Contractor                                    | Checklist to be prepared and signed jointly | C |
| iii) | Alignment & Level                                                                              | 100%                | POWERGRID specification & approved drgs.                          | Contractor                                    | Checklist to be prepared and signed jointly | B |
| iv)  | Grouting/Underpinning of foundation base plate                                                 | 100%                | POWERGRID specification & approved drgs.                          | Contractor                                    | Checklist to be prepared and signed jointly | C |
| D.   | P.C.C. Padding                                                                                 | For all locations   | IS:456 and POWERGRID approved foundation drawings & specification | Joint inspection by POWER GRID and contractor | Approval by POWERGRID                       | B |
| E.   | SHUTTERING(Form work)                                                                          |                     |                                                                   |                                               |                                             |   |
| i)   | Check for materials, breakage or damage                                                        | 100%                | IS:456, POWERGRID specification/ approved drawings                | Joint inspection by POWER GRID and contractor | Approval by POWERGRID                       | C |
| ii)  | Check for plumb, alignment parallelism, squareness and equidistance from stub                  | 100% casting        | IS:456, POWERGRID specification/ approved drawings                | Joint inspection by POWER GRID and contractor | Approval by POWERGRID                       | B |
| iii) | Dimensional check                                                                              | 100% before casting | IS:456, POWERGRID specification/ approved drawings                | Joint inspection by POWER GRID and contractor | Approval by POWERGRID                       | B |
| iv)  | Check for level & height                                                                       | 100% before casting | POWERGRID specification/ approved drawings                        | Joint inspection by POWER GRID and contractor | Approval by POWERGRID                       | B |
| v)   | Check for rigidity of                                                                          | 100%                | POWERGRID                                                         | Joint                                         | Approval by                                 | B |

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|       |                                                                                                                                                                            |                      |                                                                              |                                                           |                                         |   |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|------------------------------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------|---|
|       | frame/tightness                                                                                                                                                            |                      | specification/<br>approved<br>drawings                                       | inspection by<br>POWER<br>GRID and<br>contractor          | POWERGRID                               |   |
| vi)   | Cleaning and oiling                                                                                                                                                        | 100%                 | POWERGRID<br>specification/<br>approved<br>drawings                          | Joint<br>inspection by<br>POWER<br>GRID and<br>contractor | Approval by<br>POWERGRID                | B |
| vii)  | Diagonal bracing if<br>required as per<br>drawings/site<br>conditions                                                                                                      | 100%                 | POWERGRID<br>specification/<br>approved<br>drawings                          | Joint<br>inspection by<br>POWER<br>GRID and<br>contractor | Approval by<br>POWERGRID                | C |
| viii) | Checking of joints to<br>avoid undue loss of<br>cement slurry                                                                                                              | 100%                 | POWERGRID<br>specification/<br>approved<br>drawings                          | Joint<br>inspection by<br>POWER<br>GRID and<br>contractor | Approval by<br>POWERGRID                | C |
| E.    | PLACEMENT OF<br>REINFORCEMENT<br>STEEL                                                                                                                                     |                      |                                                                              |                                                           |                                         |   |
| i)    | Check the steel bars<br>for rust, cracks,<br>surface flaws,<br>laminates etc. (Visual<br>check)                                                                            | 100%                 | IS:456 and<br>POWERGRID<br>specification/<br>approved<br>drawings            | Joint<br>inspection by<br>POWER<br>GRID and<br>contractor | Approval by<br>POWERGRID                | C |
| ii)   | Check as per the bar<br>bending schedule<br>before placement of<br>concrete                                                                                                | For all<br>locations | IS:456,IS:2502<br>and<br>POWERGRID<br>specification/<br>approved<br>drawings | Joint<br>inspection by<br>POWER<br>GRID and<br>contractor | Approval by<br>POWERGRID<br>(Pour Card) | B |
| iii)  | Check cutting<br>tolerance for bars as<br>per check<br>list/drawings. Check<br>whether all the bent<br>bars and lap lengths<br>are as per approved<br>bar bending schedule | For all<br>locations | IS:456,IS:2502<br>and<br>POWERGRID<br>specification/<br>approved<br>drawings | Joint<br>inspection by<br>POWER<br>GRID and<br>contractor | Approval by<br>POWERGRID<br>(Pour Card) | B |
| iv)   | Check whether all<br>joints & crossing of<br>bars are tied properly                                                                                                        | 100%                 | IS:456 and<br>POWERGRID<br>specification/                                    | Joint<br>inspection by<br>POWER                           | Approval by<br>POWERGRID                | C |

