TENDER DOCUMENT
TENDER No.: NRO/CON/604/531

CONSTRUCTION OF INTERMODEL IWT TERMINAL AT VARANASI (U.P).

FOR

INLAND WATERWAYS AUTHORITY OF INDIA,
MINISTRY OF SHIPPING, GOVT. OF INDIA

VOLUME – IIB

TECHNICAL SPECIFICATIONS

EXECUTING AGENCY

ENGINEERING PROJECTS (INDIA) LIMITED
(A GOVT. OF INDIA ENTERPRISE)
Core-3, Scope Complex,
7, Lodhi Road, New Delhi-110003
TEL NO: 011-24361666, FAX NO. 011-24363426
<table>
<thead>
<tr>
<th>SI.NO</th>
<th>DESCRIPTION</th>
<th>PAGE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>CIVIL WORKS</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>ITEMS BASED ON DSR 2007</td>
<td>2 of 4</td>
</tr>
<tr>
<td>2</td>
<td>PILE WORKS</td>
<td>5 of 12</td>
</tr>
<tr>
<td>3</td>
<td>NON SCHEDULE ITEMS</td>
<td>13 of 27</td>
</tr>
<tr>
<td>B</td>
<td>ELECTRICAL WORKS</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>CONDITION &amp; SPECIFICATIONS OF ELECTRICAL WORKS</td>
<td>28 of 31</td>
</tr>
<tr>
<td>2</td>
<td>SPECIFICATION OF INTERNAL ELECTRICAL INSTALLATION / MCB &amp; MCB</td>
<td>32 of 43</td>
</tr>
<tr>
<td>3</td>
<td>SPECIFICATION OF L.T. PANAL &amp; CAPACITOR PANEL</td>
<td>44 of 53</td>
</tr>
<tr>
<td>4</td>
<td>SPECIFICATION OF DRY TYPE TRANSFORMER</td>
<td>54 of 57</td>
</tr>
<tr>
<td>5</td>
<td>SPECIFICATION OF VCB PANAL</td>
<td>58 of 65</td>
</tr>
<tr>
<td>6</td>
<td>SPECIFICATION OF CABLE LAYING</td>
<td>66 of 73</td>
</tr>
<tr>
<td>7</td>
<td>SPECIFICATION OF D.G. SET &amp; AMF PANAL</td>
<td>74 of 97</td>
</tr>
<tr>
<td>8</td>
<td>SPECIFICATION OF EARTHING</td>
<td>98 of 105</td>
</tr>
<tr>
<td>C</td>
<td>FIRE FIGHTING WORKS</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>SPECIAL CONDITIONS OF THE CONTRACT</td>
<td>106 of 112</td>
</tr>
<tr>
<td>2</td>
<td>SPECIFICATION OF FIRE FIGHTING SYSTEM</td>
<td>113 of 123</td>
</tr>
<tr>
<td>D</td>
<td>EOT CRANE WORKS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SPECIFICATION OF DOUBLE GIRDER EOT CRANE</td>
<td>124 of 151</td>
</tr>
</tbody>
</table>
CIVIL WORKS
ITEMS BASED ON DSR 2007
All works of items which are based on DSR 2007, shall be executed in accordance with the relevant latest CPWD specifications with up to date corrections.
PILE WORKS
A) PILES

1.0 BORED CAST-IN-SITU CONCRETE PILE

1.01 General

This specification covers the piling work required for the construction of intermodal terminal at Varanasi. Geotechnical investigation for the area where on land facilities and jetty structure are coming have been completed. Report may be referred to for sub soil parameters. The area falls in “Indo gangotri plains” and soil at the project side belongs to indo gangotri alluvial and are river deposit of the river Ganga its tributaries. However, general site stratigraphy is as follows:

In the river bank - Hard clayey silt
In the river - Hard clayey silt underlain with very dense silty sand

Tenderer may carry out additional investigation if felt necessary by him. Claims and objections of site and subsoil conditions shall not be entertained.

1.02.01 Codes

IS:2911 (Part 1/Section 2) – 1979: ‘Code of practice for design & construction of Bored Cast – in Situ concrete piles’ shall be referred to in conjunction with this specification during the entire design & construction work. If for any material or workmanship, appropriate Indian Standards or Codes are not available or have not been adequately specified in the Technical Specification, such material & workmanship shall conform to other suitable & codes.

1.02.02 Design

The piles shall be bored cast-in-situ cylindrical type RCC piles and shall be founded on suitable approved strata to achieve the design capacity.
1.02.03 Materials

All the materials proposed to be used, shall be free from any objectionable substances, shall conform the following stipulation. Any testing required to prove the suitability of such materials should be carried out.

1.02.03.01 Reinforced Cement Concrete for Piles shall be with minimum Cement content of 425 kg/m³ for piles. The slump of concrete for piles shall be between 160 mm to 180 mm. the water-cement ratio shall not exceed 0.45. to achieve the specified slump using specified water cement ratio without compromising with strength, if required, suitable admixture shall be used subject to approval of the Purchaser.

1.02.03.02 Preliminary mix design shall be done in accordance with IS: 10262-1982 & SP:23 subject to approval of the Purchaser. Cube tests, Slump test & other relevant tests for preliminary mix design and Routine cube test, slump test for regular concreting shall be carried out at / site laboratory at contractor’s own cost. Concrete cube tests shall be done as per IS:516-1959. Frequency of cube test shall be guided by clause 15.2 of IS: '456-2000. Slump tests (apparatus conforming to IS:IS: 7320 -1974) Shall be carried out at least once for each pile or more frequently, if desired by the Purchaser.

1.02.04 Equipment & Accessories

The equipment & accessories should be compatible with the type of sub-soil, method of installation, type of founding strata & required penetration in the founding strata.

The capacity of rig shall be adequate so as to bore upto required depth with specified diameter. Rig shall be equipped with suitable chisel to penetrate through any local obstruction/ hard strata.

1.02.05 Construction

1.02.05.01 The permissible positional deviation in horizontal direction shall not be exceed 1.5% from the designed location in more in case of piles having diameter more than 600mm.
1.02.05.02 Stabilisation of the side of borehole shall be done by the use of bentonite slurry. Direct Mud Circulation (DMC) process shall be adopted. In such cases the bentonite slurry must be used at least from the level of sub-soil water, as the hole shall then be always kept almost full with the fluid. The specific gravity of bentonite slurry shall be in the range of 1.05 to 1.10. This shall be checked regularly for each or at any change in its specified consistency. Pressure of slurry pump shall be sufficient enough to clear out all cuttings efficiently from the hole. Prevention of side collapse of bore-holes shall be taken care by with use of temporary casing if necessary. At the last stage of boring or in intermediate hard layers chisel may be used. The piles shall be installed with due consideration for safely of adjacent structures by a method. Which leaves their strength unimpaired, and which develops and retains the required bearing resistance.

1.02.05.03 Reinforcement as required shall be made into stiff cages sufficiently welded to withstand handling without any damage or distortion. Reinforcement shall be placed immediately after cleaning and inspection of the bottom of bore holes. The reinforcement should be supported away from the sides of the shaft by means of suitable space block to ensure concentric alignment in the shaft. Steps shall be taken to ensure correct positioning during concreting of reinforcement in the piles without any distoration.

1.02.05.04 Immediately before placing or reinforcement and concreting, the bored hole shall be cleaned of all the loose material, debris and all the water shall be removed. The pile tip zone shall be thoroughly replace the old bentonite slurry used during the previous operations. This shall be carried out for about 45 minutes in two stages. Cleaning for about first 30 minutes shall be done before lowering of reinforcement cage & cleaning of about 2\textsuperscript{nd} 15 minutes after lowering the reinforcement cage.

Concrete shall be so placed as to fill the entire volume of the tube or bore without the formation of voids caused be the faulty consolidation or entrapped air. Proper care shall be taken to ensure that the fluid alluvial soil does not penetrate between batches of the concrete.

In case of boreholes stabilized by bentonite slurry, concrete shall be placed by means of tenie pipe, which will be suitably closed at bottom at the start of concreting. The tremie pipe must extend upto the bottom of the borehole at the start and may be withdrawn in sections as the level of concrete rises in the borehole; but its discharge end shall at all times be
embedded in the concrete to a minimum depth of 2 m. placing of concrete should be continuous and the pile holes will be maintained full with the bentonite slurry where used throughout the concreting operation. Slurry displaced from the borehole by the concrete shall be channeled away or pumped into suitable mud pond for re-use or disposal to waste.

In case of cased holes. After the required founding level is encountered the bottom shall be sealed with concrete and the reinforcement cage shall be lowered. If the borehole is dry, concrete shall be deposited in such a manner so as to avoid any segregation of concrete followed by gradual withdrawal of casings. If water is present in the borchole, it shall be bailed out by bailer. If it is difficult to dewater by the bailer, concrete shall be placed under water by means of a placer. After the head of water has been neutralized by the head of the concrete. Excess water shall be bailed out and concrete shall then be deposited by direct pouring from the top. As is done, if the borehole is dry.

1.02.05.05 The concreted length of piles shall be measured from the toe of pile to cut off level of pile.

1.02.05.06 Temporary stoppage of work may be permitted only during boring stage. Thereafter right form boring or chiseling of final portion of pile length through subsequent activities of flushing, lowering of reinforcement cage, lowering of tremie, pre-concrete, lowering of reinforcement cage, lowering of tremie, pre-concrete flushing & upto concreting of full pile length, no halt whatsoever in the execution of work shall be permitted.

1.02.05.07 Boring for any pile shall not be carried out within a clear distance of four times of pile diameter form the adjacent pile, which has been freshly concreted within past 24 hours.

1.02.05.08 Concreting of Pile shall continue until the pile is fully formed upto a level of not less than 500 mm above cut off level of piles. Extraction of casing wherever used shall be done in such a way that no necking or shearing of the concrete in the shaft takes place. Pile length above cut off level shall not be measured for payment and shall be trimmed off free of cost. Trimming of pile top shall not be permitted before 7 days of concreting in case of mechanical chipping & 3 days in case of manual chipping.
1.02.06 **Founding Strata**

All the piles shall be founded in specified strata.

SPT Shall be carried out at founding level for at least one pile at every 10m distance subject to minimum of one test for every 25 piles or part thereof within a pile cap.

1.02.07 **Pile Load Test**

1.02.07.01 Maximum load in case of routing tests shall be limited to 1.05 times of the corresponding safe design load.

1.02.07.02 For all types of Routine load tests the testing arrangement, procedure & interpretation shall follow relevant criteria set out in IS: 2911 (part 4)- 1985 along with the following stipulations:

i) Load test shall be carried out after 28 days from the date of casting unless otherwise directed.

ii) Test load shall be applied at cut-off level, if the test level is below the ground water table. Suitable arrangement for dewatering shall be made.

iii) Loading shall be applied by reaction method consisting of a hydraulic jack placed centrally against a suitable loaded platform / anchorage system. Reaction system shall be well designed & capable of taking 1.25 times of the maximum load to be applied.

iv) Test load shall be applied to pile in a static manner. Stage loading shall be applied in equal increments of 20% of estimated safe design load. Unloading may be done in higher decrements with at least 5 stages. For Cyclic load test, each stage of loading shall correspond to unloading upto zero load. At each stage of loading & unloading, deflection of pile top shall be recorded accurate to 0.02 mm at an interval of 1, 2, 4, 8, 15, 30, 60, 120 minutes upto a time when the deflection rate reduces to 0.1 mm in 30 minutes or 0.2 mm in one hour or till two hours whichever occurs earlier.

v) Increments of loads shall be continued upto maximum load of 1.5 times of safe design load for Routine test or failure (soil –pile yielding or structural failure) whichever occurs earlier.

vi) where failure does not occur, the final test load shall be maintained for 24 hours and deflection records shall be taken at every 6 hours
interval, including initial 2 hours detailed records, as mentioned earlier.

vii) Assessment of safe load for different types of test shall follow relevant clauses of IS: 2911 (part 4) – 1985.

viii) After completion of load test, the following records/reports shall be furnished.

   a) Tabular & Graphical representation of Load vs. Settlement during loading and unloading.

   b) Tabular & Graphical representation of the Time vs. Settlement for each load.

   c) Graphical analysis of initial cyclic load test results to separate skin friction & end-bearing as per Annexure IS 2911 (part 4)

   d) Remarks concerning any unusual occurrence (if any) during boring installation or testing or piles.

1.02.08 **Standard of Acceptance**

The piles shall be accepted as satisfactory only when the work has been executed in accordance with this specification. IS Codes and the standards stated hereinafter and instructions given by purchaser at site from time to time:

a) The total volume of concrete shall not be less than actual shaft volume and not more than 40% of the calculated volume, the calculated volume for this purpose shall be the cross sectional area inside the bore multiplied by the length of the shaft. The concrete shall show the specified strength as indicated by the cube test results.

b) The toe of pile shall be at approved bearing level in each case.

c) Tolerances specified in clause No. 02.05.01 shall be satisfied.

If an individual pile fails to meet the requirements specified in any of above clause/s, such pile shall be deemed to be defective. When any pile is found defective, one or more pole shall be installed as a replacement of defective pile as necessary.
1.02.09  **Record**

A record for each pile indicating the following data shall be maintained.

a) The date and time of commencement and completion of the piling operation.

b) The particulars of the equipment and method of boring and concreting.

c) The location and type of pile, pile number, with a reference to approved drawings.

d) The diameter of the pile and verticality.

e) Bored depth, concreted depth, empty boring and nature of stratum at founding level.

f) The volume of concrete poured, quantity of cement, w/o ratio used and slump of poured concrete.

g) Details of reinforcement provided.

h) The sequence of installation of pile groups.

i) During boring operation, a separate record for rate of advancement of borehole in terms of effective time vs. boring depth shall be maintained for each pile. The effective time implies the time required exclusively for boring operation barring the time for other activities such as temporary stoppage, cleaning of hole, in – situ tests, if taken etc.

1.02.10  **General:**

Part of the pile foundation and civil works is to be carried out in the river water. During the execution period, the working area is to be kept dry by providing suitable approved arrangements such as of coffer sheet piling/coffer dam etc. The arrangement shall be got approved from the Engineer-In-Charge before executing the work. The cost of the above work shall be included in the cost of civil works & Piling works etc. respectively.
NON SCHEDULE ITEMS
1. **Supplying and filling in plinth with locally available fine sand under floors including, watering, ramming consolidating and dressing complete.**

**General**
Sand shall be clean and free from dust organic and foreign matter and its grading shall be within the limits of grading zone IV or V.
Sand filling shall be done in a manner similar to earth filling in plinth specified in 2.21.3.2 except that consolidation shall be done by flooding with water. The surface of the consolidated sand filling shall be dressed to the required level or slope and shall not be covered till the engineer-in-charge has inspected and approved of the sand filling.

**Measurements**
The length, breadth and depth of consolidated sand shall be measured with steel tape correct to the nearest cm and cubical contents worked out in cubic meters correct to two places of decimal.

**Rates**
The rates include the cost of material and labor involved in all the operations described above.

2. **Diluting and injecting chemical emulsion for pre constructional anti-termite treatment and creating a continuous chemical barrier under all round the column pits, wall trenches, basement excavation, top surface plinth filling, junction of wall and floor, along the external perimeter of the building, expansion joints over the top surface of consolidated earth on which apron is to be laid, surrounding of pipes and conduits etc. complete as per specifications.** (plinth are of the building at ground floor only shall be measured in sqm for payment).

   With chloropyriphos emulsifiable concentrates of 20 % with 1 % concentration, at the rate of 7.5 litre per sqm for vertical surface and 5 litres per sqm of horizontal surface.

**General**
The specifications of the item are similar to DSR’07 item number 2.27, the work shall be strictly executed as per IS 6313. The work shall be executed by specialized agency having adequate technical capability and experience for similar nature of work.

**Submittals**
Ten years guarantee certificate from the executing agency.
 Measurement
Plinth area of the building at ground floor shall be measured for payment.

Rate
It includes the cost of all material and labor required for all the necessary operations that may be undertaken to execute the item described above.

3. Supplying of local earth at site including royalty and carriage up to 1 km lead (earth measured in stacks will be reduced of 20 % for payment)

General
The earth shall be stacked at site in stacks not less than 50 cm high and of not less than 3.0 cum.
The earth shall be free from kankar, Moorum shingle, rocks, stones, brick bats building rubbish and any other foreign matter. The earth shall be free from clods or lumps or sizes bigger than 75 mm in any direction.

Measurements
Length, breadth and height of stacks shall be measured correct to a cm. the volume of stacks shall be reduced by 20 % for voids before payment, unless otherwise described.

Rate
The rate shall include the cost of excavating the earth from areas lying at distances not exceeding one km from the site, transporting the same at site breaking of clods and stacking at places indicated. The rate shall also include royalty if payable.

4. Filling available excavated earth (excluding rock) in layers not exceeding 20 cm in depth consolidating each deposited layer by ramming and watering lead up to 50 m and lift up to 1.5 m.

General
Normally excavated earth from same area shall be used for filling. Earth used for filling shall be free from shrubs, rank vegetation, grass, brushwood, stone shingle and boulders (larger than 75 mm in any direction) organic or any other foreign matter. Earth containing deleterious materials, salt peter earth etc. shall not be used for filling. All clods and lumps of earth exceeding 8 cm in any direction shall be broken or removed before the earth is used for filling.

Filling
The space around the foundations and drains in trenches shall be cleared of all debris, brick bats etc. The filling shall be done in layers not exceeding 20 cm in depth. Each layer shall be watered, rammed and consolidated. Ramming shall be done with iron rammers where possible and with blunt end of cow bars where
rammers cannot be used. Special care shall be taken to ensure that no damage is caused to the pipes, drains, masonry or concrete in the trenches. In case of filling under floor, the finished level of filling shall be kept to the slope intended to be given to the floor.

**Measurements**
Depth of filling shall be the consolidated depth. The dimensions of filling shall be on the basis of pre measurement correct to the nearest cm and cubical contents worked out in cubic meters correct to two places of decimal.

**Rates**
The rates include cost of all the operations described above.

5. **Providing and laying filter of gravel as per IS 8237-1985 and direction of engineer -in -charge.**

**General**
It shall consist of naturally occurring (uncrushed, crushed or broken) river bed shingle or pit gravel. It shall be sound, hard and clean. It shall be free from flat particles of shale or similar laminated material, powdered clay, silt, loam, adherent coatings, alkali vegetable, matter and other deleterious substances. Pit gravel shall be washed if it contains soil material adhering to it. These shall conform to IS: 383 unless otherwise specified.

**Stacking**
Gravel shall be stacked on a hard, dry and level patch of ground. When stack piling, the aggregate shall not form pyramids resulting in segregation of different sized materials. It shall be stacked separately according to nominal size of coarse aggregates. Stacking shall be done in regular stacks, of height not exceeding 100 cm.

**Testing**
Gravel shall be tested for following as per IS: 2386-1963

a. Determination of particle size and shape.
b. Estimation of organic impurities.
c. Surface moisture.
d. Determination of 10 % fine value.

**Measurements**
The gravel shall be measured in stacks and paid for after making a deduction of 7.5 % of the gross measurements of stacks in respect of aggregates of nominal size 40 mm and above.
No deduction from the gross measurements of the stacks is to be made in respect of aggregates of nominal size of below 40 mm.

**Rates**

The rates include cost of all the operations described above.

6. **Dry stone pitching in crates of 1 x 1 x .6 m in two layers in launching apron.**

**Measurement**

Area of the slope pitching shall be measured correct to two places of decimal for the purpose of measurement.

**Rate**

The rates include cost of all the operations required to execute the above item at site.

7. **Dry stone pitching in crates side .6 x .6 x .3 panel blocks of concrete in 2 layers as per design and requirement and direction of Engineer in charge.**

**Measurement**

Area of the slope pitching shall be measured correct to places of decimal for the purpose of measurement.

**Rate**

The rates include cost of all the operations required to execute the above item at site.

8. **Providing Moring as per size drawing design & direction of Engineer in Charge.**

**Measurement**

Area of the concrete anchoring bed block constructed to do the mooring shall be measure correct to two places of decimal.

**Rate**

The rates include cost of all the operations required to execute the above item at site.
9. Providing and fixing Catch spring for ventilators.

**General**

Centre and bottom hung ventilators shall have gun metal spring catch in the centre of the top section of the ventilator, suitable for operation by hand or pole. The catch spring shall be fixed to the frame with aluminum or galvanized or cadmium plated steel screws shall close into an aluminum catch plate, fixed to the outside of the outer ventilator frame section.

**Measurement**

It shall be measured in numbers for each catch spring fixed in position.

**Rate**

The rates include cost of all the operations described above.

10. Design, Supply, Fabrication & Erection of solid spherical Nodular MS bare space Frame structure including application of two coats of epoxy primer and polyurethane paint.

**General**

The structure shall consist of top and bottom solid nodes, member’s equivalent to the length of gate i.e. approximately 7.1 meters, props of medium quality, base and stiffener plates all complete. Design and fabrication drawings shall be submitted for approval of EIC.

All the members of the space frame shall be coated with two coats of epoxy primer and polyurethane paint.

**Measurement**

The plan area of space frame shall be measured for payment, the area calculated in square meter correct to two places of decimal.

**Rate**

It includes the cost of all material and labor required for all the operations described above.
11. Stainless signage’s hoisted on stainless steel strip or drilled in wall to the satisfaction of engineer in charge.

**General**
Flat / plate shall be of finished 304 grades shall be used; all sharp edges and corners shall be properly ground before installation, flat shall conform to IS: 6911: 1992.

Angle section ISA 40 x 40 x 5 of finished 304 grades shall be used, all sharp edges and corners shall be properly ground before installation.

**Materials**

**SS flats and angles** - virgin Stainless steel conforming to IS 6603 & 6911 of approved make sample shall be approved by Engineer-in –Charge before fixing.

**Fasteners** - bolts and nuts shall be totally galvanized and of reputed make sample shall be approved by Engineer-in –Charge before fixing.

**Mode of Measurement**
It will be measured in running meters for each length fixed in position.

**Rate**
The rate shall include the cost of all operations described above including the cost of materials and labor.

12. Fencing with 'Y'-shaped angle iron post placed at required distance embedded in RCC column top and provided with horizontal lines and two diagonals interwoven with horizontal wires, of barbed wire 9.38 kg per 100m (Minimum) between the two posts fitted and fixed with G.I staples, turn buckles etc. complete as per drawing (cost of post, earth work and RCC/concrete work to be paid for separately) :-Payment to be made per meter cost of total length of barbed wire used

**General**
Specifications of the item similar to DSR'07 item No.16.18 except that barbed wire are to be fixed on 'Y'-shaped angle iron posts embedded in RCC column top instead of angle iron post and struts.
13. Providing and laying 1st quality mirror finished vitrified ceramic floor tiles in different sizes of minimum thickness 7mm of approved makes like JOHNSON, BELL, RESTILE or equivalent make in all colors, shades, design and prints in approved pattern with border, laid on 20 mm thick cement mortar 1:4 (1 cement : 4 coarse sand) including pointing the joints with white cement and matching pigments etc. complete.

General
Specifications similar to DSR item No. 11.41, only the tiles to be used shall be 1st quality mirror finished Vitrified ceramic tiles of approved make like JOHNSON, BELL or RESTILE. Thickness of tiles shall be specified by the manufacturer; however minimum thickness of tiles shall be 7mm. The water absorption of the tiles should be less than 0.08% and flexural strength should not be less than 30N/mm². The tiles shall be first quality in all colors, shades as approved by Engineer-in-charge. The bedding mortar shall be 20mm (average) thick of proportion 1:4 (1 cement: 4 coarse sand) including pointing the joints with white cement and pigment matching the tile shade complete. (The PCC base course below 20mm thick cement mortar shall be paid separately under different item.

Preparation of surface and lying

Base concrete the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:4 (1 cement: 4 coarse sand). average thickness of the bedding less than 10mm. Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across squat on it.

Over this mortar bedding neat gray cement slurry of honey like consistency shall be spread at the rate of 3.3 Kg of cement per square meter on a small area. Tiles shall be soaked in water, washed clean and shall be fixed in this grout one after another, each tile gently tapped with a wooden mallet till it properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

The surface of the flooring during lying shall be frequent checked with a straight edge about 2m long, so as to obtain a true surface with the required slope. Where full size tiles cannot be fixed these shall be cut (sawn) to the required size and their edge rubbed smooth to ensure straight and true joints. Tiles which are fixed in the floor adjoining the wall shall enter not less than 10mm under the
plaster, skirting or dado. After tiles have been laid surplus cement slurry shall be cleaned off.

**Pointing and finishing**

The joints shall be cleaned off the gray cement slurry with wire/ coir brush or trowel to a depth of 2mm to 3mm and then be flush pointed with white cement added with pigment if required to match the color of tiles, the floor then be kept wet for 7 days. After curing the surface with be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

**Measurement**

Length and breadth shall be measured correct to a cm before lying skirting, dado or wall plaster and the areas calculated in square meter correct to two places of decimal. Where coves are used at junctions, the length and breadth shall be measured between the lower edges of the coves. No deduction shall be made nor extra paid for voids not exceeding 0.20 square meters. Deductions for the ends of dissimilar material or other articles embedded shall not be made for areas not exceeding 0.10 Square meters.

**Rate**

The rate of flooring shall include the cost of all material and labor involved in all the operations described above. Nothing extra shall be paid for the use of cut (Swan) tiles in the work.

14. Wall paneling in second class T.W. complete with polish to the satisfaction of engineer in charge.

**General**

The teakwood shall be free from decay, fungal growth, boxed heart, pitch pockets or streaks on the exposed edges, splits and cracks. Individual hard and sound knot shall not be more than 40 mm in diameter and aggregate of all knots shall not exceed one and half per cent of the area of the piece. Wood shall be generally free from sapwood, but traces of sapwood may be allowed. Panels shall be preferably made of timber of larger width. The minimum width and thickness of panel shall be 150 mm and 15 mm respectively. When made from more than one piece, the pieces shall be joined with continuous tongue and groove joint, glued together with metal dowels. The grains of timber panels shall run along the longer dimensions of the panels. The panels shall be placed such that no single panel exceeds 0.5 sqm in area.
**Mode of Measurement**

Area of wall cladded with second class teak wood shall be measured correct to two places of decimal.

**Rate**

The rate shall include the cost of all operations described above including the cost of materials and labor.

15. **Providing and fixing CI gratings hinged type with frame.**

**Mode of Measurement**

It would be in numbers for each grating fixed in position.

**Rate**

It includes the cost of all material and labor required for all the necessary operations that may be undertaken to execute the item described above.

16. **Supplying at site, weed free selection no.1 grass in carpet form.**

**General**

The item is only for supplying of grass in carpet form not for grassing, the grass shall be free from weeds and other foreign particles. The sample of grass shall be approved by engineer in charge before supplying the required quantity at site.

**Mode of Measurement**

Area of the grass carpet supplied shall be measured correct to two places of decimal.

