

**PROVIDING AND FIXING OF STEEL WORK, SHEET
BARRICATION, PLUMBING WORKS, HOME
APPLIANCES AND ELECTRICAL WORKS AT TYPE –
IV QUARTERS, JIPMER PUDUCHERRY**

Volume- III

Technical Specifications

**Tender No: HLL/IDD/CHN/18-19/012
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TECHNICAL SPECIFICATIONS

A BRIEF OF REQUIREMENT OF THE WORK:

1. General Scope of Work :

Providing and fixing of steel work, sheet barrication, plumbing works, home appliances and electrical works at Type – IV quarters, JIPMER **Puducherry**

2. Deleted

3. Deleted

4. The work shall, in general, conform to the Latest CPWD Specifications for Civil, Electrical and all other works with up to date correction slips for all sub heads of work as applicable, and, Technical Specifications included in the tender documents, wherever applicable. Wherever any aspect of design / construction / material standards is not covered under the above mentioned specification, relevant standards shall be referred to in the order of precedence which shall be as follows. In the case of discrepancy between the Schedule of Quantities, the Specifications and /or the Drawings, the following order of preference shall be observed –

- a. Description of Schedule of Quantities
- b. Particular specification and Specific Condition, if any
- c. Drawings
- d. CPWD Specifications
- e. Indian Standard Specifications of BIS/ NBC/ IRC/ BS/ ASTM/ DIN
- f. For items not covered by any of the above, the work shall be done, as per sound engineering practices and as directed by the Engineer-in-charge.

CHAPTER - A

TECHNICAL SPECIFICATIONS AND CONDITIONS- CIVIL WORKS

1. EARTH WORK: As per relevant CPWD specifications.

- a. Irrespective of the stipulations in the relevant CPWD Specifications or elsewhere in the Contract, the excavated earth shall be disposed of by the contractor at his own cost to the place as directed by Engineer – in-charge and/or permitted by the local authority after obtaining written permission of the Engineer – in-charge and no payment will be made by the HLL for disposal of this excavated earth.
- b. The Contractor shall, at his own expense and without extra charges, make provision for all shoring, pumping, dredging or bailing out water, encountered from any sources such as rains, floods, springs, subsoil water table being high or due to any other cause whatsoever. The foundation trenches shall be kept free from water while all the works below ground level are in progress without any extra payment.
- c. Filling in plinth shall be consolidated with water and compacted with pneumatic rammers, to achieve 90% relative density on testing. One test is to be carried out for 1000 sq.ms. of compacted area.

2. PLAIN CEMENT CONCRETE AND REINFORCED CEMENT CONCRETE WORK:

A. STONE AGGREGATE:

- i. Stone aggregate used in the work shall be of hard broken stone to be obtained from approved source (Quarries to be approved by the Engineer in charge) and shall conform to relevant provision in the Latest CPWD Specifications for works.

B. SAND

- i. Sand to be used for the work shall be of as specified in CPWD Specifications 2009. Sand shall be obtained from the source to be got approved by the Engineer in charge and washed if required, with appropriate equipment to bring down the chemical, inorganic and organic impurities within the permissible limits as per the direction of the Engineer in charge. The same shall consist of hard siliceous materials.

Note: Where only one variety of sand is available the sand will be sieved for use in finishing work as directed by the Engineer – in – charge in order to obtain smooth surface and nothing extra will be paid on this account.

- ii. Nothing extra shall be paid for screening or washing the sand as prescribed above.

C. FLYASH

Flyash conforming to grade 1 of IS 3812 (Part 1) may be used as part replacement of OPC provided uniform blending with cement is ensured in accordance with clauses 5.2 and 5.2.1 of I.S.456-2000 in the items of BMC and RMC. However this shall not override the provisions of the respective items.

D. CENTERING SHUTTERING AND SCAFFOLDING:

- i. All Scaffolding centering for RCC shall be with properly designed system and brought to site well in advance so that the progress of the work is not hampered for non-availability of the same.

- ii. All shuttering for RCC work except soffits of slab shall be in water proof shuttering Ply. Shuttering for slab and soffits shall be in water proof shuttering ply or in good quality mild steel plates free of dents, bends or warping and rusting as approved by the Engineer in charge.
- iii. Contractor should deploy complete one set of shuttering materials for minimum one complete floor and the shuttering material for beam bottom shall be minimum for two complete floors.

3. BRICK WORK

- a. Bricks used in the work shall be obtained from kilns to be got approved from the Engineer in charge and shall be best quality well burnt ground moulded bricks as available in the vicinity. They shall have a compressive strength of not less than 75 Kgs/sq.cm and an absorption percentage of not more than 15 (Fifteen) % of its dry weight when immersed in water for 24 hours. In all other respects they shall conform to the provision in Latest CPWD Specifications for works.
- b. Both the face of wall of thickness more than 23cm shall be kept in the proper plane. Walls of half brick thickness or less shall be measured separately and paid in sqm.
- c. Bricks wall beyond half brick thickness shall be measured in multiple of half brick (i.e. more than 115mm or equivalent) which shall be deemed to be inclusive of mortar joints. In all other respects they shall conform to the provision in relevant specifications of the work.
- d. For mortar, use of PP Cement shall be preferred.

4. CEMENT PLASTER: - The use of PP Cement shall be preferred.

A. Finishing:

- i. The extruded aluminum section has to be mechanically finished to remove all scratches; extrusion marks etc and subsequently thoroughly cleared in all alkali baths prior to anodizing.
- ii. The polyester powder coating, as required, as per item of work, shall be of desired shade with minimum average thickness to 50 microns or other shades as required and to this effect the tenderer must have to produce test certificate from authorized institutions Bureau of Indian Standard.
- iii. The polyester powder coated material should be properly wrapped in gummed tape before fabrication to avoid scratches during fabricated and erection shall be kept protected till handing over.

B. Fabrication:

- i. Before commencing the fabrication the contractor shall submit to the Engineer – in - charge for their approval detailed shop drawings, based on the Architectural drawings and corresponding specification showing junctions, fittings, accessories such as hinges flush bolts, locks, latches, latching arrangements, peg stays, rotor arms, anodize pivots gaskets rubber packing door felts, mastic, sealant etc., including fixing and sealing arrangements . Type and method of scaffolding he intends to use, Fabrication is to be taken up only after approval by the Engineer – in - charge and in accordance with the BoQ Specification. Sections for fabrication of door/ window/ventilators etc shall be as per BoQ Specification or as approved by the Engineer – in - charge.

- ii. A sample of finished door / windows/ ventilator railing etc.shall be fabricated as per the shop drawings approved by the Engineer – in - charge for final approval before under taking mass production/ fabrication,
- iii. The doors, window, ventilators and partitions shall be as per thickness given in the approved shop drawings, Polyester Powder coating shall be as specified in the item specifications.
- iv. All materials shall conform to relevant IS. Codes and in the absence of IS code, they should correspond to the best engineering practice; decision of the the Engineer – in - charge shall be final and binding on the contractor.
- v. Fabrication shall be done true to the approved shop drawing/ sample approved and in correspondence to the finished openings at the site. All joints shall be mitered at the corners, true right angles, and joints to be finished neatly to hairlines, with concealed fasteners, wherever possible joints shall be made in concealed locations.
- vi. All fabricated/finished items shall be packed and carted properly to site to prevent any damage in transit. On receipt at site they shall be carefully stacked in protected storage to avoid distortion/damage.
- vii. Site installation shall be with concealed screws, self-tapping or other approved fasteners or may be by welding, due precautions shall be taken to avoid any distortion/ discoloration /damage to the finished items.
- viii. Wood work faces /parts coming in contact with masonry shall before shifting to the site be given a heavy coat of alkali resistance bitumen paint. Steel items coming in contact with other incompatible materials shall be given a thick coat of zinc chromate primer.

5. ALUMINIUM COMPOSITE PANELS (ACP) CLADDING

- a. Scope of Work includes providing and fixing Aluminium Composite panel cladding including framing as per the elevation, section and the plan drawings provided, fabricated out of heavy duty Aluminium extruded profiles conforming to alloy 643900 WP with chemical composition and mechanical properties as per IS-733 and as per specifications. The scope of work shall be read in conjunction with the specification of curtain walling / structural Glazing System.
- b. The contractor shall design, supply, fabricate, deliver and install and guarantee all construction necessary to provide a complete aluminium composite panel cladding, complete with all necessary anchors, hardware and fittings to provide a total installation, fully in conformity with the requirements and intent of the drawing and specification as per item description.
- c. The contractor shall design the cladding as per the prevalent site conditions and building elevations profiles. The design parameters shall be in conformity the structural glazing system. No extra claims shall be entertained at any stage for aluminum profile/ wall thickness and size dimensions. The Contractor must quote rates accordingly.
- d. The anchoring / bracing of the wall cladding to the RCC beams/ columns shall be done with non-corrosive galvanized brackets of approved design, (Galvanizing to be done conforming to IS 4759-1996 up to 610 gms. Per Sq. M. (80- 90 micron thickness).

- e. The framework shall be aligned for the entire height of each Mullion and of the entire width of each Transom by laser beam equipment to ensure 100 percent 'X' axis and 'Y' axis alignment.
- f. The system should also provide for pressure equalization. The details for pressure equalization to be submitted by the contractor and got approved by the Engineer-in-charge.
- g. EPDM Gaskets of suitable profiles (to accommodate shall be provided including the labour element for fixing in appropriate locations is to be included in the rate).
- h. The Periphery of the framework shall be sealed both from inside and outside with silicon weather sealant to make the cladding watertight.
- i. Cost of Aluminium composite panel consisting of a core of polyethylene sandwiched between two aluminium skins of 0.5mm thickness with a mild edge. 4 mm total thickness with surface finish of PVDF coating as approved by the Engineer-in-charge, as shown in the elevation, plan and cross section drawings along with labour element for cutting stacking, carrying to heights and fixing to appropriate locations is included in the rates.
- j. All the vertical and horizontal section grooves are to be sealed non staining silicon sealant of make as specified in the list of approved make to make the entire system synchronous with the basic structural glazing/curtain wall structure and also make the system air tight and watertight. The fixing details should be got approved by the Engineer-in-charge. The peel off foil should be removed at the time of handing over as may be required by the Engineer-in-charge.
- k. Any joint provided between cladding elements to cater for individual panel installation and shall be sealed off with extruded EPDM gasket or silicon sealant.

l. Product

- i. ACP shall be as approved with high fibre filled sandwiched panel 4mm install on Aluminium framing and Galvanised brackets. Aluminium cladding panel to be PVDF fluorocarbon coated factory applied colours. Reverse side to be in mill finish. All the joints shall be sealed with silicon sealant of approved make. The colour of sealant to be decided by Engineer-in-Charge.
- ii. A sample of panels and installation methods to be submitted to the Engineer-in-Charge for approval.

m. Manufacture

The panels must be visually flat. Any stiffener applied to compensate for wind load must not read through.

n. Installation

The panels shall be fixed in accordance with manufacture's recommendations.

o. Technical Properties of Aluminium Composite Panels

A	Composition	4.0 mm thick aluminium composite panel comprising of high mineral filled core sandwiched between two skins of aluminium alloy, Skin material 0.5mm thick aluminium sheet (3005 H6) core material natural polyethylene.
B	Dimensions	Panel thickness : 4mm
C	Tolerance	Width \pm 2.0mm

		Length \pm 4.0mm Thickness + 0.02mm
D	Principal Properties	Panel weight: 5.5 kg/sq.m Thermal expansion: 1mm/M/60 deg.C. Moment of Inertia: 0.347 cm ⁴ /m
E	Acoustic Properties	Average airborne sound transmission loss R/N 25db (DIN 4109)
F	Mechanical Properties	Tensile strength \geq 130 N / mm ² 0.2 % proof stress 90 N / mm ² Elongation 5 % Modules of elasticity 70,000 N/mm ²
G	Thermal Transmittance	R = 0.014 m ² °C/W
	Finish	PVDF stove lacquered (Fluoro carbon) on one side and reverse side in mill finish.
	Colour	Colour to be selected by Engineer-in-Charge using standard PVDF colour chart from manufacturer.
	Panel size: Width	1000/1250/1500mm
	Length between	1500 and 5000mm
	Aluminium Extrusions	Extrusions shall be of aluminium alloy 6063 T5, conforming to BS-1470 – 1475: 1972 in mill finish.

- p. **Protection:** The finished surface shall be protected with 80 microns self-adhesive Peel Off film with two layers of white and black tested to withstand at least 6 months exposure to local weather condition, without losing the original peel off characteristic or causing stains or other damages. Protection should not be removed until after installation.
- q. **Warranties;** The Contractor shall provide a data to confirm compliance with specific requirements for resistance and fire properties. The guarantee should be for a 20 salt spray resistance and fire properties. The guarantee should be for a 20 year period against peeling chalking (No. 8 rating), fading, blistering, flaking, chipping and cracking.
- r. **Measurement:** The measurement shall be for exposed actual surface area with grooves cladded on plain/ curved surface excluding the concealed trims.
- s. **Technical Data: -** The technical data provided hereunder is for guidelines. The data, specific for the site location, shall be got approved by the contractor from the Engineer-in-Charge for the design of the ACP and structural Glazing System.
- i. **Design Wind Loading**
- 850 N/m² positive and negative to Podium.
 - 1150 N/m² positive and negative to Tower.
 - 1500 N/m² positive and negative to Crown to Tower.

No cladding element shall sustain permanent deformation of failure under loading equivalent 1.5 times the design wind pressure specified.

ii. **Deflection**

Deflection of any aluminium frame shall not exceed 1/175 of the clear span.

iii. **Expansion and Contraction**

The cladding shall be so fabricated and erected as to provide for all expansion and contraction of the components. Any temperature change due to climatic conditions shall not cause harmful buckling, opening of joints, undue

stress on fastening and anchors, noise of any kind or other defects.

iv. Flatness

The cladding surface taken individually shall not have any irregularities such as oil canning, waves, buckles and other imperfections when viewed at any position but not less than at an angle of 15 degrees to the true plane of the panel with natural lighting of incident of not less than the same angle.

v. Water Tightness

The panel cladding shall be so constructed to be water tight with provision for rear ventilation.

vi. Acoustic Treatment

The cladding panel system shall be designed so as to dampen noise caused by splashing water.

B. Fixings

- i. Fasteners including concealed screws, nuts, bolts and other items required for connecting aluminium to aluminium shall be of non-magnetic stainless steel.
- ii. Rivets used for fastening panel to aluminium sub-frame shall be of alloy aluminium large flange head type with stainless steel mandrel.
- iii. All fixing anchors, brackets and similar attachments used in the erection shall be of aluminium or non-magnetic stainless steel.

C. Weather seal

- i. All exposed joints between panels which are required to be water tight, shall be sealed with extruded EPDM gasket of hardness approx. 75 SHORE.
- ii. All secondary weather seal shall be of self-adhesive tape as approved by the Engineer-in-charge.

CHAPTER C

TECHNICAL SPECIFICATIONS PLUMBING & SANITARY WORKS

SECTION 1 GENERAL REQUIREMENT

1. Scope of work

The work shall in general conform to the Latest CPWD Specifications for works as mentioned in Schedule 'F' of the GCC. Work under this Contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required. The Contractor is required to completely furnish all the plumbing and other specialized services as described hereinafter and as specified in the schedule of quantities and / or shown on the plumbing drawings.

SECTION 2 PLUMBING FIXTURES

1. Scope of work

- a. Work under this Part shall consist of furnishing all materials & labour necessary and required to completely install all sanitary fixtures, chromium plated fittings and accessories as required by the drawings and specified in the Bill of Quantities.
- b. Without restricting to the generality of the foregoing the sanitary fixtures shall include the following:-
 - i. Sanitary fixtures
 - ii. Chromium plated fittings
 - iii. Porcelain or stainless steel sinks
 - iv. Accessories e.g. towel rods, toilet paper holders, soap dish etc.
 - v. Whether specifically mentioned or not, the rates quoted for the installation of the fixtures, appliances and accessories shall be provided with all fixing devices, nuts, bolts, screws, hangers, fasteners as required.
 - vi. All exposed pipes within toilets and near fixtures shall be chromium plated brass or copper unless otherwise specified.

2. General

- a. All sanitary fixtures, CP Fittings and CP/SS accessories shall be supplied at site of work as per manufacturers' standard supply.
- b. All fixtures and fittings shall be provided with all such accessories and fixing devices as are required to complete the item in working condition, even if the same is not specifically mentioned the Bill of Quantities, Specifications or shown on the drawings. The rate quoted will include all devices for proper fixing arrangement, nuts, bolts, screws and required connection pieces etc.
- c. Fixing screws shall be half round head stainless steel wood screws or bolts with Stainless Steel washers. Iron screws rust and will not be permitted.
- d. All fittings and fixtures shall be fixed in a neat workmanlike manner true to level and heights shown on the drawings and in accordance with the manufacturer's recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling or terrace shall be made good at Contractor's cost.

- e. Contractor shall provide poly-sulphide sealant appropriate for its use for all fixtures fixed near wall, marble core seal and edges.

3. Water Closets

a. European W.C.

- i. W.C. shall be any one of the following types:
 - a. Wall hung wash down or
 - b. single or double siphon type or
 - c. As per BOQ
- ii. Each W.C. set shall be provided with an approved type of plastic/wooden seat of approved finish compatible and fitting appropriately with the WC set with rubber buffers and hinges. The WC seat shall be those approved and accepted for fixing on a particular type of WC.
- iii. The seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C.
- iv. The edge between the fixture and the wall shall be sealed with approved type of poly-sulphide sealant.

b. Health faucet/spray (Optional)

A chromium plated spray with integral hand control valve and connected to a flexible pipe and angle valve with wall flange and hook are fixed as shown on the drawings or directed by the Engineer-in-charge. The angle valve and flange shall be paid under relevant item with abulation tap.

4. Wash Basins

- a. Wash basins shall wall mounted type or for under over/counter installation as specified in the BOQ.
- b. Each basin shall be supported on **MS galvanized** or painted C.I. brackets and the basin securely fixed to wall or under/above counter installation. The design of the brackets shall suit the basin selected and as recommended by the manufacturer.
- c. Each basin shall be provided with 32 mm dia. C.P. waste with overflow/ pop-up or standard waste with rubber plug and chain, 32 mm dia. C.P. brass bottle trap with CP pipe to wall and flange as specified in the BOQ.
- d. Each basin shall be provided with a single tap a hot & cold CP mixer with or without pop up waste fittings, 32 mm dia. CP cast brass bottle trap with outlet pipe and wall flange.
- e. The edge between the fixture and the wall or the counter shall be sealed with approved type of poly-sulphide sealant
- f. Washbasins shall be fixed at proper heights as shown on drawings. If height is not specified, the rim level shall be 79 cm or as directed by Engineer-in-charge.
- g. Each washbasin connection (separately for hot and cold) shall be provided with angle valves with CP wall flange and CP connecting pipe and of required length.

5. Sinks

- a. Sinks used shall be of any of the following types:
- b. For kitchens, pantries, and designated utility rooms the sinks shall be stainless steel sinks with or without drain boards.

- c. Each sink shall be supported by **MS galvanized** or painted C.I. brackets and clips and the basin securely fixed to wall or on the counter. The design of the brackets shall suit the basin selected and as recommended by the manufacturer.
- d. Stainless steel sinks shall be provided with 40 mm dia. C.P. basket waste with plug (as supplied by manufacturer), 40 mm dia. C.P. brass "P" trap with CP pipe to wall and flange.
- e. Each sink shall be provided with hot & cold CP mixer with approved type of a neck spout or individual taps as directed by the Engineer-In-Charge.

6. Shower set

- a. Shower set shall comprise of hot & cold water mixer, C.P. shower arm with wall flange and shower head adjustable type.
- b. Mixer shall be exposed type, single lever, concealed stop cocks with diverter and spout as selected by the Engineer-in-charge.

7. Accessories

- a. Accessories shall be of any of the following types:
 - i. Towel rails
 - ii. Towel rings
 - iii. Coat hooks
 - iv. Soap dispensers
 - v. Soap dishes
- b. Accessories shall be fixed with stainless steel half round head screws and cup washers in wall with rawl plugs or nylon sleeves and shall include cutting and making good.
- c. Porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work. The flange of the recessed fixture shall cover the recess in the wall fully.

8. Measurement & Rates

- a. Sanitary fixtures shall be measured by numbers or as specified in BOQ.
- b. Rates for all items mentioned above shall be inclusive of cutting holes and chases and making good the same, stainless steel screws, nuts, bolts, fastener and any fixing arrangements required and recommended by manufacturers, testing and commissioning.

SECTION 3 Soils, Waste, Vent & Rainwater Pipes & Fittings

1. Scope of work

- a. Work under this Part shall consist of furnishing all labour, materials, equipment's and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes and fittings as required by the drawings, and given in the Schedule of Quantities.
- b. Without restricting to the generality of the foregoing, the system shall include the following:-
 - i. Vertical and horizontal soil, waste, vent and rain water pipes, and fittings, joints, clamps and connections to fixtures.
 - ii. C.I. soil & uPVC rainwater pipes.

- iii. Connection of all pipes to sewer lines as shown on the drawings at ground floor levels.
- iv. Floor and urinal traps, cleanout plugs, inlet fittings and rainwater heads/Khurras.
- v. Testing of all pipe lines.

2. General requirements

- a. All materials shall be new of the best quality conforming to specifications and subject to the approval of Engineer-in-charge.
- b. Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- c. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- d. Pipes shall be securely fixed to walls and ceilings by suitable clamps intervals specified.
- e. Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.

3. Piping System

- a. Soil, Waste & Vent Pipes
 - i. The Soil & Waste pipe system above ground has been planned as a "two pipe system" as defined in BIS: having separate pipes for waste for kitchen sinks, showers, washbasins, AHU's condensate drains and floor drains and is approved by Engineer-in-charge.
 - ii. All waste water from AHU's plant and pump rooms, floor channels in basements will be provided with a deep seal trap before connecting to the main drain or vertical stack.
 - iii. Vertical soil & waste stacks shall be connected to a common horizontal drain pipe at basement ceiling or to an external manhole directly where feasible and shown on the drawings.
- b. Rainwater Pipes
 - i. All terraces shall be drained by providing down-takes rainwater pipes.
 - ii. Rainwater pipes are separate and independent and connected to the storm water drainage system as shown on the drawings.
 - iii. Rainwater in enclosed courtyards shall be collected in catch-basins and connected to storm water harvesting chambers as shown in drawings..
 - iv. Any dry weather flow from waste appliances, AHU's pump rooms, shall not be connected to the sewerage system.
- c. Balcony/Planter drainage

All balconies, terraces, planters and other formal landscape areas will be drained by vertical down takes as per the landscape/architectural drawings and details.
- d. Cast iron pipes & fittings (for Soil, waste, anti-siphon age pipes)
 - i. All pipes shall be straight and smooth and inside free from irregular bore, blow holes, cracks and other manufacturing defects. Pipes shall be centrifugally spun iron soil pipes conforming to sand cast to I.S. 3989.

- ii. Standard weight dimensions shall be as follows:-
 - a. Sand Cast Iron Pipes & Matching Fitting shall be in conformity to I.S. 1729
 - b. Centrifugally cast (spun) iron pipes and fittings in conformity to I.S. 3989
- e. uPVC pipes & fittings (For Rain Water Pipes etc.)
 - i. Where specified, Polythene pipes shall be uPVC pipes confirming to I.S: 4985-2000
 - ii. The details of the nominal outer diameter, weight and working pressure shall be as per the standards, for the respective pressure rating as specified in the B.O.Q.
 - iii. Polythene pipes may be cold bending to a radius of not less than eight times of their external diameter. Pipes bent for smaller radius may be made by hot bending.
 - iv. Fittings used for Polythene pipes shall be compression moulded fittings matching to the above specifications.
- f. Jointing
 - i. All Polythene pipes shall be Drip seal/Sealant and jointed as per manufacturer's specifications and relevant I.S codes.
 - ii. All pipes shall be tested after installation for a pressure equal to twice the maximum working pressure in the line as per manufacturer's specifications.
- g. Fittings
 - 1. Fittings shall conform to the same Indian Standard as for pipes. Pipes and fittings must be of matching IS Specification. Interchange of pipes of one standard with fittings on the other standard will not be permitted.
 - 2. Fittings shall be of the required degree of curvature with or without access door.
 - 3. Access door shall be made up with 3 mm thick insertion rubber washer and white lead. The bolts shall be lubricated with grease or white lead for easy removal later. The fixing shall be air and water tight.
- h. Fixing
 - 1. All vertical pipes shall be fixed by structural support clamps truly vertical. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard).
 - 2. Horizontal pipes running along ceiling shall be fixed on structural adjustable clamps (Clevis clamps) of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.
 - 3. Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the Engineer-In-Charge/Building Contractor for making such provisions in the structure as necessary. All damages shall be made good to restore the surfaces.

4. Traps

a. Floor traps

Floor traps shall be siphon type full bore P or S type cast iron having a minimum 50 mm deep seal. The trap and waste pipes shall be set in cement concrete blocks firmly supported on the structural floor. The blocks shall be in 1:2:4 mix (1 cement :2 coarse sand : 4 stone aggregate 20 mm nominal size) and extended to 40 mm below finished floor level. Contractor shall provide all necessary shuttering and centring for the blocks. Size of the block shall be 30x30 cm of the required depth.

b. Urinal traps

Urinal traps/horn shall be cast iron P or S traps with or without vent and set in cement concrete block specified for floor traps.

c. Floor trap inlet

Bath room traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a special type inlet fitting fabricated from G.I. pipe without, with one, two or three inlet sockets welded on side to connect the waste pipe. Joint between waste and hopper inlet socket shall be Drip Seal. Inlet shall be connected to a C.I. P or S trap. Floor trap inlet hoppers and the traps shall be set in cement concrete blocks as specified in para above without extra charge.

d. Gratings for traps

Floor and urinal traps shall be provided with 100-150mm square or round C.P. / Stainless steel grating / PTMT, with rim of approved design and shape as per BOQ.

e. Jointing

Soil, waste, vent and anti-siphonage pipes shall be jointed with Lead joint/Drip seal joint as mentioned in the BOQ. The following minimum procedures shall be complied with while making the pipe joints:-

- i. Ensure that the pipes are clean internally and undamaged.
- ii. The pipes shall be cut square with sharp tools.
- iii. The cut ends of the pipes shall be filed/ reamed and finished smooth.
- iv. Any deformed ends shall be re-rounded.
- v. It shall be ensured that the pipe ends shall enter the fittings and sockets to full depth of the jointing area.
- vi. The pipe work shall be assembled in a manner such that it does not entail making of joints in restricted locations.
- vii. Each metal pipe spigot shall be centered with three lightly wedged pieces of hardwood or folded lead.
- viii. The jointing surfaces shall be cleaned to remove any coatings or cutting oils, etc.

f. Floor Trap Inlet/GI Inlet Fitting:

Traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a special type cast iron or G.I. inlet hopper without or with one or two or three inlet sockets to receive the waste pipe. Joint between G.I. waste pipe and hopper inlet socket shall be Drip seal

joint. Hopper shall be connected to a CI 'P' or 'S' trap with at least 50mm seal (hopper and traps shall be paid for separately). Floor trap inlet hoppers and the traps shall be set in cement concrete blocks/and supports as required for Floor trap above shall be provided without any extra charge.

5. Cleanout Plugs

a. Cleanout Plug on soil pipes

Clean out plug for Soil, Waste or Rainwater pipes laid under floors shall be provided near pipe junctions bends, tees, "Ys" and on straight runs at such intervals as required as per site conditions. Cleanout plugs shall terminate flush with the floor levels. They shall be threaded and provided with key holes for opening. Cleanout plugs shall be Cast Brass suitable for the Pipe dia. With screwed to a G.I. socket. The socket shall be Drip seal caulked to the drain pipes.

b. Cleanout Plug on Drainage Pipes

- i. Cleanout plugs shall be provided on starting point of each drain and in between at locations indicated on plans or directed by the Engineer-in-charge. Cleanout plugs shall be of size matching the full bore of the pipe but not exceeding 150 mm dia. Cleanout Plugs on drains of greater diameters shall be 150 mm dia. Fixed with a suitable reducing adapter.
- ii. Cleanout Plug at Ceiling Pipes: - Cleanouts provided at ceiling level pipe shall be fixed to a CI flanged tail piece. The cleanout doors shall be specially fabricated from light weight galvanised sheets and angles with hinged type doors with fly nuts, gasket etc., as per drawing.

6. Waste pipe from appliances

a. General

- i. Waste pipe from appliances e.g. washbasins, sinks and urinals shall be of heavy galvanized steel /CPVC as given in the Schedule of Quantities or shown on the drawings.
- ii. All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required pipes may be run at ceiling level in suitable gradient and supported on galvanized structural clamps. Spacing for clamps for such pipes shall be as per good engineering practice approved by the Engineer-In-Charge.

b. Galvanized pipes

Waste pipes from appliances shall be galvanized steel tubes conforming to I.S.1239 (Heavy class) and quality certificates shall be furnished. Pipes shall be provided with all required fittings e.g. tees, couplings, bends, elbows, unions, reducers, nipples, plugs. All G.I. waste pipes shall be terminated at the point of connection with the appliance with an outlet of suitable diameter. Pipes in chase shall be wrapped with bitumen tape and then painted with two coats of black bitumen paint. Exposed pipes with one coat of Zinc cromate with etch coating primer and two or more coats of synthetic enamel paint or as given in the Schedule of Quantities. Colour shall be as per the approved colour code.

7. Cast iron pipes for drainage

- a. All drainage lines passing under building, in exposed position above ground e.g. basement ceiling etc. shall be cast iron pipes. Position of such pipes shall generally be shown on the drawings.
- b. Cast iron pipes shall be spigot & socket (S&S) centrifugally spun iron pipes conforming to I.S. 1536. (Class LA). Quality certificates shall be furnished.
- c. Fittings
Fittings used for C.I. drainage pipe shall conform to I.S. 1538 (Heavy class). Wherever possible, junction from branch pipes shall be made by a Y- tee.
- d. Joints
 - i. Joints between pipes shall be made with pre-moulded rubber joints (Tyton Joints) supplied by the manufacturer to ensure compatibility and water tightness.
 - ii. Joints between pipes and fittings shall be made by caulked spun yarn dipped in tar and molten drip seal 45 mm deep by hammering with caulking tools.

8. Encasing pipe in Cement Concrete

Cast iron soil and waste pipes under floor in sunken slabs and in wall chases (when cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 stone aggregate 12 mm size) 75 mm in bed and all-round. When pipes are running well above the structural slab, the encased pipes shall be supported with suitable cement concrete pillars of required height at intervals of 1.8 m. Rate for concrete round pipes shall be inclusive of pillars, supports, shuttering and centring.

9. Painting

- a. All cast iron, soil, waste vent, anti-siphon age and rainwater pipes in exposed location in shafts and pipe spaces shall be painted with two or more coats of synthetic enamel paint to over a priming coat to give an even shade.
- b. Paint shall be of approved quality and shade. Where directed pipes shall be painted in accordance with approved pipe colour code.
- c. G.I. waste pipes in chase shall be painted with two coats of bitumen paint, covered with polythene tape and a final coat of bitumen paint. Exposed pipes shall be painted with two or more coats of synthetic enamel paint over each priming coat.
- d. C.I. soil and waste pipes below ground and covered in cement concrete or lead pipes shall not be painted.

10. Cutting and making good

- a. Pipes shall be fixed and tested as building proceeds.
- b. Contractor shall provide all necessary holes cut outs and chases in structural members as building work proceeds. Wherever holes are cut or left originally, they shall be made good with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) or brick work in cement mortar 1:2 (1 cement: 2 coarse sand) and the surface restored as in original condition.

11. Testing

- a. Testing procedure specified below apply to all soil, waste and vent pipes above ground including C.I. LA pipes laid in basement ceiling.
- b. Entire drainage system shall be tested for water tightness during and after completion of the installation. No portion of the system shall remain untested. Contractor must have adequate number of expandable rubber/bellow plugs, manometers, smoke testing machines, pipe and fitting work test benches and any other equipment necessary and required to conduct the tests. All testing shall be certified for its calibration by an approved laboratory.
- c. All materials obtained and used on site must have manufacturer's hydraulic test certificate for each batch of materials used on the site. All testing equipment must be calibrated and shall carry certificate from an approved laboratory.
- d. Testing soil, waste and rainwater pipes
 - i. Apart from factory test all pipes and fittings shall be hydraulically tested for a head of 3 m preferably on a specially set up work bench. After applying pressure, strike the pipe with a wooden pallet and inspect for blow holes and cracks. Pressure may be applied for about 2 minutes. Reject and remove all defective pipes.
 - ii. After installation all connections from fixtures, vertical stacks and horizontal drains including C.I. LA pipes shall be tested to a hydraulic pressure not exceeding 3 m. Such tests shall be conducted for each floor separately by suitable plugs.
 - iii. The entire installation shall be tested by smoke testing machine. The test can be conducted after the plumbing fixtures are installed and all traps have water seal or by plugging all inlets by bellow plugs. Apply dense smoke keeping the top of stack open and observe for leakages. Rectify or replace defective sections.
 - iv. After the installation is fully complete, it should be tested by flushing the toilets, running at least 20% of all taps simultaneously and ensuring that the entire system is self-draining, has no leakages, blockages etc. Rectify and replace where required.
- e. Contractor shall maintain a test register identifying date and time of each area. All tests shall be conducted in presence of Engineer-in-charge and signed by both.

12. Measurements

- a. General
 - i. Rates for all items quoted shall be inclusive of all work and items given in the specifications and Schedule of Quantities.
 - ii. Rates are applicable for the work under floors, in shafts at ceiling level area for all heights and depths.
 - iii. Rates are inclusive of cutting holes and chase in RCC and masonry work and making good the same.
 - iv. Rates are inclusive of pre testing, on site testing, of the installations, materials and commissioning of the works.

- v. Pipes (Unit of measurement, linear meter to the nearest Centimetre) or as specified in CPWD specifications.
- b. All C.I. Soil, waste, vent, anti-syphonage and rain water pipes shall be measured net when fixed correct to a centimetre including all fittings along its length. No allowance shall be made for the portions of pipe lengths entering the sockets of the adjacent pipes or fittings. The above will apply to both case i.e. whether pipes are fixed on wall face or pillars or embedded in masonry or pipes running at ceiling level.
- c. Pipes shall be measured per running metre correct to a centimetre for the finished work which shall include fittings e.g. bends, tees, elbows, reducers, crosses, sockets, nipples and nuts. The length shall be taken along centre line of the pipes and fittings. All pipes and fittings shall be classified according to their diameter, method of jointing and fixing substance, quality, and finish. The diameters shall be nominal diameter of internal bore. The pipes shall be described as including all cutting and waste. In case of fittings of unequal bore, the largest bore shall be measured.
- d. Cement concrete around pipes shall be measured along the centre of the pipe line measured per linear metre and include any masonry supports, shuttering and centring cutting complete as described in the relevant specifications.
- e. Slotted angles/channels shall include support bolts, nuts and clamps embedded in masonry walls with cement concrete blocks and nothing extra will be paid for making good the same.
- f. Fittings
Unit of measurement shall be the number of pieces. Pipe fittings are included in the rate for pipes. Urinal traps, trap gratings, hoppers, cleanout plugs shall be measured by number per piece and shall include all items described in the relevant specifications and Schedule of Quantities.
- g. Painting
Painting of pipes shall be measured per running metre and shall be inclusive of all fittings and clamps. No deduction for fittings shall be made.
- h. Excavation for soil pipes
No payment shall be admissible with respect to excavation, refilling and disposal of surplus earth for cast iron soil and waste pipes laid below ground, in sunken slabs.
- i. Engineer-in-charge's decision with respect to the correct interpretation regarding mode of measurement shall be final and binding on the contractor.

SECTION 4 Water Supply Systems

1. Scope of work

- a. Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to completely install the water supply system as required by the drawings, specified hereinafter and given in the Schedule of Quantities.
- b. Without restricting to the generality of the foregoing, the water supply system shall include the following:-
 - i. Rising main from water supply pumps to all overhead tanks.