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|      |                                                                                                                                  |                 |                                                                     |                                               |                                                                |   |
|------|----------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------------------------------------------------------------|-----------------------------------------------|----------------------------------------------------------------|---|
|      | with right guage & annealed wire as per specification                                                                            |                 | approved drawings                                                   | GRID and contractor                           |                                                                |   |
| v)   | Check for proper cover distance spacing of bars, spacers, & chairs after the reinforcement cage has been put inside the formwork | 100%            | IS:456 and POWERGRID specification/ approved drawings               | Joint inspection by POWER GRID and contractor | Approval by POWERGRID                                          | C |
| vi)  | Check whether lapping of bars are tied properly with right gauge and annealed wire as per specification                          | 100%            | IS:456 and POWERGRID specification/ approved drawings               | Joint inspection by POWER GRID and contractor | Approval by POWERGRID                                          | B |
| G.   | PILE FOUNDATION (Additional Tests)                                                                                               |                 |                                                                     |                                               |                                                                |   |
| i)   | Check of centre line of pile group                                                                                               | Each pile group | IS:2911 & POWERGRID approved pile foundation drawings/specification | Joint inspection by POWER GRID and contractor | Checklist to be prepared and signed jointly                    | B |
| ii)  | Check pile location                                                                                                              | Each pile       | IS:2911 & POWERGRID approved pile foundation drawings/specification | Joint inspection by POWER GRID and contractor | Checklist to be prepared and signed jointly                    | B |
| iii) | Temporary casing tube & permanent liner also check thickness of liner material (if applicable)                                   | Each pile       | IS:2911 & POWERGRID approved pile foundation drawings/specification | Joint inspection by POWER GRID and contractor | Verticality of the tube to be checked                          | B |
| iv)  | Bentonite slurry (if applicable)                                                                                                 | Each pile       | IS:2911 & POWERGRID approved pile foundation drawings/specification | Joint inspection by POWER GRID and contractor | Records to be kept by POWERGRID for specific gravity of slurry | B |
| v)   | Pile depth, level, size                                                                                                          | Each pile       | IS:2911 &                                                           | Joint                                         | Approved by                                                    | B |

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|       |                                           |                                            |                                                                     |                                               |                                                                        |   |
|-------|-------------------------------------------|--------------------------------------------|---------------------------------------------------------------------|-----------------------------------------------|------------------------------------------------------------------------|---|
|       | and alignment                             |                                            | POWERGRID approved pile foundation drawings/specification           | inspection by POWER GRID and contractor       | POWERGRID                                                              |   |
| vi)   | Chipping of pile head                     | Each pile                                  | IS:2911 & POWERGRID approved pile foundation drawings/specification | Joint inspection by POWER GRID and contractor | Before concreting pile cap, pile head to be chipped off for concreting | B |
| vii)  | Standard Penetrator Test                  | As per Powergrid BOQ/Specification         | IS:2911 & POWERGRID approved pile foundation drawings/specification | Joint inspection by POWER GRID and contractor | Records to be kept by POWERGRID                                        | B |
| viii) | Pile load testing                         | As per Powergrid BOQ/Specification IS:2911 | IS:2911 & POWERGRID approved pile foundation drawings/specification | Joint inspection by POWER GRID and contractor | Records to be kept by POWERGRID Approval by POWERGRID                  | B |
| ix)   | Anchor bolts if applicable                |                                            |                                                                     |                                               |                                                                        |   |
| a)    | Level, centre to centre distance of bolts | 100% on each location                      | POWERGRID approved pile foundation drawings/specification           | Joint inspection by POWER GRID and contractor | Checklist to be prepared and signed jointly                            | B |
| b)    | Visual check for galvanising              | 100% on each location                      | POWERGRID approved pile foundation drawings/specification           | Joint inspection by POWER GRID and contractor | Checklist to be prepared and signed jointly                            | B |
| 3.    | CONCRETING                                |                                            |                                                                     |                                               |                                                                        |   |
| A)    | APPROVAL OF MIX DESIGN                    | Each Mix.                                  | IS:456 & POWERGRID approved drawings and specifications             | POWER GRID Approved by lab                    | Approval by POWERGRID                                                  | A |
| B)    | BATCHING,MIX-                             | 100%                                       | IS:456 &                                                            | Joint                                         | Approval by                                                            | B |