**Rate**

The rate shall include the cost of all operations described above including the cost of materials and labor.

17. **Providing and laying Geomat layer along the embankment of the river along the complete length of site.**

**General**

A kind of three dimensional structure new-type geosynthetic material suitable for protecting water and land soil, can effectively keep water and land soil from flowing away.
**Application**

Geomat is a new-typed seed planting material with tridimensional structure. It can reduce erosion to the ground surface

**Used Place:**

It has mainly been used in the vegetation belts of road, the slope protection of road and hillside and embankments.

**Character:**

It can improve the speed of the project by ten times and reduce the cost of the project by ten times.

**Measurement**

Area of the slope pitching shall be measured correct to places of decimal for the purpose of measurement.

**Rate**

The rates include cost of all the operations required to execute the above item at site.

18. **Drilling bore hole by ODEX machine in all kinds of soil**....................complete as per the direction of Engineer-in-Charge and drawings.

From Ground level to 1st water layer strata (Minimum depth 15m).

**Measurement:** Depth of bore hole from ground level shall be measured in meter correct to a cm.

**Rate:** It includes the cost of all material and labor required for all the operations described above and as required to complete the system, but not specifically mentioned above.

19. **Supplying and packing 5 to 20mm nominal size graded stone ballast in the rain water harvesting pit as per direction of Engineer-in-Charge and drawings.**
**Measurement**: Length, breadth and depth or thickness of packed stone ballast filling shall be measured in correct to a cm. The consolidated cubic contents of packed stone ballast shall be calculated net to the nearest 0.01 cubic meter.

**Rate**: It includes the cost of all material and labor required for all the operations described above and as required to complete the system, but not specifically mentioned above.

20. **Supplying and packing 5mm to 20mm graded gravel of approved quality as per the direction of Engineer-in-Charge and drawings.**

**Measurement**: Length, breadth and depth or thickness of packed gravel filling shall be measured in correct to a cm. The consolidated cubic contents of packed gravel shall be calculated net to the nearest 0.01 cubic meter.

**Rate**: It includes the cost of all material and labor required for all the operations described above and as required to complete the system, but not specifically mentioned above.

21. **Supplying and filling of graded coarse sand (1.5 to 2 mm size) as per the direction of Engineer-in-Charge and drawings.**

**Measurement**: Length, breadth and depth or thickness of sand filling shall be measured in correct to a cm. The consolidated cubic contents of sand filling shall be calculated net to the nearest 0.01 cubic meter.

**Rate**: It includes the cost of all material and labor required for all the operations described above and as required to complete the system, but not specifically mentioned above.

22. **Supplying, assembling, lowering and installation of 200mm dia UPVC pipe (10kg/sqcm) fixing in Vertical Position as per the direction of Engineer-in-Charge and drawings. (a) 200mm dia Blind pipe (10kg/sqm); (b) 200mm dia slotted pipe (10kg/Sqm size of slot = 1.59mm)**

Quality plans and Sample shall be approved by EIC before supply and installation.

The pipes shall be of approved make and conform to Indian standards.
The pipe shall be of 10 kg/ sq cm pressure rating.

**FITTINGS:**
The item includes providing and fixing of all necessary fittings. Fittings shall be of approved make and shall conform to Indian standards.

**Measurement:** Length of only installed pipe shall be measured in meter correct to a cm excluding any cutting or wastage.

**Rate:** It includes the cost of all material and labor required for all the operations described above and as required to complete the system, but not specifically mentioned above.

23. **Providing and fixing bail plug of required length with hoots etc at bottom of pipe.**

Quality plans and Sample shall be approved by EIC before supply and installation.

Bail plug shall be fitted at the bottom of the pipe as per the standard design and drawings approved by Engineer-in-Charge. The item includes providing and fixing of all necessary fittings. Fittings shall be of approved make and shall conform to Indian standards.

**Measurement:** Number of bail plugs installed in position shall be counted for the purpose of payment.

**Rate:** It includes the cost of all material and labor required for all the operations described above and as required to complete the system, but not specifically mentioned above.

24. **Providing and fixing cap for 200mm dia pipe with locking arrangement of approved design to prevent foreign matter getting into the bore hole as per design and direction of Engineer-in-Charge and drawings.**

Quality plans and Sample shall be approved by EIC before supply and installation.

Cap shall be round having threads inside and opening key of the same material. The item includes providing and fixing of all necessary fittings. Fittings shall be of approved make and shall conform to Indian standards.
Measurement: Number of caps installed in position shall be counted for the purpose of payment.

Rate: It includes the cost of all material and labor required for all the operations described above and as required to complete the system, but not specifically mentioned above.

25. Providing and fixing 80mm dia UPVC Vent pipe with mosquito proof coupling.

Specifications similar to DSR item no: 12.40. Vent pipe shall be fitted with Mosquito proof coupling of approved design. Quality plans and Sample shall be approved by EIC before supply and installation. The item includes providing and fixing of all necessary fittings. Fittings shall be of approved make and shall conform to Indian standards.

Measurement: Length of only installed pipe shall be measured in meter correct to a cm excluding any cutting or wastage.

Rate: It includes the cost of all material and labor required for all the operations described and as required to complete the system, but not specifically mentioned above. Also it includes the cost of all the fittings required and assembling.

26. Supplying and fixing 500mm diameter CI manhole cover (medium duty) with frame, the weight of cover to be not less than 58 kg.

Specifications similar to DSR item no: 19.18.2. The item also includes providing and fixing in position of matching CI frame (medium duty) with necessary lugs embedded in RCC, etc.

Measurement: Number of CI cover and frame installed in position shall be counted for the purpose of payment.

Rate: It includes the cost of all material and labor required for all the operations described above and as required to complete the system, but not specifically mentioned above.
27. Constructing brick masonry chamber ................. all complete as per standard design:
   (a) Inside size 900x800mm and 1m average depth including 500x450 mm pre-cast RCC horizontal grating with frame complete as per standard design. With class designation 75 flyash lime bricks conforming to IS: 12894 or burnt clay flyash bricks conforming to IS: 13757

Specifications similar to DSR item no: 19.7 except pre-cast RCC grating with matching frame of EIC-approved design to be provided in place of CI cover.

**Measurement:** Number of CI cover and frame installed in position shall be counted for the purpose of payment.

**Rate:** It includes the cost of all material and labor required for all the operations described above and as required to complete the system, but not specifically mentioned above.
ELECTRICAL WORKS
CONDITIONS AND SPECIFICATIONS FOR ELECTRICAL WORKS
1. The work shall be carried out as per the Specification attached. All the installation shall comply with the requirement of Indian electricity Rule 1956 amended up to date. If the specification for any item is not available in the specifications cited above, relevant IS specifications and National Electrical Code – 1983 shall be followed. In case IS specifications are also not available, the decision of the Engineer-In-charge given in writing based on acceptable sound Engineering Practice and local usage shall be final and binding on the contractor.

2. All the material to be used on the work shall be of superior quality and shall have to be got approved from the Engineer-In-Charge before use at site.

3. The layout for running of the conduits, positions of switches fitting etc. shall have to be got approved from the Engineer-In-Charge before execution of the same.

4. All the conduit to be laid shall be provided with fish wire of not less than 16 SWG for which nothing extra shall be paid.

5. All the switches to be provided for lighting / fans / light plug / power plug / call bell etc. shall be of modular type of superior quality.

6. The contractor shall make his own arrangement for the safe custody / storage of his material. Breakage, damage if any done during the storage / execution, the same shall be replaced / rectified by the contractor at his own cost.

7. The contractor is bound to sign the entry / entries made by the Engineer-In-Charge or his representative in the site order book time to time.

8. Good workmanship is an essential requirement for compliance with the rules & specifications.

9. The entire installation shall be at the risk and responsibility of the contractor until these are tested and handed over to the department.

10. Earthing loop earthing shall invariably be as per the relevant specification.

11. Notwithstanding the schedule of quantity, all items of inter-related work considered necessary to make installation complete and separative deemed to be included shall be provided by the contractor at no extra cost.

12. Contractor shall provide the shop drawings of conduiting for Electrical, Telephone, Fire Fighting System and other allied services for approval prior to start of work from Engineer-in-charge / Architect / Consultant.
13. The cover of all junction boxes shall be of Bakelite sheet.

14. The tenderer shall submit a sample board, in incorporating in it the samples of all electrical wires, conduits etc. proposed to be used for approval from Engineer-in-charge / Consultant before commencement of work. No extra payment shall be given for the same.

15. The electrical works shall be executed in close co-ordination with the progress of Building work. This being absence of the contract, no claim for idles labour will be entertained.

16. Any damage caused to Building as a result of execution of electrical work shall be responsibility of the electrical contractor. The damage if so caused shall be made good by the contractor promptly at his own cost to the entire satisfaction of the Engineer-In-charge.

17. Embedding of earth electrode shall be done in the presence of Engineer-in-charge or his authorized representative.

18. The contractor shall submit the completion plan separately for each floor for one particular building only in triplicate on Blue print showing the conduit layout of electro-mechanical services and route of circuits, sub-mains etc.

19. The Engineer-in-charge will be at liberty to get the work inspected through the C.T.E. or any other agency appointed by the Govt. or Municipal Corporation and the result of their finding will be binding on the contractor.

20. Contractor shall not assign or sub-let the work without prior approval of Engineer-in-charge / Consultant.
SPECIFICATIONS FOR INTERNAL ELECTRICAL INSTALLATION

SECTION 1. GENERAL AND TECHNICAL

1. POINT WIRING

A point (other than a socket outlet point) shall include all work necessary in complete wiring to the following outlets from the controlling switch or MCB. The scopes of wiring for a point shall however, include the wiring work necessary in tapping from another point in the same distribution circuit.

a] Points for ceiling / exhaust fan points, pre-wired light fittings, and call bells.

b] Modular plate type switch with GI box and plate of specified make.

c] Point wiring proposed with 1.5 sq.mm PVC insulated copper conductor cable.

1.1 Scope

a] Control switch.

b] 3 pin or 6 pin socket.

1.2 Point wiring for socket outlet points

a] The light plug (6A) point and power (15A / 16A) point wiring shall be measured on linear basis, from the respective tapping points namely, switch box, another socket outlet point, or the sub distribution board as the case may be upto the socket outlet.

b] The GI Box, switch / MCB, socket outlet and other accessories shall be measured and paid as separate item.

c] The power point outlet may 16A / 6A or 16A / 6A six pin socket outlet, where so specified in the tender documents.
2. **CIRCUIT AND SUBMAIN WIRING**

2.1 **Circuit Wiring**

Circuit wiring shall mean the wiring from the distribution board up to the tapping point for the nearest first point of that distribution circuit, viz. up to the nearest first switch box.

2.2 **Submain wiring**

Submain wiring shall mean the wiring from one main / distribution switchboard to another.

2.3 **Measurement of circuit and submain wiring**

a] Circuit and submain wiring shall be measured on linear basis along the run of the wiring. The measurement shall include all lengths from end conduit as the case may, exclusive on interconnections inside the switch board etc. The increase on account of diversion or slackness shall not be included in the measurement.

b] The length of circuit wiring with two wires shall be measured from the distribution board to the first nearest switch box in the circuit irrespective of whether the neutral conductor is taken to switchbox or not.

c] When circuit wires and wires of point wiring are run in same conduit/ circuit wiring shall be measured on linear basis depending on the actual number and sizes of wires run in the existing conduit.

d] Protective (loop earthing) conductors which are run along the circuit wiring and the submain wiring shall be measured on linear basis and paid for separately.

3. **SYSTEM OF DISTRIBUTION AND WIRING**

3.1 **Distribution**

a] Main distribution board shall be controlled by a circuit breaker or linked switch with fuse. Each outgoing circuit shall be controlled by a switch with fuse, circuit breaker or only a fuse on the phase or live conductor.

b] The branch distribution board shall be controlled by a linked switch fuse or circuit breaker. Each outgoing circuit shall be provided with a fuse or miniature circuit breaker (MCB) of specified rating on the phase or live conductor.
c] Triple pole distribution boards shall not be used for final circuit distribution, unless specific approval of the Engineer-in-charge is obtained. In such special cases, the triple pole distribution boards shall be of HRC fuse type or MCB type only.

d] The loads of the circuits shall be divided, as far as possible, evenly between the numbers of ways of the distribution boards, leaving at least one spare circuit for future extension.

e] 'Power' wiring shall be kept separate and distinct from 'Lighting' wiring, from the level of circuits i.e. beyond the branch distribution boards.

3.2 Wiring system

a] Unless and otherwise specified in the tender documents, wiring shall be done only by the "Looping system". Phase or live conductors shall be looped at the switch boxes and neutral conductors at the point outlets.

b] Lights, fans and call bells shall be wired in the 'lighting' circuits. 15A/16A socket outlets and other power outlets shall be wired in the 'Power' circuits. 5A/6A socket outlets shall be wired in the 'lighting' circuits in non residential buildings and in the 'power' circuit in residential buildings.

3.3 Passing through walls or floors

a] Where a wall pipe passes outside a building so as to be exposed to weather, the outer end shall be mounted and turned downwards and properly bused on the open end.

3.4 Joints in wiring

a] There shall be no joints in the through-runs of cables. If the length of final circuit or sub-main is more than the length of a standard coil, thus necessitating a through joint, such joints shall be made by means of approved mechanical connectors in suitable junction boxes.

b] Termination of multi-stranded conductors shall be done using suitable crimping type thimbles.

4. Rating of outlets (to be adopted for design)

a] Ceiling fans shall be rated at 80 W. Exhaust fan, fluorescent tubes, compact fluorescent tubes, HPMV lamps, HPSV lamps etc. shall be rated according to their capacity. Control gear losses shall be also considered as applicable.
5A / 6A and 15A / 16A socket outlet points shall be related at 100W and 1000W respectively, unless the actual values of loads are specified.

5. **CAPACITY OF CIRCUITS:**

a] "Lighting" circuit shall not have more than a total of 10 points of light, fan and socket outlets, or a total connected load of 800W, whichever is less.

b] "Power" circuit shall be designed with only one outlet per circuit in nonresidential buildings. The circuit shall be designed based on the load. Where not specified, the load shall be taken as 1 KW per outlet.

c] "Power" circuit in residential buildings shall be designed for not more than two outlets (15A/ 16A and / or 5A/ 6A) per circuit. The ratings for load calculation purposed shall however be taken as per the type of outlets.

d] Load more than 1 KW shall be controlled by an isolator or miniature circuit breaker.

6. **WIRING ACCESSORIES**

6.1 **Control switches for points**

a] Control switches of 15A/ 16A rating may preferably be only of modular type. If, however, modular type switch is used for controlling a socket outlet, combined switch cum socket shall not be permitted.

b] Power (15A/ 16A) outlets shall be controlled by single pole modular type switches or by MCB's, where specified. Only MCB's shall be used for controlling industrial type socket outlets, and power outlets above 1 KW.

6.2 **Socket outlets**

a] Socket outlets shall be of the same type, namely modular type, as their control switches. These shall be rated either for 5A/ 6A, or 15A/16A. Combined 5A/ 15A, or 6A/ 16A six pin socket outlet may be provided in 'power circuits only where specified.

b] Outlet boxes for socket outlets (both 15A/ 16A ands 5A/ 6A) points in residential buildings shall be of size 175mm x 100mm.

c] 5A/ 6A and 15A/ 16A socket outlets shall be installed at the following positions, unless otherwise specified.

i) Non-residential buildings - 23 cm above floor level.
ii) Kitchen - 23 cm above working platform and away from the likely positions of stove and sinks.

iii) Bathroom - No socket outlet is permitted for connecting a portable appliance thereto. MCB / IC switch may be provided above 2.1 m for fixed appliances, and at least 1 m away from shower.

7. FITTINGS

7.1 Indoor type fittings

a] Fittings using discharge lamps shall be complete with power factor correction capacitors, either integrally or externally. An earth terminal with suitable marking shall be provided for each fitting for discharge lamps.

b] Fittings shall be installed such that the lamp is at a height of 2.5 m above floor level, unless otherwise directed by the Engineer-in-charge.

7.2 Bulk head fittings

Bulk head fittings shall be of cast iron / cast aluminium body, suitably painted white inside and gray outside, complete with heat resistant glass cover, gasket, BC lamp holder for 100 W incandescent lamp / CFL Lamp of 11 W.

8. MCB TYPE DISTRIBUTION BOARD (MCBDB)

a] MCB DB's may be of single phase, 3 phase (horizontal type) suitable for feeding single phase loads, or 3 phase (vertical type) suitable for feeding single phase as well as 3 phase loads, as specified. These shall be complete with accessories, but without MCB's which shall be specified as a separate item in the tender documents.

b] The current ratings and the number of ways shall be as specified. Blanking plates shall be provided to close unused ways. These shall be indicated as separate item in the Schedule of work.

9. PRE-WIRED MCB DISTRIBUTION BOARDS

a] The board shall also be provided with a loose wire box as a compartment for the complete width and, depth of the board, and of minimum height of 125 mm in case of TPN DB's, and 100 mm in case of SPN DB's.

b] The board shall be provided with a hinged cover of 1.6 mm thick sheet steel in the front. Only the knobs of the MCB's shall protrude out of the front covers through openings neatly machine made for the purpose.
c] The board shall be complete with the following accessories:-
   i) 200 A copper busbar (s).
   ii) Neutral link.
   iii) Common earth bar.
   iv) DIN bar for mounting MCB's.
   v) Elmex type terminal connectors suitable for incoming and outgoing cables.
   vi) A set of indication lamps with HRC cartridge fuses for each phase of the incoming supply.
   vii) Earthing stud. (s)

Note: - MCB’s and blanking plates shall be specified as separate items, as required.

10. **SWITCH BOARD LOCATIONS**

10.1 **Cubicle type switchboards**

   Cubicle type switchboards shall be conform to section 4 of "General Specifications for Electrical Works (Part - IV - Substation), 1982".

11. **SWITCH BOARD INSTALLATION**

   a] Unless and otherwise specified in the tender documents, a switchboard shall not be installed so that its bottom is within 1.25 m above the floor.

   b] There shall be a clear distance of 1 m in front of the switch boards. The space behind the switchboards shall be either less than 20 cm or more than 75 cm. If there are any attachments or bare connections at the back of the switch board. Rule 51 (c) of the Indian Electricity Rules shall apply.

   c] Where it is required to terminate a number of conduits on a board. it may be convenient to provide a suitable MS adopter box for the purpose. Such boxes shall be provided with the prior approval of the Engineer-in-charge and this will be paid for separately.

   d] No apparatus shall project beyond any edge of the panel. No fuse body shall be mounted within 2.5 cm of any edge of the panel.
Busbars and interconnecting strips in fabricated boards shall be PVC tapped or sleeved in Red, Yellow and Blue for phases, and Black for neutral. The interconnecting cables shall also follow this colour coding.

12. ATTACHMENT OF FITTINGS AND ACCESSORIES

12.1 Conduit wiring system

a) All accessories like switches, socket outlets, call bell pushes and regulators shall be fixed in flush pattern inside the switch/ regulator boxes.

b) Aluminum alloy or cadmium plated iron screws shall be used to fix the accessories to their bases.

c) The switch box/ regulator box shall normally be mounted with their bottom 1.25cm from floor level, unless otherwise directed by the Engineer-in-charge.

13 FIXING TO WALLS AND CEILING

a) Wooden plugs for ordinary walls or ceiling shall not be used in view of the ban on use of timber in Govt. works. However, where so specified, these shall be of well seasoned teak or other approved hard wood not less than 5 cm long by 2.5cm square on the inner end, and 2cm square on the outer end. They shall be cemented into walls within 6.5mm of the surface, the remainder being finished according to the nature of the surface with plasters or lime punning.

b) PVC sleeves/ dash fasteners should normally be used for fixing to walls or ceiling.

14. FANS, REGULATORS AND CLAMPS

14.1 Ceiling fans

a) Ceiling fans including their suspension shall confirm to relevant Indian Standards.

b) For wooden or steel joists and beam, the suspension shall consists of MS flat of size not less than 40mm x 6mm, secured on the sides of the joists or beams by means of two coach screws of size not less than 5 cm for each flat. Where there is space above the beam, a through-bolt of size not less than 1.5cm dia. shall be placed above the beam from which the flats are suspended. In the latter case, the flats shall be secured from movements by means of another bolt and nut at the bottom of the beam. A hook consisting of MS rod of size not less than 1.5cm dia. shall be inserted between the MS flat through oval holes on their sides. Alternatively, the flats may be bent inwards to hold tightly between them by means of a bolt and nut, a hook of’s’ form.
c] For concrete roofs, a 12mm dia. MS rod in the shape of 'U' with their vertical legs bent horizontally at the top at least 19 cm on either side, or bound to the top reinforcement of the roof shall be used.

**METALLIC CONDUIT WIRING SYSTEM**

1. **APPLICATION**

   a] Recessed conduit is suitable generally for all applications. Surface conduit work may be adopted in places like workshops, plant rooms, wiring above false ceiling/below false flooring, and at locations where recessed work may not be possible to be done. The type of work, viz. surface or recessed, shall be as specified in the respective works.

   b] Flexible conduits may only be permitted for interconnections between switchgear, DB's and conduit terminations in wall.

2. **MATERIALS**

   2.1 **Conduits**

      a] All rigid conduit pipes shall be of steel and be ISI marked. The wall thickness shall not be less than 1.6mm (16 SWG) for conduits upto 32mm dia. and not less than 2mm (14 SWG) for conduits above 32 mm dia. These shall be solid drawn or reamed by welding, and finished with galvanised or stove enamelled surface.

      b] No steel conduit less than 20mm in diameter shall be used.

   2.2 **Conduit accessories**

      a] All conduit accessories shall be of threaded type, and under no circumstances pin grip type or clamp grip type accessories shall be used.

      b] Saddles for surface conduit work on wall shall not be less than 0.55mm (24 gauge) for conduits upto 25mm dia. and not less than 0.9mm (20 gauge) for larger diameter. The corresponding widths shall be 19mm & 25mm.

   2.3 **Outlets**

      a] The switch box or regulator box shall be made of metal on all sides, except on the front. In the case of cast boxes, the wall thickness shall be at least 3mm and in case of welded mild steel sheet boxes, the wall thickness shall not be less than 1.2mm (18 gauge) for boxes up to a size of 20cm x 30cm, and above this size 1.6mm (16 gauge) thick MS boxes shall be used. The metallic boxes shall be
duly painted with anticorrosive paint before erection as per chapter 10 of these specifications.

b] Outlet boxes shall be of one of the size, covered in the Schedule of Rates (Elect.), Part I- Internal- 2007.

c] Where a large number of control switches and/ or fan regulators are required to be installed at one place, these shall be installed in more than one outlet box adjacent to each other for ease of maintenance.

d] An earth terminal with stud and 2 metal washers shall be provided in each MS box for termination of protective conductors and for connection to socket outlet/ metallic body of fan regulator etc.

e] Clear depth of the box shall not be less than 60mm, and this shall be increased suitably to accordance mounting of fan regulators in flush pattern.

f] The fan regulators can also be mounted on the switch box covers, if so stipulated in the tender specifications, or if so directed by the Engineer-in-charge.

3. INSTALLATION

3.1 Common aspects for recessed and surface conduit works.

a] Bends in conduit

i) All necessary bends in the system, including diversion, shall be done either by neatly bending the pipes without cracking with a bending radius of not less than 7.5cm, or alternatively, by inserting suitable solid or inspection type normal bends, elbows or similar fittings, or by fixing cast iron inspection boxes, whichever is most suitable.

ii) No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.

3.2 Additional requirements for surface conduit work.

a] Fixing conduit on surface

i) Conduit pipes shall be fixed by saddles, secured to suitable approved plugs with screws in an approved manner at an interval of not more than one meter, but on either side of the couplers or bends or similar fittings, saddles shall be fixed at a distance of 30 cm from the centre of such fittings.

b] Fixing outlet boxes
i) Only a portion of the switch box shall be sunk in the wall, the other portion being projected out for suitable entry of conduit pipes into the box.

3.3 Additional requirements for recessed conduit work

a] Fixing conduits in chase

i) The conduit pipe shall be fixed by means of staples, J-hooks, or by means of saddles, not more than 60 cm apart, or by any other approved means of fixing.

ii) All threaded joints of conduit pipes shall be treated with some approved preservative compound to secure protection against rust.

b] Fixing conduits in RCC work

i) The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same.

ii) Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius which will permit easy drawing in of conductors.

c] Fixing inspection boxes

i) Suitable inspection boxes to the minimum requirement shall be provided to permit inspection, and to facilitate replacement of wires, if necessary.

ii) These shall be mounted flush with the wall or ceiling concrete. Minimum 65mm depth junction boxes shall be used on roof slabs and the depth of the boxes in other places shall be as per IS: 2667 - 1977.

d] Fixing switch boxes and accessories

i) Switch boxes shall be mounted flush with the wall. All outlets such as switches, socket outlets etc. shall be flush mounting type, unless otherwise specified in the Additional Specifications.

e] Fish wire

i) To facilitate subsequent drawing of wires in the conduit, GI fish wire of 1.6mm / 1.2mm (16/ 18 SWG) shall be provided along with the laying of the recessed conduit.
### TABLE - I
Maximum number of PVC insulated 650/1100 V grade aluminium / copper conductor cable conforming to IS: 694/1990.

Clause 2.2 a]

<table>
<thead>
<tr>
<th>Nominal</th>
<th>20mm</th>
<th>25mm</th>
<th>32mm</th>
<th>38mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-Sectional Area of Conductor</td>
<td>S</td>
<td>B</td>
<td>S</td>
<td>B</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>1.50</td>
<td>5</td>
<td>4</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>2.50</td>
<td>5</td>
<td>3</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>-</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>-</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>16</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>25</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>35</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>50</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>70</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
MOULDED CASE CIRCUIT BREAKER:

1. **GENERAL**

Moulded Case circuit breaker shall be suitable for 415 Volts, 3 Phase, 50 Hz AC supply. MCCB shall confirm to BS: 3871 Part II, IS: 2516 (Part I & II) 1977 or JIS-C-8370 in all respects. The breaking capacity shall not be less 50 KA.

2. **CONSTRUCTION**

The MCCB cover & case shall be made of high strength, heat resistant & flame retardant, thermosetting insulating material. The moving contacts of all poles of circuit breaker shall be so mechanically coupled that all poles, except the switched neutral, if any, make & break substantially together, whether operated manually or automatically, even if an overload occurs on one protected pole duly.

Circuit breaker shall have thermo magnetic type release/electronic trip release. Contact trips shall be made of suitable arc resistant, sintered alloy for long electrical life. Terminals shall be of liberal design with adequate clearance.

3. **ACCESSORIES**

MCCB shall be provided with the microprocessor based over current/short circuit release.

4. **INTERLOCKING**

Moulded case circuit breaker shall be provided with the following interlocking devices for interlocking the door of a switch board:

a) Handle interlock to prevent necessary manipulations of the breaker.

b) Door interlock to prevent the door being opened when the breaker is ON/OFF position.