- ii. Distribution system from overhead tank to all fixtures and appliances for cold & hot water.
- iii. Insulation to hot water pipes within toilets.
- iv. Connections to all plumbing fixtures, and appliances.

2. General requirements

- a. All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Engineer-in-charge.
- b. Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- c. Short or long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted for short connections.
- d. As far as possible all bends shall be formed by means of a hydraulic pipe bending machine for pipes up to 25 mm dia. Bends and elbows may be used for pipe dia. greater than 32 mm.
- e. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- f. Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals approved by the Engineer-In-Charge.
- g. Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

3. Water Supply System

- a. Contractor should study the site plan and water supply system diagram for overviews of the system.
- b. Source
 - i. Water supply will be acquired from HLL's mains line (water report enclosed).
 - ii. The rising mains will be connected to the main fire static tank and then overflow into the main domestic water tank located in basement.
- c. Water supply piping for garden hydrant and sprinkler and irrigation system will be separate and independent connected to a different pumping system.

4. Pipes & Fittings

a. Galvasined Iron Pipes

- i. All pipe inside the building and where specified, outside the building shall be galvanized Iron pipes conforming to I.S. 1239 of Class specified. When class is not specified they shall be heavy class.
- ii. Fittings shall be malleable iron galvanized of approved make. Each fitting shall have manufacturer's trade mark stamped on it. Fittings for CPVC pipe shall include couplings, bends tees, reducers, nipples, union and bushes. Fittings shall conform to I.S. 1879-(Section I to X).

- iii. Pipe and fittings shall be joined with screwed joints, after cutting a pipe with a hacksaw or a cutting machine care shall be taken to remove burr from the end of the pipe after reaming with a proper file.
- iv. Pipe threaded joints will be made by applying suitable grade of TEFLON tape used for drinking water supply.(Use of red and white lead sutli will not be permitted for screwed joints)
- v. All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. G.I. pipes inside shall be fixed in wall chases well above the floor. No floor shall be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other areas as shown on drawings.

b. Chlorinated Polyvinyl Chloride (CPVC) Pipes

- i. All pipe inside the building and where specified, inside the building shall be CPVC pipes conforming to I.S. 15778-2007 and/or ASTM F-441 Schedule 40 of Class specified and having thermal stability for hot & cold water supply. When class is not specified they shall be heavy class.
- ii. Fittings shall be CPVC of approved make. Each fitting shall have manufacturer's trade mark stamped on it. Fittings for CPVC pipe shall include couplings, bends tees, reducers, nipples, union and bushes and shall be of best make as approved by the Engineer-in-charge.
- iii. Pipe and fittings shall be joined with one step CPVC solvent cement and testing of joints complete as per direction of Engineer in Charge.
- iv. Pipes shall be cut either with a wheel type plastic pipe cutting or hacksaw blade and care shall be taken to make a square cut which provides optimal bonding area within a joint. Burrs and fittings should be removed from the outside and inside of pipe with a pocket knife or file. The tubing should make contact with the socket wall 1/3 or 2/3 of the way into the fitting socket. Only CPVC solvent cement conforming to ASTM-F493 should be used for joining pipe with fittings. An even coat of solvent cement should be applied on the pipe end and a thin coat inside the fitting socket. After applying the solvent cement on both pipe and fitting socket, pipe should be inserted into the fitting socket within 30 seconds, and rotating the pipe ¼ to ½ turn while inserting so as to ensure even distribution of solvent cement with the joint. The assembled system should be held for 10 seconds (approximately) in order to allow the joint to set up. An even bead of cement should be evident around the joint and if this bead is not continuous remake the joint to avoid potential leaks.
- v. When making a transition connection to metal threads, special Brass / plastic transition fitting (Male and female adapters) should be used. Plastic threaded connections should not be over torqued Hard tight puts one half turn should be adequate.
- vi. Only CPVC solvent cement conforming to ASTM F 493 should be used for joining pipe with fittings and valves. The cement solvent should be used within 30 days after opening the company's seal and tightly close the seal after using in order to avoid its freezing. The frozen cement solvent should be discarded immediately and fresh one should be used.
- vii. For Horizontal runs, support should be given at 3 foot (90 cm) intervals for diameters of one inch and below and at 4 foot (m) intervals for larger sizes. Hangers should not have rough or sharp edges which come in contact with the tubing.

- viii. All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. CPVC pipes inside shall be fixed in wall chases well above the floor. No floor shall be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other areas as shown on drawings.

c. Clamps

- i. G.I/CPVC pipes in the shaft and other locations shall be supported by clamps of design approved by Engineer-In-Charge. Pipes in wall chases shall be anchored by hooks. Pipes at ceiling level shall be supported on structural clamps.
- ii. Spacing of clamps, hooks etc. Shall be as per good engineering practice approved by the Engineer-in-charge

d. Unions

Contractor shall provide adequate number of unions on pipes 50mm and below to enable easy dismantling later when required. Unions shall be provided near each gunmetal valve, stop clock, or check valve and go on straight runs as necessary at appropriate locations as required and /or direct by Engineer-In-Charge.

e. Flanges

- f. Flanged connections shall be provided on pipes 65 mm and above as required or where shown on the drawings generally as follows:

1. On straight runs not exceeding 30 m, near bends and at connections to main branch lines.
2. On all valves ends
3. On equipment /pump connections as necessary and required or as directed by Engineer – in - charge.

- g. Flanged connections shall be made by the correct number and size of the bolts and made with 3 mm thick insertion neoprene gaskets Bolt hole dia. for flanges shall conform to match the specification for C.I. sluice valve to I.S. 780 and C.I. butterfly valve to IS: 13095.

h. Trenches

- i. All water supply pipes below ground shall be laid in trenches with a minimum cover of 60 cms. The width and depth of the trenches shall be as follows:-

Dia. of pipe	Width of trench	Depth of trench
15 mm to 50 mm	30 cm	75 cm
65 mm to 100 mm	45 cm	100 cm

- ii. **Sand filling**

Where specified in the Schedule of Quantities all G.I. pipes in trenches shall be protected with fine sand 15 cm all around before filling in the trenches.

- i. Where shown on the drawings, main pipe lines may be run in masonry trenches from the pump house to the buildings in phase I & II, filled up with sand and buried in ground as per architectural /landscape details.

j. Painting

All pipes above ground shall be painted with one coat Zinc with each coating and two coats of synthetic enamel paint of approved shade and quality. Pipes shall be painted to standard colour code specified by Engineer-in-charge.

k. Pipe protection

- i. Where specified in the Schedule of Quantities all pipes in chase or below floor shall be protected against corrosion by the application of two coats of bitumen paint covered with bitumen tape and a final coat of bitumen paint before covering up the pipe.
- ii. All G.I. / CPVC water supply pipes below ground shall be protected against corrosion by applying one layer of 4 mm thick multilayer anticorrosive polymeric mix tape applied over a coat of primer as per recommendations of the manufacturers. (Pypcoat)

l. Insulation

Hot water pipes within a toilet /kitchen from hot water header shall be insulated with **nitrile rubber insulation on hot water supply** of required size as per specifications.

i. Materials:

Insulation material for Pipe insulation shall be Closed Cell Elastomeric Nitrile Rubber or closed cell cross linked polyethylene foam. Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.038 W/moK or 0.0313 Kcal / Mhr oC or 0.212 BTU / (Hr-ft²-oF/inch) at an average temperature of 30oC. The product shall have temperature range of -40 oC to 105oC. Density of material shall not be less than 0.06 gm/cm³. The insulation shall have fire performance such that it passes minimum CLASS 1 as per BS476 part 7 for surface spread of flame. Water vapour permeability shall not exceed 0.024 perm inch (3 x 10⁻¹⁴ Kgs / m.sec.Pa).

ii. Workmanship:

Insulating material in tube form shall be sleeved on the pipes. On existing piping, slit opened tube from insulating material shall be placed over the pipe and adhesive (as recommended by the manufacturer) shall be applied as suggested by the manufacturer. Adhesive must be allowed to tack dry and then press surface firmly together starting from butt end and working towards centre.

All insulation work shall be carried out by skilled workmen specially trained in this kind of work. All insulated pipes shall be labelled (HWS / HWR / HWRR) and provided with 300 mm wide band of paint along circumference at every 1200 mm for colour coding. Direction of fluid shall also be marked. All painting shall be as per relevant BIS codes.

iii. Mode of measurements & payment:

The rate includes cost of all labour, materials, tools and plants etc. required for satisfactory completion of this item.

The rate shall be for a unit of one Running metre.

5. Valves

a. Ball valves

- i. Valves 50 mm dia. and below shall be screwed type ball valves with stainless steel balls spindle Teflon seating and gland packing tested to a hydraulic

pressure of 20 kg/cm² and accompanying couplings and steel handles to B.S. 5351.

b. Butterfly Valves

- i. Valves 65 mm dia. and above shall be cast iron butterfly valve to be used for isolation and/or flow regulation. The valves shall be bubble tight, resilient seated suitable for flow in either direction and seal in both direction. Valves shall be provided with matching flanges with neoprene insertion gasket 3 mm thick .P.N 1.6
- ii. Butterfly valve shall be of best quality conforming to IS: 13095.

c. Non Return Valve

- i. Where specified non return valve (swing check type) shall be provided through which flow can occur in one direction only, It shall be single door swing check type of best quality conforming to IS: 5312.P.N1.6
- ii. Each butterfly and slim type swing check valves shall be provided with a pair of flanges screwed or welded to the main line and having the required number of galvanized nuts, bolts and double washers of correct length.
- iii. Sluice valve shall be of approved makes conforming to I.S.:780 of class as specified.

6. Storage Tanks

a. Overhead Tanks

Overhead water storage tanks for water supply shall be reinforced cement concrete.

b. Tank connection and accessories

- i. Contractor shall provide the following to each tanks:
 1. Inlet and outlet connections to pumps, equipment and main pipe lines.
 2. Tank overflows with mosquito proof gratings
 3. Scour drain and valve as per drawings
 4. Water level gauge with approved type of brass gauges, plastic tube, a wooden board with level marking.
- ii. Electronic level controllers, cabling, sequence controllers and all related equipment shall be provided by agency executing the pumping system work. Plumbing contractor shall provide necessary G.I. sleeves and co-operate with the contractor to ensure that the work is successfully executed.

7. Testing

- a. All pipes, fittings and valves, after fixing at site, shall be tested by hydrostatic pressure of 1.5 times the working pressure or 10 kg /cm² whichever is more. Pressure shall be maintained for a period of at least 12 hours without any drop & withstand for 8 hrs.
- b. A test register shall be maintained and all entries shall be counter-signed by Contractor(s) in the presence of Engineer-in-charge.
- c. In addition to the sectional testing carried out during the construction, Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes or failure of fittings, to the building, furniture and fixtures

shall be made good by the Contractor during the defects liability period without any cost.

- d. After commissioning of the water supply system, Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones at no extra cost and the same shall be tested as above.

8. Measurements

a. G.I./CPVC pipes

- i. G.I./CPVC pipes above ground shall be measured per linear metre (to the nearest cm) and shall be inclusive of all fittings e.g. couplings, tees, bends, elbows, unions, and flanges. Deduction for valves shall be made. Rate quoted shall be inclusive of all fittings, clamps, cutting holes chases and making good the same and all items mentioned in the specifications and Schedule of Quantities.
- ii. G.I./CPVC pipes below ground shall be measured per linear metre (to the nearest cm) and shall be inclusive of fittings, e.g. couplings, tees, bends, elbows, unions. Deduction for valves shall be made. Rates quoted shall be inclusive of all fittings, excavation, back filling and disposal of surplus earth, cutting holes and chases and making good and all other items mentioned in the specifications and Schedule of Quantities.

- b. Gunmetal, cast iron, butterfly and non-return valves puddle flanges, level indicators and meters shall be measured by numbers.

- c. Brick masonry chamber for valves and meters shall be measured by number and include all items given in the Bill of quantities.

d. Painting/pipe protection

Painting/pipe protection for pipes shall be measured per linear metre over finished surface and shall include all valves and fittings for which no deduction shall be made.

- e. Engineer-In-Charge's decision with respect to the correct interpretation regarding mode of measurement shall be final and binding on the contractor.

SECTION – 5 Water Supply Pumping System & Allied services

1. Scope of work

- a. Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required for the satisfactory supply, installation, completion and commissioning of water supply pumping system and allied works as described hereinafter, as specified in the schedule of quantities and/or shown on the plumbing drawings and described in the scope of work .

2. The System

- a. The system described below is for the contractors bidding for the works to understand the extent and scope of work and the intent in the manner in which the water supply system is planned and shall be executed. This does not form a part of the contractor's scope of work with respect to the various elements that are described in this paragraph.

b. Sources of supply

Local water supply for which a water main from the main road to the underground water tank will be laid by contractor.

c. Underground water tanks

- i. Static fire water storage tanks in compartments .Connections from the tube well water supply lines will be made into these tanks. Water will overflow into the raw water tanks
- ii. Raw Water Tank to hold the tube well as well as CWS Supply water will be made to:
 1. A set of pumps will be connected to and water filter and chlorination system and the filtered water stored in the Treated Water Tanks (in three compartments. All piping and connections for this system are a part of this contract, if required.
 2. Domestic Water Pumping Systems
- iii. Water supply to the various buildings will be made from a set of pumping sets to the overhead water and supplementary fire tanks located on the terrace of each building.

3. Rising Mains & level control system

- a. Water from the pumps described above will fill each tank by a rising main to each tower.
- b. To control the level in each tank and enable it to fill as the water demand so requires, each tank will be provided with a ball cock to shut off the water supply when the tank is full.
- c. A set of electronic level sensing probes will be installed in each tank. The probes installed in each pumping system will be wired to a central electronic panel which will activate the pump when any one of the tank probe signals low water conditions and top up all tanks. No excess flow will occur due to the ball cock in the tank.

4. Level Controllers

- a. Level controllers shall be electronic magnetic type using required number of stainless steel type probes, shrouded in PVC sheath or encapsulated in a stainless steel pipe. The level controller will be used for following applications:-
 - i. Provide a audible high water alarm when water level in the sump reaches a pre-determined high level in the sump location at MCC panel installed in wall near sump location
- b. Overhead tank level controller cum indicators
 - i. Each OHT to be provided with required number of stainless steel electronically operated probes (housed in a stainless steel protective housing) and connected by a control cable to a central junction box connected to MCC panel located in the pump house at basement. A common multi-core cable from each group of buildings will be laid to the pump room in basement. The probes will function as follows:
 - ii. To cut off the water supply pumps when all the OHT is full and to start the pump if any OHT level reaches at pre-determined low level.
 - iii. Provision shall be made to enable the operation of the second duty pump in case the water level does not rise above a pre-determined level in the tank

due to water demand which is higher than capacity of duty pump no.1 to meet.

- iv. Indicate the water level in each OHT in the level indicating panel installed in the pump room
- v. Each OHT are also provided with a float valve to stop the supply in individual OHT when level reaches a cut off high level.

c. Control & Indicating Panel (For overhead and underground water tanks)

- i. A centralized indicating stand-alone wall mounted panel fabricated from 14 g. with seven tank process MS sheet and painted inside and outside with stove enamelled finish with clear vertical panels for each group of buildings & tanks shall indicate water level in each tank by means of digital display unit to indicate water level in each tank in four levels ($\frac{1}{4}$ th, $\frac{1}{2}$, $\frac{3}{4}$ and full). The panel shall be installed on the control console panel located in the pump room or as directed by the Project Engineer. The panel shall have:
- ii. Digital level indicator panel meter for each water tank.
- iii. Etched plate identification plates.
- iv. Control cabling from MCC to the panel installed in the control room as directed by the Engineer-In-Charge.
- v. Cabling from PHT sensing probes to the panel

5. Pressure filters for Water Supply System, if required.

a. Specification shall apply for water filtration system

- i. Pressure filters shall be manufactured with factory made bobbin wound polyester fibre glass multilayer filters fitted with internal GI distribution pipe with polypropylene diffusers on top, collector pipes and arms, inlet and outlet header vertical water pressure dished ends complete with initial charge of filter media, G.I. face piping, accessories testing and commissioning complete, Working Pressure 2.4 kg/cm² (Test pressure 3.75 kg/cm²). Along with bfv & nrv & gauge, prv etc.
- ii. Each vessel will be provided with suitable pressure tight manhole cover appropriately located for inspection and repairs.
- iii. The diameter and height of each vessel shall be as per the design requirement and given in the BOQ and as per site conditions.

b. Multi-Port Valves

- i. Each vessel will be provided with multi-port valves to operate and regulate the normal flow, backwash and rinsing, rapid washing, on the face piping.
- ii. Provide suitable sampling cocks to draw water samples for raw water and treated water.

c. Face Piping

- i. Each vessel shall be provided with non-corrosive face piping from the inlet to the outlet. Face piping shall be CPVC (IS 4985) 10 kg/cm² all CPVC fittings are heavy grade to pipe and solvent weld and flanged joints
- ii. All valves shall be butterfly valves as specified in the piping section over 65 mm dia. and for pipe dia. below 50 mm dia. shall be provided with ball valves.

d. Water Filtration Plant (For Domestic Water)

- i. Design parameters for the proposed filter shall be as follows:
 1. Filter media: - Graded aggregate of required size selected coarse and fine silica sand as per latest water treatment practice. Aggregate and sand to be acid washed and having purity of 99.9%.
 2. Depth of filter media:- Approx. 750-900 mm deep (as per manufacturer's design)
 3. Back washing :- By air scouring through air blower (approx. 5.1 lpm/m² of filter surface area and water supply from raw water pumps by reverse flow)
 4. Output Water Quality for Domestic Filters: To conform to IS 10500 for the relevant design criteria

e. Chemical Dosing Pumps

- i. Pump applications
 1. Chlorination of raw water from tube wells,
- ii. Dosing system comprising of an electronic metering pump with, 100 lit capacity uPVC/HDPE solution tank with level gauge and lid on top.
- iii. Electronic driven metering pumps with mechanically actuated diaphragm with oil lubricated gear mechanism. The output of the pump should be adjustable for operation from 10-100%. Pump construction shall be corrosion resistant polypropylene or similar material. Pump electrical circuit shall be interlocked with the main raw water /pool recirculation pumps so that they operate only when the pumps are operating.

f. Air Blower for Back Washing

- i. Low pressure air blower with TEFC electrical motor, belt driven or direct drive, all mounted on a common structural based plate with oil and water separator.
- ii. Air blowers will be used for back washing operations. The air blower shall be designed for operation of one filter at a time. Blowers will be designed for air flow of approx 5.1 lpm/m² air capacity at 0.5 kg/cm² pressure. (This may be modified to suit manufacturer's requirement for filters offered.)
- iii. The electrical switchgear shall be included in the respective MCC panel of the system

SECTION 6 Pipes & Fittings

1. Headers, piping and connections

- a. All pipes within the plant room building in exposed locations and shafts including connections buried under floor and for suction and delivery headers shall be G.I. / CPVC pipes (medium class) and thickness specified. Pipes up to 150 mm dia. shall conform to I.S. 1239.
- b. Pipe 200 mm dia. and above shall be G.I. ERW tubes to IS 3589. If black pipes are available they shall be galvanized before use.
- c. Fittings for G.I. pipes shall be approved type malleable iron or wrought iron screwed galvanized fittings for screwed joints. Fittings 200 mm dia. may be shop fabricated but shall be shop galvanized after fabrication.

- d. All M.S. structural supports and clamps shall be galvanised. All the pipe work within plant room shall be adequately supported with G.I. structural supports from floor or ceiling as required and directed by Engineer-In-Charge.

2. Jointing

a. G.I. Pipes (Screwed joints)

Pipe shall be provided with metal to metal threaded joints. Teflon tape shall be used for lubrication and rust prevention. (USE OF LEAD /ZINC BASED JOINTING COMPOUND ARE NOT PERMITTED)

b. Flanged joints / Dead Joints

a. Flanges shall be provided on:

- i. Straight runs not exceeding 12-15 m on pipe lines 80 mm dia and above.
- ii. Both ends of any fabricated fittings e.g. bends, tees etc. of 50 mm dia or larger diameter. (When Permitted)
- iii. Both end of all suction delivery and other headers.
- iv. For jointing valves, appurtenances, pumps, connections with pipes, to water tanks and other places necessary and required as good for engineering practice.
- v. Flanges shall be as per applicable I.S. with appropriate number of G.I. nuts and bolts, 3 mm insertion rubber gasket complete.
- vi. The cost of flanges is included in the rates of pipes along with fittings.

c. Unions

Provide approved type of dismountable unions on pipes lines 50 mm and below near valves or inspector test/drain and assemblies and as required as per site conditions.

d. Vibration Eliminators

All suction and delivery lines and as shown on the drawings double flanged reinforced neoprene bellow type flexible pipe connectors shall be provided. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connectors shall be as per site requirements in accordance with manufacturer's details.

3. Valves

a. Sluice valves

- i. Full way Sluice Valves shall be used on the suction connection to pumps and headers.
- ii. Sluice valves (80 mm dia. and above) shall be C.I. double flanged sluice valves with rising stem. Each sluice valve shall be provided with wheel in exposed positions and cap top for underground valves. Contractor shall provide suitable operating keys for sluice valves with cap tops.
- iii. Sluice valves shall be of approved makes conforming to I.S.780 PN1.6 class

b. Butterfly Valves (PN 1.6 rating)

- i. Butterfly Valves shall be used in all other locations as required conforming to IS 13095.PN 1.6
- ii. They shall have a cast iron body.
- iii. Disc shall be CI heavy duty electrolyses nickel plated abrasion resistant.

- iv. The shaft to be EN-8 Carbon Steel with low friction nylon bearings.
 - v. The seat shall be drop tight constructed by bonding resilient elastomer inside a rigid backing.
 - vi. Built in flanged rubber seals.
 - vii. Actuator to level operated for valves above ground and T Key operated for valves below Ground.
 - viii. Built in flanges for screwed on flanged connections. Manufacturer's details on fixing and Installation will be followed.
- c. Non Return Valves (NRV PN 1.6 rating))
- i. Non return valves will be used at location to allow flow only in one direction and prevent flow in the opposite direction.
 - ii. NRV shall be cast iron slim type with cast iron body and gunmetal internal parts and accompanying flanges. Valves shall conform relevant IS or match the butterfly valves.PN 1.6
 - iii. Built in flanges for screwed on flanged connections.
- d. Ball Valves
- Ball Valves up to 40 mm dia. shall be screwed type ball valves with stainless steel balls, spindle, Teflon seating and gland packing tested to a hydraulic pressure of 20 kg/cm² and accompanying coupling and steel handles (to B.S. 5351).

4. 'Y' Strainers (PN 1.6 rating)

Provide cast iron 'Y' type strainers with gunmetal internal strainers, CI screwed plug to be provided on all water tank suction connections to pumps.

5. Measurements (Part 1, 2 & 3)

a. General

- i. Unit rate for individual items, e.g., pressure tanks, MCC, level controller, water tank are for purposes of payments only. Piping, headers, valves, accessories, cabling and MCC to be measured separately in this contract only.
- ii. All items must include all accessories fittings as described in the specifications, BOQ and shown on the drawings.

b. Drainage Pumps & Sewage Pumps

Drainage pumps shall be measured by numbers and shall include all items as given in the specifications and schedule of quantities to provide a complete working system.

c. Level controllers & Alarms

Level controllers for each set of pumps shall be measured by number and inclusive of probes, cabling up to surface box near the pump and shall include all items as given in the specifications and schedule of quantities to provide a complete working system.

d. Piping Work

- i. Suction and delivery headers for each pumping system shall be measured per set with required length and shall include all items as given in the schedule of quantities. Painting shall be included in rate of headers.
- ii. CPVC pipes between various filters and units shall be measured per linear meter of the finished length and shall include all fittings, flanges, jointing, clamps for

fixing to walls or hangers and testing. Flanges shall include 3 mm thick insertion rubber gasket, nuts, bolts and testing.

- iii. Vibration eliminators, “Y” strainers, butterfly valves, slim non return valves, ball valves shall be measured by numbers and shall include all items as given in the schedule of quantities and specifications except from pump room.

SECTION 7 Specifications for Electrical Installation

1. Electrical Control Panels

a. General

- i. All medium voltage switchboards shall be suitable for operation at three phase/three phase 4 wire, 415 volt, 50 Hz, neutral grounded at transformer system with a short circuit level withstand of 31 MVA at 415 volts or as per schedule of quantities.
- ii. The Switch Boards shall comply with the latest edition with up to date amendments of relevant Indian Standards and Indian Electricity Rules and Regulations.

b. Switch Board Configuration

- i. The Switch Board shall be configured with Air Circuit Breakers, MCCB's, and other equipment as called for in the Schedule of Quantities.
- ii. The MCCB's shall be arranged in multi-tier formation whereas the Air Circuit Breakers shall be arranged in Single or Double tier formation only to facilitate operation and maintenance.
- iii. The Switch Boards shall be of adequate size with a provision of 25% spare space to accommodate possible future additional switch gear.

c. Equipment Specifications

- i. All equipment used to configure the Switch Board shall comply to the relevant Standards and Codes of the Bureau of Indian Standards and to the detailed technical Specifications as included in this tender document.

d. Constructional Features

- i. The Switch Boards shall be metal enclosed, sheet steel cubicle pattern, extensible, dead front, floor mounting type and suitable for indoor mounting.
- ii. The Switch Boards shall be totally enclosed, completely dust and vermin proof. Synthetic rubber gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust and vermin proof to provide a degree of protection of IP 54 as specified. All doors and covers shall also be fully gasket with synthetic rubber and shall be lockable.
- iii. The Switch Board shall be fabricated with CRCA Sheet Steel of thickness not less than 2.0 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 metal shall be seam welded and all welding slag ground off and welding pits wiped smooth with plumber metal.
- iv. All panels and covers shall be properly fitted and square with the frame. The holes in the panel shall be correctly positioned.

- v. 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 construction of the Switch Boards.

e. Switchboard Dimensional Limitations

- i. A base channel 100 mm x 50 mm x 6 mm thick shall be provided at the bottom.
- ii. A minimum of 200 mm blank space between the floor of switch board and bottom most units shall be provided.
- iii. The overall height of the Switch Board shall be limited to 2300 mm.
- iv. The height of the operating handle, push buttons etc shall be restricted between 300 mm and 2000 mm from finished floor level.

f. Switch Board Compartmentalisation

- i. The Switch Board shall be divided into distinct separate compartments comprising.
- ii. A completely enclosed ventilated dust and vermin proof bus bar compartment for the horizontal and vertical bus bars.
- iii. Each circuit breaker and MCCB shall be housed in separate compartments enclosed on all sides.
- iv. Sheet steel hinged lockable doors for each separate compartment shall be provided and duly interlocked with the breaker in "on" and "off" position.
- v. For all Circuit Breakers separate and adequate compartments shall be provided for accommodating instruments, indicating lamps, control contactors and control MCB etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, bus bars and connections.
- vi. A horizontal wire way with screwed cover shall be provided at the top to take interconnecting control wiring between vertical sections.
- vii. Separate cable compartments running the height of the Switch Board in the case of front access Boards shall be provided for incoming and outgoing cables.
- viii. Cable compartments shall be of adequate size for easy termination of all incoming and outgoing cables entering from top.
- ix. Adequate and proper support shall be provided in cable compartments to support cables.

g. Switch Board Bus Bars

- i. The Bus Bar and interconnections shall be of electrolytic Copper/ Aluminium and of rectangular cross sections suitable for full load current for phase bus bars and half rated current for neutral bus bar. The maximum current density for copper shall be 1.6 amps per sq. mm. and for Aluminium shall be 1 amp per Sq. mm. and suitable to withstand the stresses of a 31 MVA fault level or at 415 volts for 1 second or as per schedule of quantities.
- ii. The bus bars and interconnections shall be insulated with insulation tape/ fibre glass.
- iii. The bus bars shall be extensible on either side of the Switch Board.

- iv. The bus bars shall be supported on non-breakable, non-hygroscopic insulated supports at regular intervals, to withstand the forces arising from a fault level of 31 MVA at 415 volts for 1 second.
- v. All bus bars shall be colour coded.
- vi. All bus bar connections in Switch Boards shall be bolted with brass bolts and nuts. Additional cross section of bus bars shall be provided wherever holes are drilled in the bus bars.

h. Switch Board Interconnections

- i. All connections between the bus bars/Breakers/cable terminations shall be through solid tinned copper strips of adequate size to carry full rated current and PVC/fibre glass insulated.
- ii. For unit ratings up to 100 amps PVC insulated copper conductor wires of adequate size to carry full load current shall be used. The terminations of all such interconnections shall be crimped and aluminium lugs shall be used.

i. Draw out Features

- i. Air Circuit Breakers shall be provided in fully draw out cubicles. These cubicles shall be such that draw out is possible without disconnection of the wires and cables. The power and control circuits shall have self-aligning and self-isolating contacts. The fixed and moving contacts shall be easily accessible for operation and maintenance. Mechanical interlocks shall be provided on the draw out cubicles to ensure safety and compliance to relevant Standards. The MCCB's shall be provided in fixed type cubicles.

j. Instrument Accommodation

- i. Instruments and indicating lamps shall not be mounted on the Circuit Breaker Compartment door for which a separate and adequate compartment shall be provided and the instrumentation shall be accessible for testing and maintenance without danger of accidental contact with live parts of the Switch Board.
- ii. For MCCB's instruments and indicating lamps can be provided on the compartment doors.
- iii. The current transformers for metering and for protection shall be mounted on the solid copper/aluminium bus bars with proper supports.

k. Wiring

All wiring for relays and meters shall be with PVC insulated copper conductor wires. The wiring shall be coded and labelled with approved ferrules for identification. The minimum size of copper conductor control wires shall be 1.5 sq. mm.

l. Cable Terminations

- i. Knockout holes of appropriate size and number shall be provided in the Switch Board in conformity with the location of incoming and outgoing conduits/cables.
- ii. The cable terminations of the Circuit Breakers shall be brought out to terminal cable sockets suitably located at the rear / top of the panel.
- iii. The cable terminations for the MCCB's shall be brought out to the rear in the case of rear access switchboards or in the cable compartment in the case of front access Switch Boards.

- iv. The Switch Boards shall be complete with tinned brass cable sockets, tinned brass compression glands, gland plates, supporting clamps and brackets etc for termination of 1100 volt grade aluminium conductor PVC/PVCA cables.

m. Space Heaters

The Switch Board shall have in each panel thermostatically controlled space heaters with a controlling 15 amp 230 volt switch socket outlet to eliminate condensation.

n. Ventilation Fans

The Switch Board shall be provided with panel mounting type ventilation fans in each panel with switchgear rated for 2500 amp and above. The fan shall be interlocked with switchgear operation.

o. Earthing

A main earth bar of G.I./copper as required shall be provided throughout the full length of the Switch Board with a provision to make connections to the can be tap from main earthing.

p. Sheet Steel Treatment and Painting

- i. Sheet Steel materials used in the construction of these units should have undergone a rigorous rust proofing process comprising of alkaline degreasing, descaling in dilute sulphuric acid and a recognised phosphating process. The steel work shall then receive two coats of oxide filler primer before final painting. Castings shall be scrupulously cleaned and fettled before receiving a similar oxide primer coat.
- ii. All sheet steel shall after metal treatment be spray or powder painted with two coats of shade 692 to IS 5 on the outside and white on the inside. Each coat of paint shall be properly stoved and the paint thickness shall not be less than 50 microns.

q. Name Plates And Labels

Suitable engraved white on black name plates and identification labels of metal for all Switch Boards and Circuits shall be provided. These shall indicate the feeder number and feeder designation.

2. Testing

Copies of type test carried out at ACB / MCCB manufacturers works and routine tests carried out at the switchboard fabricators shop shall be furnished along with the delivery of the switchboards. Engineer-In-Charge reserves the right to get the switchboard inspected by their representative at fabricators works prior to dispatch to site to witness the routine tests as per relevant clause of SCC

3. Testing at Site

- a. Pre-commissioning tests as required and as per manufacturers recommendations shall be carried out on each switchboard at site before energizing the switchboards including but not restricted to the following.
 - i. Physical checking of the switchboards including checking alignment of panels, interconnection of Bus bars, tightness of bolts/connections and evidence of damage/cracks in any components.
 - ii. Physical checking and inspections of Inter panel wiring
 - iii. Checking free movement of ACBs/MCCBs/SFUs
 - iv. Checking of operation of breakers

- v. Insulation tests of bus bar supports and control wiring etc. with 1.1 kV megger.
- vi. Primary & secondary injection tests of relays and CTs.
- vii. Checking of Interlocking function.

4. Cables

i. Medium Voltage Cables

- a. Medium voltage cables shall be aluminium conductor PVC insulated, PVC sheathed armoured conforming to IS 1554. Cables shall be rated for a 1100 Volts. The conductor of cables from 16 Sq. mm. to 50 mm² shall be stranded. Sector shaped stranded conductors shall be used for cables of 50 mm² and above. Conductors shall be made of electrical purity aluminium 3/4 H or H temper. Conductors shall be insulated with high quality PVC base compound. A common covering (bedding) shall be applied over the laid up cores by extruded sheath of unvulcanised compound. Armouring shall be applied over outer sheath of PVC sheathing. The outer sheath shall bear the manufacturer's name and trade mark at every meter length. Cores shall be provided with following colour scheme of PVC insulation.

1 Core	:	Red/Black/Yellow/Blue
2 Cores	:	Red and Black
3 Cores	:	Red, Yellow and Blue
3.5/4 Cores	:	Red, Yellow, Blue and Black

- b. Current ratings shall be based on the following conditions.
 - i. Maximum conductor temperature 70° C
 - ii. Ambient air temperature 45° C
 - iii. Ground temperature 30° C
 - iv. Depth of laying 1000 mm
- c. Short circuit rating of cables shall be as specified in IS 1554 Part-I.
- d. Cables have been selected considering conditions of maximum connected loads, ambient temperature, grouping of cables and allowable voltage drop. However, the contractor shall recheck the sizes before cables are fixed and connected to service.
- e. M.V. cables shall be PVC insulated aluminium/copper conductor and armoured cables conforming to IS Codes. Cables shall be armoured and suitable for laying in trenches, duct and on cable trays as required. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and un armoured cables.

ii. On Trays/Walls

- a. Wherever so specified, cables shall be laid along walls/ceiling or on cable trays. Cable shall be secured in position and dressed properly by means of suitable clamps, hooks, saddles etc. such that the minimum clear spacing between cables is diameter of the cable. Clamping of cables shall be at minimum intervals as below.

Type of Cable	Size	Clamping by	Fixing Interval
MV	Up to and including 25 sq	Saddles 1 mm thick	45 cms

	mm		
MV & HV	35 sq mm to 120 sq mm	Clamps 3 mm thick 25 mm wide	60 cms
MV & HV	150 sq mm and above	Clamps 3 mm thick 40 mm wide	60 cms

Note: The fixing intervals specified apply to straight runs. In the case of bends, additional clamping shall be provided at 30 cm from the centre of the bend on both sides.

b. Cable trays

- i. Channel or of ladder design as specified in BOQ. Cable trays shall be fabricated from sheet G.I of thickness as per BOQ Cable trays, of sizes as per schedule of quantities and drawings shall be of perforated doubled bend and shall be complete with tees, elbows, risers, and all necessary hardware.
- ii. Trays shall have suitable strength and rigidity to provide proper support for all the contained cables. Trays shall not have sharp edges, burrs or projections injurious to cable insulation. Trays shall include fittings for changes in direction and elevation. Cable trays and accessories shall be painted with two coats of red oxide zinc chromate primer after proper surface preparation and two finishing coats of synthetic enamel paint of approved make or as specified in BOQ. Cable trays shall have side rails or equivalent structural members.
- iii. Cable trays shall be mounted on support structure as specified by means of specified size of threaded rods and suitable fasteners. Spacing of the support structure shall be such that the cable trays shall remain perfectly horizontal without buckling when fully loaded with cable runs. The support structure shall be suspended from ceiling slab or grouted to walls in an approved manner. Width of the horizontal arms of the support structure shall be same as the tray width plus length required for threading /bolting /welding to the vertical supports. The length of vertical supporting members for horizontal tray runs shall be to suit the number of tray tiers required. Cable trays shall be bolted/ welded to the support structure. Minimum clearance between the top most tray tier and the ceiling shall be 300 mm. Trays shall be erected properly to present a neat and clean appearance. Trays shall be installed as a complete system. The entire cable tray system shall be rigid. Each run of cable tray shall be completed before laying of cables. Cable trays shall be erected so as to be exposed and accessible. Cables shall be fixed to the tray by clamps fabricated from minimum 3 mm thick GI sheets. The cables shall be dressed properly so as to provide minimum one cable diameter clearance between adjacent cables and from tray ends. Cable trays shall be earthed by 2 runs of 25 mm x 3 mm GI strips throughout their lengths.