# POWERGRID CORPORATION OF INDIA LIMITED

(Quality Assurance & Inspection Deptt.)

|     |                                                                                                     |                           |                                                         |                                               |                                                                                             |   |
|-----|-----------------------------------------------------------------------------------------------------|---------------------------|---------------------------------------------------------|-----------------------------------------------|---------------------------------------------------------------------------------------------|---|
|     | ING & PLACING OF CONCRETE AND COMPACTING                                                            |                           | POWERGRID approved drawings and specifications          | inspection by POWER GRID and contractor       | POWERGRID                                                                                   |   |
| C)  | FIXING OF CHIMNEY COLUMN<br>Check for Width/length squareness, parallelism & equidistance from stub | 100%                      | IS:456 & POWERGRID approved drawings and specifications | Joint inspection by POWER GRID and contractor | Approval by POWERGRID                                                                       | C |
| D)  | PLACING CONCRETE, AND COMPACTING                                                                    | 100%                      | IS:456 & POWERGRID approved drawings and specifications | Joint inspection by POWER GRID and contractor | Min. gap between boxes and reinforcement bars should be maintained<br>Approval by POWERGRID | B |
| E)  | CONCRETE TESTING                                                                                    |                           |                                                         |                                               |                                                                                             |   |
| i)  | Slump test                                                                                          | One sample per foundation | IS:456,IS:516, IS:1199 and POWERGRID Specification      | Contractor                                    | Approval by POWERGRID                                                                       | B |
| ii) | Check for quantities for cement, fine aggregate, coarse aggregate and water while batching          | 100% on all locations     | IS:456,IS:516, IS:1199 and POWERGRID Specification      | Contractor                                    | Checklist to be prepared and signed jointly                                                 | B |

# POWERGRID CORPORATION OF INDIA LIMITED

(Quality Assurance & Inspection Deptt.)

| Sl. No. | Component/Operation & Description of Test                                          | Sampling Plan with basis                                                                                                                            | Ref. Document & acceptance norm                    | Testing Agency         | Remarks                                                                                                                   | Check |
|---------|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|------------------------|---------------------------------------------------------------------------------------------------------------------------|-------|
| F)      | CONCRETE CUBE TESTING                                                              |                                                                                                                                                     |                                                    |                        |                                                                                                                           |       |
| i)      | Compressive Strength                                                               | One sample for every 20 Cum of concreting or part thereof for each days concreting (one sample consists of min. 3 test cubes for 28 days strength). | IS:1199,IS:456, IS:516 and POWERGRID Specification | POWERGRID Approved lab | Approval by POWERGRID Cubes must be tested within a week after 28 days curing period and test results should be approved. | A     |
| G)      | CHECK FINISHING, DIMENSIONAL CONFORMITY AND WORKMANSHIP BEFORE & AFTER BOX REMOVAL | 100%                                                                                                                                                | IS:456,IS:516, IS:1199 and POWERGRID Specification | Contractor             | Approval by POWERGRID                                                                                                     | B     |
| 4.      | BACKFILLING                                                                        |                                                                                                                                                     |                                                    |                        |                                                                                                                           |       |
| i)      | Check for thickness of Layer & watering                                            | 100%                                                                                                                                                | POWERGRID Specification and approved drawings      | Contractor             | Approval by POWERGRID                                                                                                     | C     |
| ii)     | Visual check for correction/ramming                                                | 100%                                                                                                                                                | POWERGRID Specification and approved drawings      | Contractor             | Approval by POWERGRID                                                                                                     | C     |
| iii)    | Compaction test (Percentage of max. dry density)                                   | Gantry Foundation-2 samples for each pit. Equipment                                                                                                 | POWERGRID specification                            | POWERGRID approved lab | Review of lab test results by POWERGRID Elevation for testing to be                                                       | B     |