5. **TESTING**

a) Original test certificate of MCCB as per BS 3871 or JSC-8370 shall be furnished.

b) Pre-commissioning tests on the switch board Panel incorporating the MCCB shall be done as per standard specifications MV-110.
L.T. PANEL

1. GENERAL

The Panel shall be indoor type having incoming, sectionalisation and outgoing switchgear as specified. The design shall be cubicle type. The degree of enclosure protection shall be IP 54.

2. CONSTRUCTION FEATURES:

The panel shall be floor mounted free standing type, dust and vermin proof and shall include all provisions for safety of operating and maintenance personnel. The general construction shall conform to relevant IS for factory assembled panel.

The panel shall be fabricated out of sheet steel not less than 2.0mm thick, CRCA wherever necessary, such sheet steel members shall be stiffened by angle iron frame work.

General construction shall employ the principle of compartmentalization and segregation for each feeder.

The Compartment door shall be so interlocked that it shall not be possible to open the door with the switch in ON position. An arrangement for defeating this door interlock shall be provided for testing purposes.

Overall height of the board shall not exceed 2.4 metres. Operating levers, handle etc. of highest unit shall not be at a height more than 1.8 metres for convenience of operation and cable termination.

Multi-tier mounting of feeders is permissible. The general arrangement for multi-tier construction shall be such that the horizontal tiers formed present a pleasing and aesthetic look.

All cable entries shall be through gland plates. Suitable numbers of knock outs for cable entry shall be provided to take care of the present and future requirements. Thickness of gland plate shall be 8.0 mm.

The construction shall include necessary cable supports for clamping the cable in the cable alleys or rear cable chambers.
The design of frame work and end covers shall be such as to require a minimum number of screws visible from outside.

The general arrangement shall be got approved before fabrication.

3. **BUS BAR:**

The bus bar shall be of aluminium of high conductivity electrolytic quality and of adequate section.

The minimum cross section of bus bar shall be as per size specified below:

<table>
<thead>
<tr>
<th>Current ratings in amp upto</th>
<th>Recommended rectangular cross-section</th>
<th>Aluminium</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of strips / phase</td>
<td>Size in mm.</td>
</tr>
<tr>
<td>100</td>
<td>1</td>
<td>20 x 5</td>
</tr>
<tr>
<td>200</td>
<td>1</td>
<td>40 x 5</td>
</tr>
<tr>
<td>300</td>
<td>1</td>
<td>50 x 6</td>
</tr>
<tr>
<td>400</td>
<td>1</td>
<td>40 x 10</td>
</tr>
<tr>
<td>500</td>
<td>1</td>
<td>50 x 10</td>
</tr>
<tr>
<td>600</td>
<td>1</td>
<td>50 x 12</td>
</tr>
<tr>
<td>800</td>
<td>1</td>
<td>75 x 12</td>
</tr>
<tr>
<td>1000</td>
<td>1</td>
<td>100 x 12</td>
</tr>
<tr>
<td>2500</td>
<td>3</td>
<td>125 x 10</td>
</tr>
</tbody>
</table>

*Note*: (Bus bar calculation shall be furnished by vendor)

The sections can be accepted in other rectangular cross-sections and numbers also, provided the total cross-sectional area offered is not less than the total cross-sectional area shown in the above table against the respective bus-bar
rating. Necessary tolerance as per relevant IS shall be permissible. Busbar calculation shall be furnished considering ambient temperature, enclosure etc.

The bus bar system may comprise of a system of horizontal and vertical bus bars run in bus bar alleys. The circuit could be arranged on either side of the bus bar. In the case of rear access, horizontal bus system shall run suitably either at the top or bottom.

Minimum clearance to be maintained for air insulated Panel for medium voltage application shall be as follows:

<table>
<thead>
<tr>
<th>Between</th>
<th>Minimum Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase to Earth</td>
<td>26mm</td>
</tr>
<tr>
<td>Phase to Phase</td>
<td>32mm</td>
</tr>
</tbody>
</table>

Bus bar support insulation shall be made of non hygroscopic, non combustible, tack resistant high strength SMC / DMC material and shall be of suitable size and spacing to withstand the dynamic stress due to short circuit currents.

All connections to individual circuits from the bus bar shall be with solid connections and the same shall be extended upto connector / insulated stud capable of taking cable / Bus-bar trunking of size suitable for that circuit. The connector / insulated stud shall be located near the respective cable entry points in the cable alley.

All bus bars and connections shall be suitably sleeved with PVC Heat Shrinkable sleeves or suitably insulated in an approved manner.

4. **PAINTING**:

All sheet work shall undergo a process of degreasing, pickling in acid, cold rinsing phosphating, passivating and than be sprayed with high corrosion resistant primer. The primer shall be baked in an oven. The finishing treatment shall be by applying a minimum of two or more coats upto a smooth finish of powder coated of approved shade.
5. **INDICATION LAMPS**:

5.1 Each INCOMER shall have:

1. A set of three indicators (RED, YELLOW & BLUE) for indicating the healthiness of the incoming phases.
2. A set of two indicators, RED for OFF status and GREEN for ON status of the incoming switches.

5.2 Each outgoing shall have a set of two indicators, RED for OFF status and GREEN for ON status of the outgoing switch.

5.3 Each indicator shall be of multiple LED type.

Supply to the indicators shall be protected through MCB of suitable rating.

6. **CONTROL WIRING**:

All control and indication wiring etc. shall be with suitable copper conductor PVC insulated cables conforming to relevant specifications. Minimum size of control wiring shall be 2.5 mm².

Runs of wires shall be neatly bunched and suitably supported and clamped.

Identification ferrules shall be used at both ends of the wires.

All control wirings meant for external connection are to be brought out on a terminal board to be located near the cable entry meant for such external cables.

7. **INSTALLATION**:

The installation work shall cover assembly of various sections of the panels lining up, grouting the units etc.

In the case of multiple panel switch boards after connecting up the bus bars etc. all joints shall be insulated with necessary insulation tape or approved insulation material.
A common earth bar shall be run throughout the length of the panel. It will be ensured that all metal parts of the panel are connected to this earth bar system. The recommended size of earth bus bar shall be in accordance with general specification for electrical works (Part I internal as amended up to date). However minimum size of earth bears shall be 25 mm x 6mm copper or 50 mm x 6mm GI Strip.

8. **TESTING AND COMMISSIONING:**

Commissioning checks and tests shall include the following:

(a) Operational checks.
(b) Interlock function checks.
(c) Continuity checks of wiring, fuses etc. as required.
(d) Insulation test: When measured with 500 V meggar.
(e) Trip tests and protection gear test.
CAPACITOR BANK & PANEL

1. GENERAL

This specification covers requirements of Medium Voltage Capacitors and Control Panel to be used for power factor improvement of the electrical system and shall be connected to Main L.T.Panels. Automatic Power Factor Correction Panel shall function to improve power factor of the system in which it is connected. It shall improve power factor upto 0.95 from initial power factor of 0.70.

2. CODES AND STANDARDS

The design, manufacture and performance of power capacitors and accessories shall comply with all currently applicable statutes, regulations and safety codes for power installation as prescribed in relevant IS codes and to requirement of Local Electricity Supply Authority to which the equipment shall be installed.

Unless otherwise specified the capacitor and control panel shall conform to following:

(a) IS: 2834  - Shunt capacitors for power systems.

(b) IS: 2147  - Degree of protection provided by enclosures for low voltage switchgear and control gear.

(c) IS: 8623  - Specification for factory built assemblies of switchgear and controlgear (upto 1000 volts).

(d) IS: 2959  - A.C contractors for voltage not exceeding 1000 volts.

3. CONSTRUCTIONAL FEATURE

Capacitor bank shall be suitable for operation on 415 volts, 3 phase, 4 wire, 50 c/s, solidly earthed A.C supply system. The capacitor shall be connected to the 415 volts bus shall be manually as well as automatically switched in and out in steps so as to correct the power factor to be required value depending on the actual KVAR requirement of bus.
The capacitor bank shall be complete with the required capacitor units with the supporting post insulators, sheet steel cubicles, busbars, connecting strips, foundation channels, fuses, corrosion proof rating plate etc.

Each basic unit is to be built up with a number of elements. These elements should be wounded with high grade metallised poly propylene film. These metallised film capacitors should be self healing, having very low loss factor. Capacitor element to be completely sealed with epoxy resins to provide max. humidity protection and highest insulation. The capacitor elements are to be given adequate outside insulation and should be put in all welded surface treated M.S containers.

Externally each capacitor unit shall have two separate earthing points, name plate conforming to the requirements of IS: 2834 (amended upto date), discharge resistance etc.

The capacitor bank may comprise suitable number of single phase self cooled hermetically sealed units in series parallel combination to achieve required KVAR rating. However, failure of one unit shall not create on over voltage on other units connected in parallel to avoid failure of parallel units.

Each capacitor unit / bank shall be provided with directly connected continuously rated, low loss discharge device built into the unit to reduce the residual voltage to a safe value within the specified time as recommended in the relevant standard after the capacitor has been disconnected from the supply.

All capacitor shall be suitable protected against over current by means of suitable over current protection which is adjusted to interrupt the circuit when the current exceeds the safe permissible limit.

Capacitor units shall also be protected against the internal faults and the effected units / banks shall be automatically and immediately isolated in the event of such fault.

Each capacitor unit shall continuously operate at the following overload conditions separately.

(a) Over voltage upto 10% of the rated RMS voltage.
(b) Over current upto 15% of the rated current.
(c) Max. Reactive output upto 30% over the rated reactive output.
4. **CAPACITOR CONTROL PANEL**

The control panel shall be indoor, cubicle type, floor mounted, dust & vermin proof conforming to degree of protection IP54 excepting the enclosure enclosing capacitor bank which shall be of protection class IP-42.

Cubicle shall comprise rigid structural frame enclosed by 2mm thick cold rolled sheet steel, doors and covers shall be from 2.0mm thick cold rolled sheet steel. Structural frame work with foundation with foundation bolts etc. shall be provided at the bottom to mount control panel directly on concrete/floor/steel channel base.

All doors, removable covers shall be casketed all around preferably with neoprene gaskets.

The capacitors control panel shall, in general, comprise of the following and shall be housed in well ventilated panels. Capacitors and their control elements may be installed in different compartments of the same panel to minimise space requirement.

Capacitor panel shall be modular system. Each modular rack shall be suitable for accommodating capacitors of 20 KVAR maximum, switching contactors in 8 steps and protecting MCCB of suitable rating. Number of modular racks required shall be depending of KVAR rating. Capacitors mounted in the rack shall be single phase, low losses with suitable capacitor grade oil and housed in aluminum housing.

Automatic power factor correction panel shall have a command module. This module shall control automatic P.F. correction panel. The four step microprocessor based P.F. controller provided in this module shall have two set points for target P.F. setting; automatic adjustment of C/K; digital P.F. display; auto/ manual switching facility which enables switching of any step without using separate push buttons and optimum switching time. Cooling fan shall be provided for efficient performances.

Fuses shall be HRC, preferably link type, with a minimum interrupting capacity equal to the listed short circuit current. Fuses shall be complete with fuse base and fitting of such design as to permit easy and safe replacement of fuse element. Visible indication shall be provided o blowing of the fuse.

The contactors shall be three pole, air break type designed for duty class III category AC3 with none bouncing provided with 2 NC & 2 NO auxiliary lamps.
contacts rated type with series register. Lamp and lens shall be replaceable from front.

The main buses and connection shall be of high conductivity aluminum/aluminum alloy, sized for specified current ratings shall be limited to 105 degree centigrade and 100 degree centigrade for silver plated copper joints and aluminum joints respectively.

For all bus connections shall be fully insulated for working voltage with adequate phase/ground clearance. Insulating sleeves for busbars and shrouds for joints shall be provided. Shrouds for busbar and for joints shall be provided. Shrouds for busbar joints and tapping points shall be of two part epoxy resin cast/fiber glass molded. Min. clearance of 26mm. is required between phases and between phase and earth irrespective of sleeve/surrounds provided for busbar. Insulating surrounds shall be of moulded type.

Bus supports shall be non-hygrosopic type epoxy/SMC/DMC with high creepage surface.

Busbars shall be color coded for easy identification and so located that the sequence R-Y-B shall be from left to right, top to bottom or front to rear, when viewed from the front to panel assembly.

The horizontal busbar chamber shall be separate and totally enclosed.

Screws of corrosion resistant material shall be furnished on all ventilating louvers to prevent the entry of insects.

All internal wiring inside the cubicle shall be carried out with 650 V grade, PVC insulated copper wires duly ferruled at either end. The power wiring above 100A shall be carried out with PVC insulated AL. links.

Separate labels shall be provided for Relay, Instruments, MCCB's, indicating lamp etc.

Painting shall include emulsion clearing, pickling with dilute acid, washing and rinsing by water, phosphating and oven drying. One (1) coat of stowing type zinc chromate primer and two (2) coats of synthetics enamel.

Automatic control relay with necessary taps shall be provided.
5. **TESTS**

   Routine tests shall be carried out on assembled capacitors and control panel as per relevant Indian Standards.

   Type tests reports for similar capacitor units shall be submitted.

   Three (3) copies of type test and routine test certificates shall be submitted for Engineer-in-charge.

6. **INSPECTION**

   Visual inspection including witnessing routine tests shall be carried out by Engineer-in-Charge or his authorized representative.

   Contractor shall notify Engineer-in-Charge or his authorized representative in writing at least fifteen (15) days prior to Contractor’s scheduled inspection test.
SPECIFICATION OF DRY TYPE TRANSFORMER

1.0 SCOPE

Covers the detailed requirements regarding design, manufacturing and testing & commissioning of resin cast transformer required for sub-station.

2.0 CODES AND STANDARDS

Transformers shall comply with the latest editions of Indian Standards no. IS: 2026 Part-I to Part-V (Power Transformers) and IS-11171 (Dry Type Power Transformers). In case the provision of Indian Standards is not directly applicable to Dry Type Transformers, the provision of latest IEC – 726 and any other relevant IEC shall apply. Latest Standards as applicable shall be followed for Insulating Materials, Bushing, Installation and Maintenance of Transformers.

3.0 SERVICE CONDITIONS

Altitude : Less than 1000 meters
Maximum Ambient Temp. : 50° C
Minimum Ambient Temp. : 0° C
Installation : Highly corrosive, dusty, humid and tropical

4.0 RATING AND TYPE

The transformer shall have core type construction, 3 phases and shall be suitable for Indoor / Outdoor service under the climatic conditions prevailing at site. The transformer shall be capable of withstanding thermal and mechanical effects of Short circuit at terminals of any winding with full voltage maintained on other winding as per IS – 2026.

5.0 WINDINGS

The windings shall be manufactured from high quality electrolytic grade copper conductor and fully insulated for rated voltage by nomex-calendered paper. The high and low voltage windings shall be totally encapsulated and should be Cast under vacuum in moulds with fiber glass reinforced epoxy resin laminate. Both HV & LV
windings of each phase shall be separately cast as a rigid tubular coil with no mechanical & electrical connection between their co-axial arrangements. The transformer shall be free of partial discharges at least up to 1.1 times the rated voltage. The windings shall absorb no moisture under the worst tropical conditions.

6.0 CORE

The core shall be built up with high quality, non-ageing, low loss & high permeability CRGO (Cold reduce Grain Oriented) Silicon Steel Lamination of very high magnetic properties. CRGO sheet shall be coated with inorganic material like carlite or equivalent insulation to reduce eddy current to minimum. After shearing, the laminations shall be treated to remove all burrs and shall be annealed to remove all the residual stresses.

Core framework and clamps shall be arranged and tightened to securely hold laminations in order to prevent any settling or displacement in case of heavy shocks during transport, handling or short circuits. All the iron parts, except the core shall be galvanized and treated with high temperature resistant paint. Core fastening bolts shall be insulated to reduce losses and avoid hot spots. Transformer shall be designed to withstand 10% overfluxing corresponding to rated voltage.

Suitable lugs shall be provided for lifting the complete core & coil assembly of the transformer.

7.0 INSULATION

Inter-turn and inter coil insulation shall be designed such that the dielectric stress is uniformly distributed throughout the windings under all operating conditions. The windings shall be provided with Class ‘H’ insulation or better.

8.0 TEMPERATURE RISE

The temperature rise of the windings shall not exceed 90°C by resistance on continuous full load above maximum ambient temperature of 50°C and in no case shall reach value that may damage the core itself or other adjacent parts.

9.0 TAP CHANGING

Off Circuit Bolted Tap changing device shall be provided on High Voltage side for tapping from +5% to –10% of the input voltage in steps of 2.5%. Inspection window with glass and neoprene gasket shall be provided on the transformer enclosure to view the tapping position.
10.0 **PARALLEL OPERATION**

The transformers shall be suitable to operate in parallel among themselves.

11.0 **VECTOR GROUP**

Transformer shall have vector group of Dyn 11.

12.0 **IMPEDANCE**

The desired impedance shall be as mentioned in the IS – 2026.

13.0 **FLUX DENSITY**

The maximum flux density at any point in the core and the winding shall not exceed 1.6 Tesla on the normal rated tap voltage & frequency.

14.0 **CURRENT DENSITY**

The maximum current density at any point in the winding shall not exceed 2.2 Amps per sq.mm. at the rated full voltage & frequency.

15.0 **COOLING**

The transformer shall be designed for natural cooling (AN).

16.0 **ENCLOSURE**

Transformers shall be provided with a sheet steel enclosure with adequate provision for ventilation. The degree of protection of enclosure shall be IP – 21 for indoor installations. The sheet steel thickness of enclosure shall be minimum 2 mm CRCA.

17.0 **END TERMINATION**

Cable box shall be provided on both HV & LV side for termination of cables.

17.1 **HV Ends**

Terminals shall be suitable to receive one run of XLPE cable. Cable entry shall be from bottom.
17.2 **LV Ends**

Terminals shall be suitable to receive XLPE cable. The complete cable details shall be given on finalization of the order.

18.0 **UNDER CARRIAGE**

Transformers shall be supported on structural base equipped with bi-directional rollers suitable for moving the fully assembled transformers.

19.0 **ACCESSORIES**

The following fittings shall be provided on the Dry Type Transformers:

i) Rating & Terminal marking plate
ii) 4 nos. bi-directional flat rollers
iii) 2 nos. earthing terminals with lugs on the transformer base channel on diagonally opposite ends
iv) Lifting arrangement
v) Extra Neutral point
vi) 1 no. PT-100 sensor in each LV windings wired upto the winding temperature indicator scanner. The instrument shall have two sets of adjustable contacts for alarm & trip. Instrument shall have scanner to read and show temperature of all the three phases sequentially.

20.0 **TESTS**

Transformers shall be subjected to routine and type tests as specified in IS: 2026, IS: 11171, IEC – 726 & given below:

20.1 **Routine Tests:**

All routine test shall be carried out as per IS / IEC at manufacturer work type test certificate shall be furnished by manufacture after award of work.
TECHNICAL SPECIFICATION OF VCB PANEL

GENERAL

The technical specifications covers the equipment to be supplied, delivered, erected and commissioned for 6.6 KV Panels suitable for 6.6 KV, 3 Phase earth systems, 50 Hz.

STANDARDS AND CODES

The following Indian Standards specifications and codes of Practice will apply to the equipment and the work covered by the Codes of Practice will apply to the equipment and the work covered by the Scope of this Contract. In addition, the relevant clauses of the Indian Electricity Act 1910 and Indian Electricity Rules 1926 as amended upto date shall also apply. Where ever appropriate standards are not available, relevant British and/or IEC Standards shall be applicable.

ISO 9001 – 2000 certified equipment shall be used as a part of the Contract in line with Government Regulations. Necessary test certificates in support of the specification shall be submitted prior too supply of the equipment.

It is to be noted that updated and current Standards shall be applicable irrespective of those listed below.

- 6600 Volt Circuit Breaker IS 13118
- Metal Enclosed Switchgear and Controlgear
  For voltages above 1000 volts IS 3427 : 1969
- Electrical Relays for Power System Protection IS 3231 : 1986
- Voltage Transformers IS 3126 Parts I to IV 1978
- Current Transformers IS 2702 : 1981
  Part I to IV
- Specifications for Dry Type Power Transformers IS 11171 : 1982
- Code of Practice for Installation And Maintenance of Transformers IS 10028 : 1981
- Rubber Mats for Electrical Works IS 2424 : 1983
- PVC Sleeving for Electrical purposes IS 1921 : 1961
- Danger Notice Plate IS 2221 : 1982

6600 VOLT CIRCUIT BREAKERS

TECHNICAL PARAMETERS

The 6600 volt circuit breakers shall be triple pole Vacuum Circuit breaker as specified suitable for indoor mounting with the requirements of the relevant Indian Standards. The Circuit Breakers shall be suitable for operation at 6600 volts 3 phase 50 Hz supply system and shall have a certified symmetrical breaking capacity of 350 MVA at 6600 Volts or as specified.

CIRCUIT BREAKER CONSTRUCTIONAL FEATURES

The 6600 Volt circuit breaker shall be suitable for flush front, metal clad, truck mounted, vertical isolation, horizontal draw out type and fully interlocked. The truck that carries the Circuit Breaker shall be of rigid fabricated construction Each Circuit breaker shall be housed in a separate compartment enclosed on all sides. Each withdrawal truck shall have its own Circuit Breaker.

All electrical connections on the truck shall be brought to secondary plugs, which engage similar sockets in the housing. The draw out mechanism shall be so designed and constructed as to permit smooth withdrawal and insertion. The movement shall be free of jerks, easy to operate and positive.

Sheet steel barriers shall be provided between
- Instrument Panel and Potential Transformer
- Instrument panel and Current Transformers
- Busbar chamber and Circuit Breaker compartments

Vacuum circuit breaker shall have an assembly of three Vacuum interrupters of proven design. The Vacuum interrupters offered shall be of similar make as that of the circuit breaker.
CIRCUIT BREAKER OPERATING MECHANISM

The Circuit Breaker shall be trip free and equipped with a 230 V AC motor charged closing mechanism shall be such that the Circuit Breaker is at all times free to open immediately the trip coil is energized.

Mechanical ON/OFF position indication shall be provided on the front of the circuit breaker. The operating mechanism shall be mounted on the front panel of the truck.

The operating handle and the mechanical trip push button shall be at the front of and integral with the Circuit Breaker.

The operating mechanism shall provide distinct and separate positions of the Circuit Breaker on the cradle.

-Service
-Test
-Isolated
-Maintenance

CIRCUIT BREAKER INTERLOCKING

Breaker shall be provided with the following mechanical safety Interlocks to ensure protection of the equipment and the operator.

The Circuit breaker cannot be unless it is in the ‘PLUGGED IN’ position.

Breaker cannot be withdrawn from or pushed into the housing unless the main contacts are open.

Circuit Breaker cannot be put into service without making the secondary connections between the truck and housing.

The cover of the draw out voltage transformer cannot be opened unless the transformer is isolated.
CIRCUIT BREAKER AXILLARY CONTACTS

Each Circuit Breaker shall be provided minimum of 6 N.O. and 6 N.C. auxiliary contacts. These contacts shall close before the main contacts when the circuit Breaker is plugged in and vice versa when the Circuit Breaker is lowered.

PROTECTION RELAYS

The Circuit Breaker shall have over current, earth fault protection and auxiliary relay devices as specified in the schedule of Quantities. The relays shall be mounted flush on a separate compartment with the access from the rear for wiring and maintenance. The trip circuit supervision relay and master trip relay in each panel shall be required besides over current and earth fault protection.

POTENTIAL AND INSTRUMENT TRANSFORMERS

A draw out type cast resin voltage transformer shall be mounted in the panel and connected to the Line. This shall be arranged for Horizontal isolation.

The Circuit Breaker shall have the required current transformers as specified in the Schedule of Quantities for metering and protection mounted outside the Circuit Breaker compartment but within the free standing cubicle. The transformers shall comply to the relevant Indian Standards. All Transformers for metering shall be Accuracy Class 1 and of capacity 15 VA and ratio as required. Dual core current transformers shall be provided for metering and protection.

INSTRUMENTATION

Instruments and indicating lamps as required in the Schedule of Quantities shall not be mounted on the Circuit Breaker compartment door. A separate adequate compartment shall be provided. The instruments and relays shall be accessible for testing and maintenance without danger of accidents contact with the parts in the Switch gear Panel.

Square pattern flush mounting meters and selector switches of the three ways and OFF pattern complying with the requirements of the relevant Indian Standards shall be used.

The current transformers for metering and protection shall be mounted on the solid copper bus bar with proper supports.
Neon type indicating lamps shall be provided for phase and other operational indications.

**TYPE TEST CERTIFICATES**

The Contractor shall submit type test certificates of the Circuit Breakers complying to the relevant Indian Standards from a recognized Test House. The type test results submitted shall be valid type test result within a period of 5 years from the date of supply.

**6.6 KV SWITCHGEAR PANEL GENERAL**

The switch gear panels shall be suitable for operation at 6600 volt 3 phase 50 Hz supply system. The Switchgear panels shall comply with the requirements of the latest edition with up to date amendments of the relevant Indian Standards Specifications, Indian Electricity Rules and Regulations.

**SWITCHGEAR CONFIGURATION**

The panel shall be configured with 6600 Volt circuit Breakers, associated metering and protective devices and other equipment as called for in the Bill of Quantities. Each 6600 Volt Circuit Breaker shall be housed in an individual panel in single tier formation.

**EQUIPMENT SPECIFICATIONS**

All equipment used to configure the Switch gear Panel shall comply with the relevant Standards and Codes of the Bureau of Indian Standards and detailed technical specification as included in this tender document.

**CONSTRUCTIONAL FEATURES**

The 6600 Volts Switchgear Panel shall be totally enclosed, dead front, metal clad, cubicle Pattern, and floor mounted extensible on both sides and suitable for indoor use.

The Switchgear Panels shall be totally enclosed and completely dust and vermin proof. Synthetic rubber gaskets between all adjacent units and beneath all cover shall be provided to tender the joints dust and vermin proof and to provide a degree of protection of IP4X. All doors and covers shall also be fully gasketed with synthetic rubber and shall be lockable.
The Switchgear Panels shall be fabricated with CRCA sheet Steel of thickness not less than 2 mm. and shall be folded and braced as necessary to provide a rigid support for all components. The doors and covers shall be constructed from CRCA Sheet Steel of thickness not less than 1.6 mm. Joints of any kind in sheet steel shall be seam welded and all welding slag ground off and welding pits viped smooth with plumber metal. All panels and covers shall be properly fitted and square with the frame. The holes in the panel shall be correctly positioned.

Fixing screws shall enter holes tapped into an adequate thickness of metal or provided with hank nuts. Self-threading screws shall not be used in the connection of the switchgear panel.

**SWITCHGEAR PANEL LIMITATIONS**

Switchgear Panel height shall be restricted to a maximum of 2400 mm.