5. LAYING OF CABLES

Cables shall be so laid that the maximum bending radius is 12 times the overall diameter of the cable for medium voltage cables. Cables shall be laid in masonry trenches, directly on walls/cable trays, directly buried in ground or in pipes/ducts as elaborated below. Cables of different voltages and also power and control cables shall be laid in different trenches with adequate separation. Wherever available space is restricted such that this requirement cannot be met, medium voltage cables shall be laid above HT cables. Where more than one cable is laid side by side, cable marker tags of approved type inscribed with cable identification details shall be permanently attached to cables at entry points to the building, at specified intervals for cables laid direct in grounds and in locations like manholes, pull pits etc.

6. Drawings

Shop drawings for control panels and wiring of equipment showing the route of conduit cable shall be submitted by the contractor for approval of Engineer-in-charge before starting the fabrication of panel and starting the work. On completion, all details like location of panels, switches, junction/pull boxes and cables route etc. shall be furnished by the contractor.

7. Measurement

Panels shall be counted as number of units. The quoted rate of panel shall also include all accessories, switch gear, fuses, contractor, indicating meters and lights as per the specification. Cable tray, Power & Control cable shall be measured in running meter.

SECTION 8 Commissioning and Guarantees

1. Scope of work

The work under this section shall consist of pre-commissioning, commissioning, testing and providing guarantees for all equipment, appliances and accessories supplied and installed by the contractor under this contract.

2. General requirements:

- a. Work under this Part shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this Part
- b. Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.
- c. On award of work, contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

3. Pre commissioning

- a. On completion of the installation of all pumps, piping, valves, pipe connections, electrical wiring, motor control panels and water level controlling devices the contractor shall proceed as follows:-
 - i. Testing of M.C.C
 - ii. Tests to be carried out for motor control centres shall be:
 - iii. Insulation resistance test with 500 volt megger, before and after high voltage test, on all power and control wiring.
 - iv. High voltage test sat 2000 volts A.C. for one minute on all power and control wiring.
 - v. Low voltage continuity test (6 volts) on power wiring of each feeder, between bus bars and the outgoing terminals with switches and contactors in closed position.
 - vi. Low Voltage continuity test (6 volts) on all control wiring.
 - vii. Operation test for all feeders with only control supply made 'on' to ensure correctness of control wiring, operation of the various equipment used such as push buttons, protective devices, indicating lamps and relays etc. All contactors shall be checked and there shall be no chattering.

- viii. Earth continuity test with voltage not exceeding 6 volts between various non-current carrying metallic parts of equipment, steel work etc. And the earth bus provided in the MCC.
- ix. Operation of all instruments and meters provided on the MCC.

b. Pipe work

- i. Check all clamps, supports and hangers provided for the pipes.
- ii. Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant Part of the specifications. If any leakage is found, rectify the same and retest the pipes.
- iii. Check all face piping and valves
- iv. check air blower connections

4. Commissioning & testing

a. All pumping sets

Start the duty pump on manual controls, check its operation and then test run on auto controls. Change over the duty pump and test it in the same manner as the first pump.

b. Test runs the entire system to ensure satisfactory performance.

5. Handing Over

- a. All commissioning and testing shall be done by the contractor to the complete satisfaction of the Engineer-In-Charge and the job handed over to the Engineer-In-Charge or his authorized representative.
- b. Contractor shall also hand over, to the Engineer-In-Charge, all maintenance & operation manuals, 4 sets of As Built drawings and all other items as per the terms of the contract with soft copy.

6. Guarantees

- a. The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.
- b. The form of warranty shall be as approved by the Engineer-in-charge.
- c. The warranty shall be valid for a period of one year from the after getting virtual completion certificate.
- d. The warranty shall expressly include replacement of all defective or under capacity equipment. Engineer-In-Charge may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.
- e. The warranty shall include replacement of any equipment found to have capacity lesser than the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Engineer-In-Charge.
- f. The contractor shall separately submit with this offer his charges per month for operation of mechanical equipment(s) after commissioning and handing over.

SECTION 9

I.S. Codes

Following codes and Indian standards shall be applicable as amended up to date-

A. Electrical equipment

1. Marking & arrangement for switch gear bus bars, main connections and auxiliary wiring- I.S. 375
2. Direct acting electrical indicating instruments - I.S.1248
3. Metal enclosed switch gear and control gear - I.S. 3427
4. A.C. Contactors of voltage not exceeding 1000 volts. - I.S. 2959
5. A.C. Motor starters of voltage not exceeding 1000 volts. -I.S. 1822
6. Air breaks isolation for voltages not exceeding 1000 volts -I.S. 2607
7. Heavy duty air break switches and composite unit of air break switches and fuses for voltage not exceeding 1000 volts. - I.S. 4047
8. PVC insulated cables (for voltage Up to 1100 volts with copper/ aluminium conductors)(Section I & II)- I.S. 694
9. Normal duty air break switches and composite units of air break switches and fuses for voltage not exceeding 1000 volts.-I.S. 4064
10. Code of practice for earthing - I.S. 3043
11. Pumps & motors
 - a. Centrifugal pumps -I.S. 1520
 - b. Electrical Motors - I.S.7538
12. Pipes
 - a. G.I. Pipes - I.S. 1239
13. Valves
 - a. Butterfly Valves -IS 23339/13095
 - b. Slim Type NRV -I.S. 7312
 - c. Sluice valve -I.S. 780
14. Vibration Eliminator
15. Water Shock Absorbers
16. Pipe Colour Code as per I.S. 2379-1983.

SECTION 10 Technical Information for Water Supply & Drainage Pumps to be furnished by Bidder:

i. Pumps

- a. Make
- b. Model
- c. Pump Discharge - Max/Min
- d. Pump Head Min/Max,
- e. Impeller Material
- f. Motor HP
(Specify make, class of insulation & rated voltage \pm %)
- g. Shaft Seal Type & make
- h. Type of Coupling
- i. Efficiency of Pump
- j. Type of Bearings

k. RPM

ii. Pressure Tanks (Where specified)

- a. Make
- b. Material of Construction
- c. Internal finish
- d. External finish
- e. Air balloon/ diaphragm
- f. specifications

iii. Submersible pumps- Plant Room- Sewage

- a. Make
- b. Model No.
- c. Pump discharge lpm - max / min
- d. Pump head min/max,
- e. Impeller material
- f. Motor HP (Specify make, class of insulation & rated voltage \pm %)
- g. Shaft seal Type & make
- h. Type of coupling
- i. Efficiency of pump
- j. Type of bearings
- k. RPM

iv. Motor Control Centres (Give detail on separate sheets if required)

- a. Make
- b. Type (floor/wall mounted)
- c. Make of switch gear
- d. Make of meters
- e. Make of accessories
- f. Confirm that all switch gear starters match the capacities of pumps offered.

v. Power & control cables

- a. Make

vi. Electronic Level controllers

- a. Make
- b. Model No.

vii. Electronic High Water Alarm

- a. Make
- b. Model No.

viii. Electronic Level Indicator

- a. Make
- b. Model

ix. Pipes /CPVC

- a. Make offered
 - i. Heavy Class 150 mm dia. & below
 - ii. Heavy Class 200 mm dia. & above
- b. CPVC Pipe

x. Butterfly Valves

- a. Make
- b. Material

- c. Test pressure
- xi. **NRV Slim Type**
 - a. Make
 - b. Material
 - c. Test pressure
- xii. **Vibration eliminators**
 - a. Make
 - b. Material
 - c. Test pressure
- xiii. **Pressure**
 - a. Working pressure
 - b. Test pressure
 - c. Filtration/holding Capacity
 - d. Inlet/outlet sizes
- xiv. **Painting/coating**
 - a. Inside
 - b. Outside
- xv. **Equipment** - **Air Blower** **Chlorinator**
 - a. Make
 - b. Model
 - c. Pump Discharge -Max/Min
 - d. Pump Head - Min/Max,
 - e. Impeller Material
 - f. Motor HP (Specify make, class of insulation & rated voltage \pm %)
 - g. Shaft Seal
 - h. Type of Coupling
 - i. Efficiency of Pump
 - j. Type of Bearings
 - k. Speed of Pumps
- xvi. **Motor control centres**
 - a. Type (floor/wall mounted)
 - b. Make of switch gear
 - c. Make of panel meters
 - d. Confirm that all switch gear starters are of capacities for pumps offered.
- xvii. Pipe fitting scheduled.
- xviii. C.I. Pipe
- xix. RCC Pipe.
- xx. L.A. Pipe.
- xxi. HDPE Pipe.
- xxii. Insulation Material
- xxiii. Flow Meter.
- xxiv. PRV
- xxv. Hydro-pneumatic Pump.
- xxvi. Water meter.

CHAPTER E
SPECIAL CONDITIONS FOR ELECTRICAL SERVICES

1.0 GENERAL

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

2.0 The contractor shall obtain all sanctions (electrical loads, approval of drawing/ ESS/ D.G.'s estimator/ approval of meter room etc. from the concerned authorities and permits required for the electrical installation work. All actual fee payable in this regard will be reimbursed against receipt/documentary evidence. On completion of work, the contractor shall obtain NOC from SEB & Director of Safety of the concerned state; a copy of the same shall be delivered to HLL. Contractor shall be responsible for handing over to SEB and other authorities shall be responsibility of contractor till commissioning and getting electricity in the complex.

The HLL shall have full power regarding the materials or work got tested by independent agency at the electrical contractor's expenses in order to prove their soundness and adequacy. The contractor will rectify the defects/suggestions pointed out by HLL/ independent agency at his own expenses.

The installation shall comply in all respects with the requirements of Indian Electricity Act 1910, Indian Electricity Rules (IER) 1956 and other related Laws and Regulations as amended up to date, thereunder and special requirements, if any, of the State Electricity Boards etc. The bidder is liable to furnish the list of authorized licensed persons/ employed/deputed to carry out the works/perform the assigned duties to fulfill the requirement of Rule No.3 of IER 1956 as amended up to date.

3.0 DRAWINGS

i) Shop Drawings

The contractor shall prepare detailed coordinated electrical shop drawing indicating lighting/lighting fixtures, convenience outlets, D.G.'s, H.T., Transformer, M.V. Panel Boards/Relay Panel, PCC, DB's, Rising Mains, Cable Schedule with other relevant services and submit to the HLL for approval or the Engineer-in-Charge before commencing the work. The shop drawings shall indicate all setting out details and physical dimensions of all components with wiring and cable details including system operating write up in the system i.e. 33 KV Panel Board, Control and Relay Panel Package Substation, D.G.'s, PCC's, MCC's, cable schedule and routes, manhole trap and fixing details as well as for conduit indicating run and size of wire/cables, outlet/pull/junction boxes etc. with fixing details etc. for the above mentioned work. All work shall be carried out on the approval of these drawings. However, approval of these drawings do not relieve the contractor of his responsibility for providing maintenance free and fool proof system including any missing component/accessories to meet with the intent of the specifications. Contractor will submit 2 prints for preliminary approval and finally six prints for distribution.

ii) Completion Drawings/As Built Drawings

On completion of the work and before issue of certificate of virtual completion, the contractor shall submit to the HLL 4 sets along with soft copy of 'As Built' drawings (in AutoCAD & PDF format) of the work along with 01 Nos. cloth tracing originals including

write up (trouble shooting, installation, operation and maintenance manual with instructions) incorporating all such changes and modifications during engineering and execution along with warrantee & guarantee certificates from manufacturers.

These drawings must provide:

- Run and size of conduit, inspection and pull boxes including routing and locations.
- Number and size of conductor in each conduit.
- Locations and rating of sockets and switches controlling the light and power outlet.
- A complete wiring diagram as installed and schematic drawings showing all connections in the complete electrical system.
- Location of outlets of various services, junction boxes, light fixtures.
- Location of all earthing stations route and size of all earthing conductors.
- Layout and particulars of all cables.
- Location and details of PCC's, MCC's, Feeder Pillars, capacitor control panels, PLC D.G. set panel, UPS panel, and relay panels with description detailed control wiring diagram.
- Location of transformer and its details and control wiring diagram.
- Location of Hume pipe and manhole including HT/LT cable layout and scheduling.
- Location of D.G.'s, exhaust and auxiliary equipment with schematic drawings.
- Layout of cable trays with support and their fixing details.
- Location of all earthing station, route and size of all earthing conductor.
- Layout and particulars of rising mains with fixing details.

iii) Position of HT/LT Switch Boards/Transformer & D.G.'S

The recommended position of the switch boards, transformer & D.G.'s as shown on the layout drawings will be adhered to as far as practicable.

The contractor shall submit 2 sets of samples of each type of accessories and apparatus, proposed to be used in the installation at site for approval (drawings or samples) as required shall be submitted by contractor and the choice of selection out of the approved list lies with the HLL. For all non-specified items, approval of the HLL shall be obtained prior to procurement of the same. HLL shall in no way be liable for rejection of the any material due to poor quality, poor workmanship, poor material etc.

4.0 MANUFACTURER'S INSTRUCTIONS

Where manufacturers have furnished specific instructions, relating to the material/equipment to be used on this job, covering points not specifically mentioned in this document, manufacturers' instructions should be followed.

5.0 MATERIALS AND EQUIPMENT

All the materials and equipment shall be of the approved make and design. Unless otherwise called for any approval by HLL's Engineer-in-Charge, only the best quality materials and equipment shall be used.

The contractor shall fill in the data sheet for capital equipment as attached elsewhere in this document. The Material/Equipment shall be rejected due to not giving / filling in the details of the said equipment.

6.0 GENERAL DETAILS

6.01 Space Heaters & Lighting.

One of more adequately rated heaters thermostatically controlled with On-Off switch and fuse shall be provided to prevent condensation in any panel compartment. The heaters shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation. CFL lamp shall be provided in any panel compartment.

6.02 Fungistatic Varnish

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts, which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

6.03 Ventilation Opening

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

6.04 Degree of Protection

The enclosures of the Control Cabinets, Junction Boxes and Marshalling Boxes, Panels etc. to be installed shall provide degree of protection as called for in specification / BOQ whenever it is not mentioned it shall be as given below.

- Installed out door: IP-55.
- Installed indoor in air-conditioned area: IP-52.
- Installed in covered area: IP-52.
- Installed indoor in non-air-conditioned area where possibility of entry of water is limited: IP-42.
- For L.T. switchgear (AC and DC distribution boards): IP-52.

The degree of protection shall be in accordance with IS: 13947 (Part-I)/IEC-947 (Part-I). Type test report for degree of protection test, on each type of the box shall be submitted for approval.

6.05 Rating Plates, Name Plates and Labels

Main PCC, PCC's, MDB and auxiliaries items installed in the building are to permanently attach to it in a conspicuous position. A rating plate of non-corrosive material with engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of the loading conditions of equipment in question has been designed to operate and such diagram plates as may be required by the purchaser. The rating plate of each equipment shall be according to IEC requirement.

All such nameplates, instruction plates, rating plates shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates one with Hindi and the other with English inscriptions may be provided.

6.06 First Fill of Consumables, Oil and Lubricants

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, welding/soldering/brazing material for all copper/G.I. earthing and essential chemicals etc. which will be required to put the equipment/scheme covered under the scope of the specifications, into successful operation, shall be furnished by the Contractor unless specifically excluded under the exclusions in these specifications and documents.

7.0 DESIGN IMPROVEMENTS

The bidder shall note that the equipment offered by him in the bid only shall be accepted for supply. If for any reason, Contractor wishes to deviate from specification, prior permission from HLL will be sought.

If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly in the specification.

8.0 QUALITY ASSURANCE PROGRAMME

To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the Purchaser's site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be outlined by the Contractor and shall be finally accepted by the Purchaser after discussions before the award of Contract. A quality assurance programme of the contractor shall generally cover the following:

- His organization structure for the management and implementation of the proposed quality assurance programme.
- Documentation control system.
- Qualification data for bidder's key personnel.
- The procedure for purchases of materials, parts components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
- System for shop manufacturing and site erection controls including process controls and fabrication and assembly control.
- Control of non-conforming items and system for corrective actions.
- Inspection and test procedure both for manufacture and field activities.
- Control of calibration and testing of measuring instruments and field activities.
- System for indication and appraisal of inspection status.
- System for quality audits.
- System for authorizing release of manufactured product to the Purchaser.
- System for maintenance of records.
- System for handling storage and delivery.
- A quality plan-detailing out the specific quality control measures and procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

The Purchaser or his duly authorized representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor/his Vendor's quality management and control activities.

9.0 QUALITY ASSURANCE DOCUMENTS

The Contractor shall be required to submit the following Quality Assurance Documents within three weeks after dispatch of the equipment.

- All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication and reports including radiography interpretation reports.
- Welder and welding operator qualification certificates.
- Welder's identification list, listing welders and welding operator's qualification procedure and welding identification symbols.
- Raw material test reports on components as specified by the specification and/or agreed to in the quality plan.
- Stress relief time temperature charts/oil impregnation time temperature charts.
- Factory test results for testing required as per applicable codes/mutually agreed quality plan/standards referred in the technical specification.
- The quality plan with verification of various customer inspection points (CIP) as mutually and methods used to verify the inspection and testing points in the quality plan were performed satisfactorily.

10.0 INSPECTION, TESTING AND INSPECTION CERTIFICATE

- The HLL or duly authorized representative shall have at all reasonable times free access to the Contractor/ Manufacturer's premises or works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection, if part of the works is being manufactured or assembled at other premises or works, the Contractor shall obtain permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site at the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.
- All equipment being supplied shall conform to type tests and shall be subject to routine tests in accordance with requirements stipulated under respective sections. Bidder shall submit the type tests reports for approval. The Contractor shall intimate the HLL the detailed programme about the tests at least three (3) weeks in advance in case of domestic supplies. If for any item type test is pending payment would be made on successful completion of type/routine test(s) actually carried out as per HLL instructions.
- The Contractor shall give the HLL thirty (30) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account. The HLL, unless witnessing of the tests is virtually waived off, will attend such tests within thirty (30) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the presence of HLL and he shall forthwith forward to the HLL duly certified copies of tests in triplicate.
- The HLL shall within fifteen (15) days from the date of inspection as defined shall inform in writing to the Contractor of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and make the necessary modifications accordingly.
- When the factory tests have been completed at the Contractor's or Sub-contractor's works, the HLL shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the HLL, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the HLL. Failure of the issue such a certificate shall not prevent the Contractor from

proceeding with the works. The completion of these tests or the issue of the certificate shall not bind the HLL to accept the equipment should, it, on further tests after erection, is found not to comply with the Specification. The equipment shall be dispatched to site only after approval of test reports and issuance of clearance by the HLL.

- The contractor shall arrange all necessary instruction and testing facilities free of cost for this purpose including air travel, lodging and boarding expenses.
- For tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be required by HLL or this authorized representative to carry out effectively such tests of the equipment in accordance with the Specification.
- The inspection by HLL and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.
- The HLL will have the right of having at his own expenses any other tests(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests to satisfy that the material comply with the specifications.
- The HLL reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipment for these tests shall be provided by the Contractor.

11.0 TESTS

11.01 Charging

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the HLL and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The pre-commissioning tests to be performed as per relevant I.S. given and shall be included in the Contractor's quality assurance programme.

11.02 Commissioning Tests

- The available instrumentation and control equipment will be used during such tests and the Contractor will calibrate all such measuring equipment and devices as far as practicable. However, unmeasurable parameters shall be taken into account in a reasonable manner by the Contractor for the requirement of these tests. The tests will be conducted at the specified load points and as near the specified cycle condition as practicable. The Contractor will apply proper corrections in calculation, to take into account conditions, which do not correspond to the specified conditions.
- All instruments, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.
- Pre-commissioning test shall be carried out as per relevant IS and/or as specified in the relevant clause.
- The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning of the equipment. However necessary fee shall be reimbursed by MoHFW on production of requisite documents.

12.0 PACKAGING

All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of availability of Railway wagon/truck/trailer sizes in India should be taken account of the Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. HLL takes no responsibility of the availability of any special packaging/transporting arrangement.

13.0 PROTECTION

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

14.0 FINISHING OF METAL SURFACES

14.01 General

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts and bolts and spring washers shall be electro galvanized. All steel conductors used for earthing/grounding (above ground level) shall be galvanized according to IS: 2629.

14.02 Hot Dip Galvanizing

- The minimum weight of the zinc coating shall be 700 gm/sq.m and minimum thickness of coating shall be 85 microns.
- The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discolored patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.
- After galvanizing drilling or welding shall be performed on the galvanized parts of the earthing materials. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.
- The galvanized steel shall be subjected to six one minute dips in copper sulphate solution as per IS-2633.
- Sharp edges with radii less than 2.5mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards.
 - Coating thickness,
 - Uniformity of zinc,
 - Adhesion test,
 - Mass of zinc coating.

- Galvanized material must be transported properly to ensure that galvanized surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

14.03 Painting

- All sheet steel work shall be degreased, pickled, phosphate in accordance with the IS-6005 "Code of practice for phosphating iron and sheet". All surfaces which will not be easily accessible after shop assembly shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.
- After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be shopped.
- Powder coating/electrostatic painting of approved shade shall be applied.
- The exterior color of the paint shall be as per shade no.697 of IS-5 or as approved by Engineer-in-charge and inside shall be white or as approved by Engineer-in-charge. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments, if required.
- In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures like electrostatic painting etc. the procedure shall be submitted along with the Bids for HLL's review and approval.

15.0 HANDLING, STORING AND INSTALLATION

- In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Purchaser or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented.
- Contractor shall follow the unloading and transporting procedure at site, as well as storing, testing and commissioning of the various equipment being procured by him separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's Engineer(s) and shall extend full co-operation to them.
- In case of any doubt/ misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the HLL. Contractor shall be held responsible for any damage to the equipment consequent for not following manufacturer's drawings/instructions correctly.
- Where assemblies are supplied in more than the one section, Contractor shall make all necessary connections between sections. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

- The Contractor shall submit to the HLL every week, a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.
- The Contractor shall be fully responsible for the equipment/material until the same is handed over to the HLL in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by HLL, as well as protection of the same against theft, element of nature, corrosion, damages etc.
- The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment, which require indoor storage.
- The words 'erection' and 'installation' used in the specification are synonymous.
- Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.
- The minimum phase to earth, phase to phase and section clearance along with other technical parameters for the various voltage levels shall be maintained as per relevant IS.

16.0 PROTECTIVE GUARDS

Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy installation and removal for maintenance purpose.

17.0 DESIGN CO-ORDINATION

The Contractor shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

18.0 DESIGN COORDINATION MEETING

The Contractor will be called upon to attend design co-ordination meetings with the Engineer, and the HLL/ MoHFW during the period of Contract. The Contractor shall attend such meetings at his own cost at New Delhi or at mutually agreed venue as and when required and fully co-operate with such persons and agencies involved during those discussions.

19.0 TOOLS AND TACKLES

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dis-assembly and maintenance of the equipments.

CHAPTER F

TECHNICAL SPECIFICATIONS – ELECTRIFICATION

SECTION 1: GENERAL DETAILS

1. Degree of Protection

The enclosures of the Control Cabinets, Junction Boxes and Marshalling Boxes, Panels etc. to be installed shall provide degree of protection as called for in specification / BOQ whenever it is not mentioned it shall be as given below.

- Installed out door: IP-55.
- Installed indoor in air-conditioned area: IP-52.
- Installed in covered area: IP-52.
- Installed indoor in non-air-conditioned area where possibility of entry of water is limited: IP-42.
- For L.T. switchgear (AC and DC distribution boards): IP-52.

The degree of protection shall be in accordance with IS: 13947 (Part-I)/IEC-947 (Part-I). Type test report for degree of protection test, on each type of the box shall be submitted for approval.

2. Rating Plates, Name Plates and Labels

Rating Plates, Name Plates and Labels shall be permanently attached to Main PCC, PCC's, MDB and auxiliaries items installed in the building, in a conspicuous position. A rating plate of non-corrosive material with engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of the loading conditions of equipment in question has been designed to operate and such diagram plates as may be required by the purchaser. The rating plates for all equipment shall be according to IEC requirement.

All such nameplates, instruction plates, rating plates shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates one with Hindi and the other with English inscriptions may be provided.

3. First Fill of Consumables, Oil and Lubricants

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, welding/soldering/brazing material for all copper/G.I. earthing and essential chemicals etc. which will be required to put the equipment/scheme covered under the scope of the specifications, into successful operation, shall be furnished by the Contractor unless specifically excluded under the exclusions in these specifications and documents.

4. Finishing Of Metal Surfaces

4.1. General

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts and bolts and spring washers shall be electro galvanized. All steel conductors used for earthing/grounding (above ground level) shall be galvanized according to IS: 2629.

4.2. Hot Dip Galvanizing

- The minimum weight of the zinc coating shall be 700 gm / sq.m and minimum thickness of coating shall be 85 microns.
- The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discolored patches, bare spots, unevenness of coating, splatter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.
- After galvanizing drilling or welding shall be performed on the galvanized parts of the earthing materials. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.
- The galvanized steel shall be subjected to six one minute dips in Copper Sulphate solution as per IS-2633.
- Sharp edges with radii less than 2.5mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards.
 - Coating thickness,
 - Uniformity of zinc,
 - Adhesion test,
 - Mass of zinc coating.
- Galvanized material must be transported properly to ensure that galvanized surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

4.3. Painting

- All sheet steel work shall be degreased, pickled, phosphate in accordance with the IS-6005 "Code of practice for phosphating iron and sheet". All surfaces which will not be easily accessible after shop assembly shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.
- After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be shovelled.
- Powder coating/electrostatic painting of Siemens Gray RAL 7032 shade shall be applied.
- The exterior color of the paint shall be as per Siemens Gray RAL 7032 or as approved by Engineer-in-charge and inside shall be white or as approved by Engineer-in-charge. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments, if required.

- In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures like electrostatic painting etc. the procedure shall be submitted along with the Bids for HLL's review and approval.

5. **PROTECTIVE GUARDS**

Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy installation and removal for maintenance purpose.

SECTION -2: 33KV VCB SWITCHGEAR

1. **SCOPE**

All the necessary approvals & liaison for obtaining new HT connection and Load enhancement from present approved load to the required load, as per applicable case, shall be in the scope of the contractor. Only fee paid to the authority shall be reimbursed against the submission of the original receipt and nothing shall be paid extra on this account.

Manufacturing and supplying of integrated cubicle type metal clad, Form 3a, floor mounted and draw out type free standing, front operated indoor type 33 KV switchgear as per specifications given below:

The switchgear enclosure shall conform to degree of protection IP 4 X. The switchgear shall be made from CRCA sheet steel 2 mm thick (CRGO) and shall be folded and braced as necessary to provide a rigid support for all components.

The switchgear assembly shall form a continuous dead front line up of free standing vertical cubicles. Each cubicle shall have a lockable front hinged door and a removable bolted back cover. All covers and doors shall be provided with neoprene gaskets. Suitable arrangement for lifting of each cubicle shall be provided. Design and construction of the switchgear shall be such as to permit extension at either end.

Vacuum Circuit breaker shall be provided with surge arresting device for protection against lightning and switching over voltage. Two separate and distinct connections to earth shall be provided for each surge arrester.

2. **STANDARDS AND CODES**

Updated and current Indian Standard Specifications and 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 2003, Indian Electricity Rules 1956, National Building Code 2005, National Electric Code 2008, Code of Practice for Fire Safety of Building (general): General Principal and Fire Grading – IS 1641 - 1988 as amended upto date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable.

33000 Volt Circuit Breaker:	IS 13118; 1991
Metal Enclosed Switchgear and Control gear for voltages above 1000 volts	IS 3427: 1969
Electrical Relays for Power System Protection	IS 3231: 1986
Voltage Transformers	IS 3156: 1978
Current Transformers	IS 2705: 1981
Rubber Mats for Electrical Works	IS 5424: 1983
Danger Notice Plate	IS 2551: 1982

AC isolators and earthing switches	IEC 129
AC metal enclosed Switchgear	IEC 298

3. BREAKER COMPARTMENT

Vacuum Circuit Breaker shall be mounted in draw out truck with front plate which covers the cubicle when the breaker is in service position. This front plate shall be provided with view glass to facilitate observation of mechanical ON/OFF indication of Circuit breaker, Spring charged / discharged indication and operation counter.

Necessary orifice shall be provided for manual charging of the springs. ON/OFF push button for opening and closing of the circuit breaker shall also be provided. The draw out truck shall have two positions for the circuit breaker VIZ isolated / Test & Service.

4. BUS BAR COMPARTMENT

Bus bars of rectangular cross section of copper conductor supported by cast epoxy insulator to withstand full short circuit currents up to 26.4 kA for one second shall be provided at the rear. Bus bar chamber shall be provided with inter panel barriers with epoxy cast seal off bushings.

5. CT AND CABLE COMPARTMENTS

At the rear of the panel sufficient space shall be available to accommodate three numbers epoxy CT's of double core and two numbers three core cable termination. The cable entry shall be from the top / bottom.

6. SEPARATE COMPARTMENTS

Circuit breakers, instrument transformer, bus bars, cable etc shall be housed in a district different compartments as required for form 3 a, compartmentalization. All relays, switches, lamps, etc. comprising the control, indication and protective devices shall be housed in a separate compartment on the front of the cubicle.

7. TECHNICAL PARTICULARS OF VCB CIRCUIT BREAKER

Rated Current	-	630 A
Rated Voltage	-	33 kV
Rated Frequency	-	50 Hz
Rated Short Circuit breaking Current	-	26.4 kA for 3 Sec.
Rated short circuit making Current	-	75 kA
Insulation Level (KV rms/KVP)	-	28 kV / 75 kV

8. EARTHING SWITCH

Cable earthing switch shall be provided in the cable chamber and shall be operated from the front of the panel. The ON/OFF position of switch shall be indicated by mechanical indicator. The Earthing switch shall be suitably interlocked with the breaker, so that it can be operated only when the breaker is in OFF position.

Earthing switch shall also be provided on bus bar side. The ON/OFF Switch shall be indicated by mechanical indicator. The earthing switch shall be suitably interlocked with the breaker, so that it can be operated only when the breaker is in OFF position.

9. ISOLATING CONTACTS

The breaker isolating contacts shall consist of two parallel flat silver plated copper bars with ball point contacts to give a vertical tolerance of ± 10 mm.

10. LOW VOLTAGE PLUG AND SOCKET CONNECTOR

A twenty pin plug and socket connection along with flexible leads shall be provided to connect control instrumentation and interlock circuits on the breaker truck and in the panel. The plug and socket assembly shall be suitably interlocked with the truck positions like service and test/isolated position

11. INTERLOCKS

The following interlocks shall be provided:

- The truck cannot be moved from either test to service position or vice versa, when the circuit breaker is 'ON'.
- The circuit breaker cannot be switched 'ON' when the truck is in any position between test and service position.
- Front part of the truck cannot be removed when the breaker in 'ON' position.
- The low voltage plug and socket cannot be disconnected in any position except test/isolated position.
- The truck cannot be moved inside the panel, when the LT plug and socket is disconnected.
- Earthing switch cannot be switched 'ON' when the truck is inside the panel.
- The truck cannot be inserted when the earthing switch is 'ON'.

12. SAFETY DEVICES

The following Safety devices shall be provided for the safety of the operating personnel:

- Individual explosion vents shall be provided for breaker/bus bar/cable chambers on the top of the panel to let out the gases under pressure generated in case of fault inside the panel.
- Cubicle with front plate to withstand the pressure for internal arc fault as per PEHLA recommendation.
- Cubicle with front plate to withstand the pressure for internal arc fault
- Circuit breaker and sheet metal enclosure shall be fully earthed.
- Self-locking shutters shall be provided which shall close automatically when the truck is withdrawn to 'Test position' and no separate padlocking of the shutter shall be required.

13. PROTECTIVE EARTHING

The earthing connection between the truck and the cubicle shall be by means of sliding contacts so that the truck is earthed in the isolated position when inserted and remains earthed when the truck is pushed further into the connected position or when the truck is being withdrawn until the truck has moved part the isolated position.

14. CURRENT TRANSFORMER

I. GENERAL REQUIREMENTS

Accommodation shall be provided in the circuit breaker panel, to mount one set of dual ratio CT. Access to the CTs for cleaning, testing or changing shall be from the front, back or top of the panel.

II. RATING

Dual ratio CTs of suitable burden (but each not less than 15 VA) shall be preferred with 5 amps secondary's.

Instrument Security Factor (ISF) of each CT shall not be more than 5.

The CT's shall conform to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits. CT terminals shall be shorting type. Current & voltage circuits shall be laid in separate wire ways. Secondary terminals of CTs shall be brought out to a suitable terminal block which will be easily accessible for terminal connections. Test terminal block shall be provided in the front side of the panel for testing purpose.

CT's shall have 2 Nos. of cores for following application:

Core -1 for metering

Core -2 for over current & earth fault protection.

Class of accuracy of each winding

Metering class 1

Protection class 5P10

15. POTENTIAL TRANSFORMERS

The potential transformers shall be confirming to IS 3156/ IEC 185. The primary windings of the potential transformers shall be insulated and shall be of the cast rest in type.

Potential Transformer (PT's) shall be mounted on a draw out trolley and housed in separate metal compartment and shall have control fuses on the H.V. side and a miniature circuit breaker on the L.V. side of the windings. HT HRC Control fuses shall be confirming to IS - 609385/ IEC - 282. Miniature Circuit breaker shall comply with IS -608828/ IEC - 898.

Padlocking facilities shall be provided for both service and isolated position.

The potential transformer shall be as specified below:

Ratio	:	33000/ V3/ 110/ V3/ 110 V
V A Burden	:	200 VA for 100/V3 and 110 V winding
Class	:	CL -1 for both the windings.
Basic Insulation level	:	36/75 KV
Over voltage factor	:	1.2 Continuous

Single phase PT's shall be used and shall be connected in Star/ Star.

16. PROTECTION AND TRIPPING ARRANGEMENT PROTECTION

The protection and tripping arrangement of circuit breaker shall be :

- Numeric Type Instantaneous short circuit protection Device No.50 Range 500 – 2000% shall be provided on all phases.
- Numeric Type Back up over current protection for Phase faults Device No.51 Range 50 – 200% shall be provided on all phases.
- Numeric Type Ground fault protection Device No.50G with stabilizing resistor. CT's. Range 20 – 80% shall be provided.
- Lockout and trip supervisory relays etc shall be provided with manual reset facility.

- Auxiliary relay for transformer fault.
- Surge Arrestor

17. CONTROL WIRING

The control wiring shall be carried out with minimum 2.5 sq. mm. PVC insulated, Fire Resistent, copper conductor cables. The wiring shall be securely fixed and neatly arranged to enable easy tracing of wires. Identification PVC ferrules shall be fitted to all wire terminals to render easy identification and facilitate checking in accordance with IS 5578 and 11353.

18. METERING INSTRUMENT PANEL ACCESSORIES

I METERING

Digital Type Tri-vector meter of approved make shall be provided on the incomer feeder. Specification of the meter shall be as follows:

Accuracy: Class 0.2, compliant to revenue class certification

ANS I – C 12.20 – 1998 on all measurements.

- : Real time measurement per phase & average V, I, PF, KW, KVAR, KVA
- : Peak demand, sliding window. Protected.
- : V & I unbalance, Phase reversal
- : Time of Use (TOU)

Power Quality Measurement : Total Harmonics

Logging & recordings for all measurement: Interval or event-based, 32 channel measurement & recording

: Event logging

: “Bust” data recording

: Min/ Max recording

Alarming : Over & under measurement detection by 24 set point functions.

Multiport Communication : One each of RS 485 and RS 232 ports.