# POWERGRID CORPORATION OF INDIA LIMITED

(Quality Assurance & Inspection Deptt.)

|      |                                                    |                                    |                                                       |            |                                             |   |
|------|----------------------------------------------------|------------------------------------|-------------------------------------------------------|------------|---------------------------------------------|---|
|      |                                                    | and other foundation-20% at random |                                                       |            | decided by POWERGRID                        |   |
| 5.   | BRICK-WORK                                         |                                    |                                                       |            |                                             |   |
| i)   | Mortar mix/proportion                              | Random                             | IS:2250, POWERGRID Specification & CPWD Specification | Contractor | Approval by POWERGRID                       | B |
| ii)  | Plumb & Alignment                                  | Random                             | POWERGRID Specification & CPWD Specification          | Contractor | Approval by POWERGRID                       | B |
| iii) | Joints                                             | Random                             | POWERGRID Specification & CPWD Specification          | Contractor | Approval by POWERGRID                       | B |
| 6.   | PLASTERING                                         |                                    |                                                       |            |                                             |   |
| i)   | Plastering thickness and evenness                  | Random                             | POWERGRID Specification & CPWD Specification          | Contractor | Approval by POWERGRID                       | B |
| ii)  | Mortar mix proportion                              | Random                             | POWERGRID Specification & CPWD Specification          | Contractor | Approval by POWERGRID                       | B |
| 7.   | CURING FOR CONCRETE, MASONRY, PLASTERING ETC.      | 100% on all location               | IS:5613 & POWERGRID Specification                     | Contractor | Approval by POWERGRID                       | C |
| 8.   | SWITCH YARD EARTHING                               |                                    |                                                       |            |                                             |   |
| i)   | Check for dimension of earth mat rod               | Random                             | POWERGRID Specification & drawings                    | Contractor | Approval by POWERGRID                       | B |
| ii)  | Depth of excavation                                | Random                             | POWERGRID Specification & drawings                    | Contractor | Approval by POWERGRID                       | C |
| iii) | Check for weld joints and anti corrosive treatment | Random                             | POWERGRID Specification & drawings                    | Contractor | Approval by POWERGRID                       | B |
| iv)  | Backfilling                                        | 100%                               | POWERGRID Specification & drawings                    | Contractor | Approval by POWERGRID                       | C |
| 9.   | SITE SURFACING                                     |                                    |                                                       |            |                                             |   |
| i)   | Levelling                                          | 100%                               | POWERGRID Specification and approved drawings         | Contractor | Checklist to be prepared and signed jointly | C |

# POWERGRID CORPORATION OF INDIA LIMITED

(Quality Assurance & Inspection Deptt.)

|           |                                                                  |                                                                                                      |                                                                                                                           |                                          |                                                                                                              |   |
|-----------|------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|------------------------------------------|--------------------------------------------------------------------------------------------------------------|---|
| ii)<br>a) | Soil Sterilisation<br>Spraying of<br>chemicals                   | 100%                                                                                                 | POWERGRID<br>Specification and<br>Manufacturers<br>recommendations                                                        | Con tractor                              | Checklist to be<br>prepared and<br>signed jointly                                                            | B |
| iii)      | Grading of 20/40mm<br>Stone                                      | 1 sample per<br>lot of 500<br>Cubic Metre<br>or part<br>thereof from<br>each source<br>for each size | IS: 383, IS: 2386<br>and<br>POWERGRID<br>Specification.<br>The grading shall<br>be as per single<br>sized nominal<br>size | Contractor/<br>POWERGRID<br>Approved lab | Each source to<br>be approved by<br>POWERGRID<br>Review and<br>acceptance of<br>test results by<br>POWERGRID | B |
| iv)       | Compacted thickness<br>of 20/40 mm stone<br>layers as applicable | Random                                                                                               | POWERGRID<br>Specification and<br>specification<br>drawings                                                               | Contractor                               | Checklist to be<br>prepared and<br>signed jointly                                                            | B |