**SWITCHGEAR PANEL COMPARTMENTALISATION**

The Switchgear Panels shall be divided into distinct separate compartments comprising of breaker compartment, meter compartment and relays compartment.

A completely enclosed ventilated dust and vermin proof bus bar compartment for the vertical and horizontal busbars. Each Circuit Breaker shall be housed in a separate compartment enclosed on all sides.

Separate and adequate compartments shall be provided for accommodating instruments, indicating lamps, protective relays, control fuses etc as required. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts.

A horizontal wireway with screwed covers shall be provided at the top to take interconnecting control wiring between vertical sections.

Cable compartment shall be of adequate size for easy termination of all incoming and outgoing cables. Adequate and proper supports shall be provided in the compartment for supporting the cables.

**SWITCHGEAR PANEL BUSBARS**

The main horizontal and vertical interconnection busbars shall be of hard drawn high conducting electrolytic copper and of rectangular cross sections suitable for full rated current. The current density for copper shall be 1.6 amps per sqmm. The busbars and interconnections shall be insulated. The busbars shall be extensible on either side of the Panels.

The busbars shall be supported on non-breakable, non hygroscopic insulated supports at regular interval. All busbars and interconnections shall be color coded. The main horizontal busbars shall run through the entire length of the Switchgear Panels.
SWITCHGEAR PANEL INTERCONNECTIONS
All interconnections shall be with solid electrolytic copper of adequate size to carry, the full rated current and insulated.

DRAWOUT FEATURES
All Circuit Breakers shall be provided in fully, drawout cubicles. These cubicles shall be such that drawout is possible without disconnection of the wires and the cables. The power and control circuits shall have self-aligning and self-isolating contacts, which shall be easily accessible for maintenance. Mechanical interlocks shall be provided on the drawout cubicles to ensure safety and compliance to the relevant Standards.

SWITCHGEAR PANEL INTERLOCKS
Each group of busbars and feeder connections shall be fitted with automatically operated safety shutters with positive opening and closing when the Circuit Breaker is raised or lowered. Facility shall be provided for hand operation of the shutters and latching in either open or closed position. Padlocking provision of the shutter in the closed position shall be included for maintenance purposes.

POTENTIAL AND INSTRUMENT TRANSFORMERS
A draw out type cast resin voltage transformer shall be mounted in the panel and connected to the line. The tank shall be arranged for horizontal isolation. All current transformers for metering shall be Accuracy Class I and of capacity and ratio as required.

INSTRUMENTS AND PROTECTION RELAYS
Instruments, indicating lamps and all protection and control relays shall not be mounted on the Circuit Breaker compartment door. A separate adequate compartment shall be provided. The instruments and relays shall be accessible for testing and maintenance without danger of accidental contact with live parts in the Switchgear Panel. Neon type indicating lamps shall be provided for phase and other operational indications.

The current transformers for metering and protection shall be mounted on the solid copper busbars with proper supports.

SWITCHGEAR PANEL INTERNAL WIRING
All wiring for relays and metering shall be with PVC insulated copper conductor wires. The maximum size of copper conductor control wires shall be 2.5 sq.mm. All control circuits shall be provided with protective H.R.C. fuses. Instrument testing plugs shall be provided for testing the meters.
SPACE HEATERS
The Switchgear Panels shall have in each panel thermostatically controlled space heaters with a controlling 15 Amp 230 volt switch socket outlet to eliminate condensation.

EARTHING
One main earth bus bar of copper shall be provided throughout the length of the Switchgear Panels to provide an integral earthing to the entire switchboard.

DESIGNATION LABELS
Suitably engraved white on black nameplates and identification labels of metal for all Panels and circuits shall be provided. These shall indicate the feeder number and the designation.

SHEET STEEL TREATMENT AND PAINTING
Sheet steel treatment used in the construction of the Switchgear panels should have powder coating finish and should have undergone seven tank painting process.

All sheet steel work shall after metal treatment be powder coated with two coats of shade 631 to IS 5. Each coat of paint shall be properly stored and the paint thickness shall be not less than 20 microns.

INSTALLATION
The foundations prepared as per the manufacturers drawings shall be leveled, checked for accuracy and thereafter the Switchgear Panels installed. All bus bar connections shall be checked with a feeler gauge after installation. The cable end boxes shall be scaled to prevent the entry of moisture. The main earth bars shall be connected to the sub-station earths.

A 12mm thick rubber matting of approved make shall be provided in front of the Switchgear Panels and along its entire length. The width of the rubber matting shall be 1000mm. The rubber mat shall withstand 12 KV for 1 minute and leakage current shall not exceed 160-mA/sq.m. After installation of the Switchgear Panels, these shall be tested prior to commissioning.

TESTING AND COMMISSIONING
Prior to commissioning the following tests shall be carried out:
Mechanical operation of the Circuit Breakers.
Insulation resistance test shall be carried out between phases and phases and earth.
Accuracy and operation of all control and protection relays and tripping sequences shall be checked.
CABLE LAYING

The work include receiving storing and laying of cables installation of poles supplying and fixing of fitting, earthing as per CPWD general specification for External works, 1974 amended upto 1994 including its safe keeping as per specification below.

The cables shall be XLPE insulated & PVC sheathed armored conforming to IS: 1554 (Part-1) – 1988. Cross linked polyethylene insulated, PVC sheathed (XLPE), conforming to IS: 7098.

INSTALLATION:

Cables shall not be bent sharp to a small radius either while handling or in installation. The minimum safe bending radius for XLPE cables shall be 12 times the overall diameter of the cable. At joints and terminations, the bending radius of individual cores of a multi core cable of any type shall not be less than 15 times its overall diameter.

The ends of lead sheathed cables shall be sealed with solder immediately after cutting the cables. In case of PVC cables, suitable sealing tape shall be used for this purpose, if likely exposed to rain in transit storage. Suitable heat shrinkable caps may also be used for the purpose.

ROUTE:

While the shortest practicable route should be preferred, the cable route shall generally follow fixed developments such as roads, footpaths etc. with proper offset so that future maintenance, identification etc. are rendered easy. Cross-country run merely to shorten the route length shall not be adopted.

Cable route shall be planned away from drains & nears the property, especially in the case of LV/MV cables, subject to any special local requirements that may have to be necessarily complied with.

Corrosive soils, ground surrounding sewage effluent etc. shall be avoided for the routes.

Whenever cables are laid along well-demarcated or established roads, the LV/MV cables shall be laid farther from the kerb line than HV cables.

Where cables cross one another, the cable of higher voltage shall be laid at a lower level than the cable of voltage.
PROXIMITY TO COMMUNICATION CABLES

Power and communication cables shall as far as possible cross each other at right angles. The horizontal and vertical clearances between them shall not be less than 60 cm.

LAYING DIRECT IN GROUND

This method shall be adopted where the cable route is through open ground, along roads/lanes etc. and where no frequent excavations are likely to be encountered and where re-excavation is easily possible without affecting other services.

TRENCHING

WIDTH OF TRENCH

a. The minimum width of the trench for laying a single cable shall be 35cm.

b. Where more than one cable is to laid in the same trench in horizontal formation, the width of the trench shall be increased such that the inter-axial spacing between the cables, except where other specified, shall be at least 20cm.

c. There shall be a clearance of at least 15cm between axis of the end cables and the sides of the trench.

DEPTH OF TRENCH

a. Where the cables are laid in a single tier formation, the total depth of trench shall not be less than 75cm for cables upto 1.1 KV and 1.2 m for cables above 1.1 KV.

b. When more than one tier of cables is unavoidable and vertical formation of laying is adopted, the depth of the trench in above shall be increased by 30cm for each additional tier to be formed.

c. Where no sand cushioning and protective covering are provided for the cables as per above, the depth of the trench as per above shall be increased by 25cm.
LAYING OF CABLE IN TRENCH

a. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 8cm in depth, before laying the cables therein.

b. However, sand cushioning as per above need not be provided for MV cables, where there is no possibility of any mechanical damage to the cables due to heavy or shock loading on the soil above. Such stretches shall be clearly specified in the fender documents.

TESTING BEFORE LAYING

At the time of issue of cable for laying, the cables shall be tested for continuity and insulation resistance. The cables shall be tested for continuity of cores and insulation resistance and the cable length shall be measured, before closing the trench. The cable end shall be sealed/covered as per above clause.

SAND COVERING

Cables laid in trenches in single tier formation shall have a covering of dry sand of not less than 17cm above the base cushion of sand before the protective cover is laid.

In the case of vertical multi-tier formation, after the first cable has been laid, a sand cushion of 30cm shall be provided over the base cushion before the second tier is laid. If additional tiers are formed, each of the subsequent tiers also shall have a sand cushion of 30cm as stated above. Cables in the top most tiers shall have final sand covering not less than 17cm before the protective cover is laid.

Sand covering as per above need not be provided for MV cables where a decision is taken by the Engineer-in-charge as per above sub clause, but the inter-tier spacing should be maintained as in above with soft soil instead of sand between tiers and for covering.

Sand cushioning as per above shall however be invariable provided in the case of HV cables.

EXTRA LOOP CABLE

At the time of original installation, approximately 3m of surplus cable shall be left on each terminal end of the cable and on each side of the underground joints. The surplus
cable shall be left in the form of a loop. Where there are long rungs of cables such loose cable may be left in the form of a loop. Where there are long runs of cables such loose cable may be left at suitable intervals as specified by the Engineer-in-charge.

Where it may not be practically possible to provide separation between cables when forming loops of a number of cables as in the case of cables emanating from a substation, measurement shall be made only to the extent of actual volume of excavation, sand filling etc. and paid for accordingly.

**MECHANICAL PROTECTION OVER THE COVERING**

a. Mechanical protection to cables shall be laid over the covering in accordance with below to provide warning to future excavators of the presence of the cable and also to protect the cable against accidental mechanical damage by pickaxe blows etc.

b. Unless otherwise specified, the cables shall be protected by second class brick of nominal size 22cm x 11.4cm x 7cm or locally available size, placed on top of the sand (or, soil as the case may be) the bricks shall be placed breadth-wise for full length of the cable. Where more than one cable is to be laid in the same trench, this protective covering shall cover all the cables and project at least 5cm over the sides of the end cables.

c. Where bricks are not easily available, or are comparatively costly, there is no objection to use locally available material such as tiles or slates or stone/cement concrete slabs. Where such an alternative is acceptable, the same shall be clearly specified in the tender specifications.

d. Protective covering as per above need not be provided only for MV cables, in exceptional cases where there is normally no possibility of subsequent excavation. Such cases shall be particularly specified in the Tender specifications.

**BACK FILLING**

The trenches shall be then back-filled with excavated earth, free from stones or other sharp edged debris and shall be rammed and watered, if necessary in successive layers not exceeding 30cm depth.

Unless otherwise specified, a crown of earth not less than 50mm and not exceeding 100mm in the center and tapering towards the sides of the trench shall be left to allow
for subsidence. The crown of the earth however, should not exceed 10cm. so as not to be a hazard to vehicular traffic.

The temporary re-statements of roadways should be inspected at regular intervals, particularly during wet weather and settlements should be made good by further filling as may be required.

After the subsidence has ceased, trenches cut through roadways or other paved areas shall be restored to the same density and materials as the surrounding area and re-paved in accordance with the relevant building specifications to the satisfaction of the Engineer-in-charge.

Where road beams or lawns have been cut out of necessarily, or kerb stones displaced, the same shall be repaired and made good, except for turning / asphalting, to the satisfaction of the Engineer-in-charge, and all the surplus earth or rock shall be removed to places as specified.

**LAYING OF SINGLE CORE CABLES**

Three single core cables forming one three-phase circuit shall normally be laid in close trefoil formation and shall be bound together at intervals of approximately 1m.

The relative position of the three cables shall be changed at each joint at the time of original installation, complete transposition being effected in every three consecutive cable lengths.

**LAYING IN PIPES / CLOSED DUCTS**

Stone ware pipes, GI, CI or spun reinforced concrete pipes shall be used for cables in general; however only GI pipe shall be used as protection pipe on poles.

The size of pipe shall not be less than 10cm in dia. for a single cable and not less than 15cm for more than one cable.

Where steel pipes are employed for protection of single core cable feeding AC load, the pipe should be large enough to contain both cables in the case of single-phase system and all cables in the case of poly phase system.

Pipes for MV cables shall be independent one.

In the case of new construction, pipes as required (including for anticipated future requirements) shall be laid along with the civil works and jointed according to the CPWD Building Specifications.
These pipes shall be laid directly in ground without any special bed except for SW pipe which shall be laid over 10cm thick cement concrete 1:5:10 (1 cement: 5 coarse sand: 10 graded stone aggregate of 40mm nominal size) bed. No sand cushioning or tiles need be used in such situations.

Pipes laid for protection shall be paid extra if not covered in the schedule of quantities.

**ROAD CROSSINGS**

The top surface or pipes shall be at a minimum depth of 1m from the pavement level when laid under roads, pavements etc.

The pipes shall be laid preferable askew to reduce the angle of bend as the cable enters and leaves the crossing. This is particularly important for HV cables.

When pipes are laid cutting an existing road, care shall be taken so that the soil filled up after laying the pipes is rammed well in layer with watering as required to ensure proper compaction. A crown of earth not exceeding 10cm should be left at the top.

Manholes shall be provided to facilitate feeding/drawing in of cables with sufficient working space for the purpose. Suitable manhole cover shall cover them. Sizes and details shall be indicated in the schedule of work.

**CABLE ENTRY INTO THE BUILDING**

Pipes for cable entries to the building shall slope downwards from the building. The pipes at the building end shall be suitably sealed to avoid entry of water after the cables are laid.

Cable-grip / draw-wires, winches etc. may be employed for drawing cables through pipes/closed ducts.

Measurement for drawing / laying cables in pipes / closed duct shall be on the basis of the actual length of the pipe / duct for each run of the cables, irrespective of the lengths of cables drawn through.

**LAYING IN OPEN DUCTS**

Open ducts with suitable removable covers (RCC slabs or chequered plates) are generally provided in substations, switch rooms, plant rooms, workshops etc., for taking the cables. The cable ducts should be of suitable dimensions for the number of cables involved.
Laying of cables with different voltage rating in the same duct shall be avoided. Where it is inescapable to take HV & MV cables same trench, they shall be laid with a barrier between them or alternatively, one of the two (HV/MV) cables may be taken through pipe(s).

Splices or joints of any type shall not be permitted inside the ducts.

The cables shall be laid directly in the duct such that unnecessary crossing of cables is avoided.

Where specified, ducts may be fixed with clamps on the walls of the duct or taken in hooks/brackets/through in ducts.

Where specified, ducts may be filled with dry sand after the cables are laid and covered as above, or finished with cement plaster, especially in high voltage applications.

Providing duct is not in this scope of work.

**LAYING ON SURFACE**

This method may be adopted in places like switch rooms, workshops, tunnels, rising (distribution) mains in buildings etc. This may also be necessitated to the existing installation, where other methods of laying may not be feasible.

Cables may be laid in surface by any of the following methods as specified.

a. Directly clamped by saddles or clamps,

b. Supported on cradles,

c. Laid on troughs/trays, duly clamped.

The saddles and clamps used for fixing the cables surface shall comply with the requirements.

Saddles shall be secured with screws to suitable approved plugs. Clamps shall be secured with nuts on the bolts, grouted in supporting structure in an approved manner.

In the case of single core cables, the clamps shall be of non-magnetic material. Suitable non-corrosive packing shall be used for clamping unarmored cables to prevent damage of cable sheath.

Cables shall be fixed neatly without undue sag or kinks.
The arrangement of lying in the cables in cradles is permitted only in the case of cables of 1.1 KV grade of size exceeding 120 sq.mm. In such cases, the cables may be suspended on MS flat cradles of size 50 mm x 5 mm which in turn shall be fixed on the wall by bolts grouted into the wall in an approved manner at spacing of not less than 60 cm.

All MS components used in fixing the cables shall be either galvanized or given a coat of red oxide primer and finished with 2 coats of approved paint.
SPECIFICATION OF DIESEL GENERATING SET

1.1 SCOPE

In general, the contractor shall supply, assemble, erect, test and commission 250 KVA (at 45 deg. C ambient and 200 m above MSL) Silent type D.G. sets, AMF panel, Earthing System complete in all respects.

1.2 DEFINITIONS

The following abbreviations used in the Bill of Quantities and specifications represent:-

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IER</td>
<td>Indian Electricity Rules 1956.</td>
</tr>
<tr>
<td>BS</td>
<td>British Standard</td>
</tr>
<tr>
<td>BSCP</td>
<td>British Standard Code of Practice.</td>
</tr>
<tr>
<td>HRC</td>
<td>High Rupturing Capacity.</td>
</tr>
<tr>
<td>GI</td>
<td>Galvanized Iron.</td>
</tr>
<tr>
<td>CI</td>
<td>Cast Iron</td>
</tr>
<tr>
<td>APLSTS</td>
<td>Aluminium Conductor, Paper Insulated Lead sheathed, Double Steel Tape Armoured and Serving.</td>
</tr>
<tr>
<td>PVC</td>
<td>Polyvinyl Chloride</td>
</tr>
<tr>
<td>HT</td>
<td>High Tension</td>
</tr>
<tr>
<td>A-AMP</td>
<td>Ampere</td>
</tr>
<tr>
<td>KV</td>
<td>Kilo Volts</td>
</tr>
<tr>
<td>PT</td>
<td>Potential Transformer</td>
</tr>
<tr>
<td>CT</td>
<td>Current Transformer</td>
</tr>
<tr>
<td>OCB</td>
<td>Oil Circuit Breaker</td>
</tr>
<tr>
<td>ACB</td>
<td>Air Circuit Breaker</td>
</tr>
<tr>
<td>CFS</td>
<td>Combination Fuse Switch</td>
</tr>
<tr>
<td>MCB</td>
<td>Miniature Circuit Breaker</td>
</tr>
<tr>
<td>IC</td>
<td>Iron Clad</td>
</tr>
<tr>
<td>ICTPN</td>
<td>Iron Clad Triple Pole &amp; Neutral</td>
</tr>
<tr>
<td>ICDP</td>
<td>Iron Clad Double Pole</td>
</tr>
<tr>
<td>DB</td>
<td>Distribution Board.</td>
</tr>
<tr>
<td>NC</td>
<td>Normally Closed</td>
</tr>
<tr>
<td>KVAR</td>
<td>Kilo Volt Ampere - Reactive</td>
</tr>
<tr>
<td>SWG</td>
<td>Standard Wire Gauge</td>
</tr>
<tr>
<td>KVA</td>
<td>Kilo Volt Ampere.</td>
</tr>
<tr>
<td>MS</td>
<td>Mild steel.</td>
</tr>
</tbody>
</table>
1.3 **GUARANTEE AND DEFECTS LIABILITY PERIOD:**

The contractor shall guarantee that all equipments shall be free of any defects due to defective materials and bad workmanship and that the equipment shall operate satisfactorily and the performance and efficiencies of the equipment shall not be less than the desired values. The guarantee shall be valid for a period of 24 months after taking over and any parts found defective shall be replaced free of cost by the contractor. The services of the contractor's personnel if requisitioned during this period for such work shall be made available free of any cost to the Owner.

If the defects be not remedied within a reasonable time, the Owner may proceed to do so at the contractor's risk and expenses without prejudice to any other rights.

1.4 **COMPLETENESS OF OFFER:**

Offer shall include cost of all equipment, assemblies, accessories, transportation, loading, unloading, erecting, testing and commissioning and associated work which are necessary for the complete assembly and delivery of the equipment at site, whether or not these have been mentioned in this tender. The price shall include all taxes and duties etc. and nothing extra shall be paid on any account.

Tenderers shall also give technical details of all items included in their tender.

1.5 **INSPECTION AND APPROVAL:**

The D.G. Set before dispatch shall be inspected and tested for four hours at full load and thereafter at 10% overload for one hour, by the owner's representative at supplier's works and only on his approval the same shall be dispatched. Nothing extra shall be paid for conducting this test and for any consumables used.

The D.G. Set will be tested on completion of the work at site in all respects. The D.G. Set shall again be tested for four hours at full load and thereafter at 10% overload for one hour the required electrical load and all consumables including the fuel etc. shall be provided by the contractor and nothing extra shall be paid for this.

1.6 **RATES**

(i) The work shall be treated as on works contract basis and the rates tendered shall be for complete items of work inclusive of all taxes (including works contract tax, if any), duties, and levies etc. and all charges for items contingent to the work, such as, packing, forwarding, insurance, freight and delivery at site for
the materials to be supplied by the contractor, watch and ward of all materials for the D.G. Set work at site etc.

(ii) Prices quoted shall be firm.

(iii) The rate quoted for D.G. Set shall be on local project basis.

1.7 **DEVIATION**

Contractor shall stipulate the deviations, if any, from these Technical Specifications, and the reason thereof.

1.8 **EXCLUSIONS**

Any items excluded from the offer, but functionally required, should be clearly defined and listed, giving description of the items, quantity and cost.

1.9 **WORKS TO BE DONE BY THE CONTRACTOR**

(i) Unless and otherwise mentioned in the tender documents, the following works shall be done by the contractor, and therefore their cost shall be deemed to be included in their tendered cost:-

(ii) Cutting and making good all damages caused during installation and restoring the same to their original finish.

(iii) Painting at site of all exposed metal surfaces of the installation other than pre-painted items like fittings, fans, switchgear/distribution gear items, etc. Damages to finished surfaces of these items while handling and erection, shall however be rectified.

(iv) Temporary shed if required over the storage space and locking arrangement thereof, and watches and ward of the materials and completed installation till completion of the work.

(v) Testing and commissioning of completed installation.

1.10 **TOOLS FOR HANDLING AND ERECTION:**

All tools and tackles required for handling of equipments and materials at site of work as well as for their assembly and erection and also necessary test instruments shall be the responsibility of the contractor.
1.11 **CONTRACT DRAWINGS**

Contract drawings are basic but shall be closely followed as actual construction permits. Any deviations made shall be in conformity with the Architectural and other services drawings. Shop drawings shall be submitted by the contractor and got approved. Any deviations in drawings will be brought to the Notice before work is executed. Contractor shall verify all dimensions at site and bring to the notice of the authority any or all discrepancy or deviations noticed.

1.12 **DETAILED WORKING DRAWINGS**

Detailed working drawings on the basis of which actual work is to be proceeded will be furnished to the contractor by the client from time to time. Variation of any nature from those indicated in the drawings made available to him at the tender stage which are as ‘Advance Drawings’ as a guide to generally describe the scheme will not entitle the contractor for claiming any additional payment, payments will be made on the actual measurement of the work done, as admissible, as per drawings, at the accepted rates entered in the Schedule of Quantities forming part of this tender document.

1.13 **SHOP DRAWING, MAINTENANCE MANUALS Etc.**

On the award of the work, the contractor shall immediately proceed with the preparation of detailed shop drawings, detailing the equipment that are to be installed and the ancillary works that art to be carried out. Four sets of all such working drawings shall be submitted to the client for their approval to ensure that the works will be carried out in accordance with the specifications and drawings, including such changes as may have been mutually agreed upon. The drawings shall be received by the client for his approval within two weeks of the award of work.

The contractor shall prepare and supply the following drawings (4 sets) to the client for approval;

**For D.G. Set and Mechanical Works**

D.G. Set Enclosure Details including Plan, Section and Elevation.

Layout details - fuel piping / Exhaust fan details / trench details for fuel pipe.

Foundation Drawing for D.G. Set enclosure & Exhaust pipes

Fixing details for exhaust piping etc.
**For Electrical Works**

General layout-Plan, section, elevations

Foundation/Fixing arrangement.

Wiring-Power & Control for AME panel, GA drawing of AMF panel cable routing, trench details etc.

1.14 **APPROVALS**

1.14.1 The contractor shall obtain all information relating to local regulations, Bye-Laws, application of any and all laws relating to his work or profession and his having to execute work as required. No additional claims shall be admissible on this account.

1.14.2 Contractor shall obtain approval of the installation from the relevant inspection Authorities at all stages and on completion of the installation work. The rates quoted by the contractor for various items of the work shall be deemed to include any money payable to the Government/Municipal Authorities/Statutory Bodies/Electrical Inspectorate/ Pollution Control Board/CCOE etc. for obtaining approvals and nothing extra shall be paid to the contractor on this account.

**TECHNICAL SPECIFICATION FOR DIESEL GENERATING SET**

1.0 **SCOPE OF WORK**

1.1 The offer shall cover complete supply, transportation, foundation, installation, testing and commissioning of diesel engine alternator set. All minor civil works including Foundation, electrical and other works associated with the testing, installation and commissioning of the sets shall be carried out by the tenderer as per specification and schedule of item. The tender should quote for complete job to be executed under the works contract. The tenderers are advised to inspect the site to obtain first hand information of all site conditions before tendering.

1.2 Fuel Oil System from day tank to engine.

1.3 Lub. Oil System and speed governing system.

1.4 Alternator with excitation system and automatic voltage regulator (AVR) and necessary protection and metering CT’s in terminal box of alternator.

1.5 Cooling system with Radiator.

1.6 Electrical Main Panel (AME Panel), Cabling, Earthing etc.
1.7 Obtaining statutory approvals for DG set system.

1.8 Acoustically Treated DG Set Enclosure.

1.9 Erection, testing and final checking up of the installation at site, commissioning and putting the DG sets into successful operation including AME panel.

2.0 **EQUIPMENTS & SERVICES EXCLUDED FROM THE SCOPE OF THIS SPECIFICATION**

All except minor civil works and foundation/platform for DG set is excluded from the Contractor’s scope of work. However, the responsibility of co-ordinating with the civil contractor ensuring completion of contract rests with the contractor.

3.0 **DESIGN**

The design and workmanship shall be in accordance with the best engineering practices, to ensure satisfactory performance and service life. The equipment offered by the contractor shall be complete in all respect. Any material or accessories, which may not have been specifically mentioned, but which are useful and necessary for the satisfactory and trouble free operation and maintenance of the equipment, shall be provided without any extra cost to the purchaser.

4.0 **CODES & STANDARDS**

The design construction, manufacture, inspection, testing and performance shall comply with all the currently applicable statues, safety codes, relevant Bureau of Indian Standards (BIS) British Standards (BS), International Electro Technical Commission (IEC) Publication, NEMA, VDE and DEMA Standards.

Some of the applicable Standards are listed below:-

- **IS 1601**: Performance and testing of 1C engines for General Purpose.
- **BS-649**: Performance and testing of diesel engines for General Purpose.
- **IS-4722**: Rotating electrical machines.
- **IS-4889**: Method of determination of efficiency of Rotating Electrical machinery.
- **IS-6491**: Degree of protection provided by enclosures for Rotating Electrical machinery.
- **IS-4729**: Measurement and evaluation of vibration of Rotating Electrical machines.
- **AIEE-606**: Recommended specification for speed governing of internal (1959) combustion engine generator units.
- **IS-2705**: Current transformers.
IS-1248 : Electrical indicating instruments.
ISO-8528 : Reciprocating IC engine driven AC Gensets Section
           (Part II)

5.0 **GENERAL**

5.1 The DG set shall be super silent type, water cooled with radiator, manually and
     automatically operated, designed for continuous operation at 100% load at 100%
     time duty operation except the time required for periodic maintenance. The DG
     set shall comprise of diesel engine, coupled to four pole alternator on a single
     frame with integrated microprocessor based genset monitoring and control
     system having self regulated, brushless/static excitation system.