II. INSTRUMENT PANELS

The instrument panel shall be part of the housing. Relays, meters and instruments shall be mounted as per general arrangement drawings to be submitted by the vendors. They shall be of flush mounting type.

III. INSTRUMENTATIONS

Digital type Power factor meter of class 1.0 accuracy conforming to IS: 1248 shall be provided at incomer panel.

Digital type Ammeter of specified range to class 1.0 accuracy and 96 x 96 sq mm in size as per IS - 1248 shall be provided at both incomer and outgoing panels along with necessary selector switches.

Digital type frequency meter class of 1.0 accuracy conforming to IS:1248 shall be provided at incomer panel.

IV. The following minimum indication lamps shall be provided in the front of cubicle.

Breaker open / closed / tripped, spring charged, trip circuit healthy and control supply healthy. Lamps shall be clustered LED type and trip circuit supervision scheme shall be of continuous supervision type.

- V. After meeting all necessary control and indication requirements 2 nos. NO and 2 nos.. NC auxiliary of the breaker shall be made available for the UMNICRC, wired up to terminal block.
- VI. Separate MCB's shall be provided for lamps, heaters and other instrumentation etc. on each panel.
- VII Anti-condensation space heaters suitable for operation on 240 V single phase, 50 Hz A.C. for each cubicle and with thermostat control one incandescent lamp with switch and 3 pin 5 amps plug socket.

19. DRAWINGS/DOCUMENTS REQUIRED FOR REVIEW/APPROVAL

Following drawings documents shall be submitted by the manufacturer for approval.

- General arrangement (GA) of equipment layout.
- Equipment list.
- Relay and metering system schematics.
- Supply and erection schedule.
- Catalogue and specification sheets.

20. QUALITY ASSURANCE

Vendor shall submit in substantial detail a quality assurance plan indicating all activities step by step at various manufacturing/fabrication stages to meet the requirement of this specification and various standards/regulations/practices to enable comprehensive assessment of its merits and reliability.

21. TEST AT MANUFACTURERS WORKS

Copies of type tests and of routine tests carried out at manufacturer's works shall be furnished along with the delivery of the switchboards. Engineer-in-charges/CLIENTs reserves the right to get the switchboard inspected by their representative at manufacturer's works prior to dispatch to site to witness the routine tests, for which purpose the contractor shall provide the necessary facilities and also give due notice.

22. TESTS AT SITE

Pre-commissioning tests as per manufacturer's recommendations shall be carried out on the switchboard a site after installation including but not restricted to the following.

- Physical checking of the switchboard including checking for damage or cracks in components, bolt tightness, gasket ting etc.
- Checking of vacuum bottles to ensure leak tightness
- Insulation testing of Bus bar supports by 2.5 kV megger
- Insulation testing of Control wiring by 1.1 kV megger.
- Testing of relays and CTs with secondary injection kit.
- Checking of breaker operation.
- Checking of earth continuity.
- High potential test / Pressure testing

23. RUBBER MATS:

All HT Panels shall be provided with suitable grade rubber mats conforming to the relevant IS Code.

SECTION -3 : DISTRIBUTION TRANSFORMER

A. 33/0.433 kV OIL TYPE DISTRIBUTION TRANSFORMER WITH ON LOAD TAP CHANGER MECHANISM WITH AUTOMATIC VOLTAGE REGULATOR

1. GENERAL

The step down double wound core type transformers shall be suitable for Outdoor mounting with a voltage ratio of 33000/433 Volts and of the naturally oil cooled with a Delta/Star configuration. The transformer shall comply with the regulations of IEC 76, B.S. 171, IS: 1180 as amended up to date.

2. TRANSFORMER DETAILED SPECIFICATIONS

2.1. TRANSFORMER OPERATION

The transformer shall be suitable for operation on 33 kV, 3 phase 50 cycle earthed system, connected Delta on H.V. side and star on the L.V. side with neutral brought out for independent Earthing (Vector Group DYN11). The transformer shall be suitable for continuous operation at the rated capacity under Site conditions.

2.2. TRANSFORMER MATERIAL

The material used in the manufacture of the transformer shall be of the best quality of their respective kind available as per standard specifications.

2.3. CORE

The core shall be built up with high grade non-aging, low loss and high permeability CRGO lamination special silicon steel suitable for transformers. After being sheared, the lamination shall be treated to remove all burs and shall be re-annealed to remove all residual stresses. Each lamination shall be coated with a durable, insulating coating. Core assembly shall be provided with lugs suitable for lifting the complete core and coil assembly of the transformers. Core and coil shall be so fixed that there is permanent displacement of windings on other parts when the transformer is moved or during short circuit. Core frame parts shall be galvanized.

2.4. WINDINGS

The HV and LV windings shall be of copper conductors using highly densified glass fiber reinforcement. Temperature rise of winding shall not exceed 50 deg C by resistance on continuous full load above ambient of 50 deg C and temperature rise of oil shall not exceed 45 deg C above ambient of 50 deg C. Flux density at any point in winding and core shall not exceed 1.7 T on normal rated voltage and frequency.

2.5. On Load Tap Changer (OLTC)

The transformer shall be provided with an Automatic On Load Tap Changer (OLTC) with Remote Tap Changer Control (RTCC) facility. The OLTC suitable for an incoming voltage variation from +10% to -10% in 17 steps on H.V. side so as to give a near constant voltage of 433 volt on the L.V. side. The OLTC shall be provided with automatic voltage sensing relay and shall be fully automatic in operation.

The OLTC shall be supplied with the first filling of the oil, oil surge relay, shut off valve for the OLTC oil surge relay, trip contracts, access windows for OLTC

connection etc. The OLTC shall be provided with motorized / manual operation alongwith handle for operating manually. Mechanical tap position indicator shall be provided.

OLTC shall be provided with remote / local operation facility with selector switch for remote/local operation. The Remote Tap Changer Control Panel (RTCC) shall have remote indicator for the position of the steps and automatic voltage regulating relays. The RTCC Panel shall have Push buttons for Raise and Lower. The RTCC shall have indicating lamps for :-

- Tap in progress
- Raise
- Lower
- Out of step indication

2.6. INSULATION CLASS

The insulation material shall be insulation class 'A'.

2.7. TRANSFORMER TAPPINGS

'ON' load tap changing links on HV side. The tappings to be provided for variation on HV side from + 5% to – 15% in steps of 2.50%. each.

2.8. TRANSFORMER CHARACTERISTICS

The no load voltage ratio of the transformer shall be 33000/433 Volts and the percentage impedance shall not exceed 6.25% or as per IS.

2.9. TRANSFORMER TERMINATIONS

The transformer shall have self-supporting cable boxes with suitable glands and cable sockets for receiving 33,000 Volt grade XLPE cables on the H.V. side as required.

On the LV side the transformer shall have a suitable self supporting terminal arrangement with extended busbars to receive 1100 Volt grade Aluminium Conductor Sandwich Busduct as specified.

2.10. TEMPERATURE RISE PARAMETERS

Thermistor sensors shall be embedded in the low voltage winding for warning and tripping, for temperature control. The temperature detectors shall be suitable for 24 volts D.C. The temperature rise when continuously operated of windings by resistance method shall not exceed 20 deg C over 50 deg C ambient for warning and 45 deg C over 50 deg C ambient for tripping.

2.11. TRANSFORMER FITTINGS

The transformer alongwith OLTC shall be manufactured in accordance with the requirements as specified in the Standards stated above and shall be fitted with:

1. Diagram and Rating plate
2. Lifting Lugs.
3. Two earthing terminals on either side of the tank.
4. Four bidirectional rollers on the under carriage for movement.
5. Winding Temperature Indicator with alarm contacts for alarm and trip circuits.

6. Externally operated tapping switch with position indicator & locking arrangement.
7. Terminal marking plate.
8. Jacking Lugs.
9. H.V. cable box for 3 core XLPE cable as required.
10. L.V. cable box suitable for reception of XLPE armoured cables or chamber for receiving sandwich/ air insulated bus ducts as required.
11. Oil conservator with drain plug.
12. Oil filling hole and cap.
13. Filter valve with plug.
14. Drain valve with plug or cover plate.
15. Oil level indicator with minimum marking.
16. Dehydrating breather (Silica gel breather)
17. Air release valve.
18. Explosion vent.
19. Thermometer pocket with plug.
20. 150 mm dial type contact thermometer with maximum temperature indicator and alarm and trip contacts for oil temperature.
21. Buchholz relay of double float type with alarm and trip contacts and M.S. box for terminating control cables of 4 x 2.5 sq. mm. size.
22. L. V. Neutral bushing
23. Shut-off valve between Buchholz relay and conservator.

The transformer shall be complete with the first filling of insulating oil as per IS 335 - 1983 including makeup fill at site.

2.12. TRANSFORMER GUARENTEED TECHNICAL PARTICULARS

The following guaranteed technical particulars of the transformer shall be furnished.

- a) Core loss
- b) Load loss
- c) Percentage Impedance

2.13. TRANSFORMER TESTING

Prior to acceptance and dispatch of the transformer, the CLIENT/HLL reserves the right to witness the routine tests at manufacturer's works. The transformer shall be subjected to the following routine tests as per relevant Standards at the manufacturers Works. The test certificates shall be submitted to the CLIENT/HLL/Engineer-in-charges for approval prior to dispatch.

- a) Measurement of Winding Resistance
- b) Ratio polarity and phase relationship
- c) Losses in kW at No load, 50% Load, 75% Load and 100% Load
- d) Impedance Voltage
- e) No load and Full load current

- f) Insulation resistance
- g) Induced over voltage withstand
- h) Separate source voltage withstand

In addition type test certificate for following parameters shall also be submitted to CLIENT/HLL/ Engineer-in-charges for record. Any type test if specifically asked for by CLIENT/HLL, shall be carried out on the equipment covered by this contract shall be done at extra cost prior to dispatch.

- a) Temperature Rise
- b) Impulse Voltage withstands.

2.14. INSTALLATION

The transformer shall be installed as per the manufacturers' instruction manual and shall conform to the requirements of IS 10028: 1981.

Transformer and all other accessories shall be handled carefully in its upright position as indicated on the packing cases. Lifting lugs and jacking pads shall be use for lifting the transformer. Utmost care shall be taken in proper application of jacks. Where transformer is dragged or pulled on sleeper or rollers, the traction eyes provided at the bottom frame shall be used with suitable wire ropes and shackles.

Transformer shall be mounded on concrete plinth/foundation prepared for the purpose. Rollers shall be checked and locket to prevent movement of the transformer after being positioned after on the plinth.

The transformer cable end boxes shall be sealed to prevent entry of moisture.

The transformer neutral and body earthing shall be as per the requirements of IS 3043-1966 and the Local Inspecting Authorities.

2.15. COMMISSIONING TESTS

The following tests shall be carried out prior to commissioning at site by third party

- a) Insulation resistance of the winding between phases and phase and earth on the H.T. side.
- b) Winding resistance of all the windings on all tap positions.
- c) Voltage ratio test shall be carried out by applying low voltage on H.T. side and measuring the voltage between phases and phase and neutral on the L.T. side for every tap setting.
- d) On commissioning of the transformer the following readings shall be taken
 - MV side voltages at all tap settings
 - Temperature rise under no load conditions
- e) Transformer Oil Test
- f) If necessary, the transformer shall be heated by applying low voltage on the HT side and shorting the LT side. This shall be done for a period of 48 hours or till all the moisture has been removed from the transformer.

SECTION 4: LT PANELS & SWITCHGEARS

1. GENERAL

The contractor shall consider the following details in their scope of works no additional cost shall be paid, wherever required:

- Supporting rigid steel framework.
- Cubicle type, 14 Gauge CRCA sheet steel enclosed.
- Complete with interconnections and distribution bus bars.
- Proper bonding to earth.
- Painting/ lettering on Breakers and distribution boards, the location they serve, providing on each panel its circuit diagram.
- Providing cable clamps / supports within distribution boards cable alley.
- TPN ACB's / MCCB's shall mean 3 pole ACB's / MCCB's with adequate size of neutral link.
- All MCB's /MCCB shall be of minimum KA breaking capacity as per CPWD General Specification Part-IV Substation
- All motor feeders MCCBs shall be of motor duty.
- All Incoming feeders shall be provided with R,Y,B Indication Lamps, LED type.
- All outgoing feeders shall be provided with ON,OFF Indication Lamps, LED type.
- LT Panels shall be Powder Coated with Siemens gray paint shade no. RAL-7032 of IS-5 or as per direction of EIC.
- Distribution panels shall be Powder Coated with Siemens gray paint shade no. RAL-7032 of IS-5 or as per direction of EIC.
- Degree of protection for following type of distribution panel enclosure shall be as per IS: 13947-1993.
- All MCCB's shall be provided with operating mechanism for door interlock.
- Current density of aluminium shall be considered as 0.8 Amp per sqmm for rated current of bus bars and current density of copper shall be considered as 1.2 Amps per sqmm for rated current of bus bars.
- Tinned copper/Aluminium/ GI earth bus shall be provided through out the length of each board.
- Tinned copper earth bus shall be provided through out the length of each board.
- All measuring instruments (Meters) shall be of digital electronic with LED of approved make.
- All hinged door shall be earthed through 2.5 sq mm tinned braided copper wire.
- All panels shall have provision of the following:
 - Pad locking of Switch board doors.
 - Pad locking of MCCB's handles in "OFF" Position.
- All Incoming feeders shall be provided with Digital Voltmeter & Digital Ammeter of size 96 X 96 sqmm along with selector switches.
- All Outgoing feeders shall be provided with Digital Ammeter of size 96 X 96 sqmm along with selector switches.
- All MCB's used for protection of resistive and lightly inductive load shall be type "B" characteristic and inductive (motor) load shall be of type "C"

characteristic and discharge lamps and UPS etc. shall be of type D characteristic.

- All incoming and outgoing Air Circuit Breakers shall be placed on middle portion of the vertical in single tier formation.
- All PTs / control transformer shall be provided with centre tap earth secondary.
- All DOL & Star-Delta Starters shall be provided with SPPR (single phase preventor relay) and 2 nos. of Aux.Contacts for Remote operation/monitor.
- The Panel fabricator shall provide Al./ Copper Bus-bars link from Breakers wherever more than two nos. of cables are terminated in the breakers.
- Readymade 16SWG Sheet steel Enclosure with cut out For MCBs
- The breaking capacity of MCCB's are mentioned panel wise. All MCCB's shall be with thermal magnetic releases upto 200 amps and microprocessor based above 200 amps capacity, unless specified otherwise.

Medium voltage switch boards/distribution boards, the combination of both these and components shall conform to the equipments of the latest revision including amendments of the following codes and standards.

The drawings, specification and BOQ complement each other and which is shown or called for one shall be interpreted as being called for on both. Material, if any, which may not have been specified but fairly required to make a complete assembly of switch gear as shown on the drawing, specifications shall be construed as being required and no extra charges shall be payable on this account.

2. CODES & STANDARDS

The design, manufacture and performance of equipment shall comply with all the currently applicable statues, safety codes, relevant Bureau of Indian Standards (BIS), British Standards (B.S.), International Dutro Technical Commission (IEC) Publication, NEMA, IDE & DEMA standard as amended upto date.

- a) IS: 13947- 1993/IEC 60947-1989: Air circuit breaker/moulded case circuit breaker.
- b) IS:3156 Voltage Transformers.
- c) IS:2705 Current transformers for metering and protection with classification Part-I, II burden and insulation & III 1964
- d) IS:9224 Low Voltage fuse and protection.
- e) IS:3231 Specification for electrical relays for power system protection.
- f) IS:8623 Specification for factory built assemblies of switchgear and control gear for voltage upto and including 1000-V AC/1200 V-DC.
- g) IS:4237 General requirements for switch gear and control gear for voltage not exceeding gear.
- h) IS:2147 Degree of protection provided by enclosures for low voltage switch gear and control gear.
- i) IS:1018 Switchgear and control gear selection/installation & maintenance.
- j) IS:1248 Direct acting electrical indicating instruments.

- k) IS:375 Arrangement for switchgear, bus bars, main connections, auxiliary wiring and marking.
 - l) IS:2959 AC contactors for voltage not exceeding 1000V.
 - m) IS:5578 Guide for marking of insulated conductors.
 - n) IS:11050 Guide for forming system of marking and identification of conductors & apparatus terminal.
 - o) IS:1248 Direct acting indicating analogue electrical measuring instruments and Testing accessories.
 - p) IS:600 Code of practice for phosphating of iron & steel.
3. The board shall be metal enclosed single front, indoor, floor mounted, free standing type or wall mounting type as mentioned in BOQ. The panel shall be designed for a degree of protection of IP-55. However bus bar chamber shall have IP: 42 degree of protection incase bus bar rating exceed 1600 Amps. Keeping in view the operating height of the top switch 1750 mm from finish floor, 300mm clear space shall be left throughout the panel at bottom. The cold rolled sheet steel will be of 2mm thick. The structure shall be mounted on a rigid base frame of folded sheet steel of minimum 3mm thickness and 75 mm height.
 4. LT Panels shall be total Type Tested Assembly (TTA), **if specified in BOQ**. Also Incoming & Outgoing Feeders should be communication ready with suitable relays/ transducers, communication ports and communication cards for transmitting event and logging data to Building Management System (BMS), if specified in BOQ.
 5. All cutouts and covers shall be provided with synthetic rubber gaskets (preferably neoprene).
 6. The panel shall be divided into distinct vertical sections each comprising of:
 - i) Complete enclosed bus bar compartment for running horizontal and vertical bus bars.
 - ii) Complete enclosed switchgear compartment one for each circuit for housing air circuit breaker, MCCB/MPCB with starters etc.
 - iii) Compartment for power and control cables of at least 300mm width covering entire height provided.
 - iv) The panel shall have sufficient space at least 20% of outgoing feeders for future use.
 7. The front of each compartment shall be provided with hinged single leaf door with locking facilities. Panel shall be provided with suitable lifting facilities. Isolators and MCCB/ACBs and accessories shall be of fixed/drawout type as per BOQ.
 8. Each feeder shall be compartmentalized. Cable entry shall be from top/bottom with 3 mm thick gland plate with suitable numbers & sizes of knockout holes (as called for in schematic/ fabrication drawings).
 9. The panel shall be provided with three phase buses & neutral bus bars of high conductivity electrolytic copper/Aluminium sections throughout the length of the panel & shall be adequately supported and braced to withstand the stressed due to the short circuit current of 50/65 KA rms. for 1 sec. as called for in BOQ/Data Sheet. Maximum temperature rise of bus bars and bus bar connection while carrying rated current shall not exceed 40 Deg.C over an ambient temperature of 50 Deg.C. The Current density of Bus Bar shall be 0.8 Amp/mm² for Aluminium and 1.2 Amp/ mm² for copper.

10. The minimum clearance in air between phases and between phases and earth for the entire run of the bus bar connections shall be 32mm minimum. Bus bars support insulators shall be made of non-hygroscopic non-combustible track resistant and high strength SMC or polyester fiberglass moulded material.
11. All bus bars shall be colour coded as per IS: 375.
12. Copper /G.I./Aluminium earth bus of suitable size shall be provided at the bottom of the panel throughout the length. Similarly suitable size of strip in each vertical section for earthing the individual equipment/accessories shall be provided and connected to main horizontal bus.
13. Sheet steel hinged lockable doors shall be interlocked with MCCB to prevent opening of the panel when MCCB is on position. Safety interlock with operating handle shall be provided.
14. Contactors shall be electromagnetic type with interrupted duty as per IS: 2959. The main contacts shall be of silver or silver alloy, provided with minimum 2 NO and 2 NC auxiliary contacts. The push button should be of shrouded type and each should be provided with 1 NO and 1 NC contact. Colour coding shall be as per IS: 6875 (Part-II).
15. Air Circuit Breaker and Moulded Case Circuit Breakers
 - a. General:-
 1. **MCCBs:**
 - i. MCCBs should preferably be used for loads below 800 Amperes.
 - ii. Upto 160 A MCCBs shall be of > 20 Ka ($I_{cs}=I_{cu}$) at 433 V Short CKt. Current rating and should be Thermal Magnetic.
 - iii. From 200 A- 250 A MCCBs shall be of > 35 Ka ($I_{cs}= I_{cu}$) at 433 V Short Ckt. Current rating and should be Thermal Magnetic.
 - iv. From 300 A onwards MCCBs shall be of > 50 Ka ($I_{cs}=I_{cu}$) at 433 V Short Ckt. Current rating and should be microprocessor based having over load and short circuit protection. If used as incomer should also have earth fault protection & time delay. Earth leakage modules are not acceptable.
 2. **ACBs (IEC 60947-2; IS 13947):**
 - i. From 800 A onwards ACBs shall normally (MCCBs should be used judiciously for such loads) be used. These should have 50/65 KA ($I_{cu}=I_{cs}$) Short Ckt. Current rating with microprocessor based overload, short circuit and earth fault protection at 415 volts, 50 Hz
 3. The Air Circuit Breaker shall be of air break type in order to eliminate fire and explosion risk and shall comply with the IEC with a rupturing capacity of not less than 40 MVA / 31 MVA at 415 volts or as specified elsewhere (The service short circuit breaking capacity shall be as specified and equal to the short circuit with stand value $I_{cs} = I_{cu}$). The breaker shall be provided with variable microprocessor based releases within built fault differentiation for integral over load, short circuit and earth fault & other protection as called for in BOQ, LED indication for type of fault, CT's for protection and measurement class as called for in BOQ, and LCD display of curves and parameters. Electrical endurance without maintenance shall be greater than 2000 cycles.
 4. Mechanical & electrical anti-pumping devices shall be provided in breaker, as required.

5. The breaker shall have memory for logging history for type of fault, load, time & date and the Vendor shall mention in the data sheet for no. of loggings available in the breaker memory.
6. The ACB shall be Electrically Operated Draw Out type (EDO). ACB shall consist of a horizontal draw out pattern triple/four pole, fully interlocked, independent motorized spring operated mechanism. The mechanism should be such that the circuit breaker is at all times free to open immediately. The trip coil is energized. Current carrying parts should be silver plated and suitable arcing contacts shall be provided to protect the main contact arc-chutes for each pole shall be provided and shall be lifted out for the inspection of main and arcing contact.
7. Self-aligning cluster type isolating contacts shall be provided on breaker for interlocking protection metering and for any other purposes. The breaker should have 3 distinct positions - SERVICE/TEST/ISOLATED within the cubicle.
8. The ACB shall be with molded housing class II front fuse and shall be suitable for Isolation.
9. Breaker shall be provided with automatic safety shutters to screen the main live contact when the breaker is withdrawn. The frame of the circuit breaker could be positively earthed when the breaker is racked into the cubicle.

b. Safety

The following safety arrangements shall be provided for the safety of the personnel to prevent mal-operation.

- i) Interlock to prevent the truck from being withdrawn or replaced except in the fully isolated position.
- ii) Interlock to prevent earth connection from being made by the earthing device except breaker is open.
- iii) Interlock to prevent the breaker being closed unless it is fully raised.
- iv) Interlock to prevent the breaker from being made alive without its rack in position.

c. Protection Releases

Self-powered & true RMS sensing microprocessor based release with following features.

a) Incomer ACB of Panels:

Long time short circuit protection with time delay. Instantaneous and earth fault protection with LCD display to show RMS Current, RMS Voltage, Frequency, kW, kVA & kVAR readings in all three phases, neutral (for 4 pole) simultaneously. The other features of the release to be as under.

- The release should display distinct fault indication for each type of tripping for faster fault diagnosis and reduce down time & should protect ACB from over temperature and Phase unbalance.
- Release should provide contact wear indication in display no. of operation seen by the breaker for case of maintenance.
- The release shall be self-diagnosis & should provide fault history including cause of fault as well as level of fault current. It should be possible to store minimum 20 last trip data with nonvolatile memory.

- The protection setting of release should be accessible to change locally.
- LCD display should be at least 4 line display and should be able to display current in all the 3 phases and neutral (4 pole) simultaneously.

b) For Outgoing ACB feeder:

Long time Short circuit protection with time delay (for discrimination), instantaneous. The other features of the release to be as under.

The release should have distinct fault indication for each type of tripping for faster fault diagnosis and reduced down time and shall protect ACB from over temperature and phase unbalance.

- Operation counter
- Alarm and warning indication

Type test certificate : The ACB's shall be type tested and certified for compliance to IS 13947/equivalent / EC standard from Indian / International testing authority, supplier to submit certificate of the same..

d. MOULDED CASE CIRCUIT BREAKER (MCCB)

MCCB shall conform to the latest IS13947-1993/IEC 60947. The Service Short Circuit Breaking Capacity (Ics at 415 VAC) should be as specified.

MCCB shall be Current Limiting and comprise of Quick Make – Quick Break switching mechanism & Double Break Contact system. The arc extinguishing device and the tripping unit contained in a compact, high strength, heat resistant, flame retardant, insulating molded case with high withstand capability against thermal and mechanical stresses. All MCCBs shall be capable of defined variable overload short circuit and earth fault adjustment with thermo- magnetic releases upto 250A and with electronic release above 250A onwards.

The Service Short Circuit Breaking Capacity (Ics at 415 VAC) should be as called for in BOQ and is the required minimum value for that feeders/ panel, however if the rating of feeder mentioned is not available, the contractor shall use next higher rating without any extra charges. The service short circuit breaking capacity shall be equal to ultimate breaking capacity of MCCB, i.e. $I_{cs} = 100\% I_{cu}$

The trip command shall override all other commands. MCCB shall employ maintenance free double break contact system to minimize the let thru' energies and shall be capable of achieving discrimination upto the full short circuit capacity of downstream MCCB. The manufacturer shall provide both the discrimination tables and let thru' energy curves. The MCCB shall not be restricted to Line/Load connections.

The handle position shall give positive indication of 'ON', 'OFF' or 'Tripped' thus qualifying to disconnection as per the IS/IEC indicating the true position of all the contacts. In case of 4 pole MCCB the neutral shall be defined and capable of offering protection upto full rating. The remote tripping coil should be of continuous duty. The general-purpose control switch shall be provided for ON/OFF Auto/Manual. The switch shall be provided with engraving plates on the front with the complete inscription.

The switch shall be normally a fixed control box type heavy-duty unit.

Indicating lamps shall be of the panel mounting, LED type and shall have execution plates marked with its function wherever necessary. The color of the lamp cover shall be red for 'ON' and green for 'OFF' indicating lamps shall be provided with series resistor. MCCB shall be provided with interlocking device

for interlocking the door of switchboard. Following shall be included if specified in the drawing or in the schedule of quantities:

- Under Voltage Trip
- Shunt Trip
- Alarm Switch
- Auxiliary Switch

e. CONTACTORS

The contactors should comply with the latest IEC947-4 and the corresponding IS13947-4 standard. They shall have UL and CSA approval. The contactors should be rated for AC3 duty at 415V and 50Hz. The contacts should be fast closing and fast opening type. The making and breaking capacity values of the contactors should be as follows (as per IEC947-4):

For AC3 Duty

- Making Capacity equal to or more than 10 Ie
- Breaking Capacity equal to or more than 8 Ie

For AC4 Duty

- Making Capacity equal to or more than 12 Ie
- Breaking Capacity equal to or more than 10 Ie

The contactors should be capable of frequent switching and should operate without derating at 60°C for AC3 applications. They should be climate proof as standard. The coil of the contactor should have class H insulation to support frequent switching.

The rated voltage of the contactor shall be equal or superior at 690 V, and rated insulation voltage shall be 690 V. The rated impulse voltage of the contactor should be 8 KV.

The contactor should be modular in design with minimum inventory requirements and built in mechanically interlocked 1NO 1NC auxiliary contact up to 32A. They should be suitable for the addition of auxiliary contacts and other electrical auxiliaries without any compromise on the performance or the operation of the contactors. The contactors from 4 KW to 400 KW will be associated with the same auxiliary contact block range.

Wherever D.C control is required, the contactor should have wide range (0.7 to 1.25Uc) D.C coil with built in interference suppression as standard.

The control and power terminals should be at separate layers preferably with colour coding (black for power and white for control)

All contactors power connection will be finger safe (IP2X) as standard.

They should be capable of being integrated into automated system (PLCs etc.) without any interposing components in minimum operating conditions.

The thermal over load relay if used will be directly mounting under the contactor without any specific connections.

f. NAME PLATES & LABELS

- i) Panel and all modules shall be provided with prominent engraved identification plates. The module identification designation. For single front

switchboards, similar panel and board identification labels shall be provided at the rear also.

- ii) All nameplates shall be of non-rusting metal or 3-ply lamicold, with white engraved lettering on black background. Inscription and lettering sizes shall be subject to CLIENT/HLL's approval.
- iii) Suitable stencilled paint marks shall be provided inside the panel/module identification of all equipments in addition to the plastic sticker labels. These labels shall be partitioned so as to be clearly visible and shall have the device number, as mentioned in the module wiring design.

g. PAINTING

All steel work shall be pretreated in tanks and finally powder coated of approved shade.

h. WIRING

Control and protective wiring shall be done with Fire Resistant (FR) copper conductor PVC insulated 1100 volts grade multi-stranded flexible wire of 2.5 sq.mm cross section. The colour coding shall be as per latest edition of IS: 375.

Each wire shall be identified by plastic ferrule. All wire termination shall be made with type connection. Wire shall not be taped or spliced between terminal points.

Terminal blocks shall preferably be grouped according to circuit function and each terminal block group shall have at least 20% spare capacity.

Not more than one wire shall be connected to any terminal block. All doorframe of L.T. switchboard shall be earthed with bare braided copper wire.

i. RUBBER MATS:

All LT Panels shall be provided with 1100 Volt grade rubber mats conforming to the relevant IS Code.

j. AUTO OPERATION OF MAIN L.T. PANEL CUM SYNCHRONIZING PANEL-

Normally the load will be catered by mains (From Transformers). However in case of failure of supplies the system will be operated as under

- a. In case of grid failure PLC will start the master DG (DG Set - 1) and will issue closing command to its ACB on building up full voltage.
- b. After closing the ACB of the master DG, PLC will issue command to closed bus coupler after a preset time interval.
- c. If load increase beyond 80% or any other preset value of capacity of master DG (DG Set -1) Capacity, the PLC will issue the tripping command to the bus coupler breaker ACB.
- d. Once the bus coupler ACB is turned off, the PLC will issue command to start the DG Set -2. After the DG Set -2 is started and build up full voltage & ready to synchronize by synchronizing relay, closing command will be given to the ACB of DG Set – 2.
- e. Same sequence will be repeated for DG Set – 3.

The above sequence is applicable when D.G Set -1 is selected as Master DG Set., in case of selection of DG Set -2 or DG Set –3 as Master DG Set, then sequence will be change in circular motion.

In case of failure of start of any DG Set, the next DG will be started automatically. When the load decreases the DG Set will stop in reverse sequence with the prior setting of time interval.

In process if any one DG Set fails to start, audio visual indication will be there and next selected DG shall start after a particular interval of time.

The selection of master D.G. shall be programmed in PLC as specified time interval decided by client.

CONDITION – I (GRID RESTORE)

- a. In case of grid restore PLC will see its stability till set time (Approx. 3 to 5 minutes), if grid supply is stable till set time then PLC will trip all the DG breakers and bus coupler as required.
- b. After ensuring tripping of all DG Set and bus coupler ACB's, PLC will issue the closing command to the Transformer breakers and required bus coupler.

CONDITION – II (MANUAL OVER RIDE)

The above PLC Control System can be totally manually override through Auto/Manual switch. However in this case all starting / Stopping monitoring of DG Sets as well as Closing /Opening of incomer Bus coupler breaker will be close / open depending upon load requirement manually.

k. TESTING & INSPECTION

After completion of all work at the manufacturer's works the switchboards shall be inspected and tested in presence of CLIENT/HLL's representative. However, stage inspection may be carried out from time to time to check progress of work and workmanship. The following tests shall be carried out:

- i) All routine tests specified in relevant Indian/British Standards shall be carried out on all circuit breakers.
- ii) Test for protective relay operation by primary or secondary injection method.
- iii) Operation of all meters.
- iv) Secondary wiring continuity test.
- v) Insulation test with 1000 Volts megger, before and after voltage test.
- vi) HV test on secondary wiring and components on which such test is permissible (2 KV for one minute)
- vii) Simulating external circuits for remote operation of breaker, remote indicating lights and other remote operations, if any.
- viii) Measurement of power required for closing/trip coil of the breaker.
- ix) Pick up and drop out voltages for shunt trip and closing coils.
- x) CT Polarity test.

Vendor shall provide all facilities such as power supply, testing instruments and apparatus required for carrying out the tests. Required copies of test certificates for all the tests carried out alongwith copies of type test certificates and certificates from Sub-Vendor for the components procured from them are to be submitted before dispatch of switchboards.

l. DRAWINGS AND INFORMATION

The Vendor shall furnish following drawings/documents in accordance with the following requirements:

- i) General Arrangement drawing of the Switchboard, showing front view, plan, foundation plan, floor cutouts/trenches for external cables and elevations, transport sections and weights.
- ii) Sectional drawings of the circuit breaker panels, showing general constructional features, mounting details of various devices, bus bars, current transformers, cable boxes, terminal boxes for control cables etc.
- iii) Schematic and control wiring diagram for circuit breaker and protection including indicating devices, metering instruments, alarms, space heaters etc.
- iv) Terminal plans showing terminal numbers, ferrules markings, device terminal numbers, function etc.
- v) Relay wiring diagrams.
- vi) Equipment List.

Vendor shall furnish required number of copies of above drawings for Purchaser's review, fabrication of switch boards shall start only after Purchaser's clearance for the same. After final review, required number of copies and reproducible shall be furnished as final certified drawings.

The information furnished shall include the following:

- i) Technical literature giving complete information of the equipment.
- ii) Erection, Operation and Maintenance Manual complete with all relevant information, drawings and literature for auxiliary equipment and accessories, characteristics curves for relays etc.
- iii) A comprehensive spare parts catalogue.

M. TOOLS

One complete set of all special or non-standard tools required for installation, operation and maintenance of the switchboard shall be provided. The manufacturer shall provide a list of such tools with his quotation.

N. SPARES

The manufacturer/tenderer shall also supply a complete list of commissioning spares and tools. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.

O. QUALITY ASSURANCE

Quality Assurance shall follow the requirements of CLIENT/ HLL as applicable. Quality Assurance involvement will commence at enquiry and follow through to completion and acceptance thus ensuring total conformity to Client's requirements.

SECTION 5.0 BATTERY& BATTERY CHARGER

1. SCOPE

The specifications give details of the Battery Charger suitable for HT/ LT Panels. The batteries are housed in the Bottom Compartment of the Battery Charger. Sealed maintenance Free Batteries upto 24V – 200 AH or Lead Acid Batteries upto 24V – 150AH can be housed in the Battery Compartment. The Battery Charger is a

composite Battery Charger cum DC Distribution Board.

2. GENERAL

The Battery Charger shall be Float cum Boost type, Thyristor controlled. The Charger shall have selector switch for Auto Float – Boost/Manual Float/Manual Boost Mode of operation. During Auto Float – Boost Mode, Automatic Changeover shall take place from Float Mode to Boost Mode and vice – versa. This means that when the Batteries are fully charged the charging shall automatically change from Boost charge to Trickle charge.

3. Construction Feature

Float cum Boost Charger and DC Distribution Board shall be housed in Sheet Steel Cubicle with Panels of 2.0 mm thickness, louvers for ventilation, gland plate, 3 mm thick, will be provided for cable entry from bottom. The cubicle shall be painted in Siemens Grey Shade. The Battery Charger shall be divided into two Compartments. The Upper Compartment shall house the Battery Charger & DCDB with all the necessary controls. The Lower Compartment shall be suitable for housing the Batteries.

4. Performance

- a. The D.C. Output Voltage of Float/Boost Charger shall be stabilized to within $\pm 2\%$ for A.C. Input variation of $230V \pm 10\%$, frequency variation of $50 \text{ Hz} \pm 5\%$ and D.C. Load variation of 0 – 100%. The Voltage Regulation shall be achieved by a constant voltage regulator having fast response SCR controlled. The ripple content in output shall be within 3% of D.C. Output Nominal Voltage.
- b. There shall be provision to select Auto Float/Manual Float /Manual Boost Modes. During Auto Float Mode the Battery Charging shall automatically changeover from Boost Mode to Float Mode and vice – versa. During Manual Float/Boost Modes it shall be possible to set the output volts by separate potentiometers.
- c. The Battery Charger shall have automatic output Current Limiting feature.