## Section: GENERAL GUIDELINES FOR IMPLEMENTATION

1. Details of categories of check codes A,B & C including accepting and deviation dispositioning authorities are indicated at Annexure-I.
2. POWERGRID specification shall mean POWERGRID technical specification, approved drawings data sheets and LOA provisions applicable for the specific contract.
3. Acceptance criteria and permissible limits for certain tests are indicated at Annexure-II. For balance tests, site to verify the same with respect to POWERGRID specification, relevant Indian Standards and/or prevalent code of practice.
4. It is clarified that the tests indicated at column 2 of this FQP i.e. against column “Component operation & Description of Test”, are only generally required to be conducted. However, POWERGRID reserves the right to carry-out any additional tests at any stage if the situation so warrants.
5. POWERGRID site representative shall witness all the tests conducted by the contractor as mentioned in the FQP. However, in case of tests conducted in the POWERGRID approved lab, it is preferred to witness the tests in the lab itself, if possible.
6. Head of GHQ shall approve testing laboratory before accepting the test results from the lab.
7. Head of GHQ shall approve the sources for cement , coarse aggregate, fine aggregate & water before actual utilization.
8. All the testing & measuring equipments used by the contractor for testing are required to be calibrated. A copy of valid calibration report shall be retained by POWERGRID as records.
9. Classification of foundations shall be approved by POWERGRID based on the Joint Inspection Report & soil investigation reports.
10. Curing of concrete work should be continued for minimum period of 10 days.

# **POWERGRID CORPORATION OF INDIA LIMITED**

**(Quality Assurance & Inspection Deptt.)**

## **11. ZONE-IV FINE AGGREGATE**

11.1 Zone-IV fine aggregate shall be used for nominal mix. Reinforced cement concreting work.

11.2 Zone-IV fine aggregate shall be avoided for design mix reinforced cement concreting work unless tests have been done to ascertain the suitability of proposed with the prior approval POWERGRID site.

12. Bricks should be free from cracks, flaws and modules of free lime. They should have smooth rectangular faces with sharp corners and should be uniform in colour.

## **13. CEMENT**

13.1 In case of cement is in the scope of the contractor, the same shall be procured from sources approved by POWERGRID site and got tested on sample basis for specified acceptance tests as specified in the FQP at a reputed Third Party Lab approved by POWERGRID site.

13.2 The samples of cement for site testing shall be taken within three weeks of the delivery and all the tests shall be commenced within one week of sampling. If the cement remains in store for a period of more than six months. All the site tests are required to be repeated before usage.

## **14. REINFORCEMENT STEEL & STRUCTURAL STEEL USED IN CABLE TRENCHES & FOUNDATIONS**

14.1 In case supply of steel is in the scope of the contractor, the same shall be procured from the main producers i.e. SAIL, TISCO, IISCO or Rashtriya Ispat Nigam or the rerollers approved by main producers. The steel shall be got tested at site on sample basis for specified acceptance tests as specified in this FQP at a reputed Third Party Lab approved by POWERGRID site.

14.2 The results of the testing of cement and reinforcement steel referred in 13.1 and 14.1 above shall be got approved from POWERGRID site before cement and reinforcement steel are put to use. However, in exceptional cases due to exigencies of work. POWERGRID site may authorize the contractor to use Cement and Reinforcement Steel even before the test results are received. However, in all such cases, if the test results subsequently received are found to be not complying with the specified acceptance criteria, the contractor shall have to dismantle and recast all such foundations cast with such non-conforming materials at his own cost. Confirmation to this effect shall be obtained from the contractor by the Project authorities beforehand in all such cases.

15. The contractor shall submit welding procedure specification (WPS) including the type of electrode used for approval of POWERGRID site before starting the welding work.

16. Approval/acceptance of individual test results by POWERGRID in the course of execution of contract will not relieve the contractor of his contractual obligations and responsibilities, nor does it limit the Owner's right under the contract.

17. In case, requirement of special items like Super Sulphated Cement, Corrosive Resistant Reinforcement Steel (CRRS) etc. arise due to site conditions, the specific approval of POWERGRID may be obtained before using the same and all the tests as per relevant standards shall be carried out.