5.2 All equipment shall be of the class most suitable for working under the conditions
     specified and shall withstand the atmospheric conditions without deterioration.

5.3 The contractor shall also indicate in his offer the time schedule for routine
     maintenance/overhauling operations necessary for continuous satisfactory
     operation of DG set.

6.0 **PERFORMANCE REQUIREMENT**

6.1 The equipment shall be capable of delivering continuously at the generator
     terminals, 100% output at 100% load at 100% time except for periodical
     maintenance when operating under the site and ambient conditions described in
     this specification. Genset should have minimum 50% single step loading capacity
     and it should be able to take full load within 25 seconds from start.

     The design parameters of the generator and excitation system shall be so
     chosen, that the set is stable while running at any load between no-load and full
     load. It should have synchronous speed control with load sensing governing
     system and should be capable of paralleling between sets at synchronous speed.

6.2 Engine should be heavy duty four stroke, turbo charged after cooled, V
     construction Electrical start. Engine should have minimum lub oil change period
     of 500 hrs.

6.3 The DG set should be capable of running at 100% load continuously for minimum
     500 hours before any change of lub oil or filters.

6.4 Contractor to specify and guarantee maintenance contract cost and to give an
     undertaking to take a comprehensive maintenance contract at a price with draft
     scheme papers.
7.0 **DIESEL ENGINE - CONSTRUCTION**

7.1 Material of construction of major parts.

- a) M.S. Base Frame
- b) Crankcase - Aluminum alloys or as per manufacturer design.
- c) Crank - Shaft, connecting rods - forged alloy steel
- d) Piston - Al. Alloy casting
- e) Piston rings - Alloy steel
- f) Engine block - cast iron or as per manufacturers design.
- g) Cylinder liner - cast iron

All other materials of construction for pipe/pipe fittings etc. shall be as per relevant standards.

7.2 One common base frame shall be provided for mounting the engine and alternator, complete with electric suspension between generating set and foundation, leveling lines etc. as required.

7.3 All externally mounted hardware shall be high tensile steel only.

7.4 The normal speed of engine shall preferably be 1500 RPM at standard operating conditions as per BS – 5514 and the direction of rotation shall be clearly marked on the set.

7.5 The engine shall be fitted with an exhaust gas driven turbo charger of water cooled type complete with its own self contained lubricating system. The turbo charger shall be positioned at the free end of the engine. The turbo charger will be provided with a provision to check its lube oil level.

7.6 The engine shall be fitted with a charge air intercooler of the air / water type. Air from the turbocharger compressor passes through the inter cooler and then to the engine manifold. The intercooler shall be of tubular construction or as per manufacturer design with aluminum bronze tubes, mild sheet steel and cast iron water headers.

7.7 The engine shall be capable of starting and operating for a few minutes without water for cooling. Contractor shall indicate the maximum time for which the diesel engine can so operate.

7.8 The engine shall be fitted with exhaust gas driven turbo charger for forced exhaust of gas Upto 40 mtr. high exhaust pipe (Approx). The design/capacity of turbo charger should be as recommended by the manufacturer.
8.0 **FUEL OIL SYSTEM**

8.1 The manufacturer shall furnish a 3 mm thick mild steel day tank suitable for 12 hr full load run capacity. The day tank shall be suitably located in the acoustic enclosure and shall be complete with gauge glasses, filling, draining and vent connection with brass float valve and level switch for low and high level alarm.

8.2 The fuel oil system shall be provided with full flow duplex oil cartridge filter having the provision to change them while DG is running.

8.3 The fuel oil system shall be equipped with a crankshaft driven fuel oil transfer pump, which will draw the fuel oil from the day tank via filters and shall be as per the engine manufacturer design.

8.4 Direct injection system shall be designed, taking into account the type of fuel used, engine speed, etc. so as to achieve safe knock free performance with low emission smoke exhaust. Exhaust system pollution level shall be indicated and has to be got approved from concerned authorities.

8.5 The interconnected piping from day storage tank to engine together with piping, fitting, relief valves, return line of surplus oil from the injectors and other accessories shall be supplied & erected by the contractor without any extra charge.

8.6 Engine will be supplied with fuel leakage module to detect the fuel leakage from the engine and transfer it back to day tank for reuse.

9.0 **LUBRICATING OIL SYSTEM**

9.1 All lubricating parts of the engine shall be connected to pressurized lubricating oil distributing piping system being continuously charged by gear type lube oil pump mounted at the free end of the engine, and driven from the engine crank shaft. The pumps shall take suction from a sump tank integral with the engine through a foot valve, suction filter through oil cooler, and deliver oil to a main supply header. High pressure oil shall be supplied to the main and big end bearings, crankshaft bearings, governor, auxiliary drive gear etc. Suitable lubricating arrangement for engine cylinder valve gear, cams and pistons at the required level shall be arranged. A pressure relief valve shall be mounted on the main supply header for safety against too high pressure while starting with cold oil. A timer based auto running (auto priming pump) shall be provided to keep engine lubricated all the time.

9.2 All necessary accessories such as pressure gauges temperature indicators, pressure relief valves, bypass valves, pressure switches shall be furnished within the contract without any extra charge.
10.0 **COOLING SYSTEM**

This section comprises of the supply, erection, testing and commissioning of the radiator and axial flow fans conforming to the specifications and in accordance with the requirements as per equipment schedule. The radiator will be with first fill of cool at of recommended grade.

11.0 **ENGINE STARTING SYSTEM**

The electric starting system shall comprise starter motor, starter batteries (minimum 2 No. of 180AH each) and battery charger and all the required instrument and accessories as required.

12.0 **GOVERNING SYSTEM**

12.1 The governor shall be electronic type.

12.2 **EXHAUST SYSTEM**

Engine exhaust system shall be fitted with residential type silencer, ducting, bends, thermally insulated aluminum clad exhaust piping etc. shall be provided along with structural support with stays for the engine.

13.0 **ENGINE MOUNTED INSTRUMENT PANEL**

Engine will be supplied with engine mounted microprocessor based fully integrated generating set monitoring, metering and control system which should be equipped with digital electronic governor along with digital AVR to facilitate discreet control of speed and voltage. It should be equipped with starting control including integrated fuel ramping to limit the black smoke frequency overshoot with optimized cold weather starting. The indicating panel should have communication network facility to facilitate remote hooking on a common network. Engine instrument panel should be equipped with digital alarm and status mirage to monitor and display the following parameters of engine and generator.

**Engine Indicators**

- Digital tachometer
- Running hours counter
- Starting attempts counter
- Lube Oil pressure low (for idle and for rated speed)
- Lube Oil temperature high
- Turbocharger oil level low
- Coolant temperature high
- Coolant pressure high
Exhaust gas temperature high
Over speed

**Electrical Indicators**

3 x current
3 x voltage
Frequency
Active power
Reactive power
Power factor
Frequency totalizer
Battery voltmeter

**Signal alarms**

Cranking bar missing
Control panel fault
24 VDC fault
Failure to start
Fuel day tank level low
Cooling Tower fan fault
Water temperature low (inhibits rated speed)
Battery low voltage

**Controls and selectors**

Operating mode selector switch (stop, manual, auto, test)
Start/stop pushbuttons
Manual control selector switch (idle, rated, synchro, loading)
Emergency stop pushbutton
Fault reset pushbutton

14.0 **ALTERNATOR**

14.1 The alternator shall be industrial type, SPDP, IP23, Class F insulation, self ventilated, air cooled, rotating field, salient pole, brushless, machine with exciter and shall be rated continuous duty with temperature rise class F. The alternator should comply with standard IEC, VDE, BS, ANSI.

14.2 The alternator shall have a continuous rating of not less than the value specified under specific requirement in Annexure-I at 0.8 pf (lag) and the voltage specified.

14.3 The short circuit ratio (SCR) of the generator at rated KVA and rated voltage shall not be less than 0.5.
14.4 The alternator shall withstand without mechanical damage an over speed of 20% for a period of 2 minutes.

14.5 The alternator shall be capable of withstanding without damage/injury for three times the line current for 10 seconds.

14.6 The alternator shall be capable of withstanding for fifteen (15) seconds. A current of fifty (50) percent in excess of its rated current, the voltage being maintained as near the rated value as possible, consistent with max. capacity of the prime mover.

14.7 Six nos. embedded PT-100 of platinum to measure the winding temperature and 2 nos. bearing PT-100 to measure temperature shall be provided.

14.8 The leads of embedded WTDs shall be wired up to the terminal block in a separate terminal box. Manufacturer shall indicate the setting values for each WTD/BTD for alarm and trip.

14.9 On line greasing facility with grease nipples and grease relief devices shall be provided.

14.10 All external nuts and bolts shall be of high tensile steel only.

14.11 Alternator shall be provided with anti-condensation space heater of adequate rating suitable for 240V, 50 Hz, 1ph A.C. supply and shall be wired up to a separate terminal box.

14.12 Two independent earth terminals on the frame, complete with nuts, spring washer and plain washer shall be provided.

14.13 Alternator shall be provided with suitable terminal box for terminating bus duct. Suitable arrangement shall be provided in the terminal box for formation of star point for alternator neutral earthing.

14.14 The alternator should be capable to sustain the unbalanced current between the phases upto minimum 30% of rated current.

14.15 The radio interference should be within limit of the CISPR standard.

14.16 Alternator should be dynamically balanced complete with rotor and shaft.

14.17 The alternator should have double long life regreasible bearing. It should be flanged on engine, connected with elastic coupling.

14.18 The alternator shall be suitably derated for operation at 50 deg. C
The Alternator shall be capable of handling at least 50% non-linear load.

15.0 EXCITATION SYSTEM

15.1 The alternator shall be provided with a complete diode type brushless excitation system, capable of supplying the excitation current of the generator under all conditions of output from no load to full load and capable of maintaining voltage of the generator constant at one particular value.

15.2 The exciter shall have class-F insulation.

15.3 The excitation system shall comprise a shaft driven AC exciter with rotating rectifiers. The rectifiers shall have in-built protection for over-voltage.

15.4 The alternator should be complete with shunt and booster excitation. The exciter shall be fast response type and shall be designed to have a low time constant to minimize voltage transients under severe load changes. The excitation voltage response ratio shall be at least 0.8.

15.5 The rated current of the main exciter shall be at least 10% more than the alternator rated exciter current and it shall have a 40% overload capability for 10 seconds.

15.6 No external supply shall be required during starting and normal running of the alternator.

16.0 AUTOMATIC VOLTAGE REGULATOR

16.1 An automatic high speed, dead band type voltage regulator shall be provided complete with all accessories. The regulation system shall be provided with equipment for automatic and manual control.

16.2 The regulator shall regulate the output voltage from generator current and potential signals. Series compounding transformer shall be provided to enable maintaining adequate terminal voltage in the event of terminal faults. Alternatively excitation system shall be provided with arrangement for field forcing. Contractor shall co-ordinate suitable of protection relays for generator with the operational characteristics of automatic voltage regulator, specially under short circuit conditions.

16.3 Voltage regulation and steady stage modulation shall be within + 1% of the line voltage with manual voltage adjustment capability within + 5%.

16.4 Necessary equipment for field suppression and surge protection shall be provided.
16.5 The response time of the exciter and the generator shall be properly matched to avoid hunting.

16.6 AVR system shall be provided with equipment for automatic and remote operation/control as required.

Necessary equipment shall be furnished for the following:

a) To prevent automatic rise of field voltage in case of failure of potential supply.

b) To initiate transfer from automatic to manual control of excitation on fuse failure in the generator potential signal. Circuit to assure correct division of reactive power for parallel operation. The excitation and voltage regulation shall be designed to cause necessary de-excitation in case of short circuit. Cross current compensation circuit shall be provided.

17.0 **PAINTING**

17.1 All steel surfaces, which are to be painted, shall be thoroughly cleaned, degreased and supplied with primer prior to assembly and shall be applied with two coats of epoxy paint shade 631 as per IS5.

17.2 All castings shall be sand blasted, degreased and cleaned before painting.

18.0 **TESTS**

19.0 **DIESEL ENGINE**

Following tests shall be carried out at the engine manufacturer's works in the presence of employer if so desired.

DG set and the auxiliaries shall be assembled at the manufacturer's works and the following tests shall be performed.

a) One (1) hour at full load with fuel consumption
b) One (1) hour at 3/4 load with fuel consumption
c) One (1) hour at 50% load with fuel consumption
d) Four (4) hours at full load followed by a 1 hour continuous load at 110% and with fuel consumption.
e) Engine starting time
f) I.H.P. /B.H.P. test
g) Noise/Vibration test

Before each test, the engine shall be brought to a steady state under the conditions of the test.
19.2 The alternator shall be subjected to following routine tests:

a) Measurement of resistance of stator and rotor windings
b) Insulation resistance of stator and rotor windings
c) High voltage tests on stator and rotor windings
d) Open circuit and short circuit tests
e) Temperature rise test
f) Regulation test
g) Efficiency test
h) Momentary overload test
i) Vibration and noise level measurement

In addition to the above routine tests temperature rise test on generator shall be conducted.

19.3 VOLTAGE REGULATOR

a) Sensitivity test
b) Response time test

19.4 TESTS AT SITE

a) The tests shall be performed after proper installation of the diesel generating unit at site to prove the proper operation of interlock circuits and the capability of the engine to start and pick-up load in the specified time, under supervision of the employer representative responsible for supervision, testing and commissioning.

b) Guarantee tests to prove guaranteed performance of the DG set shall also be carried out at site after proper installation. The load test with available load at site will be given for about 8 hours.

19.5 TEST CERTIFICATE

a) Test certificate shall be submitted in six (6) copies.

b) The test certificate shall be furnished to the authorities for prior approval before dispatch of any equipment from works and the approval in writing from employer shall be essential to effect dispatch of the equipment.

c) The test reports shall furnish complete identification of the data, including serial number of each equipment.
20.0 **SPECIAL TOOLS AND TACKLES:**

The contractor/vendor shall supply tools as given below:

a) A standard tool box shall be made of 16 SWG, MS sheet duly painted and be of minimum 400mm x 200mm size.
b) Tool box shall contain minimum following tools for the operation and maintenance of equipments (Make Jhalani/ Taparia):

Spanner set having 10 pieces from 6mm to 38mm size, open end type.
Spanner set having 10 pieces from 6mm to 38mm size, ring type.
Box spanner with rod for transformer terminal nuts – 1 set.
Insulated screw driver of 300m size – 1 No.
Digital Millimeter of Philips make – 1 No.
Adjustable spanner of 300mm size – 1 No.
Insulated Pillar set 200 mm size - 1 No.
Wire cutter and peeler set of wire upto 06 sizes – 1 Set.

21.0 **SPARE PARTS**

No Spare parts are needed along as a part of this contract.

22.0 **DRAWINGS, DATA AND MANUALS**

Drawings and details as indicated elsewhere shall be furnished along with each of the bid.

23.0 **DEVIATION**

Should the contractor desire to deviate from this specification in any way, he shall draw specific attention to such deviation.

Unless such deviations are recorded in the deviation sheets, as submitted with offer, it will be taken for granted that the offer is made in conformity with the specifications.

24.0 **GUARANTEED PERFORMANCE**

The contractor shall furnish, along with the offer the technical particulars as called in the Annexure. The performance figures quoted in the technical particulars sheet shall be guaranteed with the tolerance permitted by relevant standards.
25.0 PACKING FOR SHIPMENT

25.1 The equipment shall be suitable protected by respective packing for the shipment distance and weather conditions involved.

25.2 For transportation, if totally enclosed boxes are not used, the equipment shall be mounted on skids and enclosed in the open frame wooden crates. However, items like instruments and other components not assembled with equipment number and part number for case of identification.

26.0 SYSTEM OPERATION:

Diesel - alternator sets function will as follows:-

26.1 AUTOMATIC MODE

While the normal mains supply is healthy the diesel alternator set will be at rest and the load will be supplied by the mains.

After a time delay of 1.5 seconds from the main supply failure the diesel engine shall start.

When the DG set attains its rated speed and voltage a closing signal shall be given to the MCCB of the DG set.

When the voltage in the mains gets restored, its quality is monitored for about one minute and if proven satisfactory the main supply breaker shall close automatically for transfer of the load from Diesel engine to the main supply at L.T. Panel.

The set shall stop after idle running of one minute after restoration of main supply.

The diesel alternator set reverts to its standby conditions & it’s ready to start should the mains supply fail again.
SOUND ATTENUATED ACOUSTIC ENCLOSURE

A suitable “SOUND ATTENUATED” ACOUSTIC ENCLOSURE” to provide high level of “NOISE REDUCTION” shall be provided to house the D.G. Sets.

ACOUSTIC ENCLOSURE

The acoustic enclosure housing for the diesel generating set shall be designed on the best engineering practice. It should aesthetical looks and brings down sound noise to 75 dB when measured from a distance of 1 meter away from the DG Set as per noise pollution norms.

Enclosure construction shall be fully bolted keeping in view the major service requirements all doors shall be provided with specially designed hinges and lockable handles, Battery, Fuel tank and MCCB shall be housed inside the enclosure.

The DG Set shall be supported on a base frame in CRCA Sheet enclosure with suitable ducting for air inlet and outlet. The enclosure frame shall be of rectangular steel tubes. The doors & enclosure is treated and painted with deco paint for longer life and weather proof. Requisite air circulation for heat dissipation and combustion shall be provided by axial fans. All oil & fuel connections shall be through steel braided pipes for fuel safety reasons.

The acoustic enclosure consists of the following:-

ACOUSTIC INSULATION

High density resin bonded glass wool shall be provided on all five sides including doors and roof to absorb noise. The door shall have acoustic gas proof gaskets all along its periphery.

Resin bonded Rockwool of high density (96 Kg / Cu. mtr.) with minimum 100 mm thickness with tissue paper (min 50 gm/sq.m) covered with perforated 1.6 mm painted MS sheet shall be used as sound absorption material on all five sides including doors is provided. The air ducts shall also be covered with mineral wool.

Acoustic hoods with noise splitters provided to block and reduce the sound leakage

EXHAUST SYSTEM

The exhaust gas is taken out of enclosure through suitable size class C MS pipe and noise suppressor duly insulated with 50 mm Rock wool insulation, 24 G Aluminium cladding.
A suitably designed residential type noise suppressor complete with acoustic and thermal insulation shall be provided.

**FUEL TANK AND BATTERY SYSTEM**

The enclosure shall be provided with separate chambers for fuel storage tank and battery storage for safety purpose.

**ARRANGEMENTS**

The engine and alternator are coupled by means of a flexible coupling and both the units including the radiator shall be mounted on rigid fabricated base frame to form a compact arrangement of the equipment. Base frame shall be of MS steel and suitably machined to ensure perfect alignment and alternator with rigid construction to ensure minimum vibrations.

The complete enclosure shall be detachable which can be dismantled in parts of its easy installation anywhere.

**PAINTING**

The acoustic enclosure shall be painted with good quality Duco Automotive paint with a prior red oxide primer base and other protection for making it suitable for installation in open areas.

**VIBRATION ISOLATION**

To avoid transfer of vibration from genset to enclosure & surrounding specially designed vibration isolators shall be used.

**SAFETIES**

The enclosure shall have the following safeties;

- High Enclosure Temperature
- Emergency Stop Push button outside the enclosure.
The enclosure shall also be provided with space heater complete with thermostat and controlling ELCB working on 220 V. AC supply and chamber illumination lamp working on 24 V. DC supply.

**BATTERIES**

One set of batteries. The batteries shall be EXIDE/AMARON/OKAYA make. The size, voltage, AH and number of plates shall be as technically required. These details shall be submitted by the supplier with the quotation. The batteries shall be fully charged. The size and length of leads shall be as required at site.

**FIRST FILL OF ENGINE OIL:**

D.G. Set shall be provided complete with first fill of Engine Oil.

**APPROVALS:**

Contractor on behalf of the owner shall be responsible to complete all formalities and shall obtain the approvals, sanctions and clearance certificate (NOC) for the installation of DG Sets and for restricted use of DG set from the concerned statutory authorities such as pollution control board of State/central government state detracted board chief fire officer of state government, chief electrical inspector of state government, tariff advisors committee of regional fire insurance, Local power supply company etc.
AMF PANEL

CONSTRUCTION:

1. GENERAL FEATURES

The control panel shall be fabricated out of sheet, totally enclosed, dust, damp and vermin proof free standing floor mounted type & front operated. It shall be made into sections such that as far as feasible, there is no mixing of control, power DC & AC functions in the same section and they are sufficiently segregated except where their coming together is necessary. Sheet steel used for fabrication shall not be less than 2 mm thick. Hinged doors shall be provided preferably double leaf for access for routine inspection from the rear etc. There is no objection to have single leaf hinged door in the front. The degree of protection required will be IP-54 conforming to IS: 2147.

2. TERMINAL BLOCKS AND WIRING

Terminal blocks of robust type and generally not less than 15 Amps capacity, 250/500 V grade for DC upto 100 V and 660/1100 Volts grade for AC and rest of the junction shall be employed in such a manner so that they are freely accessible for maintenance. All control and small wiring from unit to unit inside the panel shall also be done with not less than 2.5 sq.mm. copper conductor PVC insulated and 660/1100 volts grade. Suitable colour coding can be adopted. Wiring system shall be neatly formed and run preferably, function wise and as far as feasible segregated voltage wise. All ends shall be identified with ferrules at the ends.

Labels: All internal components shall be provided with suitable identification labels suitably engraved. Labels shall be fixed on buttons, indication lamps etc.

Painting: The entire panel shall be given primer coat after proper treatment and powder coating with 7 tanks process before assembly of various items.

Equipment requirements: The control panel shall incorporate into assembly general equipment and systems as under.

1. Control system equipments and components and components such as relays, contactors, timers, etc. both for automatic operation on main failure and as well as for manual operation.
2. Equipment and components necessary for testing generating sets healthiness with test mode and with load on mains.
3. Necessary instruments and accessories such as voltmeter, power factor meter, KW meter, KWH meter, Ammeter, Frequency meter etc. In one energy analyzer unit with selector switch to obtain the reading of desired parameters.
5. Necessary visual audio alarm indication and annunciation facility.
7. Necessary excitation control and voltage regulating equipment.
8. Necessary overhead cable termination all internal wiring, connection etc as required.
9. MCCB Breaker of suitable capacity as specified in the schedule of work.

System operation: These facilities provided vide clause 6.1.5 shall afford the following operational requirements.

3. **Auto Mode**

1. A line monitor shall monitor supply voltage on each phase. When the mains supply voltage fails completely or falls below set value (variable between 80 to 95% of the normal value) on any phase, the monitor module shall initiate start up of diesel engine. To avoid initiation due to momentary disturbance, a time delay adjustment between 0 to 5 second shall be incorporated in start-up initiation.

2. A three attempt starting facility shall be provided 6 seconds ON, 5 seconds OFF, 6 seconds ON, 5 seconds OFF, 6 second ON, if at the end of the third attempt, the engine does not start, it shall be locked out of start, a master timer shall be provided for this function. Suitable adjustment timers be incorporated which will make it feasible to vary independently ON-OFF setting periods from 1-10 seconds. If alternator does not build up voltage after the first or second start as may be, further starting attempt will not be made until the starting facility is reset.

3. Once the alternator has built up voltage, the alternator circuit breaker shall close connecting the load to the alternator. The load is now supplied by the alternator.

4. When the main supply is restored and is healthy as sensed by the line voltage monitor setting, both for under voltage and unbalance, the system shall be monitored by a suitable timer which can be set the system shall be monitored by a suitable timer which can be set between 1 minute to 10 minutes for the load to be transferred automatically to main supply.

5. The diesel alternator set reverts to standby for next operation as per (a),(b) and (c) above.
4. **Manual Mode**

1. In a manual mode, it shall be feasible to start-up the generator set by the operator on pressing the start push button.
2. Three attempt starting facility shall be operative for the start up function.
3. Alternator circuit breaker close and trip operation shall also be through operator only by pressing the appropriate button on the panel and closure shall be feasible only after alternator has built up full voltage. If the load is already on ‘mains’, Pressure on ‘close’ button shall be ineffective.
4. Engine shut down, otherwise due to faults, shall be manual by pressing a ‘stop’ button.

5. **Test mode**

1. When under ‘test’ mode pressing of ‘test’ button shall complete the start up sequence simulation and start the engine. The simulation will be that of mains failure. Sequence I (a) and (b) shall be completed.
2. Engine shall build up voltage but he set shall not take load by closing of alternator circuit breaker. When the load is on the mains, monitoring of performance for voltage/frequency etc. shall be feasible without supply to load.
3. If during test mode, the power supply has failed, the load shall automatically get transferred to alternator.
4. Bringing the mode selector to auto position shall shot down the set as per sequence I (d) provide main supply is ON. If the main supply is not available at that time, the alternator shall take load as in (c) above.

Engine shut down and alternator protection equipments: Following shut down and protection system shall be integrated in the control panel.

6. **Engine**

(i) Low lubricating oil pressure shut down. This shall be inoperative during start up and acceleration period.
(ii) High coolant (water) temp. shut down.
(iii) Engine over speed shut down.

**Alternator Protection:**

Following protection arrangement shall be made:

(i) Over load
(ii) Short circuit
(iii) Earth fault
(iv) Over voltage
7. **Monitoring and metering facilities:**

1. Necessary energy analyzer unit for visual monitoring of mains, alternator and load voltage, current, frequency, KWH, power factor, etc.

2. A set of visual monitoring lamp indication for:

   (i) Load on set
   (ii) Load on mains
   (iii) Set on test (Alternator on operation duty, Alternator on standby duty)
   (iv) Set of lamp for engine shut down for over speed, low lub. Oil pressure and high coolant water temperature; overload trip of alternator, earth fault trip of alternator, engine lock out and failure to start etc. All these indications shall have an audio and visual alarm. When operator accepts the alarm, the hooter will be silenced and the fault indication will become steady until reset by operating a reset button.

**Operation devices:** A set of operation devices shall be incorporated in the front of panel as under:

1. Master Engine Control Switch: This shall cut off in ‘OFF’ position DC control to the entire panel, thus preventing start-up of engine due to any cause. However, battery charger, lamp test button for testing the healthiness of indication lamps, DC volt meter / ammeter etc. shall be operative. It shall be feasible to lock the switch in OFF position for maintenance and shut down purposes.

2. Operation selector switches OFF/AUTO/MANUAL/TEST position.

3. Energy analyzer unit for display of various electrical parameters – like voltage, current, frequency, KW, power factor, etc.