5. Components

The Battery Charger shall essentially comprise of the following:

- a. 1 No. Double Pole ON/OFF MCB at A.C. Input.
- b. 1 No. Pilot Lamp to indicate Charger ON.
- c. 1 No. MAIN TRANSFORMER: Double Wound, naturally air – cooled, having Copper winding.
- d. 1 Set Single Phase full wave Bridge Rectifier consisting of 2 nos. Diodes and 2 nos. SCR's, liberally rated, mounted on Heat Sinks and complete with Resistor/Condenser network for surge suppression.
- e. 1 No. Rotary Switch to select AUTO FLOAT/MANUAL FLOAT/MANUAL BOOST. During Auto Float Mode Automatic Changeover shall take place from Float Mode to Boost Mode and vice – versa.
- f. 1 Set Solid state constant potential controller to stabilize the DC Output Voltage of the Float cum Boost Charger at $\pm 2\%$ of the set value for AC Input Voltage variation of $230V \pm 10\%$, Frequency variation of $\pm 5\%$ from 50Hz and simultaneous Load Variation of 0 - 100% and also complete with Current Limiting Circuit to drop the Float Charger Output Voltage upon overloads to enable the Battery to take over.

- g. 1 No. Electronic Controller to automatically changeover Battery Charging from Boost to Float and vice – versa.
- h. 1 No. DC Ammeter and Toggle Switch to read Charger Output Current and Battery Charge / discharge current.
- i. 1 No. Moving Coil DC Voltmeter to read the DC Output Voltage.
- j. 2 Set Potentiometer to adjust the output Voltage during Manual / Auto Float and Boost Modes.
- k. 1 No. Double Pole ON/OFF MCB at Charger Output.
- l. DC Distribution Board :-
 - INCOMER : 1 No. 63A DP MCB, as called for in BOQ.
 - OUTGOING : Suitable No. 16A/20A DP MCB, as called for in BOQ.

6. Alarm Annunciation :

Visual and Audible Alarm with Manual Accept/Reset Facility shall be provided for the following:

- a. A.C. Mains Fail.
- b. Charger Fail.
- c. Load/Output over volt.

RATING :

A C INPUT : 230V \pm 10% AC 50 Hz Single Phase

D C OUTPUT : To Float/Boost charge 24V / 100AH
Batteries and also supply a continuous load

CURRENT RATING: 15.0 Amps

FLOAT MODE : 27.0 V Nominal (Adj. between 24.0 – 28.0V)

BOOST MODE : 28.0 V Nominal (Adj. between 24.0 – 30.0 V)

Voltage Regulation: \pm 2% of the set value

RIPPLE : Less than 3%.

For 24V / 100 AH Batteries the Charger Rating is given in the Specification for Batteries of other capacities refer to the Table as given below:

BATTERY CAPACITY	CHARGING RATING
24V / 40AH	10.0 Amp.
24V / 60AH	15.0 Amp.
24V / 100AH	15.0 Amp.
24V / 120AH	20.0 Amp.
24V / 150AH	25.0 Amp.
24V / 200AH	30.0 Amp.

SECTION 6.0 INTELLIGENT MOTOR CONTROL CENTRE (IMCC)

1. FUNCTIONAL REQUIREMENTS:

It shall be used to receive, control and distribute electrical power at 415 V, 50 Hz, AC in sheet steel housing and communicate real time operating parameters to Building

Management System (BMS) and SCADA. The specifications describe the requirements for the low voltage intelligent motor control centre (IMCC), which shall fundamentally provide for the following:

- Achieve controls through microprocessor based systems
- Replace hardwiring by using network technology
- Provide enhanced degree of diagnostic and protective functions.

The IMCC shall provide comprehensive protection on motors by integrating intelligent motor protection relays (IMPR) or intelligent protection devices (IPD) inside the switchboard. The IMCC should also bundle the bus communication with the most common protocols found in the industrial networks (like Modbus SL /Modbus TCP/Profibus DP/Device Net etc).

- Operating temperatures -40 deg C to +75 deg C.
- Design Requirement and Scope of Supply:

2. Statutory Requirements:

Motor Control Centre is to be manufactured/ assembled as per the latest applicable Indian Standards, Indian Electricity Rules, Indian Electricity Act, Fire Insurance Regulations and comply with all currently applicable statutory requirements of concerned State Electricity Inspectorate and safety codes in the locality where the equipment will be installed and as per the detailed specifications mentioned below. The manufacturer of the panel must possess a Type Test Certificate from CPRI.

The IMCC should be equipment labeled with the brand name of an international company (like IMCC SIEMENS/ Rockwell Automation/Schneider/ L&T/ ABB), which owns the complete range of the major switchboard components and intelligent devices used in the IMCC. The IMCC should provide the flexibility to choose different solutions in motor protection and monitoring functions according to the requirements of critical motors and non-critical motors and relevant loads.

The switchboard manufacturer could be the original designer of IMCC (like L&T/ ABB/SIEMENS/Rockwell Automation/Schneider) or an authorized Channel Partner of original IMCC designer. All switchgear used in the switchboard shall be of the same manufacturer to allow better interoperability, seamless integration and installation.

3. Housing Details:

The switchboard shall be fabricated using pressed and shaped cold rolled steel sections structure of adequate thickness. The sheet steel used for panel shall be minimum 14 SWG sheet except that the partition plates, inter-panel barriers and cubical doors may be made of 16 SWG. The switchboard shall consist of free standing front and back open able panels arranged to form a continuous line-up of wardrobe type cubicles of uniform height. Cold rolled sheets shall be used for doors and front covers. Front doors shall be hinged type with quarter turn fasteners and bus bars and cable alleys covers shall be bolted type. Each wardrobe type cubicle shall house 8 to 9 feeders or as per design requirement of shipping lengths.

Switch Board shall be extensible at both the ends by addition of vertical sections. Ends of the bus bars shall be suitably drilled for this purpose. Panels at extreme ends shall have openings, which shall be covered with plates screwed to the panel. The switchboard shall be provided with integral base frame. The cable gland plate shall be 3.0 mm thick.

The switchboard shall be totally enclosed, dust, weather and vermin proof and shall conform to degree of protection not less than IP 44 as per IS 2147. Gaskets of durable material shall be provided all round the perimeter of adjacent panel, panel and base

frame, removable covers, doors and other openings.

All hardware shall be corrosion resistant. All joints and connections shall be made by galvanized zinc passivated or cadmium plated high tensile strength steel bolts & nuts. Spring washers shall be provided to secure against loosening.

The switchboard shall be non-draw out wardrobe type design except for the individual ACB cubicles used, if any, for incoming, outgoing and bus coupler. Each wardrobe shall contain 8 to 9 feeder components as per design. The IMCC shall be suitable for indoor installation. Suitable cable & bus bar alleys shall be provided if required. All components of the switchboard shall generally be approachable from front. However, IMCC can be in double front execution also if specifically asked for. The maximum and minimum operating handle/push button height of any feeder shall not be more than 1900 mm or less than 300 mm with reference to panel bottom. Supporting arrangement and saddles for dressing of power and control cables shall be provided. Maximum shipping length of MCC shall be as per the IEC design. IMCC shall be extendable both sides. Space heaters with toggle switches, fuses and thermostat shall be provided in each cable alley.

The maximum height of the panel shall generally be restricted to 2300 mm and maximum length of a shipping section shall be 2500 mm. Each shipping section shall be provided with suitable lifting hooks. These hooks when removed shall not leave any opening in the board. Supporting arrangement for dressing of power and control cables in cable alleys also shall be provided.

Minimum depth of cubicle for installing ACB shall be 1000 mm.

Minimum width of cable and bus bar alleys shall be 300 mm.

Internal arc features: The switchboard should be designed to minimize the risks of occurrence of internal arc and whenever such an arc occurs it should prevent its effect on operators and material/equipment surrounding the switchboard. The short-circuit withstand capacity of the panel with busbar and supports shall be minimum 50 KA/1 sec.

4. Painting

All metal surfaces shall be thoroughly cleaned and degreased to remove all scales, rust, grease and dirt. Fabricated structures shall be pickled and treated to remove any trace of acid. The under-surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. The under surface shall be made free from all imperfections before undertaking the final coat.

After preparation of the under surfaces, the panel shall be spray painted with final two coats of approved shade of powder coating (RAL 7032 Siemens grey). Thickness of powder coating shall not be less than 60 microns.

The finished panels shall be dried in stoving ovens in dust free atmosphere. Panel finish shall be free from imperfections like pin holes, orange peels, run-off paint, etc.

All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust, corrosion, etc.

Nameplates:

Apart from panel nameplate highlighting the operating voltage, the nameplates for all incoming & outgoing feeders shall be provided on doors of each compartment. Nameplates shall be fixed by screws only and not by adhesives. Engraved nameplates shall preferably be of 3-ply (Black-White-Black) acrylic sheets or anodized aluminum. Special danger plates shall be provided as per requirement. Lettering size shall be 5mm or 15 mm as directed.

Inside the panels, stickers should be provided for all components giving identification no. As per detailed wiring diagram.

- i. Cooling Fan & filter assembly, lighting of panels, heater: Each section of the panel shall be provided with a set of cooling fan, filter assembly and 2' long T5 tube light fitting operating through a SP MCB and door limit switch.
- ii. Each section of the panel shall also be provided with heating plate and a suitable thermostat.
- iii. Bus bar Sizing Connection and Supports:

The bus bars shall be made from high purity & high conductivity copper or Aluminium. The bus bars and supports shall be capable of withstanding the rated and short circuit current stated in the single line diagram/feeder details. Minimum size of power (phase) bus bars shall not be less than 200 Amps rating. Maximum current density permissible for Copper Bus Bars shall be 1.2 Amps/mm². Likewise, maximum current density permissible for Aluminium Bus Bars shall be 0.8 Amps/mm². A suitable section aluminum earthing bus bar shall be provided in the panel at bottom throughout the length of the panel. Minimum cross section of Al earth bus shall be 300 sqmm. Provision shall be made to connect the earthing bus bar to the plant earthing grid at two ends. All doors shall be earthed using flexible copper connections to the fixed frame of the switchboard. The busbars shall be tinned to protect against oxidation.

The bus bars shall be provided with heat shrinkable PVC insulating sleeves of 1100 V grade. Red, yellow and blue colour shall be used for phase bus bars and black colour shall be used for neutral bus bars. The sleeves should be non-flammable and self-extinguishing type. All joints in main horizontal bus bars and all tap-off connections from the main horizontal bus bars shall be suitably shrouded. Supports for bus bars shall be made of suitable size non-hygroscopic and non-flammable epoxy compound SMC / DMC blocks and these should be adequate in number so as to avoid any sag in the bus bars.

Minimum clearance between bus bars phase to phase shall be 25 mm and that between phases to neutral / earth shall be 20 mm.

- iv. Power Connection:

For power interconnection within the panel board:

Copper conductor PVC insulated cables of adequate cross section shall be used. However, for current rating above 100 Amps, Copper bus bar strips of adequate rating shall be used. Minimum size of copper conductor to be used shall not be less than 4.0 mm². Cable lugs / sockets of suitable size and type shall be used for all interconnections and cable terminations.

For incoming feeders of the MCC, aluminium conductor cable will be used and hence the panel is to be designed for receiving these and wherever required cable boxes with bus bar extensions for receiving more no. of cables, shall be provided in panel by supplier.

For all outgoing motor feeders, the suitable size terminal blocks shall be provided in cable alleys and wiring up to these from contactors shall be done by panel supplier. These terminal blocks shall be heavy-duty type to withstand high starting currents. The cable entry shall be either from top or bottom as specified in feeder details. Removable gland plates of minimum 12 gauge thickness shall be provided on top/ bottom of panel (as required), for cable entries. The cable alleys shall also be totally isolated from switchgears by suitable partition plates.

To prevent accidental contacts, all junctions of interconnecting cables and bus

bars also shall be shrouded suitably using coloured PVC insulation tape.

Standard colour code of red, yellow and blue for phases and black for Neutral to be followed for all bus bars/conductors.

v. Auxiliary wiring and terminals:

Wiring for all controls, protection, metering, signaling etc. inside the switchboard shall be done with 1100 V gray colour PVC insulated FR copper conductors. Minimum size of these conductors shall not be less than 1.5 mm². However, CT circuit wiring shall be done with 2.5 mm². Control wiring to components fixed on doors shall be flexible type.

10% spare terminals shall always be available in each terminal block. Control wiring up to these terminal blocks shall be done by supplier.

15% spare feeders of various ratings completely prewired shall be supplied in each of the IMCC.

All conductors should be terminated using compression type cable sockets / lugs at both the ends.

Each control wiring termination shall be identified at both the ends by PVC ferrules. The identification termination numbers should match with those on drawings. Suitable size SP MCB shall be used for tapping power for control circuit wiring.

For all motor starter feeders, provision for control wiring to remote ON/OFF control is to be made. The auxiliary wiring for the same shall be brought up to terminal block in the feeder's cubicle

vi. Switchgears:

a. Air Circuit Breakers (ACBs):

These shall be electrically operated, fully draw out type (EDO) with built-in microprocessor based programmable protection, and suitable for 415 V, 50 Hz supply. Microprocessor based programmable protection unit shall have settings for overload, short circuit, instantaneous and earth fault currents with time delay and LED indicators to show various conditions such as power ON, overload, short-circuit, instantaneous earth fault, percentage load, self-diagnostic test etc. ACB shall have LCD display window indicating parameters for 3-phases like voltage, current, frequency, kWh, KVA, kVAR, Power Factor etc.

Mechanical spring charging mechanism stored energy type shall be provided with mechanical indicators to show 'Open', 'Closed', 'Service' & 'Test' positions. The circuit breaker shall be provided with mechanically operated emergency tripping device. This device shall be available on the front of the panel.

The control supply shall be 240 V AC. 6 NO + 6 NC auxiliary contacts shall be provided.

The interlocks shall be as under:

It shall not be possible to plug in a closed circuit breaker or to draw out a circuit breaker in closed position. It shall not be possible to operate a circuit breaker unless it is in fully plugged-in, test or fully isolated position. In test position, the breaker shall be tested without energizing the power circuit. The ACB feeder cubical door cannot be opened when ACB is "ON". However, it shall be possible to defeat this interlock for inspection purpose. Closing and trip coils shall work under the following voltage variation conditions:

Closing coils - 85 % to 110 % of rated voltage

Trip coils - 50 % to 130 % of rated voltage

For series tripping, overload, short circuit and under voltage/shunt trip release shall be provided.

Built-in relays for overload, short circuit, instantaneous and earth fault protection shall be provided for incoming feeders' ACB. Suitable port like RS 485 shall be available in ACB for transferring/ communicating data pertaining to operation parameters to main BMS system.

Current rating, short circuit current, protection relays etc. shall be as specified in feeder details.

b. Moulded Case Circuit Breakers (MCCB)

MCCBs shall always be provided with separate rotary operating handle mechanism with door interlocking. The MCCBs shall be of three / four pole construction (as required in the feeder details) arranged for simultaneous three / four pole manual closing or opening and automatic instantaneous tripping on short circuits. MCCBs shall be provided with adjustable type tripping device with inverse time characteristics for over load protection.

Closing mechanism shall be quick make, quick break & trip free type. Operating handle shall give a clear 'ON', 'OFF' & 'TRIP' indications. Control voltage for MCCB shall be 240 volts. The MCCBs shall be rated for continuous maximum duty as specified. The rating of the MCCBs shall be as per the feeder details.

Minimum rated breaking capacities shall be as under:

MCCBs upto 200 Amps 35 KA

MCCBs above 200 Amps 50 KA

Note: All feeders having 3 pole MCCB shall be provided with neutral link complete with isolating link. However, the MCCBs for incoming and non-motor outgoing feeders shall be of 4 pole construction, unless stated otherwise.

c. Motor Protection Circuit Breaker (MPCB):

All motors below 40 HP shall be protected by Motor Protection Circuit Breakers (MPCB) having suitable rating thermal overload relays. These shall be used along with contactors as specified in feeder details.

The MPCB will have motor protection tripping characteristics, current limiting and shall have low let through energy. It shall have bi-metallic overload protection and electromagnetic release for short circuit protection. MPCB shall have inbuilt single phase protection and adjustable overload settings.

In the MPCB, it shall be possible to have accessories like auxiliary contacts, trip alarm contacts, shunt release/under voltage release, as required for motor control and protection. MPCB shall give indication for 'ON'/'OFF' and tripping on fault. The breaking capacity of MPCB shall not be less than 50 KA. MPCB shall have rotary operating mechanism with door interlock and provision to lock it in 'OFF' position with a padlock.

d. Switch Disconnecter fuse units

The load break switches shall be heavy duty, air break type suitable for continuous maximum rating with manual quick make / break mechanism. These shall have positive isolation with positive indication of contact separation. They shall have high short circuit making and withstanding

capacities. Breaking capacity shall correspond to AC 23A utilization category. Mechanical interlock shall be provided to prevent opening of door in switch 'closed' position and prevent closing of switch in door 'open' position. However, it should be possible to defeat this arrangement for testing purpose. Live terminals of the switch shall be shrouded.

e. Fuses

These shall be non-deteriorating HRC cartridge link type with operation indicator which will be visible without removing fuses for the service. These shall be complete with moulded phenolic fuse base and cover. The fuse base shall be so located in the modules to permit insertion of fuse pullers and removal of fuse links without any problem. One set of fuse pullers to cover entire range of fuses used in the panel shall also be provided.

f. Contactor

The rating of the power contactors shall be as required depending upon the feeder rating indicated in the specifications and as per the feeder details table provided in this specification below. Contactors coils shall be suitable for 240 volts, 50 Hz. unless otherwise specified. All contactors shall be supplied with minimum 2 NO + 2 NC auxiliary contacts. Additional contacts if required for interlocking etc. shall also be provided. Minimum contactor rating for power shall be 9 Amp. All the three contactors of Star Delta Starter shall be of same rating. Rating of contactors shall be based on feeder rating.

All contactors of motor starters shall be suitable for AC 3 duty unless specified otherwise.

g. Protective Devices:

Intelligent Motor protection relays are required for DOL and Star- Delta feeders instead of bimetallic overload relay or other special relays for incoming & outgoing feeder. These shall be fixed on DIN rails or on mounting boards.

The supplier must have a local representative office with qualified support staff to provide training, technical support and service.

The IMPR should provide the communication ports for the connection to the communication network. It should be easily integrated into the communication architecture with remote information access.

It shall be an open communications system, which means that it shall be directly connected to the main industrial network protocols, listed below:

- ModBus SL
- ModBus / Ethernet
- Profibus DP
- DeviceNet

The IMPR should embed the relevant network protocol in built-in (native) mode.

The IMPR supplier should provide user-friendly software running in a Windows environment to ease the IMPR on-relay configuration. The software should have menus and icons for easy access to the data required, guided navigation to go through all the data of the same function in one screen and with a file management system.

h. Timers:

The timers shall be continuously adjustable & electronic type, suitable for 240 V, 50 Hz supply. The timers for Star Delta automatic starters shall have time delay of 0 to 60 seconds between changeover of contacts.

i. Push Buttons (PBs):

Push buttons shall be complete with actuator and contact block and shall be generally mounted on doors of the cubicles. Colours shall be as follow:

Stop/ open/ emergency - Red

Start/ close - Green

It should have minimum 1 NO + 1 NC contacts. Push buttons shall conform to IP - 65 protections against dust and water ingress.

j. Indication Lamps:

All outgoing & incoming feeders shall be provided with 'ON' indication lamps.

Colours shall be as under:

Phases : Red, Yellow & Blue

ON : Red

OFF : Green

TRIPPED : Yellow

Indicating lamps shall be of LED (cluster of high intensity light emitting diodes) type, suitable for 240 V AC supply. These shall be provided with translucent covers of red, green and amber colours as required. These lamps shall be of minimum 22.5 mm dia. Indication laps to be provided for all feeders.

k. Current Transformers (CTs):

CTs shall be cast resin insulated type. Primary and secondary terminals shall be marked indelibly. CTs shall preferably be mounted on stationery parts. These shall be capable of withstanding momentary short circuit and symmetrical short circuit current for 1 second and shall have a minimum rating of 10 VA. Neutral side of CTs shall be earthed.

Protection CTs shall be of low reactance, accuracy class "5P" and an accuracy limit factor greater than "10". Instrument CTs shall be of accuracy class "1.0" and accuracy limit factor less than "5.0".

Separate CT's to be provided for protection and metering purpose.

l. Measuring Instruments:

These shall be of square pattern having approximate dimensions 96 mm X 96 mm, flush mounting type. Necessary auxiliary instruments like CTs etc. are also included in the scope of supply.

All AC meters shall be of Digital type for displaying three phases reading. Suitable selector switch shall be provided if the digital meter does not have provision for simultaneous display of three phase readings.

Voltmeter shall be suitable for direct line connection. Voltmeters shall be connected through MCBs only.

Intelligent Panel Meter shall be provided with incoming feeder of the MCC for the measurement and digital display of Multifunctional Electrical Parameters such as voltage, current, active power, reactive power, frequency, power

factor, active energy, reactive energy, etc. Data port will be provided to communicate all these parameters to Main PLC Panel through suitable data bus/ signal communication cable which shall be further transferred to central BMS system.

All motor feeders of 15 HP and above shall be provided with ammeter. Ammeter shall also be provided for all incoming & outgoing ACB / MCCB / switches of rating 100 A & above. Ammeters shall always be CT operated.

m. Special Requirements:

Feeder details for incoming and outgoing for this project as per battery limit to be worked out by the supplier as per the design requirements of the plant. All motor feeders shall have soft starters and VFD wherever specified and required as per the process requirements. Variable Frequency Drive (VFD) Unit will be provided for a motor feeder irrespective of its rating, only if specifically mentioned by the Purchaser. Suitable Line Chokes will be provided in VFD feeders. Load side chokes wherever required are also to be included.

Each motor feeder shall consist of an MPCB/ MCCB, an IMPR (Intelligent Motor Protection relay or intelligent controller), auxiliary relay, start & stop pushbuttons, ON/OFF/TRIP indicating lamps and SPMCB for control circuit protection. All the feeders shall have communication capable IMPR which shall be communicating to the BMS through communication bus.

Soft Starter must have suitable port for data communication and inbuilt protections for single phasing, phase sequence, over current, overvoltage, under voltage etc. In case of motors having embedded thermistor winding, Soft Starters for these motor feeders should have in-built thermistor relay.

Separate 24 V DC power source for controlled power supply shall be of suitable rating from UPS to be provided and logically distributed.

The following selection table shall be followed for switches & contactors of motor feeders unless otherwise specified in BoQ:

Sr. No.	415 V HP	MCCB rating A	MPCB rating A	Type of starter
1	Up to 7.5 HP	-	16	DOL
2	10 HP	-	16	DOL
3	12.5 to 15 HP	-	25	Star Delta
4	20 to 25 HP	-	40	Star Delta
5	30 to 35 HP	-	50	Star Delta
6	40 HP	63		Star Delta
7	45 HP	100		Star Delta
8	50 to 60 HP	125		Star Delta
9	65 to 70 HP	200		Star Delta
10	75 to 90 HP	200		Star Delta
11	100 to 125 HP	250		Soft Starter
12	150 to 180 HP	400		Soft Starter
13	200 to 250 HP	400		Soft Starter
14	275 to 400 HP	630		Soft Starter

For incoming feeder of rating up to 630 A, 4 pole MCCB & for rating higher than 630 A, 4 pole ACB shall be provided unless otherwise stated in the feeder details.

MCCB, 4 pole shall be provided (unless stated otherwise) for outgoing feeders of rating 63 Amps and above and preferably these shall be located at the

lower portion of the panel. These feeders shall have isolating link for neutral in case 3 pole MCCBs are to be supplied as per the requirement given in feeder details.

Electrical interlocking shall be provided between various feeders as required by the process and specified in feeder details. Interlocking will also be provided in software programme of Main PLC Panel.

ON/OFF operation of all motor feeders shall be possible in both Auto mode (PLC signal operation) as well as Manual mode (Push Buttons) from MCC through A/M selector switch. Indication for ON/OFF/TRIP for all motor feeders shall be provided.

Each incoming feeder shall have independent instrumentation, protection relays, APFC relays etc.

Provision shall be made to communicate operational parameters / data from all incoming/outgoing feeders to main PLC/ DCS Panel through suitable data bus/ signal communication cable. Operation parameters of motor feeders like ON/OFF status, actual current, trip status etc shall be communicated.

RUBBER MATS:

All LT Panels shall be provided with 1100 Volt grade rubber mats conforming to the relevant IS Code.

Supplier has to submit GA, control & power circuit drawing for approval to purchaser before starting manufacturing of MCC.

All the major components of an MCC shall be of same "Make".

Feeder details for incoming and outgoing for this project, as per battery limit and as per the design requirements of the plant, to be worked out by the supplier.

Wherever desired distributed I/O's with Communication adaptors or linking devices shall be installed in each shipping split or shipping section and factory wired to each starter unit. MCC shall be connected to remote controller/SCADA via one network of high bandwidth. Network connection from remote controller wherever required is to be made to the communication adaptor/linking devices installed in each shipping unit. However in general it is preferred that all the intelligent relays, Soft Starters and VFD provided in the panels for electrical equipment shall be interfaced to the Central PLC through open protocol communication cable (open networks) for control action and data acquisition/diagnostic information directly at device level. The VFD shall be dynamically controlled from the PLC depending on the program and feedback system from field. These VFD shall have Battery backup and communication port. The routing of network cables in IMCCs may be through horizontal and vertical wireways. However more optimized approaches such as use of Trunk lines and drop lines isolated behind barriers or Independent, easy-connect ports on drop lines - are preferred. These configurations would provide independent, readily accessible ports to simplify installing, withdrawing, relocating and adding plug-in units. The configuration is preferable to daisy-chain architecture, in which moving or adding an MCC unit requires interrupting the chain and disabling downstream units. The open networks shall be such as Ethernet, Modbus, DeviceNet and PROFIBUS.

Intelligent Motor Control Relay:

The specifications of the Intelligent motor control relay (Intelligent motor

management relay) shall be as given below:

A. General

The motor management device should conform to IEC 60947-4-1, 60947-5-5 & 60947-8 for overload and thermistor protections. The device should be suitable for operation at ambient temperature upto 60 Deg C. The components in the main circuit (i.e. Current / Voltage measuring devices) should have rated operation voltage of upto 690V.

The device should offer comprehensive motor management functions including Protection, Monitoring, Control and Diagnostics functions as detailed subsequently in this specification.

B. Construction

The motor management & control device should be of the latest technology available. The device should be compact and preferably modular in construction. The device should have integrated communication port for direct link to higher level, with open protocol bus system.

The protection system should be independent/autonomous of the automation system. i.e. Motor protection & control should continue to be available for operation in the event of a communication or automation system failure.

The device should have a control voltage of either 24V DC or a wide band control voltage from 110 to 240 V AC/DC, as applicable.

The basic unit shall have the following minimum status display

- Device Readiness
- Status of control supply
- Feeder fault indication
- Status of communication with PLC

The device shall have facility to test/reset as standard. It shall be possible to select between manual reset (at the device) or remote reset (through PLC/SCADA from control room)

C. Functional Requirements

i. Protection Functions

The device shall incorporate the following protection function as standard.

- Over load protection with trip adjustment
The device should have an in-built thermal motor model(thermal memory)
- It shall be possible to adjust the reset time after an overload
- Provision for connecting thermistor inputs
- Phase failure protection
- Unbalance protection with adjustable time delay
- Stall protection with adjustable time delay

ii. Monitoring Functions

The device shall incorporate the following monitoring function as standard

- Over current monitoring with adjustable time delay

- Under current monitoring with adjustable time delay
- Earth fault Monitoring with adjustable time delay

When threshold value of above settings exceed, it shall be possible to set the type of response (Warning, Tripping, Signalling and Disable)

- Motor Operating Hours monitoring
- Motor Stop time monitoring
- No. of starts monitoring

When threshold value of above protection setting exceeds, it shall be possible to set the type of response (Warning, Signalling and Disable)

Additionally, the following monitoring functions shall be possible as an option and should be provided for feeders wherever specifically asked for.

- Under voltage monitoring
- Power factor monitoring
- Active Power Monitoring
- Phase sequence monitoring
- Temperature monitoring via PT100 / PT 1000, NTC, KTY 83/84 inputs
- Recording the curves of measured values like current, voltage, power
- Monitoring of Analog values using Analog I/O modules

iii. Control Functions

In order to minimize the wiring & interlocks, the device shall have built-in software logics to achieve the various control functions

iv. Standard function blocks

- The Intelligent Motor Control and Protection Device shall have standard control function control blocks.

v. Diagnostics, Service & Operating Functions

The motor management system shall make available the following diagnostics, service and operating data on the bus system for further processing by the higher level control system. (e.g. PLC/SCADA)

D. Operating data

The following shall be available at the PLC as part of the cyclic send data

- Motor switching state (ON, OFF, Direction of rotation, Right, Slow fast etc)
- Current (maximum of the 3 phases)

The “cyclic send data” should consist of a minimum of 16 bits for communicating status of various aspects of the feeder like current limit exceeded, motor operating hours exceeded etc.

E. Diagnostic & Service data

The device should be capable of signalling/warning in case of overload of 115% of set current.

It should be possible to set “warning” or “trip” as response for current limits exceed, unbalance in current, earth fault, operating hours exceeded. It should be possible to read from the device the value of last trip current.

In case of a device fault or a trip, the device shall send the diagnostic data to the PLC for the user to analyze. The diagnostic information should consist of status information on fault type, status information on limits exceeded, Status information on warnings, device healthiness, bus fault, cooling down period (in case of overload fault), no. of starts, motor operating hours.

Event log with a capacity to record last 20 events, shall be accessible whenever required.

F. Measured Values:

The device shall by default transmit the current value (maximum of the 3 phases).

However, it shall be possible to access from the PLC other related parameters like percentage of unbalance, power factor, current in the 3 phases, last trip current, time to trip (for a feeder undergoing overload), cooling down period (after an overload trip), active power, apparent power.

Optionally where power/voltage monitoring is specified the following additional data should be available

- Voltage in the three phases (Line-to-Line) in Volts
- Consumed energy in kWh
- Active Power in Watts
- Apparent power in VA
- Phase voltages in V
- Power factor
- Phase sequence

G. Configuring & Communication

The supplier shall offer standard software for configuring the device. It shall be possible to configure a device either individually or over a communication network. For this purpose, provision for connecting a laptop should be available at the motor management device.

The device shall have integrated communication facility to communicate directly on a bus system without any additional components.

The device shall be able to transmit cyclic as well as acyclic data to higher-level automation. It shall be possible to define each bit in the cyclic and acyclic data sent to the PLC. The data defined as cyclic shall be fetched by master PLC in a sequential manner. i.e. one slave after other. The critical events like tripping of device or alarm shall be sent to master PLC on priority basis (acyclic transfer) irrespective of the slave sequence.

In order to achieve minimum response time, the device shall be capable of transmitting data at a speed of 12Mbps, suitable for operation with high-speed bus systems.

SECTION 7.0 EARTHING & LIGHTING PROTECTION SYSTEM

1. Earthing

All electrical equipment is to be earthed by connecting two earth strips from the frame of the equipment to a main earth ring. The earthing ring will be connected via several earth electrodes. The cable armour will be earthed through cable glands.

Earthing shall be in conformity with provision of rules 32, 61, 62, 67 & 68 of Indian Electricity Rules 1956 and as per IS-3043-1966 amended as on date.

The following shall be earthed:

- i. Transformer & D.G. Set neutrals.
- ii. Transformer and DG Set Housing.
- iii. HT and LT Panels.
- iv. Non-current carrying metallic parts of electrical equipment such as switchgear, bus ducts, rising mains, panel boards, motor control centres, capacitor panels, power panels, distribution boards, cable trays, metal conduits, welding sockets, transformer yard fencing etc.
- v. Generator & motor frames.
- vi. All fixtures, sockets outlets, fans, switch boxes and junction boxes etc. shall be earthed with PVC insulated copper wire as specified in item of work. The earth wires ends shall be connected with solderless bottle type copper lugs.
- vii. The third pin of Outlets on UPS shall be provided with a separate PVC insulated Cu. Wire (green with yellow stripe) as Isolated ground earth wire apart from the earthing of box.

The earth connections shall be properly made. A small copper loop to bridge the top cover of the transformer and the tank shall be provided to avoid earth fault current passing through fastened bolts, when there is a lightning surge, high voltage surge or failure of bushings.

The shop drawing for earthing system shall be prepared by the contractor and be got approved by CLIENT/Engineer-in-charge. The work shall be done in accordance with approved drawings.

All earth electrodes shall be given to a depth sufficient to reach permanently moist soil. Their location shall be marked and approval taken from Engineer-in-Charge before excavation for the same.

The earth electrodes shall be tested for earth resistance by means of a standard earth test ohms meter. All tests shall take place during the dry months, preferably after a protected dry spell.

The resistance between earthing system and the general mass of earth shall not be greater than 1 ohm.

The earth loop resistance to any point in the electrical system shall not be in excess of 1 ohm in order to ensure satisfactory operation of protective devices.

The resistance to earth shall be measured at the following: -

- a) At each electrical system ground or system neutral ground.
- b) At one point on each grounding system used to ground electrical equipment enclosures.
- c) At one point on each grounding system used to ground wiring system enclosures such as metal conduits and cable sheaths or armoured.

All earthing conductors shall be of high conductivity copper/ G.I. as per B.O.Q. and shall be protected against mechanical damage. The cross-sectional area of earth conductors shall not be smaller than half that of the largest current carrying conductor. However, the contractor shall use the sizes specified in the bill of quantities of the Tender.

Pipe Earth Electrode

G.I. pipe shall be of medium class and of the size and dia as specified in BOQ. G.I. Pipe electrode shall be cut tapered at bottom and provided with holes of 12mm dia drilled not less than 7.5cm from each other upto 2m of length from bottom. The electrode shall be buried in the ground vertically with its top not less than 20cm below ground level.

Plate Earth Electrode

The plate earth electrode shall consist of copper plate or G.I. plate as per item of work. The plate electrode shall be buried in ground with its faces vertical and top not less than 2.5m below Ground level. The plate shall be filled with charcoal dust and common salt filling, extending 15cm around it on all sides.

A watering pipe as specified in BOQ, of medium class G.I pipe shall be provided. The top of the pipe shall be provided with a funnel and a G.I. mesh screen for watering the earth. In the case of pipe electrode a removable plug shall be provided as per drawing. This will be housed in a masonry sump (with cement plastering) of not less than 40 cm square and 40 cm deep. A C.I. frame with hinged cover of 10mm thickness and locking arrangement shall be suitably provided over the sump. The earthing lead from electrode onwards shall be suitably protected from mechanical injury by a suitable dia medium class PVC/ HDPE pipe. The overlapping in G.I. strips in joints shall be rivetted with revets and welded in approved manner. The protection pipe within ground shall be buried at least 30 cm deep (to be increased to 60cm in case of road crossing and pavements). The portion within the building shall be recessed in walls and floors to adequate depth. In the case of plate earth electrode, two nos. 50mm x 6mm GI/Cu. Strip the earthing lead shall be securely bolted to the plate with two zinc passivated bolts, nuts, checknuts and washers. In case of pipe electrode, it shall be connected by means of a through bolt, nuts and washers and cable socket. Main earthing conductor is taken from the earth electrode with which the connection is to be made.

No earth pit shall be fixed within 2.5M of a wall of foundation. The location of the earth electrode will be such where the soil has reasonable chance of remaining moist. Effort shall be made to locate them in grass lawns or near flowerbeds or water taps. The distance between two earthing pits/stations shall be at least 3.0 meters.

The following selection table shall be followed for earthing of electrical loads: All earthing shall be made with two runs.