18. All the materials shall be stored by the contractor in a manner affording convenient access for identifications and inspection at all times. Storage of material shall be in accordance with IS: 4032 (Latest Edition).

# POWERGRID CORPORATION OF INDIA LIMITED

(Quality Assurance & Inspection Deptt.)

## ANNEXURE-I

PAGE 1 OF 1

### ACCEPTING AND DEVIATION DISPOSITIONG AUTHORITIES FOR DIFFERENT CATEGORIES OF CHECKS AS ENVISAGED IN FIELD QUALITY PLANT

| CATE<br>GORY | TYPE<br>OF<br>CHECK | 100%<br>CHECKING/WITNESSING<br>BY                  | COUNTER<br>CHECK/SURVEI<br>LLANCE<br>CHECK BY             | ACCEPTING<br>AUTHORITY, IF<br>TEST RESULTS<br>ARE WITHIN<br>PERMISSIBLE<br>LIMITS | DEVIATION<br>DISPOSITIONING<br>AUTHORITY                       |
|--------------|---------------------|----------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------------------------------|
| 'A'          | CRITI-<br>CAL       | EXECUTING DEPTT. PLUS<br>FQA REPRESN-TATIVE<br>GHQ | FQA REPRESN<br>TATIVE AND<br>RHQ/DHQ<br>REPRESN<br>TATIVE | HEAD OF DHQ                                                                       | HEAD OF RHQ IN<br>CONSULTATION<br>WITH<br>CQA, IF<br>REQUIRED. |
| 'B'          | MAJOR               | EXECUTING DEPTT.                                   | DHQ-<br>REPRESENTATI<br>VE                                | HEAD OF GHQ                                                                       | HEAD OF DHQ                                                    |
| 'C'          | MINOR               | CONTRACTORS<br>REPRESENTATIVE                      | EXECUTING<br>DEPTT.                                       | MINIMUM E4<br>LEVEL<br>EXECUTING OF<br>SUB-<br>STATION/TL                         | HEAD OF GHQ                                                    |

# POWERGRID CORPORATION OF INDIA LIMITED

(Quality Assurance & Inspection Deptt.)

ANNEXURE-2

Page 1 of 5

## ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR FOUNDATION MATERIALS AND CONCRETE

### A) CEMENT

| S. No. | Description of the tests                                                      | 33 Grade OPC as per IS:269                              | 43 Grade cement as per IS:8112 | PPC as per IS:1489         | Low Heat cement                                                               |
|--------|-------------------------------------------------------------------------------|---------------------------------------------------------|--------------------------------|----------------------------|-------------------------------------------------------------------------------|
| 1.     | Fineness (min.)                                                               | 225 m <sup>2</sup> /kg                                  | 225 m <sup>2</sup> /kg         | 300 m <sup>2</sup> /kg     | 225 m <sup>2</sup> /kg                                                        |
| 2.     | Compressive strength (min.)<br>72 ± 1 hours<br>168 ± 2 hours<br>672 ± 4 hours | 160 kgf/cm <sup>2</sup><br>220 kgf/cm <sup>2</sup><br>- | 23 MPa<br>33 MPa<br>43 MPa     | 16 MPa<br>22 MPa<br>33 MPa | 100 Kgf/cm <sup>2</sup><br>160 Kgf/cm <sup>2</sup><br>350 Kgf/cm <sup>2</sup> |
| 3.     | Initial setting time (min.)                                                   | 30 minutes                                              | 30 minutes.                    | 30 minutes                 | 30 minutes                                                                    |
| 4.     | Final setting time (max.)                                                     | 600 minutes                                             | 600 minutes                    | 600 minutes.               | 600 minutes.                                                                  |
| 5.     | Soundness (Le Chatelier Method)                                               | Maximum 10 mm expansion                                 | Maximum 10 mm expansion        | Maximum 10 mm expansion    | Maximum 10 mm expansion                                                       |
| 6.     | Heat of Hydration (max.)                                                      | -                                                       | -                              | -                          | Max. 65 cal/gm for 7 days & max. 75 cal./gm for 28 days                       |
| 7.     | Chemical composition                                                          | As per IS                                               | As per IS                      | As per IS                  | As per IS                                                                     |