4. A set of push button as specified.

5. Relays, contractor, timers, circuit breakers as required.

6. Necessary battery charger with boost / trickle selector, DC voltmeter and DC ammeter.
8.0 SCOPE

This chapter covers the essential requirements of earthing system components and their installation. This shall be read with Appendix F, which lays down criteria for their design. For details not covered in these specifications IS code of Practice on Earthing (IS: 3043-1987) shall be referred to.

8.1 APPLICATION

(i) The electrical distribution system in the Department is with earthed neutral (i.e. neutral earthed at the transformer / generator end). In addition to the neutral earthing, provision is made for earthing the metallic body of equipments and non-current carrying metallic components in the sub-station, as well as in the internal/external electrical installations.

(ii) Earthing system is also required for lightning protection, computer installations, etc. for functional reasons.

(iii) Earthing requirements are laid down in Indian Electricity Rules, 1956, as amended from time to time, and in the Regulations of the Electricity Supply Authority concerned. These shall be complied with.

(iv) Application for Internal E.I.

a) Every sub-main will have earth continuity conductor to run along with sub-main wiring. In case of 3-phase sub-main wiring two earth continuity conductors shall be provided.

b) Every circuit will have its earth continuity conductor to alongwith circuit wiring. In case of 3-phase sub-main wiring two earth continuity conductors shall be provided.

c) Looping of earth is allowed only in case of point wiring.

d) When 2/3 power outlets are looped to one circuit, earth looping of these outlets is permissible.

8.2 TYPES OF ELECTRONIC & MATERIAL

8.2.1 Earth Electrodes

8.2.1.1 Types
The type of earth electrode shall be any of the following, as specified. (For selection criteria in designs, Appendix F may be referred to).

(a) Pipe earth electrode.
(b) Plate earth electrode.
(c) Strip or conductor earth electrode.

### 8.2.1.2 Electrode materials and dimensions.

(i) The materials and minimum sizes of earth electrodes shall be as per Table IX.

(ii) GI pipe electrodes shall be cut tapered at the bottom, and provided with holes of 12mm dia, drilled not less than 7.5 cm from each other upto 2 m of length from the bottom.

(iii) The length of the buried strip or conductor earth electrode shall be not less than 15 m. This length shall suitably be increased if necessary, on the basis of the information available about soil resistance, so that the required earth resistance is obtained. Prior approval of the Engineer-in-charge shall be taken for any such increase in length.

(iv) All hardware items used for connecting the earthing conductor with the electrode shall be of GI in the case of GI pipe and GI plate earth electrodes, and forged tinned brass in case of copper plate electrodes.

### 8.2.2 Earthing Conductor & sizes

(i) The earthing conductor (protective conductor from earth electrode up to the main earthing terminal/earth bus, as the case may be) shall be of the same material as the electrode, viz. GI or copper, and in the form of wire or strip as specified.

(ii) The size of earthing conductor shall be specified, but this shall not be less than the following (For calculating the size of the earthing conductor in design, Appendix F para 3.5.1).

(a) 4mm dia. (8 SWG) copper wire.
(b) 25mm x 6mm in the case of GI strip, or,
(c) 20 mm x 3mm in the case of copper strip.

(iii) Earthing conductor larger than the following sectional areas need not be used, unless otherwise specified.

(a) 150 sq.mm. in case of GI, or,
(b) 100 sq.mm. in case of copper.
8.2.3 Earth continuity / loop earthing conductor & sizes

(i) The material and size of protective conductors shall be as specified below (for criteria in design of these appendixes F may be referred to):

<table>
<thead>
<tr>
<th>Size</th>
<th>Size of protective conductor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase</td>
<td>of the same material as</td>
</tr>
<tr>
<td>Conductor</td>
<td>phase conductor</td>
</tr>
</tbody>
</table>

- Upto 4 sq.mm: 4 sq.mm.
- Above 4 sq.mm up to 16 sq.mm: Same size as phase conductor
- Above 16 sq.mm up to 35 sq.mm: 16 sq.mm.
- Above 35 sq.mm: Half of the phase conductor

8.3 LOCATION FOR EARTH ELECTRODES

(i) Normally an earth electrode shall not be located closer than 1.5 m from any building. Care shall be taken to see that the excavation for earth electrode does not affect the foundation of the building; in such cases, electrodes may be located further away from the building, with the prior approval of the Engineer-in-Charge.

(ii) The location of the earth electrode will be such that the soil has a reasonable chance of remaining moist as far as possible. Entrances, pavements and roadways, should be avoided for locating earth electrodes.

8.4 INSTALLATION

8.4.1 Electrodes

8.4.1.1 Various types of electrodes

(i) (a) Pipe electrode shall be buried in the ground vertically with its top at not less than 20 cm below the ground level. The installation shall be carried out as shown in Fig. 11.

(b) In locations where the full length of pipe electrode is not possible to be installed due to meeting a water table, hard soil or rock, the electrode may be to reduced length, provided the required earth resistance result is achieved with or without additional electrodes, or any alternative method of earthing may be adopted, with the prior approval of the Engineer-in-charge. Pipe electrodes may also be installed in horizontal formation in such exceptional cases.
(ii) Plate electrode shall be buried in ground with its faces vertical, and its top not less than 1.5 m below the ground level. The installation shall be carried.

(iii) When more than one electrode (plate/pipe) is to be installed, a separation of not less than 2 m shall be maintained between two adjacent electrodes.

(iv) (a) The strip or conductor electrode shall be buried in trench not less than 0.5 m deep.

(b) If conditions necessitate the use of more than one strip or conductor electrode, they shall be laid as widely distributed as possible, in a single straight trench where feasible, or preferably in a number of trenches radiating from one point.

(c) If the electrode cannot be laid in a straight length, it may be laid in a zigzag manner with a deviation upto 45 degrees from the axis of the strip. It can also be laid in the form of an arc with curvature more than 1 m or a polygon.

8.4.1.2 Artificial treatment of soil

When artificial treatment of soil is to be resorted to, the same shall be specified in the schedule of work. The electrode shall be surrounded by charcoal / coke and salt as indicated in Fig. 11 and 12. In such cases, excavation for earth electrode shall be increased as per the dimensions indicated in these figures.

8.4.1.3 Watering arrangement

(i) In the case of plate earth electrodes, a watering pipe 20 mm dia. Medium class pipe shall be provided and attached to the electrodes as shown in Fig. 9 and 10. A funnel with mesh shall be provided on the top of this pipe for watering the earth.

(ii) In the case of pipe electrodes, a 40 mm x 20 mm reducer shall be used for fixing the funnel with mesh.

(iii) The watering funnel attachment shall be housed in a masonry enclosure of size not less than 30 cm to 30 cm x 30 cm.

(iv) A cast iron / MS frame with MS cover, 6mm thick, and having locking arrangement shall be suitably embedded in the masonry enclosure.
8.4.2 Earthing conductor (Main earthing lead)

(i) In the case of plate earth electrode, the earthing conductor shall be secured as indicated in fig. 11 using a through bolt, nuts and washers and terminating socket.

(ii) In the case of pipe earth electrode, the earthing conductor shall be securely terminated on to the plate with two bolts, nuts and washers and terminating socket.

(iii) A double C-clamp arrangement shall be provided for terminating tape type earthing conductor with GI watering pipe coupled to the pipe earth electrode. Galvanized “C” shaped strips, bolts, washers, nuts and check nuts of adequate size shall be used for the purpose.

(iv) The earthing conductor from the electrode up to the building shall be protected from mechanical injury by a medium class, 15mm dia. GI pipe in the case of wire, and by 40mm dia, medium class GI pipe in the case of strip. The protection pipe in ground shall be buried at least 30 cm deep (to be increased to 60 cm in case of road crossing and pavements). The portion within the building shall be recessed in walls and floors to adequate depth in due co-ordination with the building work.

(v) The earthing conductor shall be securely connected at the other end to the earth stud/earth bar provided on the switch board by:

   (a) Soldered or preferably crimped lug, bolt, nut and washer in the case of wire, and
   (b) Bolt, nut and washer in case of strip conductor.

In the case of substations or alternators, the termination shall be made on the earthing terminal of the neutral point on the equipment and/or the earth bus, as the case may be.

8.4.3 Loop Earthing/Earth continuity Conductor

(i) Earth terminal of every switchboard in the distribution system shall be bonded to the earth bar/terminal of the upstream switch board by protective conductor(s).

(ii) Two protective conductors shall be provided for a switchboard carrying a 3-phase switchgear thereon.

(iii) Loop earthing of individual units will not be however necessary in the case of cubicle type switchboards.
(iv) The earth connector in every distribution board (DB) shall be securely connected to the earth stud/earth bar of the corresponding switch board by a protective conductor.

(v) The earth pin of socket outlets as well as metallic body of fan regulators shall be connected to the earth stud in switch boxes by protective conductor. Where the switch boxes are of non-metallic type, these shall be looped at the socket earth terminals, or at an independent screwed connector inside the switch box. Twisted earth connections shall not be accepted in any case.

8.5 EARTH RESISTANCE

(i) The earth resistance at each electrode shall be measured. No earth electrode shall have a greater ohmic resistance than 5 ohms as measured by an approved earth testing apparatus. In rocky soil the resistance may be up to 8 ohms.

(ii) Where the above stated earth resistance is not achieved, necessary improvement shall be made by additional provisions, such as additional electrode (s), different type of electrode, or artificial chemical treatment of soil etc., as may be directed by the Engineer-in-Charge.

8.6 MARKING

(i) Earth bars/terminals at all switch boards shall be marked permanently, either as “E” or as

(ii) Main earthing terminal shall be marked “SAFETY EARTH – DO NOT DISCONNECT”.

8.7 USE OF RESIDUAL CURRENT DEVICES (RDCs)

An extract on selection and application of RCDs (also known as RCCBs) from IS: 12640-1988 is given at Appendix G. Provision of RCD shall be specified in individual cases keeping in view the type, use, importance, system of earthing and nature of electrical installations to be protected by the RCCBs, requirements of the local electric supply company, etc. The sensitivity shall be 30mA, 100mA, 300mA, or 500mA, as specified.
TABLE IX
Materials and sizes of earth electrodes
[Clause 8.2.1.2 (i)]

<table>
<thead>
<tr>
<th>Type of Electrode</th>
<th>Material</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe</td>
<td>GI medium class</td>
<td>40mm dia 3.45m long (Without any joint)</td>
</tr>
<tr>
<td>Plate</td>
<td>(i) GI</td>
<td>60 cm x 60 cm x 6 mm thick</td>
</tr>
<tr>
<td></td>
<td>(ii) Copper</td>
<td>60 cm x 60 cm x 3 mm thick</td>
</tr>
<tr>
<td>Strip</td>
<td>(i) GI</td>
<td>100 sq.mm section</td>
</tr>
<tr>
<td></td>
<td>(ii) Copper</td>
<td>40 sq.mm section</td>
</tr>
<tr>
<td>Conductor</td>
<td>(i) Copper</td>
<td>4mm dia (8 SWG)</td>
</tr>
</tbody>
</table>

Note: Galvanization of GI items shall conform to Class IV of IS: 4736-1986.

TECHNICAL SPECIFICATION FOR CABLES

1. SCOPE

This section covers supply and laying of LT power & Control cables.

2. INSTALLATION OF CABLES

Cables in indoor main sub-station area and residential area shall be laid in trench on multi tier trays covered with trench cover. Cables for street lighting and residential outdoor area shall be buried direct in ground. All cables shall be bent in radius not less than 15 times or as prescribed by the manufacturer which ever is higher. Cable laying shall be carried out as per CPWD specifications.

3. L.T. CABLE

The power cable shall conform to IS: 7098 (Part I) and control cable shall conform to IS: 1554(Part I) as specified in schedule.

3.1 GENERAL

LT cable shall be supplied inspected, laid, tested and commissioned in accordance with drawings, specifications, relevant Indian Standards Specifications and cable manufacturer’s instructions. The cable shall be delivered at site in original drums with manufacturer’s name clearly written on the drum.
3.2 MATERIAL

3.2.1 The MV power cable of 1100 V. grade shall be XLPE insulated Aluminium conductor armoured cable conforming to IS : 7098(Part-I).

3.2.2 The MV control cables shall be PVC insulated copper conductor armoured cable conforming to IS: 1554 (Part-I).

3.3 INSPECTION

All cables shall be inspected upon receipt at site and checked by the Engineer-in-Charge for any damage during transit.
FIRE FIGHTING WORKS
SPECIAL CONDITIONS OF CONTRACT
1. **GENERAL**

   The special conditions shall be read in conjunction with general conditions of contract and amendments / corrections thereto. If there are any provisions in these special conditions, which are at variance with the provisions in the above-mentioned documents, the provisions in these special conditions shall take precedence.

2. **I.S. STANDARDS**

   The equipments and the installation shall conform to various Indian Standards amended up to date wherever applicable.

3. **DOCUMENTS TO BE SUBMITTED BY THE FIRM:**

   a. Before start of the work: All relevant drawings as given below and catalogues of all the major parts shall be submitted after inspecting the site. The firm shall get relevant drawings approved from the ‘Fire Department’ and the work shall be executed accordingly.

   (i) General arrangement drawings showing location of fire pump, pressurization pump, wetriser, air vessel, valves, etc. of the wetriser system and sprinkler system layout plans complete with dimensions and clearances.

   (ii) Details of foundation for equipment and working load of assembled equipment.

   (iii) Piping Schematic.

   (iv) Control and protection schematic, wiring diagrams and control wiring diagrams showing the sequence of operation.

   (v) Details of external and internal hydrants and their installation details.

   (vi) Details of masonry works such as valve chamber, hose cabinet support etc.
(vii) Any other drawings or data that may be necessary for the work.

b. Alongwith dispatch of the material: The firm shall supply test certificates of all the major equipments and material like pumps, motors, engine, pump set, control gears, hoses, valves, sprinklers etc.

c. On completion of the work: The firm shall submit four sets of drawings, maintenance check charts and lubrication charts, Schematic Wiring diagram, and all other necessary operation & maintenance Instruction manuals.

4. INSPECTION AT THE PREMISES OF THE FIRM

The department’s authorised representative shall have full powers to inspect the drawings of any portion of the work or examine the materials and workmanship of the equipment at the Firm’s works or at any other place from where the material or equipment is obtained, if the department so desires. The firm shall offer the equipments for inspection well in advance before dispatch of materials from the factory. The equipment shall be dispatched from the factory only after the clearance from the Engineer-in-charge. Acceptance of any material or equipment shall in no way relieve the firm of their responsibility for meeting the requirements of the specifications. In case, any equipment is found defective or of inferior quality the firm shall have to replace the same free of cost.

5. PACKING, FORWARDING & STORAGE AT SITE

Before dispatch to site, the equipments / components / materials shall be properly packed to protect against transit damages & damages during storage either at transporter’s premises, or at the site of work.

6. ELECTRIC POWER & WATER

No Electricity & Water for erection, commissioning and testing of equipment shall be provided by the department. However, depending upon the availability of water, contractor may be allowed to tap at one point and further distribution shall be in contractor’s scope.
7. **BYE-LAWS INDEMNITY AGAINST LIABILITIES**

The firm shall comply with all bye-laws and regulations of local and statutory authorities having jurisdiction over the works and shall be responsible for payment of all fees and other charges and giving / receiving all necessary notices and keep the Engineer-in-Charge informed.

The firm shall indemnify the department against all claims in respect of patent rights, design, trade mark or name of other protected rights in respect of any equipment, machine, work or materials used for or in connection with the works or temporary works and from and against all claims, demands, proceedings, costs, charges and expenses whatsoever in respect of or in relation thereto. The Firm shall defend all actions arising from such claims and shall pay all royalties.

Fees, damages, cost and charges of all and every sort that may be legally incurred in respect thereof shall be borne by the firm.

All liabilities / recoveries on matters arising out of sales tax / excise duty / works contract tax or any other levies such as incorrect deductions, discrepancies in the filing up of returns, revised assessments by the concerned authorities etc. shall be borne by the firm.

It shall be Firm’s liability to follow all safety procedures in accordance with relevant I.S. specifications / fire-by-laws or any other statutory rules / regulations amended up to date during execution of work at site.

8. **REJECTION OF DEFECTIVE EQUIPMENT**

If the completed installation / equipment or any portion thereof, after it is taken over, is found to be defective or fails to fulfill the intent of the specifications, the Firm shall on receipt of a written notice from the Engineer-in-Charge, forthwith make good the defective installation / equipment.

Should the firm fail to rectify the defects / make good the defective installation / replace the equipment at no extra cost, within a stipulated time mentioned in the written notice, department may get the work done at the risk and expenses of the Firm.
9. **CHANGES IN SPECIFICATIONS**

The department reserves the right to make changes in the specifications of the work if in its opinion the same is found necessary. However such alterations shall be made after mutual discussion and agreement between the department and the firm. Any price implication in this regard shall be mutually discussed and agreed upon in terms of relevant clause of the contract.

Modifications or alterations by the firm in the design / specifications of any equipment / material will not be permitted by the department as a matter of principle, however the same can be agreed by the department under the exceptional circumstances where the same is necessitated due to non-availability of material / component of certain specifications or make OR such alterations constitute an improvement in the opinion of the firm and department.

Prior written approval of the department is necessary before undertaking any alteration / modifications in the design & specifications of the equipments.

10. **TESTING & INSPECTION BY THE DEPARTMENT & FIRE DEPARTMENT**

On commissioning of the installation, all equipments shall be tested as per tender specifications for proper functioning of the system in the presence of Engineer-In-Charge before being offered for inspection by the Fire Department. It will be the responsibility of the Contractor to obtain necessary ‘Clearance Certificate’ from the Fire Department / Local statutory body. Nothing extra shall be paid for persuasion or documentation. However the statutory fee payable to the authorities shall be reimbursed by the department. Necessary testing equipments along with operating personnel shall be arranged by the firm without any extra cost till clearance certificate from the fire department is obtained.

11. **OPERATION OF SYSTEM**

The department shall have the right to operate all equipments, if in operating condition, whether or not such equipments have been accepted as complete and satisfactory. Repairs and alterations shall be made by the firm at such times as directed by the Engineer-in-Charge, free of charge.
12. **TRAINING OF DEPARTMENTAL PERSONNEL**

The firm shall arrange to impart training to the Departmental personnel on the following aspects prior to provisional take over of the equipment:

a) Operation of System.
b) Adjustments of settings for controls.
c) Preventive maintenance.

13. **GUARANTEE & DEFECTS LIABILITY PERIOD**

The guarantee shall be valid for a period of TWELVE months after taking over of the installation *(After issue of licence by the Fire Department)*. The firm shall guarantee that all equipments shall be free from any defect due to the defective materials or bad workmanship and that the equipment shall work satisfactorily and that the performance and efficiencies of the equipments shall not be less than the guaranteed values. Any parts found defective during the guarantee period shall be replaced by the firm without any charge whatsoever. The services of the Firm’s personnel, if required, during this period for such work shall be made available to the department without any extra charges.

The firm shall depute their representatives to the site immediately on notification of defects by the department.

The Consequential losses and damages are, however, not covered under the purview of guarantee.
TECHNICAL SPECIFICATIONS
(FIRE FIGHTING SYSTEM)

1.0 GENERAL

1.1 The work shall be carried out as per these ‘Technical Specifications’.

1.2 In case any item(s) or part thereof is not covered under these specifications, the same shall be carried out as per relevant CPWD specifications.

1.3 The make(s) of the material to be used shall be as per the ‘List of Approved Makes’ attached.

1.4 For items not covered in the above three clauses, the work shall be carried out as per the instruction of the Engineer-In-Charge, whose decision shall be final.

1.5 Samples shall be got approved from the Engineer-In-Charge before bringing the material to site.

2.0 FIRE PUMPS

2.1 Electrical Pumps

2.1.1 The electrical fire pumps shall be suitable for automatic operation.

2.1.2 Electric motor shall be suitable for 415V ± 10%, 3 phase, 50Hz, AC supply. The class of insulation shall be F.

2.1.3 The motor starters shall be automatic star delta type above 7.5 HP rating and DOL for upto 7.5 HP rating without under voltage / no-voltage trip. However, ‘Overload’ and ‘Single Phasing Protection’ shall be provided for Pressurisation Pump (Jockey Pump) and ‘Terrace Pumps’.

2.1.4 The starters shall be integrated in the power and control panel of the system. For the terrace pumps, additional manual starting and stopping push buttons and power isolator shall be provided at the terrace level also.
2.1.5 The main electrical fire pump should be capable of delivering 150% of its rated discharge at 65% of its rated head.

2.1.6 The terrace pumps shall be located on the terrace with suction from the terrace tank and discharge connected to the riser.

2.1.7 The terrace pumps shall be started and stopped manually. Necessary interlock shall be provided so that these cannot be operated when the main electrical fire pump, pressurization pump (Jockey pump) or standby pump is operated.

2.1.8 The control and power supply board for ‘These Pumps’ shall be at the Ground floor at a convenient location.

2.2 DIESEL ENGINE PUMP

2.2.1 Engine Rating – The engine shall be cold starting type without the necessity of preliminary heating of the engine cylinders or combustion chamber. The engine shall be multi cylinder/vertical 4 stroke cycles, diesel engine, developing suitable HP at the operating speed specified to drive the fire pump. Continuous capacity available for the load shall be exclusive of the power requirement of auxiliaries of the diesel engine, and after correction for altitude, ambient temperature and humidity for the specified environmental conditions. This shall be at least 20% greater than the maximum HP required to drive the pump at its duty point. It shall also be capable of driving the pump at 150% of the rated discharge with at least 65% of its rated head for 8 hours; and for at least 3000 hours of operation before major overhaul. The engine shall have 10% overload capacity for one hour in any period of 12 hours continuous run.

2.2.2 The fuel tank shall be of welded steel construction (3 mm thick) and of capacity to allow the engine to run on full load for at least 8 hours. The tank shall be complete with necessary floor mounted supports, level indicator (protected against mechanical injury) inlet, outlet, overflow connections and drain plug and piping to the engine fuel tank. The outlet should be so located as to avoid entry of any sediment into the fuel line to the engine. All pipe lines along with fittings and accessories shall be provided for fuel oil and lubricating oil will also form part of the scope of work.

A semi rotary hand pump for filling the daily service tank together with hose pipe 5 mtrs. long with a foot valve etc shall also form part of the scope of work.
2.2.3 Starting System - The starting system shall comprise necessary batteries (2x12v), 24 volts each of 180 AH capacity, starter motor of adequate capacity and axle type gear to match with the toothed ring on the fly wheel. By metallic relay protection to protect starting motor from excessively long cranking runs suitably integrated with engine protection system shall be included within the scope of the work. The scope shall cover all cabling, terminals, initial charging and suitable MS angle stands for batteries etc.

2.2.4 Exhaust system – The exhaust system shall be complete with residential silencer suitable for outdoor installation and silencer piping including bends and accessories.

2.2.5 Engine shut down mechanism – This shall be manually operated and shall return automatically to the starting position after use.

2.2.6 Governing System – The engine shall be provided with a adjustable governor to control the engine speed within 5% of its rated speed under all conditions of load upto full load. The governor shall be set to maintain rated speed at maximum pump load.

2.2.7 Engine Instrumentation – Engine instrumentations shall include the following:
   (i) Lubricant oil pressure gauge.
   (ii) Water temperature gauge.
   (iii) Tachometer
   (iv) Hour meter
The instrumentation panel shall be suitably mounted on the engine.

2.2.8 Engine Protection Devices – Following engine protection and automatic shut down facilities shall be provided:
   (i) High lubricant oil temperature
   (ii) Low lubricant oil pressure
   (iii) High cooling water temperature
   (iv) Over speed shut down

2.2.9 Anti Vibration Mounting – Suitable anti-vibration mountings duly approved by engineer-in-charge shall be employed for mounting the unit so as to minimize transmission of vibration to the structure.
2.2.10 Battery charger – Necessary float and boost charger shall be incorporated in the control section of the power and control panel, to keep the battery under charged condition. Voltmeter to indicate the state of charge of the batteries shall be provided.

2.2.11 One full initial charge of all consumables e.g. Coolant, lubricating oil etc. will form a part of the scope of work of the contractor. This will also include all consumables e.g. fuel oil, lubricating oil etc. required for testing and commissioning of the system.

3.0 PIPING FOR WET RISER SYSTEM

3.1 PIPES

All materials shall be of the best quality conforming to the specifications and subject to the approval of the Engineer-in-charge.

3.1.1 Pipes shall be securely fixed to walls and the ceiling by suitable suspenders and clamps at intervals not exceeding 1.5 meter.

3.1.2 For pipelines upto 50 mm dia screwed jointing shall be adopted, while for pipelines above 50 mm dia welded flanged construction is to be carried out.

3.1.3 Flanged joints shall be used for connections to vessels, equipment, flanged valves etc. irrespective of the pipe size.

3.2 VALVES

3.2.1 Valves and other accessories shall be so located that they are easily accessible for operations, repairs and maintenance.

3.2.2 Sluice valves shall be kept in open position and the scope of work includes provision of necessary leather strap and pad lock so as to prevent unauthorized closing of valve.

3.2.3 Sluice valves above 65mm shall be of cast iron body and bronze / gunmetal seat. Valves upto 65 mm shall be of brass construction. Valves shall be of flanged ends. Valve wheels shall be of right hand type and have arrow head engraved or cast thereon showing the direction for turning open and closing. Valves shall conform to type PN 1.6 (tested for a pressure of a minimum of 16 Kg/cm² for sheet and a minimum of 24 Kg/cm² for body and test certificates furnished) of relevant I.S. specifications.
3.2.4 Non return valve shall be of cast iron body and bronze gunmetal seat. They shall conform to class I of relevant IS specifications and have flanged ends. They shall be swing check type in horizontal runs and lift check type in the vertical runs of piping. They shall not be spring loaded type. Valves shall be tested for a pressure of a minimum of 16 Kg/cm² for sheet and a minimum of 24 Kg/cm² for body as per relevant I.S. specifications and test certificates furnished.

3.2.5 Pressure gauges of suitable range shall be installed on each Air Vessel. The dial size shall be 150mm. The gauge shall be with necessary stop cocks.

3.2.6 Orifice plates shall be of 6mm thick stainless steel to reduce pressure on individual hydrants to operating pressure of 3.5 kg/cm². Design of the same shall be given by the contractor as per location and pressure condition of each hydrant.

3.3 **AIR VESSEL AND AIR RELEASE VALVE**

3.3.1 Air vessel on top of each wet riser piping shall be fabricated of at least 8mm thick GI pipe / sheet to withstand the pressure, i/c (dished ends and supporting legs). This shall be of 250mm dia. and 1.2m height. This shall be complete with necessary flange connection to the wet riser piping and air release valve with necessary piping to meet the functional requirement of the system. The air vessel shall be continuous welded construction. This shall be tested for twice the working pressure at the works and necessary test certificates shall be furnished.