- Control switches/glands - Copper wire 14 SWG
- Motor/isolators up to 40 HP - copper wire upto cable tray & GI strip of required size in cable tray upto earth pit.
- Motor above 50 HP up to 125 HP – GI strip of 40x3 mm.
- Switch board /motor control centre - GI Strip 50 x 6 mm
- Earthing main in trenches - GI Strip 50 x 6 mm

No of Earth pits shall be as per the system requirements.

Testing and Commissioning

Testing and commissioning shall be done as per the programme/ instructions to be given by CLIENT/HLL's authorised representative. All testing equipments necessary to carry out the tests shall be arranged by the electrical Contractor.

Before the electrical system is made live, the electrical Contractor shall carry out suitable tests to the satisfaction of CLIENT/ HLL that all equipment wiring and connections have been correctly done and are in good working condition and will operate as intended.

All tests shall be conducted in the presence of the CLIENT/ HLL authorised representative by the electrical Contractor and shall be notified one week before tests are to take place.

All measurements shall conform to establish minimum acceptable test values. CLIENT/ HLL's Engineer reserves the right to approve all test results before circuit or equipments are energised for the first time.

2. LIGHTNING PROTECTION SYSTEM

Protection of buildings against lightning shall generally be done in accordance with latest IS-Code. The installation shall be done as per routes and location of equipment indicated on the drawing and bill of quantities. The conductors and the earth electrode conductor shall be fixed so that they are free to expand and contract. Special care shall be taken in the fixing of support to allow free movement.

The materials of lightning conductors, down conductors, earth termination etc. shall be reliably resistant to corrosion or be adequately protected against corrosion. All air terminations shall be GI and the conductors shall be GI.

The entire lightning protection system should be mechanically strong to withstand the mechanical forces produced in case of a lightning strike. The system shall be installed such that it does not spoil the architectural or aesthetic beauty of the buildings but on other hand it should meet IS code/safety code.

Horizontal air terminations should be so interconnected that no part of the roof is more than 9 metres away from the nearest horizontal conductor. For a flat roof horizontal air termination along the outer perimeter of the roof is used. For a roof of larger area a network of parallel horizontal conductors shall be installed. Horizontal air terminations shall be laid along contours such as ridges, parapets and edges of flat roofs and where necessary area flat surfaces in such a way as to connect each air termination to the rest and shall, they form a closed network.

All metallic finials, chimneys, ducts, vent pipes, railings, gutters, metallic flag staff, on or above the main surface of the roof of the structure shall be bonded to and form part of the air termination network. All air terminations shall be effectively recessed against over turning either by attachment to the object to be protected or by means to substantial braces and fixing which shall be permanently and rigidly attached to the buildings.

Down conductors shall be distributed around the outside walls of the structure. They shall preferably be run along the corners and other projection, due considerations being given to the locations of air terminations and earth terminations. Lift shafts shall not be used for fixing down conductors. Metal pipes leading rainwater from the roof to the ground may be connected to the down conductors but cannot replace them. Such conductors shall have disconnecting joints. All vertical conductors shall be plumbed before fixing. Insulation shall be provided between down conductors and wall.

The lightning protective system shall have as few joints in it as possible. Wherever joints in the down conductor above ground level are necessary they shall be mechanically and electrically effective. The joint overlap shall not be less than the width of the tape. In the down conductor below ground level there shall be no joint. The joints may be clamped, screwed, bolted, revitted, sweated, braced or welded. The bonding of the external metal forming part of a structural or drain water pipe shall

have a cross sectional area not less than that employed for the main conductors. Gas pipe, however, in no case shall be bonded to the earth termination system.

Conductors shall be securely attached to the building to be protected by fasteners, which shall be substantial in construction, not subject to breakage and shall be of steel. The conductors shall be secured at not more than 900mm apart for horizontal run and 750mm for vertical run.

Where tape are required to pass through roof asphalting or other waterproofing membranes, a special seal shall be used comprising a 38mm diameter plastic, copper or aluminium tube with 100mm diameter flange 50mm from the top of the tube. The tube length shall suit the thickness of the roof through which the conductor passes, allowing for the tube to protrude 50mm above the membrane. The seal is to be asphalted in position and the conductor shall be sealed in the tube by a setting waterproof compartment.

Each down conductor shall have an independent earth termination. The interconnection of all the earth termination shall be preferable. It should be capable of isolation for testing purpose by "testing joints" at position approachable easily for the meggar testing. The whole of the system could have a combined resistance to earth not exceeding 2 ohm before any bonding has been affected to metal in or on structure or two surfaces below ground.

SECTION 8.0 CAPACITORS & CAPACITOR CONTROL PANEL

Power factor correction capacitors shall conform in all respects to IS 2834-1964. The capacitors shall be suitable for 3 phases 415V at 50 Hz frequency and shall be available in units as per B.O.Q. to form a bank of capacitors of desired capacity. All these units shall be connected in parallel by means of high conductivity electrolytic copper busbars of adequate current carrying capacity having S.C rating of 25 KA for 1 sec. Each capacitor bank shall be suitable for PVC insulated aluminium conductor armoured cables. Two separate earthing terminals shall be provided for each bank for earth connection. The capacitor bank shall be housed indoor.

The capacitor bank shall be subject to routine tests as specified in relevant Indian Standard and the test certificate shall be furnished. The capacitor shall be suitable for indoor use upto 45 Deg.C over and above ambient temperature of 50degree C. The permissible overloads shall be as given below:

- a) Voltage overload shall be 10% for continuous operation and 15% for 6 hours in a 24 hours cycle.
- b) Current overloads 15% for continuous operation and 50% for 6 hours in a 24 hours cycle.
- c) Overload of 30% continuously and 45% for 6 hours in a 24 hours cycle.

The capacitor banks shall be floor mounting type indoor housing using minimum floor space with protective guard or fencing. The capacitor bank shall be provided with 14% Detuned reactor filter to compensate third harmonics from being generated.

Capacitors shall be of aluminium foil and craft paper. Hermetically sealed in sturdy corrosion-proof sheet steel 2mm thick containers and impregnated with non-inflammable synthetic liquid and of low power loss version. Every element of each capacitor unit shall be provided with its own built in silvered fuse. The capacitor shall have suitable discharge device to reduce the residual voltage from crest value of the rated voltage to 50 V or less within one minute after capacitor is disconnected from the source of supply. The loss factor of capacitor shall not exceed 0.005 for capacitors

with synthetic impregnates. The capacitors shall withstand voltage of 2500V AC supply for 1 minute.

The insulation resistance between capacitor terminals and containers when test voltage of 500V A.C. is applied shall not be less than 50 mega ohms.

- Capacitor bank and switching equipment shall be housed in a cubicle having degree of protection IP-51 and constructed with sheet steel of minimum 2mm thickness.
- Capacitors shall be unit type having non-PCB, non-flammable non-toxic dielectric.
- Necessary discharge resistor shall be provided externally to reduce the terminal voltage to or less than 50V in 60 seconds of disconnection from supply.
- Testing shall be done as per applicable standards for shunt capacitors.

Capacitor Control Panel

The capacitor control panel shall general comprise of the following:

- a) Automatic power factor correction relay.
- b) Step controller with reversing motor.
- c) Time delay and no-volt relays.
- d) Protection MCCB / MCB.
- e) Capacitor Duty Contactor (AC-3 duty) for individual capacitors of suitable rating.
- f) Change over switch for either automatic operation or manual operation with push button control.
- g) C.T.s with ammeter and selector switch as asked for in BOQ.
- h) Voltmeter with selector switch.
- i) Indicating lights RYB.

All the capacitors and contactors shall be interconnected with PVC insulated copper conductor wires of adequate size in a neat and acceptable manner. Three phases and neutral bus bar shall be provided in panel as required.

The above control gear, P.F. meter, Digital Microprocessor based P.F. correction relay, push button station etc. shall be housed in a sheet steel metal enclosure cubical type, free standing front operated with lockable doors. The panel shall be fabricated from MS sheet steel 2mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet steel shall be seam-welded. The panel shall be totally enclosed design completely dust tight and vermin proof. Gaskets between all adjacent units and beneath all covers shall be used to render the joints effectively.

All sheet steel material used in the construction of capacitor control panel should have undergone a rigorous rust proofing process comprising Alkaline Degreasing, descaling in dilute sulphuric acid and recognised phosphating process. The steel work should then receive two coats of primer before powder coating of Siemens Grey RAL 7032 shade. The Capacitor panel shall be powder coated with minimum 60 micron thickness.

Quality Assurance

Quality Assurance shall follow the requirement of HLL and Q.A. documents as applicable. Quality Assurance involvement will commence at enquiry and follow

through to composition and acceptable thus ensuring total conformity to purchaser's requirement.

SPARES

The manufacturer/tenderer shall also supply a complete list of commissioning spares and tools. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.

SECTION 9.0 H.T. CABLE (XLPE) (33 KV & 11 KV)

The cross-linked polyethylene (XLPE) cable shall be aluminium conductor PVC outer sheath steel strip armoured over inner sheath construction. XLPE cable shall conform to testing in accordance with IS: 7098 (Part-I) 1977 and (Part-II) 1973. The screening shall be done on individual cover. The armouring applied over the common covering shall be flat steel wires. Each and every length of cable shall be subjected to routine test.

The termination and jointing techniques for XLPE cables shall be by using heat shrinkable or push on cable jointing kits.

While laying underground cables in ducts care should be taken so that any underground structures such as water pipes, sewerage lines etc. are not damaged. Any telephone or other cable coming in the way shall be properly protected as per instructions of the Engineer-in-charge. The H.T. cable shall be laid at least 1200mm below the existing ground level for cable upto 33 KV (E) in a trench 450mm wide.

Insulation tests shall be done before and after laying of cables.

After laying and jointing work is completed a high POT test shall be performed in presence of Engineer and test results submitted for approval in order to ensure that they have not been damaged during or after the laying operation. In case, the test results are unsatisfactory, the cost of all repairs and replacement and all extra work of removal and relaying will be made good by the contractor without any extra cost.

SECTION 10.0 L.T. CABLES & WIRE

1. Wires

The design manufacture, testing and supply of single core **LEAD FREE FRLS PVC** insulated 1.1 KV grade multi-stranded twisted wires under this specification shall comply with latest edition of following standards.

IS : 3961 Current rating for cables.

IS: 5831 PVC insulation and sheath of electric cables.

IS : 694 PVC insulated cables for working voltage upto and including 1100 volts.

IEC: 754(i) FRLS PVC insulated cable.

Copper multi-stranded twisted conductor FRLS PVC insulated wires shall be used in conduit as per item of work.

The wires shall be colour coded R Y B, for phases, Black for neutral and Green for earth.

Progressive automatic in line indelible, legible and sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of wire.

The material & insulation of wires shall be **ROHS compliant** (Reduction Of Hazardous Substance) and shall comply the following directives:

- EU Directive 2002/95/EC Issued Jan 2003
- EU Directive 94/62/EC and 2004/12/EC (amendment)
- EU Directive 91/338/EEC
- EU Directive 91/157/EEC & 98/101/EC (amendment)

Summary on related directives

Directive Ref.	Date	Objective	Remarks
2002/95/EC	27Jan03	Restriction of the use of certain hazardous substances in electrical and electronic equipment (EEE) and to contribute to the protection of human health and the environmentally sound recovery and disposal of waste EEE.	6 banned materials included Pb (Lead), Hg (mercury), Cr6+ (Hexavalent Chromium), Cd (Cadmium) and Flame Retardants- Polybrominated Biphenyls - PBB 1000ppm & Polybrominated Diphenyls Esters- PBDE 1000ppm. • Max. conc. value - 0.1% by weight in homogeneous material for Pb, Hg, Cr6+, PBB/ PBDE • Max. conc. value - 0.01% weight in homogenous material for Cd.
94/62/EC 2004/12/EC (amendment)	20Dec94 2Nov04	Amending directive 94/62/EC, on Packaging and Packaging Waste is to prevent packaging waste by encouraging packaging re-use and recycling while at the same time avoid distortions in the internal market.	The targets defined are the following: • Recovery of minimum 60% by weight of the packaging waste • Recycling of at least 55% and a maximum 80% by weight of the totally of packaging materials, with a material-specific minimum recycling rate for plastic of 22.5% • Max. sum of concentration levels of Pb, Cd, Hg and Cr6+>100 ppm by weight
91/338/EEC	18Jun91	Restriction on the use of Cadmium pigment (amending for the 10th time Directive 76/769/EEC)	The cadmium content (expressed as Cd metal) exceeds 0,01 % by mass is prohibited in the finished products or components of products manufactured from polymers or copolymers of vinyl chloride and stabilized by substances.

2. Cables

The design, manufacture, testing and supply of the cable under this specification shall comply with latest edition of following standards:

- IS: 8130 Conductors for insulated electric cables and flexible cords.
- IS: 7098 XLPE insulation and sheath of electric cables.
- IS: 3975 Mild steel wires, strips and tapes for armouring cables.
- IS: 7098 Current rating of cables.
- IS: 7098 XLPE insulated (heavy duty) electric cables for working voltage upto and including 1100 volts.
- IS: 424-1475(F-3) Power cable-flammability test.

Specification for cross-linked polyethylene insulated XLPE sheathed cable for working voltage upto 1.1 KV.

Specification for XLPE insulated (heavy duty) electric cables for working voltages upto and including 1100 volts.

ASTM-D: 2863 Standard method for measuring the minimum oxygen concentration to support candle-like combustion of plastics (Oxygen Index).

ASTM-D: 2843 Standard test method for measuring the density of smoke from the burning or decomposition.

IEEE : 383 Standard for type of test Class-IE, Electric cables, field splicers and connections for power generation station.

ASTME:662IEC:754(x) Standard test method for specific optical density of smoke generated by solid materials.

IS : 10418 Cable drums.

3. **Technical Requirements:**

- i. The cables shall be suitable for laying in racks, ducts, trenches conduits and under-ground buried installation with uncontrolled back fill and chances of flooding by water.
- ii. They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating condition.
- iii. The aluminium/copper wires used for manufacturing the cables shall be true circular/sector in shape before stranding and shall be of uniformly good quality, free from defects. The conductor used in manufacture of the cable shall be of H2 grade.
- iv. The cable should withstand 25 KA for 0.5 sec with insulation armour insulated at one end. Bidder shall furnish calculation in support of capability to withstand the earth fault currents. The current carrying capacity of armour and screen (as applicable) shall not be less than the earth fault current values and duration.
- v. The fillers and inner sheath shall be of non-hygroscopic fire retardant materials and shall be suitable for the operating temperature of the cable. Filler and inner sheath shall not stick to insulation and outer sheath.
- vi. Progressive automatic in line indelible, legible and sequential marking of the length of the cable in metres at every one metres shall be provided on the outer sheath of all cables and at every 5 metre 'FRLS' marking in case of 'FRLS' cables.
- vii. Strip/Wire armouring following method (b) mentioned in IS: 3975 shall only be acceptable. For single core cable aluminium wire armouring shall be used.
- viii. Allowable tolerance on the overall diameter of the cables shall be + 2mm.
- ix. The normal current rating of all XLPE insulated cables shall be as per IS: 7098.
- x. A distinct inner sheath shall be provided by pressure extrusion process for all multicore armoured and unarmoured cables as per IS: 5831.
- xi. Outer sheath shall be provided by extrusion process as per IS: 5831
- xii. The breaking load of armour joint shall not be less than 95% of that armour wire. Zinc rich paint shall be applied on armoured joint surface.
- xiii. In plant repairs to the cables shall not be accepted.

xiv. All the cables shall be supplied in non-returnable drums as per IS: 10418.

3.1 In Case of FRLS Cables

- i) The outer sheath of cables shall have an oxygen index of not less than 29 as per ASIMD: 2863.
- ii) The maximum acid gas generation by weight as per IEC: 754 (i) shall not be more than 20% for outer sheath material of all cables. Bidder shall also guarantee the maximum theoretical acid gas generation with 20% by weight of outer sheath.
- iii) The cables outer sheath shall meet the requirement of light transmission of 40% (minimum and shall be tested as per ISTMD: 2843). In case the test for light transmission is conducted as per ASTM E: 662. The bidder shall furnish smoke density values as per this standard and shall co-relate the anticipated light transmission when tested as per ASTM D: 2843.
- iv) The cable shall pass the fire resistance test as per SS: 42, 41, 475 (I) and flammability test as per EEE: 383.

4. Inspection:

All cables shall be inspected on receipt of the same at site and checked for any damage during transit.

5. Joint in Cables

The contractor shall take care that the cables received at site are distributed to various locations in such a manner as to ensure maximum utilisation and avoidance of cable jointing. Cable shall be rechecked before cutting in lengths, where the joints are unavoidable, and the location of such joints shall be got approved from the CLIENT/ HLL. The joints shall be done by qualified jointer strictly in accordance with manufacturer's instruction/drawings.

6. Joint Boxes for Cables

The cable joint boxes shall be of appropriate size suitable for type of cable of particular voltage rating.

7. Jointing of Cables

All straight through joints shall be done in epoxy mould boxes with epoxy resins. Straight through joints shall not be permitted unless the length of run is in excess of cable drum.

End terminations of cables more than 1.1 KV grade shall be done with epoxy mould boxed and epoxy resin. Cable glands shall be 1.1KV grade double compression type and made to tin plated heavy-duty brass casting and machine finished. Glands shall be of robust construction capable of clamping cable and cable armour, firmly without injury of cable.

All washers and hardwares shall be made of brass tinned. Rubber components used in the glands shall be made of neoprene of tested quality.

Cable lugs shall be tinned copper/aluminium solderless crimping type conforming to IS: 8309 suitable for aluminium or copper conductor.

Crimping of terminals shall be done by using Corrosion inhibitory compound, with crimping tool.

Fire resistant paint has to be applied 1 Metre on either side of cable joint.

The contractor shall liaise fully with all other contractors to achieve an efficient and properly coordinated installation where equipment has to be re-

positioned due to lack of site liaison; no extra cost shall be incurred by the HLL.

8. Testing of Cables

Cables shall be tested at factory as per requirement of IS: 7098 Part-I. The tests shall incorporate routine tests, type tests and acceptance tests. Prior to laying of cables, following tests shall be carried out:

- i) Insulation test between phases and phase to earth for each length of cable before and after jointing.

On completion of cable laying work, the following test shall be conducted in the presence of Engineer-in-charge/HLL/ CLIENT/ HLL.

- ii) Insulation resistance test (Sectional and overall) 1000/5000V depending upon the voltage grade of cable.
- iii) Continuity resistance test.
- iv) Sheathing continuity test.
- v) Earth test.

9. Laying of Cable

The cable drum shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming links. At all changes in directions in horizontal & vertical places, the cable shall be bent with a radius of bend not less than 8 times the diameter of cable.

The cable of 1.1KV grade shall be laid not less than 750 mm below ground level in a 375mm wide trench (throughout), where more than one cable is to be laid in the same trench, the width of the trench shall be increased such that the interaxial spacing between the cables except where otherwise specified shall at least be 150mm minimum or as per site requirements or as approved by the Engineer-in-charge. Where single core cables are used in multiphase systems, the cables shall be installed in trefoil where possible.

11KV and 33 KV HT cables shall be laid not less than 1200 mm below existing ground level.

In case the cables are laid in vertical formation due to unavoidable circumstance the depth per tier shall be increased by 200mm (minimum). Cable shall be laid in reasonably straight line, where a change in direction takes place a suitable curvature shall be i.e. either 12 times the diameter of the cable or the radius of the bend shall not be less than twice the diameter of the cable drum or whichever is less. Minimum 3-meter long loop shall be provided at both sides of every straight through joint & 3 meters at each end of cable or as directed at site.

Greater care shall be exercised in handling the cable in order to avoid forming 'Kinks'. The cable drum shall in-verbally convey on wheels and the cable unrolled in right direction as indicated on the drum by the manufacturer. The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains.

Cables laid in trenches in single tier formation, 10 cms. All around sand cushioning is provided below and above the cable before a protective cover is laid. For every additional vertical tier. The 30cm of sand cushion are provided over the initial tier. The cable shall be protected by 2nd class bricks of size not less than 230x115x75mm, stone tiles/RCC curved channel be placed on top of the sand breadth wise for the full length of the cable and where more

than one cable is to be laid in the same trench the brick shall cover all cables and project at least 8 cms. Over the outer sides of the end cables.

Filling of trenches shall be done after the sand cushioning and laying of tiles or bricks are carried out to the satisfaction of the Engineer-in-charge (Refer drawing). Back fill for trenches shall be filled in layer not exceeding 150 mm. Each layer shall be properly rammed & consolidate before laying the next layer.

PVC pipe shall be provided for all road crossing. The size of the pipe shall be according to the cable and a minimum 100mm dia. pipe shall be provided. The pipe shall be laid in ground with special arrangement and shall be cement jointed and concreting with 1:5:10 shall be made as per relevant IS with latest amendment. Location of cables laid directly underground shall be indicated by cable marker at an interval of 30 meters & with change of direction. Aluminium strip cable tag of 20mm wide with engraved tag no. shall be provided at both ends of cable.

Where the cables are to be laid in ducts (pucca trenches) in side the building, they will have to be laid on MS rack/ on MS cable trays grouted in walls trenches. Cables sizing through floors shall be protected from mechanical damage by a steel channel to a height of one meter above the floor where cable pass through wall they shall be sleeved with PVC/steel conduit.

Where the cables are laid in open (in building) along walls, ceiling or above false ceiling, cable rack (ladder type) or cable tray shall be provided. The size of the cable tray or rack shall depend on the number of cables to pass over that rack. Cable tray/rack shall be properly supported through wall/ceiling according to the site conditions. Cable laid on tray & riser shall be neatly dressed & clamped at an interval of 1000 mm & 750mm for horizontal & vertical cable run respectively either side at each bend of cable. All power cables shall be clamped individually & control cables shall be clamped in groups of three or four cables. Clamps for multicore cables shall be fabricated of 25x3 GI flats. Single core power cable shall be laid in trefoil formation & clamped with trefoil clamps made of PVC/fibre glass.

Cable openings in wall/floor shall be sealed by the contractor suitably by hession tape & bitumen compound or by any other proven to prevent ingress of water.

After the cables are laid, these shall be tested as per IS and the results submitted to Engineer-in-charges/Engineer and in case the results found unsatisfactory, all the repairing/ replacing of cables will be done by the contractor free of charge.

10. Fire Seal System

- i) All the floor/wall opening provided for cable crossing shall be sealed by fire seal system.
- ii) The fire proof sealing system shall fully comply with the requirements of relevant IS/BS: 476 Part-B. The fireproof seal system shall have minimum one hour fire resistance rating.
- iii) The fire proof seal system shall be physically, chemically, thermally stable and shall be mechanically secured to the masonry concrete members. The system shall be completely gas and smoke tight, **antirodent** and anti-termite.
- iv) The material used in fireproof seal system shall be non-toxic and harmless to the working personnel.

- v) Type of fireproof seal system shall be foaming type or **flamemastic** type compound or approved equivalent.

After laying and jointing work is completed, high voltage test should be applied to all cables to ensure that they have not been damaged during or after the laying operation and that there is not fault in the jointing.

Cables for use on low and medium voltage system (1.1KV grade cables) should withstand for 15 minutes a pressure of 3000V DC applied between conductors and also between each conductor and sheaths. In the absence of pressure testing facilities it is sufficient to test for one minute with a 1000V insulation tester. In case the test results are unsatisfactory the cost of repairs and replacements and extra work of removal & laying will be made good by the contractor.

Cable shall be installed so that separation shown in the table below are observed.

HV Cable (11 KV/ 33 KV) - HV Cable (11 KV/ 33 KV)	50 mm
ELV & LV 230 V/433 V - ELV & LV cable 230 V/433 V	Equal to the diameter of the bigger cable.
HV cables (11 KV/33 KV) - ELV & LV cables 230 V/433 V	300 mm
LV cables 433 V - Telephone/Instrument cable	350 mm
All cables - All hot pipe work	200 mm

11. Quality Assurance

Quality Assurance shall follow the requirements of CLIENT/HLL as applicable. Quality Assurance involvement will commence at enquiry and follow through to completion and acceptance thus ensuring total conformity to Purchaser's requirements.

12. Spares for Commissioning Including Consumables

The manufacturer/tenderer shall also supply a complete list of commissioning spares and tools and consumables. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.

SECTION 11.0 CABLE TRAYS

a. **Ladder type Cable tray** – for Power Cables only

Cable trays shall be ladder type fabricated out of mild steel/slotted angles and flats of required width as per design. Bends shall be prefabricated. The cable tray shall be hot dip galvanized or primed and painted with powder coating as asked for in BoQ or as approved by CLIENT/ HLL. The minimum weight of the zinc coating shall be 460 gm/sq.m and minimum thickness of coating shall not be less than 75 microns.

b. **Perforated Cable tray** – for Power Cables & Low current service both

The perforated cable trays are fabricated out of 1.6mm thick CRCA sheet steel having minimum 50mm depth or as called for in BOQ, hot dip galvanized or epoxy coated of approved shade. Perforations are maximum 10mm spaced at maximum 20mm distance. The cables shall be tied with the cable tray with nylon strip/ aluminium clamps/M.S. clamps as per requirements.

Suitable provision shall be made where a tray crosses expansion joints. The width of the tray shall allow for a suitable separation between cables the design shall allow for adequate bending radius for the sizes of cables. No

sharp bend to be allowed in cable tray. Joints between sections shall be bolted.

The tray shall be suspended from the surface of the concrete slab by means of approved steel hangers spaced at a distance of not more than 125cms. Suitable bushes shall be provided where cables pass through apertures in the tray. Cables must be securely fixed to the tray with clamps or cable ties. In routing necessary barrier and spacing shall be maintained for cables of different voltages in case they lie side by side. Telephone cables shall cross the power cables only at about right angle and these two shall not run in close proximity. Full details of the tray shall be approved by the HLL/Engineer-in-charge before fabrication. Earth continuity shall be maintained between each section of cable tray and each total run of tray shall be effectively bonded to the nearest earth continuity conductor. All nuts and bolts used shall be of galvanised steel.

Depending on the size of cable trays space of 20-33% has to be maintained for future expansion.

Cable tray is manufactured to comply with the specifications of National Electrical Code (NEC) and National Electrical Manufacturer's Association (NEMA).

SECTION 12 INTERNAL ELECTRICAL WORKS

1. Conducting (M.S Conduit)

All conduits shall be of heavy gauge solid drawn ERW welded manufactured out of 16 (1.6mm) gauge MS Sheet up to 32mm dia and of 14 gauge (2 mm) for sizes higher than this. Both inner and outer surfaces shall be smooth without burrs, dents and kinks. Conduits shall be black stove enameled inside and outside. The cross section of conduit shall be uniform throughout. The welding shall be uniform such that welded joints do not yield when subjected to flattening test. Welded joint shall not break when threaded or bent at an angle. Conduit shall conform to specifications of IS: 9537 (Part-II) and the capacity of conduits shall be in accordance with the standards and shall never be exceeded. The minimum size of the conduit shall be 20mm dia. Care shall be taken to ensure that all conduits are adequately protected while stored at site prior to erection and no damaged conduit shall be used.

2. PVC Conduit

All conduits shall be high impact rigid 2mm thickness PVC heavy duty type and shall comply with I.E.E. regulations for non-metallic conduit 2mm thick as per IS-9537/1983 (Part-III). All sections of conduit and relevant boxes shall be properly cleaned and glued by using epoxy resin glue and the proper connecting pieces. Inspection type conduit fittings such as inspection boxes, drawn boxes, fan boxes and outlet boxes shall be M.S. or otherwise mentioned. Conduit shall be terminated with adopter/PVC glands as required.

3. Accessories

Conduit accessories such as normal bends, unions, circular junction boxes and pull boxes, locknuts etc. shall be heavy gauge type and approved make. Conduit accessories shall conform in all respects to IS: 3837-1966 with latest amendment. Wherever several conduits are running together, adequately sized adoptable boxes common to all runs shall be used to avoid inserting inspection boxes in the individual run. Where it is necessary to segregate wiring metal filler shall be fixed with in the box.

Conduits shall be laid before casting in the upper portion of a slab or otherwise, as may be instructed or in accordance with approved drawings, so as to conceal the entire run of conduits and ceiling outlet boxes. Vertical drops shall be buried in columns or walls. Wherever necessary, chases will be cut by the contractor with the help of chase cutting m/c or by hand. Nothing extra shall be paid to the contractor on this account. In case of exposed brick/ rubble masonry work special care shall be taken to fix the conduit and accessories in position along with the building work. Sufficient depth of the chases will be made to accommodate the required number of conduits. The chase will be filled with cement, coarse sand mortar (1:3) and properly cured by watering for one week.

If a chase is cut in an already finished surface the contractor shall fill the chase and finish it to match the existing finish. Contractor must not cut any iron bars to fix conduits. Conduits shall be kept at a minimum distance of 100mm from the pipes of other non-electrical services. Where the conduit is to be embedded in a concrete member it shall be adequately tied to the reinforcement to prevent displacement during casting, conduits in chases shall be held by steel hooks of approved design at maximum of 100 cm centres. The embedding of conduits in walls shall be so arranged as to allow at least 12mm plaster cover the same. All threaded joints of conduit pipes shall be treated with some approved 'preservative compound' to secure protection against rust.

Suitable expansion joints fittings of approved make and design shall be provided at all the points where the conduit crosses the expansion joint in the building. (Preferably with Pilca metallic watertight conduits). Conduits shall cross at right angles of the joints only.

Separate conduit shall be used for:

- a. Normal light, fan call bell
- b. 16 A power outlets
- c. Emergency Light Point
- d. Fire alarm System
- e. LAN/ Data Network
- f. P.A. System
- g. Telephone System
- h. TV Network
- i. Access Control System
- j. Optical Fibre Cables (OFC)
- k. Or any other services not mentioned here.

Wiring for short extensions to outlets in hung ceiling or to vibrating equipments, motors etc. shall be installed in flexible conduits. Flexible conduits shall be formed from a continuous length of spirally wound interlocked wire steel with a fused zinc coating on both sides. The conduit shall be provided with approved type adaptor. A separate and accessible earth connection shall bond across the flexible conduit.

Conduit runs on surfaces shall be supported with metal 1.2 mm thick saddles, which in turn are properly secured on to GI spacer to the wall or ceiling. Fixing screws shall be with round or cheese head and of rust proof materials. Exposed conduits shall be neatly run parallel or at right angles to the walls of the building and shall be painted in color matching the adjoining area. Unseemly conduit bends and offsets shall be avoided by using better appearance. Cross cover of conduits shall be minimum and

entire conduit installation shall be clean and with good appearance. For surface work, the boxes shall be raised back pattern type, designed for use with distance saddles to give clearance of 6mm between the back of conduit and the fixing surface.

Where conduits are run on steel work, they will be fixed by means of purpose made GI Caddy clips in manner meeting with the approval of the Engineer prior to the installation being carried out. Other methods of fixing may be agreed in special circumstances, but approval must first be obtained from the site engineer.

The spacing of saddles shall be not more than 600mm centers for up to 32mm diameter conduits and at 750mm for conduit sizes of 40mm diameter and above in case of MS conduit and not more than 600 mm for PVC conduit. In addition, saddles shall be fixed at each side of any bend/Tee, or set at a distance of 200mm from the bend/Tee. The holes in the brickwork or concrete for fixing plugs shall be neatly drilled by means of a masonry drill of the appropriate size.

All the GI sheet steel /passivated boxes used for housing switches, plugs, fan regulator etc. shall be five sided conforming to IS: 5133 Part I-1969. Suitable size of boxes shall be provided a minimum of 2 adjustable fixing lugs on vertical sides. Suitable earth terminal inside each box shall be provided. All fixing lugs shall be threaded to receive standard machined chromium plated brass screws. Sufficient number of knockouts shall be provided for conduit entry. Conduits carrying wires of different circuit can terminate in common J.B having metal compartments. Necessary GI pull wires shall be inserted into the conduit for drawings wires. In case conduit pipe is required to cross any RCC beam special adopter boxes shall be provided for crossing & nothing shall be paid extra.

Where conduits are used for non-air-conditioned space to air-conditioned space or into a fan chamber or duct, a junction box shall be installed to break the continuity of such conduit at the point of entry or just outside and conduit shall be sealed around the conductors.

Particular care shall be taken during the progress of the work to prevent the ingress of dirt and rubbish such as plaster droppings into erected conduits. Conduit which has become so clogged shall be entirely freed from these accumulations or will be replaced. Screwed plastic or metal caps or turned wooden plugs shall be employed to protect all open ends. Plugs of waste wood, paper, cotton or other fibrous matter shall not be used. All unused conduit entries shall be blanked off in an approved manner and where conduits terminate in adaptable boxes, all removable box covers shall be firmly secured to provide complete enclosure. If considered necessary by the Engineer-in-charge, the conduits shall be swabbed out by drawing swabs of rag through the conduit to remove moisture prior to any cables being drawn in.

All conduit installations must be completed and erected in their totality before they are wired and must be fully rewirable from outlets to distribution boards or trunking systems etc. to which they connect. No wiring of any part of the installation shall be commenced until instructions are received to do so by the Engineer-in-charge at such time as he is satisfied that the wiring will not be damaged due to building operations.

Conduits shall be installed so that they are self-draining in the event of ingress of moisture due to condensation or any other reason. A suitable drainage hole shall be drilled at the bottom of the lowest conduit box in every 9-meter of horizontal run.

PVC bush of good quality shall be used in each conduit termination in a switch box, draw box, lighting fixtures and circular junction boxes.

Exposed conduits running above false ceilings shall be suitably clamped independently along with the dropped ceiling. Perforated straphangers or twisted attachment shall not be acceptable. In no case shall raceways be supported or

fastened to other pipe for repair and maintenance. They shall be arranged symmetrically and in the most compact design, in no way unduly criss-crossing each other. Proper spacing shall be maintained when two or more conduits run side by side. The layout of the pipes shall be co-ordinated with other services if any. The junction boxes and conduits used in hazardous areas shall be flameproof type with cast iron construction complete with threaded covers. The conduit of each circuit or section shall be completed before conductors are drawn in. The entire system of conduit after erection shall be tested for mechanical and electrical continuity throughout and permanently connected to earth conforming to the requirements by means of special approved type of earthing clamp efficiently fastened to conduit pipe in a workman like manner for a perfect continuity between the earth and conduit.

The conduit system shall be so laid out that it will obviate the use of tees, elbows and sharp bends. No length of conduit shall have more than the equivalent of two-quarter bends from inlet to outlet. The conduit itself being given required smooth bend with radius of bends suiting to the site conditions but not less than 6 times overall diameter.

Outlet boxes shall be of heavy-duty sheet steel installed as to maintain continuity throughout. These shall be so protected at the time of laying that no mortar finds its way inside during concrete filling or plastering. For fluorescent fittings, the outlet boxes heavy duty shall be provided 300mm off centre for a 1200mm fitting and 150mm off centre for a 600mm fittings or as per B.O.Q.

Draw boxes of ample dimensions shall be provided at convenient points to facilitate pulling of long runs of cables. They shall be completely concealed with MS covers flush with plasterwork painted to match the wall. These boxes will be as few as possible and located where found suitable by the HLL.

4. Switch Boxes

The switch boxes shall be zinc passivated & shall not be less than **18 SWG** thick or shall be as called for in BOQ. It will be so designed that accessories could be mounted on integral pedestals or on adjustable flat iron mounting straps with tapped holes by brass machine screw. Leaving ample space at the back and on the sides for accommodating wires and check nuts at conduit entries. These shall be attached to conduits by means of check nuts on either side of their walls. These shall be completely concealed leaving edges flush with wall surfaces. Earthing terminal inside box shall be provided.

Moulded plate switches screw less as specified in item of work shall be provided. No timber shall be used for any supports. Boxes, which come within concrete, shall be installed at the time of casting. Care shall be taken to fix the box rigidly so that its position is not shifted while concreting.

5. Wiring

All the wiring installation shall be as per IS: 732 with latest amendment. PVC insulated Fire Resistant (FR)/ Fire Resistant Low Smoke (FRLS) copper conductor cables as specified in bills of quantity shall be used for sub-circuit runs from the distribution boards to the points and shall be pulled into conduits. They shall be twisted copper conductors with thermoplastic insulations of 660/1100 volts grade. Colour Code for wiring shall be followed.