### B) COARSE AGGREGATE :

#### (i) Sieve Analysis

| IS SIEVE DESIGNATION | PERCENTAGE PASSING FOR GRADED AGGREGATE OF NOMINAL SIZE |           | PERCENTAGE PASSING FOR SINGLE SIZED AGGREGATE OF NOMINAL SIZE |          |
|----------------------|---------------------------------------------------------|-----------|---------------------------------------------------------------|----------|
|                      | 40 mm                                                   | 20 mm     | 40 mm                                                         | 20 mm    |
| 63 mm                | -                                                       | -         | 100                                                           | -        |
| 40 mm                | 95 to 100                                               | 100       | 85 – 100                                                      | 100      |
| 20 mm                | 30 to 70                                                | 95 to 100 | 0 – 20                                                        | 85 - 100 |
| 10 mm                | 10 to 35                                                | 25 to 55  | 0 – 5                                                         | 0 - 20   |
| 4.75 mm              | 0 to 5                                                  | 0 to 10   | -                                                             | 0 - 5    |

# POWERGRID CORPORATION OF INDIA LIMITED

(Quality Assurance & Inspection Deptt.)

ANNEXURE-2

Page 2 of 5

- (ii) Flakiness Index Not to exceed 25%
- (iii) Crushing value Not to exceed 45%
- (iv) Soundness of aggregate applicable for concrete works subject to frost action Loss of weight after 5 cycle not to exceed 12% when tested with Sodium sulphate and 18% when tested with magnesium sulphate
- (v) Deleterious material Not to exceed 5% of the weight of aggregate when tested as per IS:2386 Part – II (1963)
- ( C) FINE AGGREGATE
- (i) Sieve Analysis Shall confirm to Zone-I, Zone-II or Zone-III

| IS Sieve designation | Grading Zone-I | Percentage Grading Zone-II | Passing for Grading Zone-III | Grading Zone-IV |
|----------------------|----------------|----------------------------|------------------------------|-----------------|
| 10 mm                | 100            | 100                        | 100                          | 100             |
| 4.75 mm              | 90 - 100       | 90 - 100                   | 90 - 100                     | 90 - 100        |
| 2.36 mm              | 60 - 95        | 75 - 100                   | 85 - 100                     | 95 - 100        |
| 1.18 mm              | 30 - 70        | 55 - 90                    | 75 - 100                     | 90 - 100        |
| 600 Micron           | 15 - 34        | 35 - 59                    | 60 - 79                      | 80 - 100        |
| 300 Micron           | 15 - 20        | 8 - 30                     | 12 - 40                      | 15 - 50         |
| 150 Micron           | 0 - 10         | 0 - 10                     | 0 - 10                       | 0 - 15          |

- (ii) For guidance of adjusting sand in mix of concrete, the following table may be used.

| Moisture Content % | building % by volume |
|--------------------|----------------------|
| 2                  | 15                   |
| 3                  | 20                   |
| 4                  | 25                   |
| 5                  | 30                   |

- (iii) Silt Content Test: Shall not exceed 8% when tested as per test procedure specified in appendix-D of chapter 3 of 1991-92 CPWD Specification.
- (iv) Deleterious Materials: Total deleterious material shall not be more than 5% by weight.

# POWERGRID CORPORATION OF INDIA LIMITED

(Quality Assurance & Inspection Deptt.)

ANNEXURE-2

Page 3 of 5

(D) REINFORCEMENT STEEL: As per relevant Indian Standards.

(E) CONCRETE CUBE TEST

For nominal (volumetric) concrete mixes, compressive strength for 1:1½:3 (cement : sand : coarse aggregate) concrete shall be 265 kg/cm<sup>2</sup> for 28 days and for 1:2:4 nominal mix, it shall be 210Kg/cm<sup>2</sup>.