3.4 **EXTERNAL YARD HYDRANTS**:

3.4.1 External (yard) hydrants shall be located to have the outlet at about 1m above ground level. External Yard Hydrants shall be of 'Stand Post' type conforming to relevant IS specifications and comprise of stand post for single outlet, duck foot bend, flanged riser and single headed brass / gunmetal valve conforming to type A of relevant IS specifications.

3.4.2 The stand post column shall be cast iron; cast in one piece, conforming to Grade 20 of relevant IS specifications. The internal diameter at the top shall be at least 80mm.

3.4.3 Where external hydrants below ground level are specifically indicated in tender specifications, there shall be enclosed in masonry or cast iron
structure of size 75 sq.cm. & 8 cm above ground level. The hydrant shall be within 8 cm from the top of the enclosure.

3.4.4 The outlet of yard hydrants shall be angled to the ground with an instantaneous spring lock type gunmetal female coupling of 63mm dia. for connecting to the hose pipe.

3.5 **INTERNAL HYDRANTS**

3.5.1 The internal hydrant outlet shall comprise single headed gunmetal landing valve conforming to I.S. specifications.

3.5.2 Internal hydrants at each floor shall be located at about 1m above floor level.

3.6 **FIRST AID HOSE REEL EQUIPMENT**

3.6.1 First Aid hose reel equipment shall comprise reel, hose guide fixing bracket, hose tubing, globe valve, stopcock & nozzle etc. This shall conform to the relevant IS specifications.

3.6.2 The hose tubing shall be 20mm internal dia. and 36m long. The nozzle and globe valve shall be of 5mm and 20mm size respectively. These shall be conforming to the relevant IS specifications.

3.6.3 The fixing bracket shall be of swinging type (180°). Operating instructions shall be engraved on the assembly.

3.7 **HOSE PIPE**

3.7.1 Hose pipe shall be of non-percolating type as per relevant IS specifications (Type B) with nominal size of 63 mm and lengths of 15 m.

3.7.2 All hose pipes shall carry ISI marking on the body of the hose.

3.4.3.5 The hose shall have instantaneous spring lock-type coupling on ends. The instantaneous coupling shall be as per relevant IS specifications. It shall be fixed to each other by copper rivets and galvanized M.S. wires and leather bands. All couplings shall be interchangeable with each other, and shall bear ISI markings.
3.8 **HOSE REEL**

The hose reel shall be directly tapped from the riser through a 40 mm dia. pipe, the drum and reel being firmly held against the wall by use of dash fasteners. The hose reel shall be swinging type (180°) and the entire drum, reel etc. shall be as per relevant IS specifications. The rubber tubing shall be of best quality and the Gun Metal nozzle shall be 5 mm dia. shut off type as per relevant IS specifications.

3.9 **BRANCH PIPES**

Branch pipe shall be of stainless steel and should conform to relevant IS specifications. One end of the branch pipe will receive the coupling while the other end shall have a nozzle screwed to it. It shall bear ISI marking.

3.10 **HOSE CABINETS**

Each hydrant shall be housed in a Hose cabinet of suitable size. The Hydrant Cabinet shall hold single headed hydrant 2 hoses and one branch pipe as required. Internal hydrants shall normally fit the niche made for it. The cabinet shall be of minimum 1.6mm sheet, glazed doors (clear glass of 4 mm thickness). The glass shall be firmly fixed by means of steel clips and screws with rubber beading. Hinges shall also be screwed and not welded. The steel work shall have one coat of primer and two coats of red enamel paint. The words "Yard Hydrant", "Hydrant' etc., should be painted in white or red on the glass in 75 mm high letters, The Hose Box shall be lockable.

3.11 **FIRE BRIGADE INLET CONNECTIONS**

A four way fire brigade inlet connection with a non-return valve as per relevant IS specifications shall be provided to facilitate the fire brigade to pump water into the system by the use of their own equipment. This shall be housed in a M.S. cabinet with glass fronted door as per drawing.

3.12.1 **FIRE BRIGADE INLET AND DRAW OFF CONNECTION**

3.12.2 Inlet connection – a four way gun metal inlet connection as per relevant IS specifications shall be provided at the Fire Storage Tank for filling of the tank by the fire Brigade, through a 150mm dia. inlet Pipe. The connection will have the option to pressurize the building Fire System (by the Fire Brigade directly) by provision of sluice valves, tee and bend as per drawings.

3.12.3 Draw off connection – a draw off connection for drawing the water from the Fire Tank would be provided next to the inlet connection to enable Fire
Brigade to draw water from the Fire Tank. This shall consist of a gun metal stand draw off connection with a gunmetal blank cap and a chain. A 150mm suction pipe with a foot valve and strainer shall be provided as per drawings.

3.12.3.1 M.S. cabinet, for enclosing both inlet and outlet connection shall be provided as per drawings.

3.13 SUCTION STRAINER WITH FOOT VALVES

To ensure proper flow to the Fire Brigade draw off point, strainers with foot valve will be provided. These shall be of cast iron body. The seat, disc and other wearing parts will be of stainless steel. A stainless steel retainer shall be provided at the bottom.

3.14 FLUSHING OF HYDRANT SYSTEM:

After installation of complete system flushing of hydrants system shall be done as under:

3.14.1 Underground mains and lead-in connections to system risers shall be flushed before connections made to piping in order to remove foreign materials which may have entered underground during the course of installation. For hydrant system the flushing operation shall be continued until water is clear.

3.14.2 Underground mains and connections shall be flushed at a flow rate of not less than 2850 ltrs. per minute. The pump and other equipment necessary for the flushing shall be arranged by the contractor without any extra charges.

3.14.3 The water coming out from the outlet will be connected to storm water drain by means of suitable hose. Hose for the purpose shall be arranged by the contractor.

3.13.5 TESTING OF THE HYDRANT SYSTEM

3.13.5.1 TESTING OF THE PIPING

3.15.1.1.1 After laying and jointing the entire piping shall be tested to hydrostatic test pressure. The pipes shall be slowly charged with water so that the air is expelled from the pipes. The pipes shall be allowed to stand full of water for a period of not less than 24 hours and then tested under pressure. The test pressure shall be at least 1.5 times the operating pressure. The test pressure shall be applied by means of an electrical test pump to be provided by the contractor. Precautions shall be taken to ensure that the required test pressure is not exceeded.
3.15.1.1.2 The open end of the piping shall be temporarily closed for testing.

3.15.1.1.3 All leaks and defects in the pipes, joints, valves etc. noticed during the testing and before commissioning shall be rectified to the satisfaction of Engineer-in-charge.

4.0 FUNCTIONAL REQUIREMENTS

4.1 There shall be a test valve, operation of which will simulate the operation of the landing valve / external hydrant. This will enable testing the healthiness of the equipment, availability and its control.

4.2 OPERATING SEQUENCE

4.2.1 The pressurization pump shall automatically start, when set to auto-status, when the water pressure in the wet riser system falls to a pre-set value below the normal system pressure and shut down when the system pressure reaches the set value. Both the limits shall be adjustable on the appropriate controls in the pump room.

4.2.2 First the electric fire pump will start by the sudden fall of pressure in the system due to operation of the pressure switch and feed the water to the system. If within the pre-set period the electric pump fails to start or fails to develop adequate pressure, the control system shall shut down the electric pump and initiate the start up of the standby diesel pump. The main electric pump shall then be locked out. An audio visual alarm shall also be given.

4.2.3 If within a preset period the standby pump also fails to start or fails to develop adequate pressure, the control system shall shut down the standby pump and lock it out and give an audio visual indication to that effect on the control panel.

4.2.4 Automatic pressurization pump shall be shut down automatically when the main electrical fire pump or standby fire pump, start operating. Necessary integration of pipe work and control shall be provided for the purpose.
4.3 The hydrant system shall fulfill the following tests:

4.3.1 **Starting up of the pressurization (Jockey) Pump**

The pressure switch shall be set at 5.65 kg/cm² at the lower limit and 6.0 kg/cm² at the upper limit. The system drain shall be opened to cause a drop in the pressure. The Jockey Pump shall start as soon as the pressure gauge needle falls down to 5.65 kg/cm². The Jockey Pump shall also automatically stop when the system has been pressurized again to 6.0 kg/cm².

4.3.2 The main electric pump shall be set to start at 5 kg/cm². An external hydrant valve using a single length of hose and branch pipe shall be fully opened to cause a drop of pressure in the system. When the pressure drops to 5.65 kg/cm², the Jockey Pump starts. Further, drop in the pressure to 5 kg/cm² should be allowed to test automatic start-up of the main electrical fire pump. The Jockey Pump shall automatically stop at this stage. The external hydrant valve will be closed and the electrical pump shall continue to run and register rise in the pressure to 6.0 kg/cm². The electrical pump shall be stopped manually by pressing the stop button.

4.3.3 After having the system got fully charged at 6.0 kg/cm² and the main electrical fire pump having stopped, the external hydrant valve using hose and branch pipe shall be opened again. After the sequence of automatic starting of the jockey pump at 5.65 kg/cm² and starting of the main electrical fire pump at 5 kg/cm² (the jockey pump will stop automatically at the starting of the main electrical fire pump), the power supply in the pump house shall be switched off. The standby pump shall automatically come into operation at a drop in pressure to 3.5 kg/cm². The standby pump will be allowed to run for 10 minutes. The external hydrant valve will be closed and standby pump will continue to run and register a rise in pressure to 6.0 kg/cm². The standby pump will be stopped manually by pressing the stop button.

4.3.4 All these tests mentioned above shall be repeated after one hour interval. The result of all the tests should be identical again. After the system has satisfactorily withstood the above tests, it may be taken over subject to its clearance by the fire authorities.
4.4 **CONTROL PANEL**

The power and control panel for the system shall incorporate the following functional requirements.

4.4.1 The control panel shall have status selection for each of the pumps for automatic as well as manual operation.

4.4.2 The fire pumps once started shall not be stopped automatically except due to low water level in the underground storage tank.

4.4.3 The fire pumps shall be locked out for operation both for ‘manual’ & ‘automatic’ operations, once the low water control operates and furnish an audio and visual alarm on the panel. The audio alarm can be silenced by accepting the alarm. The visual alarm shall be independent for all equipments. It shall be flashing type and on acceptance remain steady. A reset button shall be provided for each pump for returning the pump for fire duty.

4.4.4 Once tripped, the electric fire pump shall remain locked out for operation irrespective of position of its operational status selection switch. Lock out indication shall be available on the panel.

4.4.5 Return to normal operation availability shall be feasible only by manual re-set of locked out units by operation of appropriate push buttons.

4.4.6 When fire pumps are brought into operation an audible tone from turbine type alarm operated by water flow in the mains shall be provided to indicate the healthiness of the system. The healthy running alarm shall not silenced till the fire pump is shut down, but the tone may be mellowed down by the operator if required.

Alarm for failure and lock out of any pump shall be distinct from ‘Healthy Alarm’. Failure alarms shall be loud and can be silenced on acceptance.

4.4.7 Terminal facilities for repeat indication of various audio and visual indications on a slave panel at a remote location shall be available.
EOT CRANE WORKS
SPECIFICATION OF DOUBLE GIRDER EOT CRANE

01.01 GENERAL AND INTENT OF SPECIFICATION

01.01.01 It has been envisaged to install a Double Girder EOT Crane having class III duty in the operation of loading and unloading at the IWAI terminal.

01.01.02 The specification of the DG EOT Crane as envisaged is indicated in this document and the enclosed tender drawings.

01.02 SCOPE OF WORK

01.02.01 The scope of work of the Tenderer shall consist of design, manufacture, fabrication, procurement, inspection, shop testing, assembly, painting, supply and transportation to site, erection, testing & commissioning of Double Girder EOT Cranes complete with electrical equipment and standard accessories with attachments as per technical parameters.

01.02.02 Supply of DSL system along with fixing brackets and accessories for power supply to the crane.

01.02.03 The tenderer shall include necessary commissioning spares in his scope and submit the list of the same. If any more spares other than those indicated are required during commissioning, the same shall be supplied by the tenderer without any cost implication to the Purchaser.

01.02.04 The Tenderer shall also quote separately itemwise price for the supply of spares for 2 years of normal operation and maintenance for each crane. The list of such spares shall also be furnished along with the tender.

01.02.05 The scope of supply shall cover the required quantity of initial fill of lubricants, hydraulic fluid, other consumables as well as their replenishment necessary during erection, testing and commissioning of the crane.

01.02.06 The scope of supply shall cover all maintenance tools and tackles with toolbox for normal maintenance or testing/inspection of the crane. A list of maintenance tools and tackles shall be furnished along with the tender. The price of the same shall be included on the price of the equipment itself.

01.02.07 The scope of supply shall cover required quantity of paints for intermediate, final coat and retouching. All cranes shall be painted as per specification prior to dispatch.
01.02.08 Obtaining statutory clearance from statutory authorities shall be the responsibility of the supplier of the crane.

01.02.09 Supply of drawings and documents shall be as per instructions indicated in Clause No. 01.05.

01.02.10 Supply of insurance spares. (list to be furnished)

01.02.11 The scope of work shall stand supplemented by stipulations mentioned elsewhere in this specification or anywhere else in the tender document.

01.03 TECHNICAL SPECIFICATION OF DOUBLE GIRDER EOT CRANE

01.03.01 General

01 EOT Cranes shall be designed, manufactured and tested in accordance with the latest revision of IS:807-1976, 3177-1999 and 4137-1985.

02 The crane components shall be standardized to keep the number of spares to the minimum.

03 All parts requiring replacement or inspection or lubrication shall be easily accessible without the need of dismantling of other equipment or structures. All electrical cables shall be so laid that they are not liable to be damaged and can be easily inspected and maintained.

04 All components for cranes of identical capacity and duty shall be interchangeable. Cranes of the same capacity and duty shall be identical in all respect unless otherwise required.

05 No cast iron parts shall be used except for electrical equipment and no wood or other combustible material shall be used unless specifically mentioned otherwise. Deviations, if any, to this clause shall be permitted only with the specific approval of the Purchaser.

06 All machinery or equipment included under this specification must be equipped with safety devices and clearances to comply with recognized standards and Purchaser’s requirements along with safety codes and statues prevalent at the place of installation of the equipment.

07 For welded construction such as that of bridge girders, end-carriages, rope drums, gear boxes etc., steel shall be as per IS:2062-1992 quality.
08 All wheels, couplings, open gears etc. shall be provided with covers, opening on strong hinges. All heavy covers, shall be provided with inspection windows.

09 Where down shop leads are located below runway rails, guards shall be provided on the crane to prevent the hoist ropes from coming in contact with down shop leads.

10 All bolts except those with nyloc nuts shall be provided with grip lock nuts or spring washers.

11 For outdoor cranes all electrical and mechanical equipment which are exposed to weather shall be completely covered or made weather proof. The covers shall be segmental to facilitate easy dismantling and assembly.

12 The end-carriages shall be fitted with substantial safety stops to prevent the crane from falling more than 25mm in the event of breakage of track wheel, bogie or axle. These stops shall not interfere with the removal of wheels.

13 Fasteners for pedestal blocks, motors, gear boxes etc. shall be easily removable from the top. Studs of body bound bolts shall not be used as fasteners for mechanical items except for fixing cover.

14 Power & control cables shall be clamped in groups separately. All trailing cables shall be clamped with PVC or non metallic clamps. Group derating factor shall be appropriately taken according to the recommendations of the cable manufactures based on the method of laying and number of cables being laid together.

15 Guards of approved design, which will push forward any object placed across the track, shall be attached to each end of the end carriages.

16 Parts of steel frames carrying machinery shall be provided with doubling plates of adequate thickness, riveted or welded & machined to true surface.

17 Defects in the material like fractures, cracks, blow holes, lamination, pitting etc. are not allowed. Rectification of any such flaw is permissible only with the approval of the Purchaser.

01.03.02 Structural Details

i) The crane bridges shall be of welded double/single web box construction and shall be designed as per IS: 807-1976 and/or AISE No. 6. The materials of construction shall be weldable mild steel in compliance with the relevant
standard. However, high strength weldable structural steel also may be used wherever required in compliance with the relevant standards.

In case the design of structures is based on IS: 807-1976, the following forces shall also be taken into consideration

a) Vertical reaction on trolley rail arising from surge load.
b) Skewing force.
c) Collision force due to buffer impact.
d) Additional vertical force due to tilting of trolley in case of rigid mast crane.
e) Torsional moment due to cantilever load, eccentric wheel load (in case of wide BOX girder), starting / stopping of LT motor.
f) Local bending stress of the flange.

Note: While calculating the allowable stress in compression, effective length of the compression flange the girder shall be taken as 0.85 of the span only.

ii) The crane bridge girders upto 12m span shall be in one piece. Girders above 12m span may be spliced. The number of such splices shall not exceed 2 upto 36m span. Beyond 36m span. Beyond 36m span, the number of splices may be 3. Splices shall be designed to resist all the forces and moments to which it is subjected to, plus 50% thereof.

However, in no case the strength developed by the splice shall be less than 50% of the effective strength of the material.

Splices shall be proportioned and arranged so that the gravity axis of the splice is in line with the gravity axis of the members joined so as to avoid eccentricity of the loading.

iii) Black bolts shall not be used in the main structure of the cranes.

iv) Cross travel rail shall be fixed to the bridge girders by clamping only and not by welding. Full length wearing plates or resilient pads of min. 10m thick shall be provided under the trolley rails.

v) Transverse fillet welding on load carrying members shall be avoided. All butt welds on tensile zone shall be X-rayed.
vi) Plates, bars, angles and where practicable other rolled sections used in the load bearing members of structures shall not less than 6 mm in thickness.

vii) The end-carriages shall be of double web plate box construction and shall be connected to the girders by welding at shop of by large gusset plates and fitted bolts to ensure maximum rigidity. Drop stops & jacking pads built-in features of the cranes. Full length chequered plate platforms shall be provided along both sides of the cranes in order to ensure easy access to crane crab, long travel gears and other parts. Safety railings shall be provided on crane bridges and crab frame. Access to the operator’s cabin shall be via stair cases only and not through ladders. Platforms to facilitate inspection and dismantling of long travel wheels and main current collectors, shall be provided.

viii) The crab frame shall be made of steel plates and rolled sections in welded construction. Crab frame shall be fabricated in one piece if there are no transport limitations. If the trolley is fabricated in more than one piece due to transport limitation, the design of the splice shall be such that one unit of mechanism mounted on one part of the trolley, does not come over the other part.

ix) Foot walks shall be of sufficient width to give at least 500 mm clear passage at all points except between railing and bridge drive where this clearance may be reduced to not less than 400 mm.

x) The platforms along the bridge girders and over the crab shall allow convenient access for replacement, inspection, lubrication etc. for different mechanical and electrical components.

xi) The minimum thickness of chequered plates shall be 6 mm O/P for indoor cranes & 8 mm O/P for outdoor cranes.

01.03.03 Mechanical Details

i) Rope drums
   Rope drum shall be of cast steel or fabricated out of rolled steel plates. Fabricated drum shall be stressed relieve before machining. The grooves of the drum shall be smooth finished. Rope drum shall be flanged at both ends.
ii) **Rope sheaves**
Rope sheaves shall be of cast steel or fabricated out of rolled steel plates.

iii) **Wire ropes**
The rope shall be hemp cored for all the cranes except hot metal cranes (where these shall be steel cored). Hot metal cranes shall be provided with double rope system, each system capable of sustaining full load safely. Also the ropes, working under water and in corrosive atmosphere, shall be galvanized and shall have steel core. Rope shall be regular right hand lay as per IS:2266-1989. The construction of the ropes shall be 6 x 37 upto 16 mm diameter and 6 x 36 above 16mm diameter.

iv) **Hook Block**
The sheaves shall be fully encased in the close fitting guards fabricated out of steel plates. Smooth opening shall be provided in the guards to allow the free movement of rope and holes shall be provided for drainage of the oil;

v) **Gears and gear-boxes**
Straight and helical spur gearing shall be used for all motions. Worm and bevel gearing may be used in exceptional cases with the specific approval of the purchaser. All first reduction gears shall have helical teeth. All pinion shall be integral with the shaft.

All gears shall be hardened and tempered alloy steel having metric module. Overhung gears shall not be used.

Surface hardness for pinion shall be 255 to 300 BHN and for gears it shall be 215 to 260 BHN. Difference in hardness of pinion and gear shall not be less than 20 BHN. All cast steel gear shall be tested by German Ray. All gear shall be enclosed in oil tight gear boxes. Gear boxes shall be of high grade cast iron/cast steel or fabricated and split at each shaft centre lines. Fabricated gear boxes shall be stressed relieved before machining. For cross travel and long travel motion, vertical gear boxes with ‘T’ split may be used. Hosting motion of hot metal and four rope grab cranes shall be preferably by means of planetary gear box.

vi) **Connection between rope drum and gearbox.**
One of the following arrangements shall be adopted for connecting the rope drum with the gearbox.
a) Flexible joint, incorporating flexible geared coupling housed within the drum.

b) Fully flexible geared coupling between the drum & gearbox.

Drive of the drum by means of spur ring mounted on the drum shall be avoided as far as practicable.

vii) Wheels

Crab/Crane wheels shall be double flanged. Wheels shall be mounted in anti-friction roller bearing housed in 'L' shaped bearing brackets for easy removal during maintenance. Flangeless wheels with the guide rollers are also acceptable.

Solid wheels shall be forged rolled/cast steel. Wheels from 400mm diameter and above may consist of hardened, rolled/forged steel tyre of not less than 60mm thickness, shrunk on to cast iron/cast steel centre.

viii) Coupling

Motor shaft be connected to the gear box with input shaft through flexible shock absorbing coupling excepting pin bush type. Rotating parts shall be suitably covered by 3.15 mm thick sheet steel hinged covers for safety. In case of single motor central drive for long travel motion, output shaft of the gear box shall be connected to the line shift through half geared couplings. Intermediate length of the line shaft may be connected through solid flange couplings. Half geared couplings with floating shaft shall be provided between the wheel and the line shaft.

ix) Bearing & bearing housing

Anti-friction bearings shall be used throughout except where required otherwise for technical reasons.

x) Buffers

Spring loaded type buffers shall be provided on all the 4 corners of the bridge girders and the end carriages for the cross and long travel motions respectively. For cranes of M1, M2 and M3 duty class, rubber buffer may be used.

xi) Brakes

The brakes shall be provided for all motions on the high speed pinion shaft of the gear train. For hot metal hoists, two brakes shall be used per motor.
xii) Lubrication

Duel line hand operated grease lubrication system shall be used for all the bearings for class M5 to M8 duty cranes. Grouped lubrication system shall be used for the class M1 to M4 duty cranes. Lubrication of the gears and pinions in the gear boxes shall be splash fed from the sump. In case of three stage reduction or more, vertical mounted gear-box (having limited motion), are used, an oil pump shall be fitted to ensure lubrication of all gears.

01.03.04 ELECTRICALS DETAILS

i) Scope of Supply

The scope of supply covers all electrical equipments commencing from MCC feeder including the cables, isolators DSL and all electrical items beyond the main current collectors of the crane i.e. DSL main current collectors, power disconnecting switch on bridge platform after main current collectors, protective and control switch gear, motors, control and brake panels, resistors, brakes, limit switches, all power and control cables, socket outlets, lighting distribution panel and lighting fixtures with lamps, festoon cable system for crane trolley magnet/grab and cable reeling drum, if specified for grab/magnet, master controllers, indicating lamps, push buttons, earthing materials etc. The scope of work also includes complete assembly and wiring of crane and testing at manufacturer’s works, erection, testing and commissioning of all electrical equipment, supply of all commissioning spares with minimum quantities as indicated in the clause no. 01.02.03 of this T.S.

All sundry erection materials required for installation and connecting up of electrical equipment with cable laying and fixing accessories shall be included in scope of supply by Tenderer.

ii) Standards

The design, manufacture, assembly and testing as well as performance of the equipment shall conform to the IPSS in respect of items for which IPSS have been issued, otherwise, to the relevant IS specifications (latest revision). In case the Tenderer is not in a position to comply fully with certain IPSS/BIS specifications, or in respect of certain items for which there are no IPSS/BIS specifications, the Tenderer may base his proposals on IEC recommendations or other reputed national or international standards subject to the approval of the Purchaser.
All equipment supplied and all work done including system design and detailed engineering shall also comply with the statutory requirements of the Government of India and the Government of Gujarat and with the Indian Electricity rules.

iii) **Climatic Conditions**

The equipment offered shall be suitable for smooth, efficient and trouble free service in the tropical humid climate prevailing at site and under the ambient temperature conditions indicated above for the different shops and areas. In hot areas of higher temperature conditions, the equipment shall be adequately protected against damage from radiant heat and hot air.

iv) **Power supply and Standard voltage levels**

The following standardized voltage levels shall be adopted:

a) **LTAC**

   earthed system  Power  415V, 3 phase, 50Hz, 4 wire solidly earthed system. Power supply be made available at this voltage only. Other voltages shall be obtained by providing transformer/transformer – rectifier unit with MCBs on both primary and secondary side and ± 5% and ± 10% taps on transformers secondary.

b) **AC control and signaling voltage**

   240V, 110V

c) **Socket outlets for Hand lamps**

   110V, single phase, 50Hz, AC obtained through suitable transformers

   Hand tools
   plug interlocked switch
   240V, 15A, 2 pin plus earth with

d) **Electro-magnetic brakes**

   individual brake control panels
   220V, DC obtained through

e) **Illumination/ lighting**

   240V, AC

The three phase symmetrical short-circuit ratings of the switch gear at 415 V shall be 50kA for 1 second.

The system / unit/ equipment shall be designed so as to be suitable for the following variations in voltage and frequency:

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>± 10%</td>
<td>+ 3% &amp; - 6%</td>
</tr>
</tbody>
</table>

Permissible variations with rated performance, rated current and control effectiveness maintained For L. T. System
Permissible variations for control and regulation equipment with rated performance and control quality maintained

+ 10% + 3% & - 6%

Voltage dip on the starting of largest LT motor shall be limited to 20% of the nominal voltage at the motor terminals. Total voltage dips on starting of large motors on crane shall be limited to 3% on crane and 6% in DSL system.

v) Trolley lines and power supply arrangements for cranes (DSL system)

01. Trolley power conductors

SFU shall be provided for at the inomer feed point to crane DSL by the tenderer. Supply and laying of incoming cable to DSL is included in the scope. Purchaser shall provide necessary feeder in the MCC at 0.00 floor.

Isolator panels shall be provided for the repair section for maintenance by the Purchaser. Necessary DSL arrangement for repair section shall be provided by Tenderer.

Boarding or access platform shall be arranged within the limits of each repair section for approach to be crane.

The conductors shall be supported at 3000mm intervals by insulators mounted on brackets welded to crane girders. Typical drawings indicating details of trolley line power conductors, supporting insulators, brackets, expansion joints, parallel aluminum bus, signal lamp assemblies etc. shall be furnished to successful Tenderer.