Looping system of wiring shall be used, wires shall not be jointed. Where joints are unavoidable, they shall be made through approved mechanical connectors with prior permission of the HLL. No reduction of strands is permitted at terminations. No wire smaller than 1.5 sq.mm shall be used and shall be as per B.O.Q. Wherever wiring is run through trunkings or raceways, the wires emerging from individual distributions shall be bunched together with cable straps at required regular intervals.

Identification ferrules indicating the circuit and DB number shall be used for submains sub-circuit wiring. The ferrules shall be provided at both end of each submain and sub-circuit.

Where single-phase circuits are supplied from a three phase and a neutral distribution board, no conduit shall contain the wiring fed from more than one phase. In any one room in the premises where all or part of the electrical load consists of lights, fans and/or other single phase current consuming devices, all shall be connected to the same phase of the supply. Circuits fed from distinct sources of supply or from different distribution boards or through switches or MCBs shall not be bunched in one conduit. In large areas and other situations where the load is divided between two or three phase, no two single-phase switches connected to different phase shall be mounted within one box.

All splicing shall be done by means of terminal blocks or connectors and no twisting connection between conductors shall be allowed.

Industrial sockets shall be of moulded plastic BoQ and deeply recessed contact tubes. Visible scraping type earth terminal shall be provided. Socket shall have self-adjustable spring loaded protective cap. Socket shall have MCB/ELCB/RCCB as specified in the schedule of work.

Maximum number of PVC insulated 650/1100 V grade/copper conductor cable conforming to IS: 694-1990.

Conduit size	20mm		25mm		32mm		40mm		50mm		60mm	
Wire size in sq.mm.	S	B	S	B	S	B	S	B	S	B	S	B
1.50	7	5	12	10	20	14	-	-	-	-	-	-
2.50	6	5	10	8	18	12	-	-	-	-	-	-
4	4	3	7	6	12	10	-	-	-	-	-	-
6	3	2	6	5	10	8	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	-	4	3	7	6	-	-	-	-
25	-	-	-	-	3	2	5	4	8	6	9	7

Notes:

- 1) The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.
- 2) The columns heads 'S' apply to runs of conduits which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns heads 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.
- 3) Conduit sizes are the nominal external diametres.

SECTION 13.0 TELEPHONE SYSTEM AND LAN WIRING

1. Point Wiring for Telephone System

- (a) The point wiring shall be carried out with telephones wires/cables, 2 pair, un-armoured, PVC insulated and sheath, 0.51 mm dia annealed tinned copper conductor, conforming to ITD specification S/WS-113C armouring and outer sheath as per IS: 1554 (Part -I) in 25 mm steel conduit (one pair always remaining spare for one point). If more than one telephone point has to be provided at one point, multi-core, un-armoured telephone cable shall be used (pairs required are equal to 2 x no. of points) in suitable size conduit. If specifically mentioned in schedule of quantities, instead of ordinary PVC insulated telephone wire as specified above, UTP cable Cat – 5 to be supplied & laid.

The item includes providing and fixing/laying of conduit, switch boxes, socket for telephones connection and telephone wires/cables etc..

Minimum diameter of steel conduit for telephone wiring shall be 25 mm.

- (b) The point shall commence from the main telephone tag box/sub tag box and would terminate at outlet box of point. Connection at both ends included in point wiring.
- (c) Steel conduit, accessories, draw out boxes, switch boxes etc. shall be supplied & laid as per the details given at 2.0.
- (d) Each telephone point shall have 1 no. flush type RJ11 telephone jack fixed on 3 mm thick, hylem sheet in MS outlet box (size 100 x 100 mm). More than one telephone socket outlet (maximum 2 nos.) can be fixed on one outlet box, provided these points are at one place and multi-pair (more than 2 pair) telephone cable has been drawn to this point from tag box. However if specified in schedule of quantities, telephone cord grid plate mounted outlet unit (RJ – 11) with moulded cover plate in recessed galvanised MS box to be provided.
- (e) Joint in telephone wiring (between main tag box/sub tag box and outlet box of point) shall not be allowed and the contractor should bear the wastage of wire if resulted due to this special requirement of telephone system. No looping in telephone system is allowed unless specifically shown in the drawing or instructed by site engineer in the drawing/instruction book.
- (f) Telephone and computer data wiring can be drawn in the same conduit, provided after drawing wires, 50% of conduit cross sectional area is free. However independent PVC insulated telephone & data wire of suitable size shall be used for telephone and computer data.
- (g) To identify each pair of multi-pair telephone wire/cable, PVC indication numbers shall be put on both end of pair just before termination.

2. Point Wiring (Computer Data)

- (a) The point wiring shall be carried out with data cable of 4 (FOUR) pairs (or as specified in schedule of quantities) un-armoured, PVC insulated and sheath, 0.50 mm dia annealed tinned copper conductor (CAT 5e or CAT 6 as specified in schedule of quantities), in suitable size conduit.

The item includes providing and fixing/laying of conduit, switch boxes, socket for computer connection and data wires/cables etc

Minimum diameter of steel conduit for telephone wiring shall be 25 mm.

- (b) The point shall commence from the main junction box or sub junction box at floor of computer data system, and would terminate at outlet box of point. Connection at both ends of cable shall be carried out by purchaser.

- (c) General specification for concealed/surface conduit system of telephone system (clause no. 5.1 (c), 5.1 (d) & 5.1 (g) shall be applicable for this system also.
- (d) Joint in computer data cable (between junction box and outlet box of point) shall not be allowed and the contractor should bear the wastage of cable if resulted due to this special requirement of computer data system.

3. Telephone Cable Work (Underground System)

- (a) The cable shall be suitable for telephone system of suitable pairs (as specified in schedule of quantities), steel armoured, PVC insulated and sheath, 0.51 mm dia annealed tinned copper conductor, conforming to ITD specification S/WS-113C armouring and outer sheath as per IS:1554(Part-I). All telephone cables for underground laying shall be jelly filled type.
- (b) Specification for laying of telephone cable in underground system shall be same as for electrical system (clause no. 4.2,4.3,4.4 and 4.5 and the same shall be followed.

4. Telephone Tag Boxes

These shall be of KRONE type using insulation displacement technique in which there is no stripping or soldering of wire, of MS sheet 14 G with connector suitable for telephone connection. It shall have hinged MS sheet cover. Tag box to be of sufficient size to not only accommodate required KRONES but also space for dressing of wires.

5. Television Point Wiring

- (a) only steel conduit minimum 25mm dia shall be provided and laid for all tv wiring. All specifications for conduiting shall be same as mentioned above.
- (b) Co-axial TV cable of single strand tinned copper conductor of diameter 0.80 mm, complete with metallic shield. Cable having signal loss less than 6 db per 100 Mts. for band 1 UHF should be provided and laid.
- (c) One number TV wall outlet in suitable MS box should be fixed at each receiving end.
- (d) In each 25 mm dia conduit max. 2 nos. co-axial cables should be drawn. There should be the least possible number of bends in the conduit system.
- (e) The samples of TV cable & wall outlet should be got approved before installing.
- (f) Matter to be checked by contractor with purchaser, whether system of each TV point having its own TV antenna is there for the project or cable TV system having common antenna for project is to be followed. This shall be specially applicable if in the project residential quarters are also included. If central cable TV system is their, necessary amplifier, tap-off, and splitters etc. to be provided as per detail drawings and schedule of quantities.

6. Enhanced Category 5 UTP specifications

- a) The UTP shall be 4-pair, with 24 SWG solid or standard copper conductors.
- b) The UTP-based cabling system shall have a 160 MHz channel bandwidth over a maximum distance of 100m (328 ft) and a channel power sum attenuation-to-crosstalk ratio (PSACR) of 9.6 dB@ 100 MHz using an interconnect or BIX cross connect configuration.
- c) The UTP-based cabling system shall use matched components from a single manufacturer, certified to deliver system performance over the lifetime of the application that the cabling system was originally designed to support.

- d) All component used in the UTP-based cabling system shall be warranted for a period of 5 years from date of installation against defects in materials and workmanship.
- e) The UTP-based cabling system shall comply with the following standards:
 - Enhanced Category 5 – TIA/EIA Addendum
 - Category 5 – ANSI/TIA/EIA-568, TIA/EIA TSB67
 - Class D – CENELEC EN50173
 - Class D – ISO/IEC 11801

7. UTP Outlets

- a) The outlet UTP connection module and its optional cover shall be available in the following colors: grey, almond, white, black, orange, red, yellow, green, blue, purple and brown.
- b) The outlet UTP connection module shall be Power Sum rated, with a power Sum NEXT performance equal to or better than ANSI/TIA/EIA-568 Category 5 pair-to-pair NEXT performance specifications, and shall have a PS5 marking to indicate compliance.
- c) The eight-position outlet UTP connection module shall accommodate six-position modular plug cords without damage to either the cord or the module.
- d) It shall be possible to inspect and/or re-terminate the UTP cable at the outlet through front access at the face plate.
- e) The faceplate housing the outlet UTP connection modules shall have aperture plugs to cover any unused openings in the faceplate.
- f) The faceplate housing the outlet UTP connection module in wall mounted single and dual-gang electrical boxes, utility poles and modular furniture (cubical) access points using manufacturer – supplied faceplates and/or adapters, equipped with front, side or angled-entry options for modular cords.

8. UTP System Testing

- a) There are two primary field test parameters for an UTP-based end-to-end cabling system. These are continuity/wire mapping and a visual inspection, both to be performed by the vendor.
- b) Continuity/wire mapping is used to verify consistency pair-to-pin terminations at each end of a given cable. It also checks for faulty connections in the run. For each of the eight conductors in the cable, continuity/wire mapping indicates:
 - Continuity of the channel to the remote end.
 - Shorts between any two or more conductors.
 - Crossed pairs.
 - Reversed pairs.
 - Split pairs.
 - Any other wiring.
 LAN wiring shall be done with Category 6 (CAT 6) wire, if specifically asked for in BOQ.

9. TELEPHONE TAG BLACK (TTB / IDF)

CAT-5e (enhanced) unshielded twisted pair cable in MS conduit shall be used to have modern structured cabling network for telephone system, to have latest

facilities for Internet and also data cabling. All the telephone Jack must terminated on RJ-11 jacks and installed onto a dual Jack faceplate. Telephone RJ-11 Jacks must be terminated with a **BLACK** Connector/Jack.

For LAN CAT 6 UTP cables shall be used for interconnecting the RJ 45 outlets to Intermediate Switch (Hub) or directly to IT room, if the running length limit permits. These Intermediate switch shall be installed in a rack/cabinet and located in electrical room of the respective floors. Fibre Optic cable or CAT-6 UTP cable shall be used for backbone to interconnect the Intermediate switch to IT room's Server rack, as per the design requirement of the specialised Vendor. All the Data Jack must terminated on an 8 wire, 8-position Jack. Each RJ-45 Data Connection will be terminated with a **BLUE** Data Jack

Only conduit routing & wiring shall be provided by the Electrical contractor and the configuration & wiring shall be done by the Vendor for the IT Networking.

EPABX system, with latest technology will be provided to provide Voice Mail & Call Accounting by costing of all calls made by telephones.

A small cabinet for Low current services shall be provided at the false ceiling level to locate all the terminal points like Tel.Tag block, tap-off box for MATV etc., for interconnecting all the low current outlets (jacks). Each tel. outlet shall be provided a separate wire from the room tag block.

Similarly one CAT-5e wire from the floor TTB/IDF shall be provided for each Tel. Outlet proposed.

A Multi pair box as per BOQ Tel. Cable shall be laid from the Service gate to the Telephone switch room MDF for Direct lines from the Service provider. Some of the lines shall be bypassed to EPABX and shall be directly provided to Top management's office & Telephone operators for direct communication to outside. Rest of the lines shall be routed through EPABX for the use of patrons & staff through extensions. The following area/desk shall have direct access to outside Tel. lines:

- a) Telephone Operator's room
- b) Telephone Switch room
- c) Security room
- d) Fire officer room

SECTION 14.0 MATV SYSTEM

1. Co-Axial Cables

- 1.1. The co-axial cable shall be of wideband type with operation upto 860MHz capability, with PE dielectric and PVC jacket.

The cable shall meet or exceed the following specifications:

	RG-6	RG-11
IS Standard IS:14131	5CA4	7CA4
Centre Copper Conductor Dia	1.02mm	1.63mm
Dielectric Dia	4.57mm	7.11mm
Dielectric Material	Cellular PE	Cellular PE
Outer Dia	7.0mm	10.03mm

Bending Radius	>75mm	>115mm
Impedance	75 Ohms	75 Ohms
Return Loss	>23 dB	>23 dB
Attenuation at 20°C	Max dB/100Mtr	Max dB/100Mtr
5 MHz	1.9	1.25
45 MHz	5.25	3.5
300 MHz	11.65	7.38
450 MHz	14.45	9.02
550 MHz	16.1	9.97
860 MHz	20.1	12.52

SECTION 15 UPS SYSTEM: SPECIFICATION FOR THE UPS.

1. Quality power Supply

The UPS shall be ON-LINE double conversion with filter, stabilized and reliable voltage that is free from all mains interference (Over voltage, frequency variations, voltage drops).

The battery cabinets used in the UPS shall be for longer runtime, The UPS shall have Optional filters, Isolation transformer module, LCD-based remote control panel, LED-based remote control panel & Communication software “professional” version.

2. The Operating mode of UPS

It should operate in on-line operating mode as follows.

- **Economy Mode:** The UPS should use Line Interactive technology, i.e. the load is powered from the mains; the energy consumption is reduced with a subsequent improvement in efficiency (98%).
- **Smart active mode:** The UPS should automatically selects On Line or Line Interactive operating mode according to the quality of the mains supply, by monitoring the number, frequency and type of disturbances at the mains power input.
- **Stand-by-off mode:** With the mains available the UPS should normally not powered and consequently the power consumption is almost nil. Only when the mains fails or falls outside a preset range, does the inverter take over in 200ms using power from the batteries. This mode shall be suitable for Emergency escape lighting as pr standard **EN 50171**.

3. The UPS shall have Expandable feature. The units can be connected in parallel up to 8 units to increase power availability or redundancy. The system can be expanded at any time. For the expandability there shall be “Hot System Expansion” feature, the additional unit can be connected in parallel while the other units are on-line and supplying regular power to the load. The new UPS is on-line and will receive the updated information automatically.

4. High Reliability

The UPS should be connected in parallel up to 8 units to exponentially increase the reliability of the system.

5. Maximum battery care

In the UPS there shall be an automatic battery test which shall be able to periodically check the efficiency of the batteries. The batteries should not be used during micro-interruption (40ms), as the required energy is drawn from a group of capacitor. (Battery saving).

6. Maximum safety for personal

There should be a feedback protection device in the UPS to prevent any voltage back feed in the upstream distribution board, thus ensuring the maintenance personal.

For Advanced communication there shall be software system which displays the most important information such as the input and output Voltage, the load applied, the remaining back-up time, etc. It should also be able to provide information even in the event of a failure, to support the fault diagnostics.

It should also contain the following hardware interfaces:

- RS232 serial port
- Dry contacts
- EPO (Emergency Power Off)
- Contact for UPS shutdown using the remote emergency button.

To allow easy and intuitive operation of the UPS There should be Mimic Panel. This helps in accessing the most important parameters: status and alarm, control and commands, input, output, battery measurements (power, current, voltage, frequency and temperature) and settings.

7. Low Input Harmonic Distortion,

The UPS shall have The Power Factor Correction (PFC), standard on all modules, so that the input power factor level to 0.95 for any load percentages so that it is ideal in conjunction with motor generator or in installation with other sensitive loads. There shall be built in Active Filter designed to reduce the level of THDi to less than 4% and to increase the input power factor up to 0.99.

This Active filter shall be based on the IGBT's Technologies controlled by the Digital Signal Processor (DSP). This DSP instantly monitors and controls the inputs current absorbed by the UPS in order to eliminate the unlike harmonics and maintain the THDi less than 4%. With the effect of Active Filter the UPS can also be connected to the low loads. These active filters shall be fitted inside the UPS so that no additional footprint is required.

Less harmonics in the UPS input reduces the neutral cable size and consequently the installation cost. Also it gives maximum reliability as any failure of the optional Active Filter has no influence on the power supplied to the load; the only consequence is the increase of current harmonics level rejected to the mains, which gives maximum reliability for the load.

8. UPS & its features:-

a. The input requirements of the UPS are as follows:

Voltage	:	400 V three-phase + Neutral
Voltage tolerance	:	± 20%+
Frequency	:	45-65 Hz
Current distortion	:	<4% with active filter
Power factor	:	0.99 with active filter

b. The Bypass of the UPS are as follows:

Rated voltage	:	400 V three-phase + N
Phases number	:	3 + N
Voltage tolerance	:	± 15%
Rated frequency	:	50 Hz
Frequency tolerance	:	± 2%
By-pass	:	Static and manual for maintenance
Transfer time	:	Nil

c. The Battery for the UPS are as follows:

Type of battery	:	maintenance-free sealed lead-acid
Battery blocks	:	12 V
Recharge time minimum	:	6 Hr

d. The Output of UPS are as follows:

Rated power	:	As per BOQ
Active power	:	As per BOQ
Phases number	:	3 + N
Waveform	:	Sinewave
Rated voltage	:	415V
Frequency	:	50 Hz
Dynamic stability	:	± 5%0.
Static stability	:	± 1% 00
Crest factor	:	3 : 1
Overload	:	110% for 5h, 125% for 10 min

e. The System of UPS is as follows:

AC/AC efficiency	:	92% in On-line mode, 98% in Economy Mode / Smart active mode/ Emergency mode.
Noise	:	50-56 Db a 1 m.
Operating temperature	:	-2° - 45°C
Relative humidity	:	95% non-condensing
Remote controls	:	EPO & Bypass
Remote signals	:	volt free contacts
Protection degree	:	IP20
Communication	:	Double RS232/C + slot for SNMP Adapter
Colour	:	Dark grey RAL 7024

f. The Standard of UPS are as follows:

1. Safety EN 62040-1
2. EMC IEC 62040-2
3. EN 50091-2 lev. A

4. Directives 73/23, 93/68, 89/336 EEC
5. EN 62040-3.

All the Work desk in front office & Back of the House area Meeting room, Business center shall be provided with 3 Nos 6A 5pin with International outlets option shall be provided for Computers/ Laptops.

All Outlets for power in IT room, Audio-visual media room, EPABX room, Fire Officer Room & Security room shall be on UPS.

A dedicated UPS system (consisting 2 set of equal capacity of UPS rack for Parallel redundancy) shall be provided for IT room & AV room equipments.

All Isolated ground and UPS receptacles should be identified using a different colour, e.g. Orange or Yellow with Green Stripe.

SECTION 16 DISTRIBUTION BOARDS & MCBs

1. General

Distribution boards shall be Double Door, of standard make with MCBs as per approved make given. Distribution boards shall be constructed out of steel sheet all weld enclosure with double door IP42 protection and shall be powder coated. Ample clearance between the conductors of opposite pole, between conductors and sheet steel body shall be maintained in order to obviate any chance of short circuit. Removable conduits entry or knockouts plates shall be provided at top and bottom to facilitate drilling holes at site to suit individual requirements. Also on additional/separate adopter box of suitable length and size shall be provided to accommodate wires and cables. No. of conduits etc. and nothing shall be payable on this account. The MCBs shall be mounted on high-grade rigid insulating support and connected by electrolytic copper bus bars. Each incoming MCB isolator shall be provided with solderless cable sockets for crimping. Phase separation barriers made out of arc resistant materials shall be provided between the phases. Bus bars shall be colour coded for phase identification.

Distribution boards shall be recessed in wall nitch or if required mounted on the surface of the wall with necessary clamp bolts etc. The mounting height shall not exceed 1200mm from finished floor level. Distribution board shall be provided with proper circuit identification nameplate and danger sticker/plate as per requirements.

All the distribution boards shall be provided with engraved nameplates with 'lighting', 'power' or 'UPS' with DB Nos., as the case may be. Each DB shall be provided with a circuit list giving details of each circuit. All the outgoing circuit wiring shall be provided with identification ferrules giving the circuit number & phase.

Each distribution board shall have a separate neutral connection bar and a separate earth connection bar mounted within the DB each having the same number of terminals as the total number of outgoing individual circuits from the distribution board. Conduit & cable armouring shall be bonded together & connected to the distribution board earth bar.

Where oversized cables are specified due to voltage drop problems, it shall be contractors responsibility to ensure that satisfactory terminal arrangements are provided without an extra cost.

2. Earth Leakage Circuit Breaker

ELCB shall be 4 pole 415 volts 50Hz, 30-300mA sensitivity. These shall be of approved make. The rating of the ELCB shall be as specified in BOQ. These shall be suitable for manual closing and opening and automatic tripping under earth fault circuit of 30-300mA as specified in item of work. The enclosure of the ELCB shall be moulded from high quality insulating material. The material shall be fire retardent, anti-tracking, non-hygroscopic, impact resistant and shall with stand high temperature. All parts of switching mechanism shall be non-greasing, self-lubricating material so as to provide consistent and trouble free operation. Operation of ELCB shall be independent of mounting position and shall be trip free type. The RCCB shall be protected against nuisance tripping by protective device.

3. Miniature Circuit Breaker

- a. The MCB shall be current limiting type and suitable for manual closing and opening and automatic tripping under overcurrent and short circuit. The MCB shall also be trip free type.
- b. Single pole/three pole versions shall be furnished as required.
- c. The MCB shall be rated for 10 KA/15 KA fault level.
- d. The MCB shall be suitable for its housing in the distribution boards and shall be suitable for connection at the outgoing side by tinned cable lugs and for bus-bars connection on the incoming side.
- e. The terminal of the MCBs and the open and close conditions shall be clearly and indelibly marked.
- f. The MCB shall generally conform to IS: 8828. -1996
- g. The MCB shall have 20,000 electrical operation upto 63A.
- h. The MCB shall have minimum power loss (Watts) as per I.S./ IEC.

SECTION 17 LT SANDWICH BUS DUCT:

1. Functional Requirements

Sandwich type LT bus ducts are required to interconnect LT side of the transformer with incoming feeder module of LT Power Control Centre. These must be feeder type straight bus bar trunking unit with no tap off facility and weather proof suitable for outdoor as well indoor installation.

2. DESIGN REQUIREMENTS AND SCOPE OF SUPPLY

2.1. Statutory Requirements

The design, construction, manufacture, supply, installation and performance of the bus ducts shall comply with all relevant currently applicable Indian Standards, Indian Electricity Rules and also statutory requirements and safety codes in the locality where the equipment would be installed and as per the detailed specification hereunder.

Busbar Trunking System must be tested as a composite system and certified by ASTA & CPRI to comply with BS 5486 Part 2, 1990, IEC 60439-2, 2000 & IS 8623 - 1993. These must also conform to the relevant codes and requirements of UL 857 / ANSI, IEE / IEEE, NEMA BU1, JIS 8364, IEC 529, SEISMIC PROTECTION CERTIFICATION.

2.2. Rating

The bus duct rating shall be of specified continuous current rating as specified in project requirement at Clause 4.0 with fault level of 50 KA. The bus duct shall be

suitable to 3 phase, 4 wires (neutral being solidly grounded) system, with integral housing ground and separate earth bars. Bus duct shall be suitable for 415 V + 10%, 50 Hz + 3%, TPN (with 100% Neutral) AC supply system.

2.3. Bus Bar Enclosure:

Bus bar Trunking must have a rugged housing profile and provide the most efficient way to dissipate heat through conduction and natural convection. All housings should be constructed from 1.6 mm electro-galvanized steel sheet coated with oven baked polyester powder paint or epoxy coated powder (shade same as that of LT PCC – Siemens Grey RAL 7032) which also provides maximum mechanical strength against electromagnetic stresses.

Bus bar trunking system shall have sandwich construction, totally enclosed with well insulated design. All necessary components like Flange End with box, straight bus ducts, Single Bolt Bridge Joints, Horizontal/ Vertical Elbow, Terminal End Cover and horizontal/ vertical supports, bolts & nuts etc. shall be supplied as per requirement. Bolts and nuts must be of stainless steel or chromed black High Tensile Steel. The terminal enclosures shall be provided with flanged ends to suit flanges of transformer / PCC. The bus duct shall be totally enclosed, dust, weather and vermin proof and shall have the construction to conform to protection class IP67 for outdoor installation. The bus duct shall be adequately supported. Adequate MS structural supports, duly painted, required for installation of bus ducts must be supplied and fixed by the supplier.

2.4. Bus bars & Supports

Bus duct shall have Aluminium bus bars fabricated with high conductivity Aluminium, 99.59 % pure, 19501 grade. All bus bars must be fully epoxy insulated. Standard lengths of 3M/2M/1M up to 0.45M must be supplied as per site requirements. Other size lengths may be made available as required. The main buses of the bus ducts shall be designed to carry continuously the current specified in the design data, while the neutral shall be 100% cross section of phase bus. The bus bars must be tropicalised to withstand higher temperature rise.

The bus bars should be able to withstand short circuit current of 50 kA RMS for 1 second. Bus bars must have Class H-180°C standard epoxy coating as insulation material for providing 100% water proofing and high mechanical strength. This insulation must be in accordance with IEC 60-439-2 and BS 5486.

For electrical connections between the bus duct and LT side of the transformer as well as on power control centre's incoming switchgear, flexible bus bars (i.e. braided flexible strips) of copper shall be provided. If required, suitable phase cross over box with bus bars crossing over each other, shall be provided.

The bus bar supports should withstand 110 kA peak short circuit current and the mechanical stress between the bus bars. The bus duct shall be complete with two nos. continuous earth buses of aluminium flats of suitable cross section to its entire length as per the statutory regulation.

3. Testing

All bus ducts must be factory tested to 2.5 kV for 60 seconds. All other routine tests as specified in the applicable Standards and Codes shall be conducted and test results of the same shall be submitted to the Purchaser.

SECTION 18 TWO/ FOUR POLE STRUCTURE:

1. TWO POLE STRUCTURE

- 1.1. This is required to receive high voltage 11 KV/ 22KV/ 33 KV electric supply from State **Electricity** Board and thereafter feed it to the HT Panel through the 11 KV/33 KV HT XLPE Cables. Each Set of the Two Pole Structure would comprise of:
 - i. 2 nos. - ISMB 200 x 100 mm, 10 M long each with necessary cross MS channels 75 x 40 mm and 3 M long each (5 nos. minimum) fitted to these for two pole structures.
 - ii. 3 nos. - Lightning arrestor, pole-mounted type suitable for high voltage, 50 Hz. AC supply with necessary copper strip clamps, bolts etc. for earthing.
 - iii. 1 set - HT pin insulators with metal parts complete.
 - iv. 1 set - HT disc insulator with metal parts complete, conforming to IS: 2544-1963 (read with latest revision, if any) and IS: 731-1963 (read with latest revision, if any).
 - v. 1 set- HT double break, triple pole, gang operated air break switch unit with suitable HT drop out fuses, operating rod of suitable length, conforming to IS: 1818-1972 (read with latest revision, if any) and complete with copper chain for earthing and earthing rod for Two Pole Structure. Suitable arrangement for providing lock to the switch in both 'ON' & 'OFF' positions.
 - vi. 1 lot - Necessary jumpers, aluminium conductors with PG clamps and connectors etc. complete for interconnections up to SEB structure.
 - vii. 1 no. - Cable end box for Two Pole Structure, epoxy type complete with all consumables, suitable for 11 KV HT XLPE cable of size 3C X 300 mm².
 - viii. 1 lot - HT danger plates of required size and anti-climbing device as per prevailing statutory regulations for Two Pole Structure
 - ix. 1 Set – 11 KV Metering Cubicle to house the CT, PT and the HT Metering Unit.(For the SEB Two Pole Structure only)*
- 1.2. Earthing pits & earthing strips etc. shall be supplied under different items of works mentioned in schedule of quantities and cost of these shall not be included under this item.

2. FOUR POLE STRUCTURE FOR HIGH VOLTAGE (11/22/33 KV)

2.1. Functional Requirements

This is required to receive 11/22/33 KV electric supply from State Electricity Board, control it and to feed to transformers/HT oil circuit breakers.

2.2. Design Requirements and Scope of Supply

- i. 4 nos. - ISMB 200 x 100 mm, 10 M long each with necessary cross MS channels 75 x 40 mm - 3 M long each (12 nos. minimum) fitted to these.
- ii. 3 nos. - Lightning arrestor pole mounted type suitable for high voltage, 50 Hz. AC supply with necessary copper strip clamps, bolts etc. for earthing.
- iii. 1 set - HT pin insulators with metal parts complete.
- iv. 1 set - Disc/shackle insulators with metal parts complete.
- v. 2 sets - HT gang operated switch units with suitable HT drop out fuses, operating rod of suitable length and complete with copper chain for earthing and earthing rod. Arrangement for providing lock to the switch.
- vi. 1 lot - Necessary jumpers, aluminium conductors with PG clamps & connectors etc. complete for interconnections.

- vii. 2 nos. - Cable end box, epoxy type complete with all consumables, suitable for 11/22/33 KV HT cable (size and type of cable will be intimated by owner/consultant).
 - viii. 4 nos. - HT danger plates 200 x 200 mm.
- 2.3. Earthing pits & earthing strips etc. shall be supplied under different items of works mentioned in schedule of quantities and cost of these shall not be included under this item.

SECTION 19 DRY TYPE DISTRIBUTION TRANSFORMER (With On load tap changing):

1. Functional Requirements

Dry type distribution transformers suitable for indoor / outdoor (strike off which is not applicable) installation are required to receive power at high voltage and step down the voltage to cater to the power requirements of the plant at stepped down voltage.

2. Design Requirements and Scope of Supply

2.1. Statutory Requirements

Transformers are to be manufactured as per IS:11171 or IEC:60726 (amended as on date) specifications, Indian Electricity Rules, including special requirements of the state Electrical Inspectorate where it is to be supplied and the detailed specifications mentioned below.:

2.2. Housing Details

The ventilated (louvered) sheet steel enclosure of the transformer shall be fabricated of good quality mild steel plates. The transformer enclosure shall conform to IP 23 class protection for indoor type and to IP 44 for outdoor type. The transformer enclosure shall be internally and externally painted with 2 coats of Zinc chromate primer followed by two coats of corrosion resistant paint of approved shade.

2.3. Standard Accessories Required :

The transformers shall be glass fibre reinforced epoxy resin vacuum impregnated / vacuum cast resin encapsulated dry type with HV & LV windings of copper conductor. The transformer Core shall be made from electrical grade low loss cold rolled grain oriented silicon steel and protected against corrosion by a resin coat. The HV & LV windings shall be completely impregnated and cast under vacuum into moulds. The insulation laminate should correspond to class F. The transformer shall be complete with the followings :

- i. On-load dry type 16 steps tap changing (OLTC) shall be provided on H.V windings of transformer, to take care of percentage voltage variation of - 10% to + 10% in step of 1.25%. The OLTC shall be complete with RTCC (remote tap changing control) and AVR. An indigenous OLTC of make 'Onload Gear, Chennai' or equivalent with proven performance shall be provided.
- ii. The On load tap changing equipment shall be complete with:
 - On load tap changing gear mounted on the transformer
 - Indoor type Remote tap changing control cubical (RTCC panel), fitted with EMCO make electronic automatic voltage regulating relay (AVR) with all necessary controls & accessories including inter connections.

- iii. It shall be suitable for the following tap change operation :
 - Local manual tap change operation with cranking handle
 - Local electrical tap change operation with raise / lower switches / push button on OLTC panel.
 - Remote electrical, non-automatic independent / group simultaneous tap change operation with raise / lower switches /push buttons on RTCC panel.
 - Remote electrical automatic tap change operation with AVR. Suitable PT / PT ratios to be provided on the LV / Secondary to provide a feed back signal to the AVR for comparison to effect automatic changeover.
- iv. The details of OLTC controls are as detailed below :
 - Manual Mechanical Control
 - i. The cranking device for operation of the OLTC gear shall be removable and located at a height not exceeding 1500 mm, above ground level for easy operation. The mechanism shall be complete with normal accessories including at least the following:
 - ii. A mechanical tap position indicator (rated tap voltages shall be marked on the diagram plate).
 - iii. A mechanical operation counter.
 - iv. Mechanical stops to prevent over cranking of the mechanism beyond extreme tap positions.
 - Electrical Control; Control circuit shall incorporate the following :
 - i. Local / remote manual electrical operation.
 - ii. Device to ensure a positive and full completion of tap change once it is initiated even if there is loss of power.
 - iii. An interlock to cut-off electrical control automatically upon recourse being taken to manual mechanical control in emergency.
 - iv. Electrical inter lock to cut-off a counter impulse for a reverse tap change, being initiated during a progressive tap change and until the mechanism comes to rest and resets circuits for a fresh operation.
 - v. All auxiliaries and devices for electrical control of OLTC gear should be housed in a weather proof cabinet mounted on the transformer and shall include :
 - a. Local tap position indicator
 - b. 5 digit operation counter
 - c. Cubicle lighting
 - d. Thermostatically controlled space heater
 - e. Miniature circuit breaker with magnetic and thermal overloads devices for controlling the incoming supply to the OLTC motor.
 - f. Pad locking arrangement for the hinged cabinet door

- g. Removable plate with cable glands
- h. Inside tap with control scheme indelibly marked
- Remote Electrical Control: Remote control panel shall comprise of the following:
 - a. Individual/parallel control on Master follower sequence selector switch
 - b. Raise/lower control switch
 - c. Potentiometer type tap position indicator
 - d. Out of step relay
 - e. Time delay relay
 - f. Indicating lamp for out of step
 - g. Out of step buzzer
 - h. Indicating lamp for tap changer supply available
 - i. Indicating lamp for tap change in progress

RTCC panel shall be dust and vermin proof, floor mounting, and freestanding type. The enclosure shall be of cold rolled sheet of 2.5 mm. All doors and opening shall be provided with neoprene gaskets.

Automatic tap changing control shall be provided complete with voltage sensing relay.

OLTC wherever called for shall be suitable for bi-directional power flow.

OLTC shall also be rated for basic insulation level value as specified for the transformer in the data sheet.

- v. Two nos. earthing terminals (without lugs).
- j. RTD Temperature controller and Scanner to protect the transformer against thermal overload by indicating winding temperature. The RTD should be embedded in each LV coil. The digital display of temperature shall be directly in degrees Celsius. Scanner shall have two sets of contacts – one for alarm and another for trip.
- k. Marshalling box for WTI
- l. Rating and diagram plate.
- m. Three nos. HT terminals in a HV cable box
- n. One no. detachable HV cable gland plate.
- o. Four nos. LT terminals in a LV cable box
- p. One no. detachable LV cable gland plate.
- q. One set of ventilation louvers in the enclosure
- r. One no. warning plate
- s. One no. surge arrester with earthing bar brought outside for grounding
- t. One no. LV neutral terminal brought outside for solid earthing
- u. Lifting lugs.

v. Two nos. base channels with bi-directional flat rollers.

w. Jacking pads with hauling hole

3. Ratings & Additional Accessories for the Transformers shall be as Follows :

3.1. The transformer rating shall be as under :

Capacity : ----- KVA

Frequency : ----- Hz.

Voltage HT : ----- kV

LT : ----- Volts

Phase : Three

Connection : DYN 11

3.2. Qty. of transformers : ---- Nos.

3.3. Cable details :

HT : ----- Sq. mm, No. of runs -----

LT : ----- Sq. mm, No. of runs -----

Type of HT cable : XLPE

Type of LT cable : XLPE / PVC insulated armoured

4. Guaranteed Performance Details to be Provided by the Bidder

1. No load losses at rated volt age & frequency : ----- Watts

2. Full load losses at rated current at 75 Deg. C. : ----- Watts

3. Impedance at rated current & frequency at 75 oC. : ----- %

4. Efficiency at full load, 0.8 P.F. lagging at 75 oC. : ----- %

5. Max. rise in winding temp. : ----- Deg C

6. Duration and percentage Overloading :

5. Transformer's Tests

The following routine tests as per IS shall have to be carried out for each transformer, at manufacturer's works, before its despatch to the destination and test reports shall be furnished.