(F) ACCEPTANCE CRITERIA BASED ON 28 DAYS COMPRESSIVE STRENGTH FOR NOMINAL MIX CONCRETE

- (a) The average of the strength of three specimen be accepted as the compressive strength of the concrete, provided the strength of any individual cube shall neither be less than 70% nor higher than 130% of the specified strength.
- (b) If the actual average strength of accepted sample exceeds specified strength by more than 30%, the Engineer-in-charge, if he so desires, may further investigate the matter. However, if the strength of any individual cube exceeds more than 30% of specified strength, it will be restricted to 30% only for computation of strength.
- (c) If the actual average strength of accepted sample is equal to or higher than specified strength upto 30%, then strength of the concrete shall be considered in order and the concrete shall be accepted at full rates.
- (d) If the actual average strength of accepted sample is less than specified strength but not less than 70% of the specified strength, the concrete may be accepted at reduced rate at the discretion of Engineer-in-Charge.
- (e) If the actual average strength of accepted sample is less than 70% of specified strength, the Engineer-in-Charge shall reject the defective portion of work represented by sample and nothing shall be paid for the rejected work. Remedial measures necessary to retain the structure shall be taken at the risk and cost of contract. If, however, the Engineer-in-Charge so desires, he may order additional tests to be carried out to ascertain if the structure can be retained. All the charges in connection with these additional tests shall be borne by the contractor.

(G) ACCEPTANCE CRITERIA FOR DESIGN MIX CONCRETE SHALL BE AS PER IS:456.

# POWERGRID CORPORATION OF INDIA LIMITED

(Quality Assurance & Inspection Deptt.)

ANNEXURE-2

Page 4 of 5

## (H) SAMPLING PLAN FOR BRICK WORK

- i) Scale of sampling and permissible number of defectives for visual and dimensional characteristics.

| No. of bricks in the lot | For characteristics specified for individual bricks |                                            | For dimensional characteristics for group of 20 bricks-No. of bricks to be selected |
|--------------------------|-----------------------------------------------------|--------------------------------------------|-------------------------------------------------------------------------------------|
|                          | No. of bricks to be selected                        | Permissible no. of defective in the sample |                                                                                     |
| (1)                      | (2)                                                 | (3)                                        | (4)                                                                                 |
| 2001-10000               | 20                                                  | 1                                          | 40                                                                                  |
| 10001-35000              | 32                                                  | 2                                          | 60                                                                                  |
| 35001-50000              | 50                                                  | 3                                          | 80                                                                                  |

Note : In case the lot contains 2000 or less bricks the sampling shall be as per decision of the Engineer-in-Charge.

- ii) Scale of sampling for physical characteristics

| Lot size    | Sampling size for compressive strength water absorption and efflorescence | Permissible no of defectives for efflorescence |
|-------------|---------------------------------------------------------------------------|------------------------------------------------|
| (1)         | (2)                                                                       | (3)                                            |
| 2001-10000  | 5                                                                         | 0                                              |
| 10001-35000 | 10                                                                        | 0                                              |
| 35001-50000 | 15                                                                        | 1                                              |

Note: In case the lot contains 2000 or less bricks, the sampling shall be as per decision of Engineer-in-Charge.

# POWERGRID CORPORATION OF INDIA LIMITED

(Quality Assurance & Inspection Deptt.)

ANNEXURE-2

Page 5 of 5

## (I) ACCEPTANCE CRITERIA FOR BRICK-WORK

- (i) Dimensional tolerances: The dimensions of modular bricks when tested shall be within the following limits per 20 bricks.

Length 372 to 388 cm ( $380 \pm 8$ cm)

Width 176 to 184 cm ( $180 \pm$ cm)

Height 176 to 184 cm ( $180 \pm 4$ cm) for 90 mm high bricks

- (ii) In case of non-modular bricks, %age tolerance will be +/- 2% for group of 20 numbers of class 10 bricks and +/- 4% for other class of bricks.

- (iii) Compressive strength: The bricks, shall have a minimum average compressive strength as specified in POWERGRID specification. The compressive strength of any individual brick tested shall not fall below the min. average compressive strength specified for the corresponding class of brick by more than 20%. In case compressive strength of any individual brick tested exceeds the upper limit specified for the corresponding class of bricks, the same shall be limited to upper limit of the class as specified for the purpose of calculating the average compressive strength.

- (iv) Water absorption: The average water absorption of bricks shall not be more than 20% by weight.

- (v) Efflorescence: The rating of efflorescence of bricks shall not be more than moderate.