Trolley power conductors shall be of mild steel angle sections. The section shall be straight, unbranded and smooth on the running surface. Joints between lengths of angles shall be welded and all welds shall be finished flush with parent metal. The conductors shall be painted with anticorrosive paint, except for contact surface. Parallel aluminum buses shall be provided as specified. The maximum continuous length of power conductor section shall not exceed 30m without an expansion joint in between. The power conductors shall be made from standard rolling length. The jointing of standard lengths shall be made by 100% but welding and top surface finished smooth by grinding to get free movement of the current collectors.
In order to provide electrical continuity across the expansion joints the power conductors on both sides of the joints shall connected by stranded aluminum conductor jumper, fitted with steel aluminum strap and lugs suitable for the steel angle sections.

02. Insulators and trolley line holders

The insulators used for the manufacture of trolley line holders shall be preferably steatite, tufnol or porcelain insulation material having substantial mechanical strength specifically against blows and vibrations. They shall be capable of withstanding the impact and shocks resulting from operation of the machine. The creepage distance of the insulators shall not be less than 80mm.

The insulators used shall have flash over values and mechanical strength not less than the following:

Dry flashover voltage : 25kV
Wet flashover voltage : 12kV
Ultimate mechanical strength : 1000kA

The trolley line holders shall generally conform to the design shown in the drawing to be furnished to the successful Tenderer. All sharp edges shall be ground smooth. The porcelain insulators shall be manufactured and tested as per IS: 1445-1997.

03. Supporting Brackets

The trolley line conductors shall be mounted on holders. The holders shall be bolted on to brackets which in turn shall be welded on to crane girder at stiffeners at regular intervals. In normal run, intermediate type of brackets shall be used, but when sectionalizing gaps or expansion joints are provided, sectionalizing type of brackets shall be provided.

04. Steel to Aluminum Straps

These are meant for connecting parallel aluminum bus at expansion joints, power supply cables from load break switch. They shall be complete with MS cadmium coated bolt nuts, spring washers, lugs etc.
05. Signal lamp assembly

Signal lamp assembly shall be industrial, heavy duty dust tight and water proof in construction suitable for indoor or outdoor locations. The units shall comprise three lamps for three phase with red glass lens and reflectors. The lamp shall be provided with dropper resistance connected in series with the lamp and the resistance shall be rated for continuous inclusion in the circuit. Alternatively, a built-in transformer may be provided to suit the lamp voltage.

06. Aluminum Parallel Bus

These buses shall be of E.C. grade aluminum. They shall be free from any deformity in profiles.

vi) **Current Collectors**

2 nos. per trolley line shall be provided. The collector shoe will be of heavy duty design and chamfered at both ends, each rated for 100% of total crane rating. Double collectors on each earth trolley line shall be provided and these shall be different from those on power trolley line. Collector shall be multi hinged for self-aligning. Collector will be designed in such a way that load is transmitted not on the insulators but on the insulator stud to avoid damage to insulators.

vii) **Power distribution on crane**

One adequately rated load break manual isolator with locking facility shall be provided immediately after current collectors on incoming line on the crane.

Power from the isolator shall be taken to the MCCB/ SFU to be provided in protective panel located at bridge platform.

The MCCB shall be provided with under voltage, over load and short circuit releases. The breaker can be closed only when:

- All master controller handles are in neutral position
- None of the stator or directional contractors are in closed positions
- Emergency comer switches not operated
- Door/ Gate switch are not actuated.
- Gravity limit switch for hoist motion not operated
- Power for lighting and magnet circuits shall be tapped from the incoming side of isolators near current collectors.
viii) **Power supply for C.T. motion**

Flexible trailing cable systems mounted on retracting support system shall be used. The system shall consist of insulated multi-conductor or several single conductor cable with permanent termination on the bridge and on the trolley. The flexible trailing cables shall have ample length and shall be supported by means of properly designed movable clamps. These clamps shall be fitted with rollers and shall run freely on a guide rail allowing relative movement of bridge and trolley without undue stress or wear on the suspended cable. Provision shall be made for inclusion spare cable at a later stage in case of necessity. The flexible cable shall be butyl rubber or EPR insulated CSP sheathed type.

ix) **Meters**

Ammeter and voltmeter with selector switches shall be provided on the incoming line in operator’s cabin.

Ammeter and voltmeter shall be provided on DC side for Electromagnets.

x) **Control features**

All controls shall be fully magnetic, operated through master controllers. All travel motions shall be provided with plain rotor resistance control with plugging. For long travel drives, the electrical control shall be grouped for the individual pair or motors separately in case of four motor drive and each pair of motors shall be able to drive the crane at reduced acceleration and speed. As an anti-skewing measure, out of a pair of motors for L.T., if one drive motor trips, the other drive motor shall also be switched off. For pendant control, plugging shall be avoided for travel motion.

Brakes shall not be used for speed control.

Synchronization of separate drives where required shall be done with the use of solid state thyristor control.

For all hoist motions, except where creep speed is required, plain rotor resistance control shall be provided on all master controller notches in the hoisting direction. The rotor resistance shall be cut out gradually when moving from lower to higher notches such that current peak of 2 times the rated current is not exceeded. In the lowering direction of the motion, controlled lowering shall be provided using one/ two plugging notches, one single phasing notch and one/ two super synchronous power lowering notches. For obtaining creep speed, conventional methods like planetary gear system,
D.C. injection (where requirement calls for creep speed in lowering direction only) etc. may be offered.

Hoist control circuit shall also be provided with anti-drop feature i.e. whenever the master controller is brought back to zero position from higher notches in both directions, the motor shall automatically be connected to hoisting direction for some time (time adjustable through timers) to avoid the downward drift of the load. Brakes shall be clamped in zero position of the master controller.

xi) Drives

Slip ring motor with rotor resistance control/ Thyristor control shall be provided for main hoist and auxiliary hoist motions. Control shall be achieved through master controllers for each direction. Rated speeds are to be provided in each direction i.e., hoisting and lowering. If slip ring motor with rotor resistance control is used for hoist motions then thyristor control shall not be used.

Speed control of the slipring motor shall be achieved through regulation of stator voltage with resistance in the rotor circuit, if necessary. The reversal of direction shall be through magnetic contactors which shall open and close at zero current.

The continuous rating of the thyristor shall be at least 2.5 times the motor rated current and the converter shall be designed and rated for load requirement taking care of peak currents during acceleration, normal operation and regeneration conditions. The dv/dt and di/dt rating of the thyristors shall be suitably selected.

The repetitive PIV rating of semi conductor devices shall not be less than 2.25 times the peak of normal system voltage. Thyristor bridges shall include Rx-Cx snubber circuits across the thyristor, high speed semi-conductor fuses with micro-switches for monitoring of failure. Closed loop regulation suitable for the system with various feedback such as speed, current etc. shall be provided. Speed feedback shall be through tacho-generator of permanent magnet type mounted on the non-driving end of the motor shaft. The regulation shall include ramp generators, potentiometers for various setting, various regulators, signal conditioners, logic command module, sequence module, trigger module, zero and over speed monitor, torque less protection module etc. as per the requirements. The control and regulation equipment shall be able to maintain their rated performance and control quality even under conditions of variation of -10% and – 15% in voltage and ± 5% in
frequency. A zero current sensing device shall be incorporated. The reversing of stator contactor shall be done at zero current. Braking down to zero speed shall be electrical with mechanical brake setting only at zero speed. Protective features like anti-drop etc. shall be incorporated to prevent load setting. The circuitry shall also provide for the protection against failure of motor torque such that the mechanical brake sets in such cases. All other features of conventional crane controls shall also be built into the scheme. The following shall also be provided on the A.C. side:

- Surge suppressor
- Over current protection
- Overload protection
- Single phase protection
- Phase sequence protection
- Ammeter and voltmeter with selector switches
- Isolating switches

Control and auxiliary supply shall be provided with separate transformer and under voltage protection.

The test shall be performed as per IEC:146.

Details of the system offered shall be furnished along with necessary single line diagrams and block diagrams.

All the control modules shall be grouped in a sheet steel enclosure. The control module cards shall be made of epoxy glaze and suitable for plugging into the racks. The cards shall be locked into the rack, which carries a sealing bar and assists locking of the cards thereby cutting down on the wear of the printed circuit connector contacts which can be subjected to high rate of vibration and further avoid the disconnection of cards from the connector. The thyristor panel shall be suitably mounted so that little vibrations are reflected to the components and connection.

The cables for the thyristor controller and associated equipment shall be laid and clamped separately on the crane.

xii) Panels

All panels shall be of free-standing floor-mounting construction, suitable to withstand vibrations encountered on crane. Hinged doors shall be provided for closed type panels. Panels shall be front wired. Front wired live points of
bottom most equipment shall be mounted at least 350 mm above the bottom cover of the panel. Panel shall be fabricated from 2.0mm thick steel sheet.

Power and control terminals shall be segregated. 10% spare terminals shall be provided in each panel.

Equipment in the panel shall be so mounted that their removal or replacement from the front is easy.

Separate control panel for each motion shall be provided.

Panels shall be of closed type when mounted on bridge platform.

Sufficient clearances shall be provided between the panels. A minimum clearance shall be provided in front of the panels for walkway and approach as per I.E. rules. The panels shall be suitably supported in the back to avoid vibrations. Open type panels may be used for installation inside the box girders. In this case, adequate lighting and ventilation shall be provided for the room.

xiii) **Switchgears**

Each mechanism motor shall be provided with MCCB, contactors on stator and rotor sides, oil dash pot type overload relays and suitably rated rotor resistances. In case of thyristor controlled drive, each mechanism motor shall be provided with breaker/switches, transformer, thyristor, rotor resistances, contactors on stator and rotor side etc. Each motor shall be fitted with a tachogenerator for speed feedback. The overload capacity of thyristors shall be 200% for 2 minutes. The speed range shall be 0-160% of rated speed.

MCB shall be provided in the control circuit of each motion.

Each brake circuit shall be provided with a suitable contactor.

Rating of contactor selected for any mechanism shall be at least 50% higher than the respective motor full load current for the mechanism duty cycle. The minimum rating of the contactor used shall be 30A and the life of each contactor shall not be less than 10,000 hrs. of operation.

Reversible directional contactors shall be interlocked both mechanically and electrically.
Motors

Heavy duty reversible crane service, totally enclosed fan cooled, foot mounted, wound rotor motor conforming to latest edition of IS:325-1996 shall be used for various drives. Class of insulation shall be F/F (Stator/ Rotor) with temperature rise limited to that for ‘B’. Pullout torque to be not less than 275% of full load torque corresponding to 40% CDF.

Motor selection shall be done as per IS: 3177-1999.

The main motor shall have following speed ranges:

a) Class M1, M2, M3 & M4 duty cranes:
   Main & auxiliary hoist : 750 rpm
   Long & cross travel : 1000 rpm
b) Class M5, M6, M7 & M8 duty cranes:
   Main & auxiliary hoist : 600 rpm
   Long & cross travel : 750-1000 rpm

All motors shall have the terminal box at top. Frame sizes shall conform to IEC Standards.

Horizontal foot mounted and with tapered shaft extension.

While selecting the motor rating following shall also be taken into consideration:

- Duty type S4 & S5
- Cyclic duty factor
- Number of switchings per hours
- Type of controls used
- Inertia of the motor and mechanism
- Ambient correction factor
- Service factor
- Derating for thyristor control
- Wind pressure

The following no. of switching per hour shall be considered for selection of motors.
- For M1 duty - 60 starts/ hour
- For M2 duty - 60 starts/ hour
- For M3 & M4 duty - 61-150 starts/ hour
- For M5 & M6 duty - 151-300 starts/ hour
- For M7 & M8 duty - 300-600 starts/ hour
Maximum permissible operating speed shall be 250% of synchronous speed or 2000 rpm whichever is less. Over load capacity 150% of full load current for 2 minutes without damage or permanent deformation.

**xv) Brakes**

Brakes shall be D.C. electromagnetic type.

Brakes shall be designed to fail safe whenever the current is interrupted either intentionally or by failure of the main supply.

Brake circuit forcing shall be provided for D.C. brakes, D.C. brake circuit shall be switched off on D.C. circuit for quick operation of brake.

A separate set of parking brake of L.T. motion shall be provided for each outdoor crane. Power supply for these brakes shall be obtained from protective panel.

**xvi) Limit Switches**

Roller lever operated, resetting limit switches shall be provided for all travel motions. For each hoist motion, a rotary cam type over hoist and over lower, self resetting limit switch shall be provided. This limit switch shall have independently adjustable cams for hoisting and lowering motion. The cams shall have adjustability such that end limit can be set to within 100mm of the hoisting or lowering motion. In addition to this, a backup ultimate limit switch of series/shunt gravity type shall be provided to prevent over hoist. The later shall be of manual reset type. In case of cranes handling hot metal, the gravity limit switch shall essentially be of series type. Provision shall be made to bridge the gravity type limit switch contact by push button/switch or any other means to lower the load. An indication shall be provided to the operator whenever this limit switch has operated. Suitable limit switch shall be provided for slack rope, gate/door opening, slew mechanism, grab closing/opening etc. wherever necessary.

**xvii) Anti-Collision Devices**

In shops where two or more cranes are operating in the same bay (at same or different level) all cranes shall be provided with suitable Anti-collision system. Anti-collision device shall be **electronic type**.

A sound signal shall be provided to the crane operator when they are at certain safe distance apart (distance to be adjusted as a function of speed at site) and crane shall stop. After few seconds, it shall be possible to run the
cranes towards each other (or only one crane can move towards the other) till buffers of the cranes meet by providing “by pass” in the operator’s cabin.

Anti-collision shall also be provided on trolley for twin trolley cranes along with suitable by pass arrangement.

xviii) **Resistances**

Air cooled, robust, heavy duty, corrosion resistant punched stainless steel grid type. Resistance shall be in single phase execution.

Rated for 10 minutes duty. Continuous duty rating of resistances shall be provided in case of hoist motions controlled by thyristor converters.

Max\(^{n}\) temperature of resistor elements shall be limited to 275\(^{0}\) C (measured by resistance method) at desired duty. Suitable tapping points shall be provided.

Resistance boxes shall be mounted in racks that permit independent removal of any selected box.

xix) **Master Controller**

Cam type master controller with joy stick type lever shall be used.

Separate master controllers for hoist, LT & CT shall be provided. Duel master controller operated with single handle shall not be used.

Master controller for each motion controls shall have four/ five notches in each direction.

xx) **Lighting, socket outlets, bells etc.**

Lighting shall be provided in operator’s cabin, staircases, platforms and working areas.

Min\(^{m}\) 4 nos. 500 Watts high pressure sodium vapor flood lights equally spaced (under crane girders) about the crane span shall be provided along with shock absorbing and anti-swing suspension arrangements. More numbers of fittings shall be provided if required for cranes with longer span and/ or longer height of lift. Fluorescent lamps with necessary fittings shall be used for operator’s cabin, staircases, platforms etc.

Adequate number of hand lamp socket outlets (2 Pin, 10A, 24V) and power socket outlets (3 Pin, 20A, 240V) shall be provided along with switches. A
hand lamp along with sufficient length of cable with a plug shall also be provided for each crane.

An alarm bell shall be provided on each crane.

xxi) **Pendant unit**

a) Following shall be included on the pendant unit:

- **Push button for**:
  - Hoist slow, hoist fast, lower slow, lower fast, left cross traverse, right cross traverse, forward long, travel, backward long travel, emergency stop conditions.

- **Switch for**:
  - Lights and bells

- **Lamps for**:
  - Power 'ON' indication and emergency corner switch operation.

xxii) **Enclosure Class**

a) For indoor operations
- Resistance boxes : IP:11
- Motors : IP:55
- All other electric equipment : IP:54

b) For outdoor operations
- Resistance boxes : IP:33 with canopy
- Motors & panel : IP:55 with canopy
- All other electrical equipment : IP:65 with canopy

xxiii) **Cables**

All cables shall have stranded copper conductors. Control wiring shall be with 2.5 mm² copper; minimum size of power cable shall be 4.0 mm² copper. Fixed wiring on cranes shall be carried out with PVC insulated. PVC sheathed armoured cable or EPR insulated CSP sheathed cable or better.

All flexible cables (i.e cables for magnet, trolley, feed, pendant unit etc.) shall have copper conductor, EPR insulation and CSP sheathing or better.

All cable shall be suitable de-rated for grouping & higher ambient temperature.

All cables shall be of 1100 Volts grade.

All accessories like cable glands, lugs, clamps, pipes, wire and terminal marks etc. shall also be provided.
Cable laying and terminations shall be such that the chances of cables getting damaged is remote.

In all passages and on trolley the cable shall be laid in trays and shall be covered by similar trays and properly clamped & fixed.

.01 LT Power Cable

1.1kV, heavy duty power cable, 4/3.5 core with stranded sector shaped (sm) or with compact circular stranded (rm/V) or circular stranded (rm) Copper conductors as applicable, PVC insulated suitable for 70°C operation as per IS:5831-1984, core stranded together provided with a common covering of PVC inner sheath, galvanized round steel wire armoured and PVC outer sheathed, multi core conforming to IS:1554 (Part-I) – 1988. Type TWY.

.02 Control Cables

1.1 kV, circular stranded (rm), annealed copper conductor, PVC insulated suitable for 70°C operation, as per IS:5831-1984, cores stranded together provided with a common covering of PVC inner sheath, galvanized round steel wire armoured and PVC outer sheathed, multi-core similar to IS:1554-(Part-I) – 1988, Type YWY.

.03 Flexible Trailing Cable


xxiv) Earthing

A ring Earthing system shall be provided on the crane. Each and every electrical equipment shall be connected to this earthing at least at two points. However the electronic circuit insulated earth wire shall run in panel and terminate at main earth connection only at one point. The earthing shall be connected to the fourth trolley line in DSL system through 2 nos of current collector. Additionally current collectors shall also be provided on crane rails for earthing on crane. All these collectors shall be connected to earthing ring.

An earth core shall be provided in trolley feed cable. The cable reeling drum shall have a separate slipring for earthing purpose.
It shall conform to general specification for earthing.

Rubber mattings shall be provided in front of the protective and control panels. All bonds between earth conductors and crane parts shall be welded if possible, or rivetted and soldered. Where screwed bonds are made, care shall be taken that there is satisfactory contact surface and nuts shall be locked to prevent their loosening. Earth connections to equipment shall be made by means of multi strand flexible conductor of adequate section.

The earth ring on the crane/machine shall be connected to the plant earthing system through to gantry rails. Each end of each gantry rail shall be bonded to the plant earthing system.

In addition, intermediate earthing bond shall be provided on the rails at every 60 m in case of linger tracks.

Flexible copper bonds shall be provided across any gap in the running gantry rail.

**01.04 TECHNICAL PARAMETERS**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>Main Hoist – 25T</td>
</tr>
<tr>
<td></td>
<td>Auxiliary Hoist - 5t</td>
</tr>
<tr>
<td>Span</td>
<td>15m</td>
</tr>
<tr>
<td>No. off</td>
<td>01 (one)</td>
</tr>
<tr>
<td>Duty class</td>
<td>M5 as per IS:3177, 807</td>
</tr>
<tr>
<td>Gantry rail level</td>
<td>+ 8.0M</td>
</tr>
<tr>
<td>Speed (m/min.)</td>
<td>Main Hoist : 10</td>
</tr>
<tr>
<td></td>
<td>Aux. Hoist : 15</td>
</tr>
<tr>
<td></td>
<td>Cross Travel : 30</td>
</tr>
<tr>
<td>Height of lift</td>
<td>Main Hoist : 22.0m</td>
</tr>
<tr>
<td></td>
<td>Aux. Hoist : 22.0m</td>
</tr>
<tr>
<td>Type of operation</td>
<td>pendant operated</td>
</tr>
<tr>
<td>Type of hook</td>
<td>single shank swivelling type</td>
</tr>
<tr>
<td>Ambient Temp.</td>
<td>55°C</td>
</tr>
<tr>
<td>Maxm. Wheel load</td>
<td>17.0T</td>
</tr>
</tbody>
</table>
Gantry rail size : CR-80
LT Wheel base : 5600mm
Over buffer : 7200mm
Hook approach : MH:1000/1300 mm from end of girder towards riverside / land side
AH:2250/2550mm from end of girder towards riverside/land side

Overhung of crane
From CL of rail : 300mm
Top of trolley form rail : 2500mm
Power supply : 415V±10%, 3 Phase, AC, 50Hz+ 3%-6%
Control voltage : 110V, 1phase, AC

01.05 DOCUMENTATION

01.05.01 Information to be furnished by the Tenderer along with the tender:

The Tenderer shall submit adequate number of technical drawings & technical data/information with tender for crane without which the tender shall be considered as incomplete & may not be considered for acceptance.

1. General arrangement drawings/clearance diagram of the crane
2. The questionnaire properly filled in.
3. Deviations from tender documents.
4. List of commissioning spare, list of spares for two (2) years normal operation and list of insurance spare for each crane as per clause no. 01.02.03, 01.02.04 and 01.02.10
5. List of special/maintenance tools & tackles as per clause no. 01.02.06.
6. Other supporting documents
7. Un-priced copy of list of equipment.
8. List of Makes.

01.05.02 List of drawings/ documents to be furnished by the successful Tenderer

1. Drgs. & documents to be submitted for approval within one month of placement of order.
2. Drgs and documents to be submitted after approval
3. Copies of drawings for approval of statutory authority (if required) shall be submitted at least 3 months prior to first shipment of crane. Obtaining
statutory clearance from statutory authorities shall be the responsibility of the crane supplier.

4. Specification of oils and lubricants and other consumables and their quantity and frequency of change.


6. Instruction for storage and re-conservation.

7. Test and inspection certificate.

8. List of spares for 2 years normal maintenance.

9. Ordering specification for operating consumables/supplies.

10. Motor list

11. Technical details of thyristor converters. If any

12. Single line diagrams of control panels. Thyristor converters. LDBs etc.

13. Connected load and 30 minute maximum demand.

01.05.03 **List of drawings/documents to be submitted along with equipment by the successful Tenderer**

1. GA drawings, complete assembly and sub assembly drawings of the equipment

2. Drawings of all equipment/component received from sub supplier.

3. Test and warranty certificate for each item of equipment.

4. Test reports and inspection reports.

5. Instruction manuals for testing and commissioning.

6. Operation, maintenance and safety manuals.

7. Requirement of special tools and tackles, if any, for subsequent maintenance.

8. Detail drawing list and specifications of all wearing out parts and parts subject to breakage during normal operating conditions.

9. List of space parts with drawings, sketches, specifications and manufacturer’s catalogue.

01.06 **QUESTIONNAIRE**

1. DPR/TPR/Boom No.

2. No. Off

3. Type of Crane

4. Supplier/ Make

5. Capacity (t)

6. Span (m)

7. Duty Class

8. Speed (normal & Creep) m/min
   a) Main hoist & creep
   b) Aux. Hoist & creep
   c) Cross travel
   d) Long travel
   e) Slew (red./min.)
9 Height of lift (m)
   a. Main hook
      Above floor
      Below Floor
   b. Aux hook
      Above floor
      Below floor
10 Crane rail height above floor (m)
11 Max wheel load (t) (without impact)
12 Type of cabin
13 Type of hook:
   a) Main hook
   b) Aux hook
14 Location (Indoor/Outdoor)
15 Hook approaches (m)
   a) Main hook (DSL side/Opposite Side)
   b) Aux hook (DSL side/ Opposite Side)
16 No of rope falls, dia, construction, & breaking strength for
   a) Main hoist
   b) Aux hoists
17 Gantry rail size
18 Crab rail size
19 Over buffer dimension (m)
20 Wheel base
21 Wheel diameter for
   a) LT wheel
   b) CT wheel
22 Handling attachments
23 Special features (weighing device etc)
24 Motor: (Type, KW, rpm, starts/hr, enclosure class, insulation etc)
   a) Main hoist
   b) Aux hoist
   c) Cross travel
   d) Long travel
25 Type of control for each motion with corresponding characteristic curve:
26 Method of obtaining creep speed:
27 Power supply
   - Power supply S.L.D:
   - Electric equipment specification
28 Control voltage
29 Ambient temp/Environment
30 Total weight of the crane (t)
31 Break up of crane weight (t)
   a) Structural
b) Mechanical

c) Electrical

32 Total weight of the crab (t)

33 Code of design

34 General arrangement drawing, incorporating the front and side elevations, plan, hook approaches, location of cabin/pendant, down shop lead, clearance dimension, handling attachments/wheel load diagram and other relevant characteristics of the crane.

35 List of deviation from the Purchaser’s specification

36 Any other information

01.07 PAINTING

All parts of the machines shall be thoroughly cleaned of loose mill scales, rust or foreign matters. The surface cleaning shall conform to standards as indicated in Tender Specification.

ALL parts excepting motors, resistors, gears etc. shall be painted at shop and at site.

All parts inaccessible after assembly shall be painted and assembled while the paint is wet.

After erection, the damaged portion of the painted surface shall be retouched and an intermediate coat/ final coat shall be applied as per Tender Specification.

Colour scheme shall be as per choice of the purchaser/ approved by the purchaser or his consultant.

01.08 QAP, INSPECTION AND TESTING OF EQUIPMENT

QAP, inspection and testing of equipment shall be as per Tender Specification.

01.09 PERFORMANCE TESTS & GURANTEE

After erection and Commissioning of Equipment, Performance tests shall be carried out to prove the performance of the system and equipment.

These tests shall be binding on both the parties of the contract determine compliance of the equipment/ system with the performance guarantee.

All the equipment, tools and tackles required for successful completion of the performance tests shall be supplied by the successful Tenderer.
All the instruments for the performance tests, as required, shall be supplied by the successful Tenderer and shall retained by him till the satisfactory conclusion of all tests at site. All cost associated with the supply, calibration, installation and return of test equipment shall be included in the scope of supply. All test instruments shall be as per standards approved by the Purchaser.

If the successful Tenderer fails to achieve the guarantee and performance parameter, he shall investigate the causes shall rectify and/or replace, free of cost to the Purchaser the defects of the equipment/system within a period of 1 (one) month from the date of commencement of performance and guarantee tests and again prove the guarantees. In such cases, the cost of modifications including labour, materials, and cost of additional testing etc., shall be borne by successful Tenderer.

If even after necessary alteration and modifications are affected, the performance guarantees are not fulfilled, the Purchaser reserves the right to reject the equipment. In the event of exercising this right, the successful Tenderer shall replace the defective equipment/system with the equipment/system that meets the performance guarantee parameters. The cost of replacement inclusive of labour, materials and repeat testing to prove compliance with the performance guarantees shall be borne by the successful Tenderer.

01.09.01 The following basic performance parameters shall be concluded:

a) All equipment shall operate at rated capacity without undue vibration and undue noise etc.

b) Measurement of noise and vibration levels.

c) Measurement of power consumption of various drive motors while operating at performance guarantee levels.

d) Continuous run system performance test.

e) All other parameters of the equipment or system indicated in the specification.

01.09.02 The equipment shall be guaranteed for a period of 12 months from the date of successful commissioning or 18 months from the date of last supply whichever is earlier.