- No load loss measurement test
- Full load loss measurement test
- Winding resistance measurement test
- Impedance voltage of transformer
- Insulation resistance test
- Turns ratio test
- Separate source voltage test
- Induced over voltage test
- Polarity Phase relationship test
- Magnetic balance test

SECTION 20 PACKAGE/ COMPACT SUBSTATION, OUTDOOR TYPE:

1. Functional Requirements:

Package/ compact Substation will be pre-fabricated substation comprising of HT Switch, Cast Resin Dry Type Transformer & MCCB Switch, all housed in a single enclosure suitable for outdoor application.

It will receive 3-phase, 50 Hz, 11 KV HT power at HT switch and step down the voltage through Dry Type Distribution Transformer. LT Power will be further fed to LT MCCB Switch Panel to cater/ feed power to LT electrical loads.

Only incoming HT cable and outgoing LT cable shall be connected to package substation at site and site work is to be kept absolute minimum.

2. Design Requirements and Scope of Supply

i. Statutory Requirements

Package Substation will be designed, manufactured and tested as per IEC 61330. HT switchgear will be manufactured as per IEC 62271 and IS 13118. Dry Type transformer will conform to IEC 60076/ 60726 and IS 11171. LT switchgear will conform to relevant IS/IEC specifications (amended as on date). Also Indian Electricity Rules, including special requirements of the concerned state electrical inspectorate and the detailed specifications mentioned below will be applicable.

ii. Housing Details:

Package Substation will be completely self-contained. It will have factory assembled weatherproof housing suitable for outdoor application, ready for placing into position upon a concrete base at site. It will be provided with four lifting hooks/eyes located on the sloping roof for easy lifting and positioning at site.

Package Substation will be compartmentalized to house main equipment viz. HT Switch, Dry Type Distribution Transformer and LT MCCB Switch housed in single sheet steel enclosure.

The enclosure of outdoor type Package Substation will be manufactured using high quality pre-galvanized; corrosion resistant sheet steel of thickness, minimum 2/1.5 mm. Non load bearing partition plates may be 1.5 mm thick. Enclosure's wall units, roof and doors will be constructed using standard modules having high mechanical strength and appealing aesthetics. All joints must be water and air-tight. Enclosure will be mounted on rigid base frame.

All compartments should be individually accessible by their own doors from outside. These doors will have stainless steel hinges for mechanical strength. Doors will be interlocked using micro switches in such a way that the Breaker/ LBS will be tripped when doors are opened. HT & LT controls' compartments will conform to IP 54 & Transformer compartment will conform to IP 23 to protect against ingress of moisture and dust inside the enclosure. Press fit type gaskets must be provided to ensure required IP protection. Padlocks must be provided on all doors to protect against vandalism.

Enclosure must be totally painted with polyurethane paint, RAL 7032 of Siemens Gray shade. Suitable space heaters with thermostat must be provided in the compartments. Suitable CFL lamps pre-wired, must be provided in all HT & LT compartments and controlled through door limit switches. Similarly, transformer compartment must have suitable incandescent lamp with bulkhead fitting controlled through door limit switches.

Openings/cut outs for incoming/outgoing cables must be sealed against ingress of moisture & dust inside the enclosure.

iii. Ventilation:

Ventilation will be achieved by means of natural air circulation from the louvers of wall/ door to the top of the roof using thermo-siphon effect. Sufficient cooling of distribution transformer will be achieved by means of ventilation openings in the transformer compartment, designed taking into consideration the transformer rating, losses and climatic conditions. Ventilation fans may be provided if required, to maintain air circulation inside compartments.

3. **HT Switchgear/ Controls Compartment:**

HT switchgear compartment will be equipped with one No. 11 KV, Vacuum Circuit Breaker of rating 630 A, with all standard accessories and controls. HT Switch will receive HT Power, control and feed same to HT side of transformer through XLPE HT cable.

R, Y, B Phase and ON/OFF/TRIP indication lamps (LED type) must be provided. Suitable range Analogue Voltmeter and Ammeter with Selector Switches, CT/PT, and Numerical Relay for protection against Earth Fault, Overvoltage, Over current, Single Phasing, Phase reversal etc must be provided. Earth Switch with Voltage Presence Indication System (VPIS) shall be provided. VCB must trip automatically in case of any fault occurring in the transformer.

In case DC supply is required for operation of HT VCB Switch, same will be supplied & installed within scope of works of this job.

4. **Transformer Compartment:**

One Number Cast Resin Dry Type Distribution Transformer along with all standard accessories shall be provided in Transformer Compartment. The compartment must be designed to provide the transformer with sufficient volume of airflow for cooling through adequately sized ventilation openings.

Transformer must be of rated capacity, step down, naturally air cooled, copper double wound having delta primary & star secondary with neutral brought out, having no-load voltage ratio of 11 KV/ 433 V, type tested at CPRI. Cast Resin Transformer must be maintenance free and should be provided with tap links on the HV winding with tapping range $\pm 5\%$ in steps of 2.5%. Off load tap changing provision must be provided.

Scanner type winding temperature indicator must be provided with 3 No RTD to measure/protect the windings against the set temperature. There should be provision to set 'High' & 'Very High' winding temperature with hooter alarm.

5. **LT MCCB/ ACB Switch Compartment:**

One Number LT MCCB/ ACB Switch, 4P (Rating as specified in BOQ) with microprocessor based releases and protection against Over current, Earth Fault must be provided in separate compartment with Incoming and outgoing feeders as specified in technical details. MCCB/ ACB will be fed 3-phase, 50 Hz power at 433 V from the LV side of transformer.

6. **Technical Specifications for Package Substation:**

i. General Characteristics:

Standard applicable: IEC 61330 for Package Substation

IEC 62271 and IS 13118 for HT switchgear IEC 60076/60726 & IS11171 for transformer

Normal Ambient Temperature: -5°C to $+40^{\circ}$

Maximum Ambient Temperature: +50°C
Enclosure construction: Modular
Ventilation: Natural
Temperature Class: K 10
Degree of Protection: IP 54 for HT & LT compartment
IP 23 for Transformer compartment

ii. HT Switchgear:

Vacuum Circuit Breaker: 1 No
Rated Voltage: 11 KV
Rated Normal Current: 630 A
Rated Frequency: 50 Hz
Rated insulation level: 28 kV rms, 50 Hz, 1 minute
75 kV impulse, 1.2/50 µs
Voltmeter: 0-12 KV (1No) with suitable PT & SS
Ammeter: 0-100 A (1 No) with suitable CT & SS
PF Meter: 0.8 (lag) – 1 – 0.8 (lead) with CT/PT
Numerical Relay: Earth Fault, Over Current, Under Voltage, Single phasing, phase reversal relay.
Indication Lamps: R, Y, B Phases and ON/OFF/TRIP

iii. Distribution Transformer:

Quantity: 1 No
Type: Cast Resin Dry Type
Rated Capacity: As specified in BOQ with Off Load Tap Changing
HT Voltage: 11 KV
LT Voltage: 433 Volts
Frequency: 50 Hz
Vector Group: Dyn11
Tapping range: ±5% in steps of 2.5 %
Instruments: Winding Temperature Indicator with suitable RTDs for all three windings.

iv. LT Switchgear:

Quantity: 1 No MCCB/ ACB, (rating as per BOQ)4P, 50 kA breaking capacity, with ON/OFF Indication & RYB phase indication lamps, 0-500 V Voltmeter with Selector switch, Ammeter with suitable CT & selector switch.

v. Earthing:

Body earthing of enclosure for Package Substation must be carried out by 50 X 6 mm GI strip at two independent earthing points. Body & Neutral earthing of electrical equipment housed inside these enclosure must be separately carried out with 50X6 mm GI/copper strip as per statutory requirements. Neutral earthing of Transformer will be done with 50 X 6 mm copper strips only.

CHAPTER I

TECHNICAL SPECIFICATIONS FOR CLOSED CIRCUIT TELEVISION SYSTEM & PA SYSTEM

1. CLOSE CIRCUIT TELEVISION SYSTEM (CCTV)

1.1 SYSTEM REQUIREMENT

The CCTV System shall be real time system consisting of Indoor dome cameras and Outdoor P/T/Z Cameras, Network-able Digital Video Recorders, Video Analytics, Monitors and Keyboard controller for PTZ cameras.

1.2 SYSTEM OBJECTIVE

- 1.2.1 To enable the important areas of the premises to be monitored remotely
- 1.2.2 To enable critical areas to be scanned from pre-selected position and generate alarms if any changes captured.
- 1.2.3 To enable automatic recording by Digital Multiplex Recorder on hard disk and to play back the recorded events on selected monitors & back-ups of the events on CD.

1.3 CAMERA

- 1.3.1 1/3" CCD, 580TVL, Min0.1 lux, 48dB, DC12V, 2.8-10mm varifocal Lens PAL INDOOR DOME CAMERA .

The camera shall have following specifications:

Analog / IP	Analog
Video Format	PAL
Horizontal Resolution (TVL)	580
Type of CCD	Interline CCD
Scanning Process	Interlaced
Minimum Illumination	0.1lux(colour), 0.01 lux (B/W)
Minimum Illumination	0.1 Lux@F1.2, 30IRE, AGC On
Electronic Shutter	1/50 - 1/100,000 sec
S/N Ratio	48 dB or more (AGC Off)
AGC	Yes
White Balance	Auto
Day & Night	No
BLC/BMB	BLC
Synchronization	Internal
Optical Zoom Ratio	NA
Optical Lens Specifications	2.8-10mm lens
Enclosure details	Indoor Ceiling/Wall
Power Input, Current Rating	DC 12V (±2V),Max. 1.0W
Listing & Approval	UL/CE/FCC
Operating Temperature	-10°C ~ 55°C
Additional Features	• 1/3" CCD (NTSC: 410,000 / PAL: 470,000) • Lux Minimum illumination • High performance 580 TV Lines Resolution • 48dB • Dip Switch control • Flicker less • BLC (Back Light Compensation

- AGC (Auto Gain Control)

1.3.2 1/4" Supper HAD CCD, Outdoor/ Indoor High Speed PTZ Dome, 36X optical, 12x digital zoom, TDN, DSS, BMB, PAL cameras.

The camera shall have following specifications:

Analog / IP	Analog
Type of Camera	PTZ Camera
Video Format	PAL
Horizontal Resolution (TVL)	530
Type of Camera	Super HAD CCD
Scanning Process	Interlaced
Minimum Illumination (Color)	
Wide area coverage	0.005
Wide dynamic range.	
Minimum Illumination	1.0 lx (30IRE) : Night shot OFF
0.1 lx (30IRE) : Night shot ON	
0.01 lx : x128 Field integration(DSS) ON	
0.005 lx (30IRE) : Night shot & DSS ON	
Electronic Shutter	1/50 to 1/10000
S/N Ratio	>50 dB
AGC	Auto with Manual Override
White Balance	Manual / Auto / Indoor / Outdoor / One push / ATW
Day & Night	True Day & Night
BLC/BMB	BLC/BMB
Synchronization	Internal / External
Optical Zoom Ratio	36X
Optical Lens Specifications	3.8 to 95 mm
Digital Zoom Ratio	12X
Pan Range	360 Deg Continuous Panning
Tilt Range	0 deg ~180 deg
Max Preset Speed	380°/sec.
No of Presets Supported	248
Number of Patterns Supported	4
Number of Privacy Masking Zone Supported	8
Number of Guard Tours Supported	8

Number of Auto Pan supported	16 scan + 1 auto pan
Relay Inputs	8
Relay Outputs	2
Enclosure details	Outdoor/Indoor Pendant with sunshield & blower
Enclosure Protection Rating	IP66
Power Input, Current Rating	18 to 30VAC, 24VAC nominal,
Listing & Approval	UL/CE/ FCC
Communication	RS422, RS485,
Operating Temperature	0°C to 50°C

Additional Features

- Built-in x36 optical power zoom lens (Total : x360 zoom with digital x12 zoom)
- Built-in Super HAD CCD
- True night shot function with IR cut filter removal mechanism
- 248 Presets : programmed with view direction, focus, iris and BLC
- 4 Patterns : record and play back user preference of surveillance path up to 240 sec.
- 16 Scans : 8 speed steps(1 to 8) for Scan with two speed steps for Diagonal Scan(Slow/Medium)
- 8 Tours : each tour consists up to 64 Presets, Patterns, Scans and other Tours
- 8 Alarm inputs with 0~8 priority / 2 Auxiliary outputs programmable NC/NO
- 8 Privacy Zones : video off or up to masked block with selectable 8 colors
- 64 steps of variable speed for panning from 0.1°/sec. to 90°/sec.
- Maximum manual speed 360°/sec. with Turbo key pressed, Preset speed: 380°/sec.
- Minimum adjustable angle is 0.0375° with Single Step move function
- programmable user preferences of speed (Slow / Medium / Fast)
- Addressable up to 999 camera IDs (Extend up to 3999 setting at factory menu)
- Built-in RS-485/RS-422 receiver driver
- On-site software upgrade and upload/download of programmed data into the Keyboard / Dome
- Built-in power-line surge protection and lightning protection
- Capable of fail-safe hot swap
- Supporting multiple protocol
- Smooth 180 ° tilting with digital flip function

1.3.3 Outdoor Box Camera with 1/3" CCD, 580TVL, 0.1lux, Color, WDR, SDN, DC12V with 1/3" CS-Mount, DC Auto Iris, 2.7-13.5mm Varifocal Lens F1.3, Long Lead, IR Corrected for D/N camera

Video Standards	NTSC	PAL
Image sensor	1/3" Interline Transfer CCD	
Effective Pixels	768(H) x 494(v)	752(H) x 582(V)

Horizontal Resolution	580 TV lines	
Minimum illumination	1 lx (50IRE)	1 lx(50IRE)
	0.1 lx (TDN)	0.1 lx (TDN)
	0.01 lx (DSS)	0.01 lx (DSS)
	0.001 lx (TDN ,DSS)	0.001 lx (TDN ,DSS)
Video Output	1.0 V p-p, 75ohms	
Synchronization	Internal	
S/N Ratio (dB)	>50dB	
Auto Gain control (AGC)	0-36dB	
AES (sec)	1/60 – 1/100.000 sec	1/50 – 1/100.000 sec
Lens Control	DC / VSD	
White Balance	AWC/ATW/MANUAL/IN/OUT	
Power source	12 VDC (10 – 14VDC)	
	12VDC/24VAC (Dual Power)	
Power Consumption	Approx. 2.5W	
Operation Temperature	-10°C to 55°C	
Dimensions (WxHxL)	67mm x 62 mm x 95.5 mm	
Weight	192g (Camera Only)	
Lens Mount	CS mount	
Listing & Approval	U L/CE/ FCC	

1.4 DIGITAL VIDEO RECORDER

The DVR shall have following specifications:

- 16 channel real-time recording **and playback in genuine D1 resolution**
- **Advanced H.264 compression technology**
- 4 hot-swappable hard disk supports up to 8TB
- HDMI, VGA support 1080P high definition video output on 16:9 LCD monitor
- Dual stream, multicast supported
- Embedded operation system
- Video record anti-tamper
- Backup through USB or network
- 16 alarm inputs, 4 alarm outputs
- Supports multi PTZ protocols
- Support scheduled remote backup using remote access software
- UL/FCC/CE, approved

Video/Audio Input

Video compression	Advanced H.264
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Analog video Input	16 channel, BNC (1.0 V Vp-p,75 Ohm),PAL/NTSC
Digital video input	4 channels High – Definition IP Camera
Audio Compression	Standard G.711
Audio Input	16 Channel , RCA
Intercom Input	1 Channel , RCA
Video / Audio Output	
Recording Resolution	D1/4 CIF /HD ½ CIF /CIF /QCIF
BNC Output	PAL :704x576 Pixels NTSC :704x480 Pixels
VGA Output	1920x1080 Pixels
HDMI Output	1920x1080 Pixels
Spot Video Output	2 Channel , BNC (10.Vp-p, 75Ω)
Frame Rate	PAL : Up to 500fps (Total Encoding) NTSC: UP to 600fps (Total Encoding)
Video Bit Rate	64Kbps~5M bps
Audio Output	2 Channel , RCA
Audio Bit Rate	64Kbps
Hard Disk Drive	
Interface	Hot swappable SATA (Up to 4)
Capacity	Each HDD Supports Up to 2TB
SYSTEM	
Event Trigger	External inputs, video loss, Camera Covered, Motion Detection Video Buffer 5S pre – and 50S post – alarm per channel
PTZ	Wide range of analog PTZ supported : Scandome ,Diamond , VCL , Pelco – P/D
Network Failure Recovery	Automatic local record upload to center storage
Dual Streaming	16 Channel individually configurable second stream
Multicast	16 Channel individually configurable multicast
Network Protocols	RTSP/RTP, HTTP, TF TP, SMTP, DHCP, SSL/TLS, NTP
External Interface	
Network Interface	1, RJ45 10M/100M Ethernet Port
Serial Interface	1xRS-232 ,1xRS-485 (PTZ)
USB Interface	2x USB2.0
Alarm Input	16 (Terminal Block)
Alarm Output	4 (Terminal Block)
General	
Power Supply	100~240VAC ,50~60HZ
Operating Temperature	0°C~ 50°C

Humidity	30% ~ 80%
Chassis	Standard 2U

1.5 CENTRAL MONITORING SYSTEM:

The Central Monitoring System should have the following features:

- Multi-DVR management, should support up to 960 video channel connection
- Should support up to 36 live view windows at one single screen and maximum 144
- windows extension viewing
- Video recording and playback management
- Local recording
- Devices management, auto search configuration and status monitoring
- Alarm management and inter linkage control
- PTZ control
- Video Snap-shot
- E-map

Max. Video Channels Connection	960 Channels
Video Display Split	1/4/9/16/25/36
PTZ Controls	Pan/Tilt/Zoom/Focus/Iris/Preset/Tour/Pattern
Video Playback	Should be provided
Snapshot	Should be provided
Local Recording	Should be provided
Alarm Management	Should be provided
Sound Management	Auto sound when alarm triggering
E-map	Support with 64 layouts
E-map Format	JPEG/BMP
Alarm Trigger	Recording/PTZ control/Relay out
Minimum PC Specs	
CPU	Intel Core2Duo E6750, RAM : 2GB above
Memory	512MB
HDD	80GB above
OS	Window XP/Vista, DirectX 9.0 above
Screen Resolution	1024 x 768 or above

1.6 LCD COLOR MONITOR – 21 INCH

- a. The monitor shall be suitable for the highest level of quality control. These shall provide reliable, high resolution video viewing in the most demanding security applications. Under scan shall be available, brightness, contrast, and power ON/OFF shall be to standards.
- b. The minimal equipment specification for alarm monitor is as follows, Color
 - i) Size : 21"
 - ii) Picture tube : Flat square, 53 cm measured diagonally

iii)	Deflection	:	90°
iv)	Resolution	:	Equal to or More than 550 lines
v)	Viewing area	:	20", Diagonal
xii)	Input voltage	:	220-230 V AC, 50 Hz, single phase
xiii)	Power Max.	:	30 W
xiv)	Linearity		
	- Horizontal	:	3 % typical
	- Vertical	:	3 % typical
xv)	Humidity	:	20%-80% non-condensing
xvi)	Operating temp	:	0 to 40°C
xvii)	Controls	:	<u>Front</u> : On-off, LED, , Sharpness, Color, Brightness, Contrast, Volume/Data (2)

1.7 LCD COLOR MONITOR – 32 INCH

- a. The monitor shall be suitable for the highest level of quality control. These shall provide reliable, high resolution video viewing in the most demanding security applications. Under scan shall be available, brightness, contrast, and power ON/OFF shall be to standards.
- b. The minimal equipment specification for alarm monitor is as follows, Color
 - i) Size : 32"
 - ii) Picture tube : Flat square, 80 cm measured Diagonally
 - iii) Deflection : 90°
 - iv) Resolution : Equal to or More than 700 lines
 - v) Input voltage : 220-230 V AC, 50 Hz, single phase
 - vi) Power Max. : 30 W
 - vii) Linearity : 2 to 3% typical
7% maximum
 - viii) Humidity : 20%-80% non-condensing
 - ix) Operating temp : 0 to 55°C
 - x) Controls : Front: On-off, LED, , Sharpness, Color, Brightness, Contrast, Volume/Data

1.8. ACCESSORIES

A. Weather proof housing for outdoor application

The Housing should be made of extruded aluminum and should be weather proof. The minimum internal dimensions of the housing should be capable of housing the camera and the Verifocal lens.

The camera housing should be:

- Compatible to camera

- Suitable for the make and model no of cameras offered and as specified by the manufacturer
- Should be compact and indoor / outdoor type as required.
- Suitable for operation in upright and inverted position'
- Should be weather proof in case of outdoor mounting.
- Should be Vandal proof

B. Camera mount

The camera mount should be:

- Of the same make as that of camera and suitable for the model number offered as specified by the manufacturer.
- Should be compact and indoor / outdoor type as required.
- Should support the weight of camera. Camera accessories such as housing pan & tilt head in any vertical or horizontal position.
- Should be weatherproof in case of outdoor mounting.

C. Speed dome controller/PTZ controller

Speed Dome Controller should have variable speed joystick, LCD for programming and it should be able to control the Encoders as well as speed dome for PAN / TILT / Zoom functions.

D. Video Wall Rack

The video wall mountings should be of powder coated MS frames/supports and should be strong enough to take care weight of all Monitors. It should be suitably fabricated in such a way that only screens of monitors should be visible outside. Power supply wiring with suitable capacity sockets /earthing should be neatly installed on the rack. Video wall computers should also be enclosed in the rack. The supporting frames of monitors should not sag due to its weight.

2. VIDEO CO-AXIAL CABLES

- 2.1 The Co-axial cable is of wideband type with operation capability up to 2400 MHz.
- 2.2 The ageing resistance of the co-axial cable complies with DIN 47252, Part 2, i.e. max. 5% increase in attenuation at 200 MHz. measured by artificial ageing (14 days at 80 deg. C)
- 2.3 Cables meets or exceed the following specifications.

Construction	RG-6 CATV
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a	Center Conductor	18 AWG tinned copper
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b.	Dielectric	Foam Polyethylene
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Nom. dia 0.180

c.	Shield	Foil - 0.003 Al. Tape
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Braid - 34 AWG 4 end

AL. 60% coverage dia 0.212

d.	Jacket	Black PVC flame retardant dia over jacket 0.272 + 0.008 Min. spot 0.023
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Electrical Properties

a.	Dielectric Strength	Conductor to shield 2000 VDC
b.	Capacitance	16.2 PF / FT, Nom
c.	Impedance	75.0 + 3.0 ohms
d.	Attenuation	DB/100 ft. 0.65 DB @ 5 MHZ 0.76 DB @ 10 MHZ 0.96 DB @ 20 MHZ 1.98 DB @ 100 MHZ 4.21 DB @ 450 MHZ 4.80 DB @ 550 MHZ 6.49 DB @ 1000 MHZ
e.	Velocity of propagation	82.0% Nom
f.	DCR	35.47 ohms / 1000 ft.
g.	SRL	30 DB (10 MHz to 300 MHz)

3. POWER/ COMMUNICATION CABLING SYSTEM

The system shall consist of video, power serial data combined cable and Cat6 cable in metallic conduits and shall be concealed as called for.

3.1 GENERAL

Prior to laying and fixing of conduits, the contractor shall carefully examine the working drawings prepared by him and approved by the HLL indicating the layout, satisfy himself about the sufficiency of number and sizes of conduits, location of junction boxes, sizes and location of switch boxes and other relevant details. Any discrepancy found in the drawings shall be brought to the notice of the MoHFW's site representative. Any modifications suggested by the contractor shall be gotten approved before the actual laying of conduits is commenced.

3.2 MATERIALS (METAL CONDUITS & ACCESSORIES)

CONDUITS

Conduits and Accessories shall conform to relevant Indian Standards. 16/14 (16 gauge up to 32mm & 14 gauge above 32 mm) gauge screwed MS conduits as specified on BOQ shall be used. Joints between conduits and accessories shall be securely made, to ensure earth continuity. All conduit accessories shall be threaded type only.

Only approved make of conduits and accessories shall be used.

Conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

Note. : Whatever materials required to be billed by the Contractor should come on site with proper challan no. and quantity mention on it.

JOINTS

All jointing shall be subject to the approval of the MoHFW's site representative. The threads and sockets shall be free from grease and oil, Connections between screwed conduit and GI boxes shall be by means of hexagon brass check nut, fixed outside and

brass bush from inside the box. The joints in conduits shall be free of burrs to avoid damage to insulation of conductors while pulling them through the conduits.

RECESSED OR EXPOSED CONDUITS

All conduits shall be as per Schedule of Quantities.

FLEXIBLE CONDUITS

Flexible conduits shall be made of heavy gauge MS strip galvanized after making the spiral. Both edges of the strip to have interlocking to avoid opening up.

BENDS IN CONDUIT

Where necessary, bends or diversions may be achieved by means of bends and / or circular cast iron inspection boxes with adequate and suitable inlet and outlet screwed joints. In case of recessed system each junction box shall be provided with a cover properly secured and flush with the finished wall surface. No bends shall have radius less than 7.5 cms or three times the outside diameter of the conduits.

FIXING OF CONDUITS

All conduits, shall be installed so as to avoid steam and hot water pipes. After the conduits, junction boxes, outlet boxes and switch boxes are installed in position, their outlets shall be properly plugged or covered so that water, mortar, insects or another foreign matter does not enter into the conduit system. Surface conduits shall be fixed by means of heavy gauge GI saddles secured at intervals not more than 600 mm, but on either side of couplers or bends or similar fitting saddles shall be fixed at a distance of 300 mm from centre of each fitting. For conduit fixing suitable PVC/Nylon fasteners shall be used.

Recessed conduiting shall be done by making chase in the masonry by chase cutter, the conduit shall be fixed in the chase by means of GI hooks not more than 600 mm apart. After fixing of conduit the chase shall be filled with cement mortar after fixing of chicken mesh and brought to the original finish level of the surface.

4.0 PUBLIC ADDRESS SYSTEM CUM VOICE EVACUATION SYSTEM

- a. The public address system with microphone and amplifier of adequate capacity with 2 Nos. manual selector switches for selecting between: (a) alarm or public address system (b) Alert tones or Evacuation tones to all the channels.
- b. The amplifier shall work on A.C. or 24 VDC power supply separate from that of the fire alarm panel. Master control for adjustment of volumes shall be provided. The amplifier unit shall have complete protection against over loads, short circuits and wrong battery polarity. The amplifier shall have hum and noise level better than 60db.
- c. Speakers with line impedance transformers (at speaker end) shall be connected to amplifier. This will be integrated with panel and shall be capable of announcing pre-recorded messages.
- d. A Message Unit shall be provided having up to 30 seconds of pre-recorded emergency messaging.
- e. The message contained in the message unit shall be recordable in the field.
- f. The Public address system shall be provided with a separate full battery back-up and suitable chart.

List of Approved Makes of Materials

S.No	Details of equipment/ material	Make/Manufacturer
1. <u>CIVIL WORKS</u>		
1.	Acoustical Panelling	ECOTONE/ Viraj/ Evolution/ Armstrong/ Oceanz
2.	Adhesive for Ceramic tiles	Cico / Pidilite / Bal Endura / Laticrete/ Fosroc
3.	Adhesive for Wood Work	Fevicol/Vamicol/Dunlop
4.	Aluminium Accessories and Hardware	Classic/ Crown /EBCO /Earl Bihari
5.	Aluminium Composite Panels	Aludecor / Alucobond /Alstone
6.	Aluminium Die-Cast handles & two point locking kit	Giesse / Securistyle / Alu – alpha
7.	Aluminium Extrusion/ Sections	Hindalco / Jindal / Indal
8.	Aluminium Fabricator	To be approved by the Engineer-in-Charge
9.	Anchor Fastner	Hilti / Fischer /Bosch/ Canon
10.	Anti – Termite Treatment	It should be done by permanent members of IPCA as approved by Engineer-in-Charge.
11.	Back up rod	Supreme Industry or equivalent
12.	Ball Cock	Sant / L&T/Audco
13.	Ball valves with floats	Zoloto / Leader / Sant
14.	Batch Mix Concrete (BMC) / Ready Mix Concrete (RMC)	The contractor to install his own computerized batching plant of suitable capacity and arrange for Transit Mixers, pumps etc. as per approval of Engineer – In- Charge. Or The RMC shall be procured from the source as approved by Engineer – in Charge. RMC Producing plants of the main Cement producers shall be preferred
15.	Brass - Stop & Bib Cock	Zoloto / Sant / Jaquar
16.	C. I Pipes & Fitting	Electrosteel/ Kesoram/ NECO/ RIF/ SKF
17.	C.I Sluice Valve & Non Return Valve	Kirloskar /Leader /Zoloto/ Audco/ Sant
18.	C.I Valves (Full way, Check and Globe Valves	Leader / Kirloskar / SKF / Zolto / Sant / Castle / Kartar
19.	C.I. Manhole Covers	NECO/R.I.F./B.C./HEPCO/SKF/KAJECO
20.	C.P. Fittings Mixer / Pillar taps/ C.P brass angle valve/ Valves Washers / C.P. brass accessories/ C.P. Waste, Spreaders, Urinal	Jaquar /Marc/ Kohler/ Grohe
21.	Cement	ACC / Ultra tech / JK Cement / Jaypee-Rewa / Ambuja / Lafarge / Bangur/ Shree
22.	Cement: White	Birla White / JK
23.	Clean Room Wall Panels with/ without return air risers, Doors/ windows etc.	CLESTRA/ NICOMAC / HEMAIR / GMP / EPACK
24.	Clear Glass / Clear Float Glass / Toughened Glass	Modi / Saint Gobain (SG) / Asahi India Safety Glass Ltd

25.	Concrete Additive	CICO/ Pidilite / Fosroc / Fairmate / MC Bauchemie
26.	Curtain Rod/ Drapery Rod/ Venetian Blinds	Vista work / Mac Décor or equivalent
27.	Dash Fasteners	Hilti / Faischer / Bosch
28.	Door closer / Floor spring	Doorking / Everite / Hardwyn/ Ozone
29.	Door Locks	Godrej / Harrison / Link/ Dorma/ Ozone
30.	Door Seal – Woolpile Weather Strip	Anand Reddiplex/ Enviroseal
31.	Door Shutters- Flush	Duro / Greenlam / Century / Merino
32.	Doors & Windows Fixtures / Fitting.	Everite / Classic/ Crown / Earl Bihari
33.	Epoxy Flooring	Fosroc/ Dr. Beck/ Flamaflor
34.	Extruded Polystyrene Board	Styrofoam by DOW Chemicals / Insuboard by Supreme Industries
35.	False Ceiling - Calcium Silicate Boards & Tiles	India Gypsum/ Armstrong / Hilux / Saint Gobain (Gyproc)
36.	False Ceiling - Metal	Armstrong / Hunter-Douglas / USG/ Saint Gobain/ Unimet
37.	False Ceiling - Mineral fibre	Armstrong / Decosonic / USG/ AMF/ Saint Gobain (Gyproc)
38.	Fire Rated Doors & Frames	Navair / Shakti-Hormann / Promat / Godrej
39.	Fire Rated Glass	Asahi India Safety Glass Ltd./ Modi/ Saint Gobin
40.	Fire Retardant Paint	Viper FRS 881/ Nullifire/ Berger
41.	Fire Seal	Sealz, Alstroflam/ Abacus
42.	Fire: Door Closures, Mortice Dead locks	Becker Fire Solution/ Inersoll Rand/ Dorma
43.	Fire: D-Type Pull Handles	Becker Fire Solution/ Dorma/ Hardwin
44.	Fire: Hinges,	Becker Fire Solution/ Inersoll Rand/ Dorma.
45.	Fire: Panic Exit Devices	Becker Fire Solution/ Inersoll Rand LCN Series/ Dorma PHA Series/ D-line
46.	Fire: Sealant	Birla/ 3m/ Hilti
47.	Fire: Tower Bolts	Suzu/ Nulite, Dorset/ Dorma
48.	Floor Hardener	Pidilite / SIKKA/ Fairmate / BASF
49.	Glass : Float & Mirror	Modiguard / Atul / Saint Gobain/ Asahi India Safety Glass Ltd / Modi Glass
50.	Glass for Aluminum Doors/ Windows/ Structural Glazing	Modiguard / Saint Gobain / Pilkington/ Asahi India Safety Glass Ltd.
51.	Glass Wool / Insulation Boards	Rockwool / UP Twiga / Lloyd Insulation
52.	Grout: Non-Shrink	Fosroc / Sikka or equivalent
53.	Grouting Compound	Bal Endura/ Pidilite/ Laticrete/ Unitile
54.	Gypsum Board / Gypsum False Ceiling/ Gypsum Partitions	Boral Gypsum / India Gypsum / Lafarge / Saint Gobain (Gyproc)
55.	Laminates/ Veneers	Century/Greenlam/Formica/Sunmica/ Merino
56.	Modular Grab bars and Disabled Hardware	Dorma / D-line
57.	Modular SS Railing System	Metallica India / D – Line International Denmark / Mobel Hardware
58.	Night Latch	Godrej / Dorma/ Ozone
59.	OT: Anti-bacterial paint	Sikka by Liquid Plastic/ Viesmann/ SSK/ TRILUX
60.	OT: Conductive Tile Flooring: ESD-Control Tile Flooring	Tarkett/ Gerflor/ Armstrong/ Forbe/ Trilux

61.	Paints - Cement Based	Snowcem Plus/, Berger (Durocem Extra)/ Nerolac (Super Acrylic)/ TATA Cem
62.	Paints - Epoxy paint	ICI Dulux/ Nerolac / Cico / Sikka / BASF / Berger / Pidilite
63.	Paints - Oil Bound Distemper / Acrylic Washable Distemper	ICI Dulux/ Asian (Tractor)/ Berger (Bison)/ Nerolac (Super Acrylic)
64.	Paints - Other Paints / Primer	ICI Dulux/ Asian/ Berger/ Nerolac
65.	Paints - Plastic Emulsion Paint	ICI Dulux/ Asian/ Berger/ Nerolac
66.	Paints - Synthetic Enamel Paints	ICI Dulux (Gloss), Berger (Luxol Gold), Asian (Apolite), Goodlas Nerolac (Full gloss hard drying)
67.	Paints - Texture paint	Berger / Spectrum / Unilite Heritage /Asian
68.	Paver blocks / Tiles (All Types)	KK / Uni Stone Products (India) Pvt. Ltd/ Hindustan Tiles/ NITCO
69.	Plywood/Block board/Ply board	Duro/ Greenply/ Century/ Kitply/ National / Anchor/ Merino
70.	Polycarbonate Sheets	Galina/ GE Plastic / Vergola / Skyarch/ Polytechno/ FlexyTuff
71.	Pre-coated Galvanised Steel Sheet	Tata BlueScope / Llyod Insulations India Ltd / S.R.Metals
72.	Pre-Laminated Particle Board	Novapan /Century /Green Ply/ Merino
73.	PVC continuous fillet for periphery packing of glazings / Structural/ Glazing	Roop / Anand / Forex Plastic/ Nagalia/Trading Company
74.	PVC Doors	Sintex/ Polyex/ Rajshri
75.	PVC Flooring	Tarkett Floors / LG Floors / Gerflor / Premier Vinyl flooring / Regent / Armstrong
76.	Reinforcement Steel / Structural Steel	SAIL/ RINL/ TATA Steel Ltd./ Jindal Steel & Power Ltd./ JSW Steel Ltd.
77.	Restroom Cubicles	Merino/ Century/ Greemlam
78.	Sealant: Poly-sulphide	Pidilite / Fosroc / CICO / Sikka
79.	SFRC / RCC Manhole Covers/ Perfect RCC Grating	KK Manholes / SK Precast Concrete/ Advent concreteovision / Daya concrete
80.	Silicon sealants /Weather Sealant / Structural Glazing Sealant	GE- Silicon / Pidilite / Forsoc / Cico /Dow Corning / Sikka/ Wacker
81.	Stainless Steel	Salem Steel/ Jindal or equivalent
82.	Stainless Steel bolts, Screws, Nuts & Washers	Kundan / Puja / Atul
83.	Stainless Steel Clamps	Hilti /Intellotech Konzept or equivalent
84.	Stainless Steel CP Grating	Chilly / Camry or equivalent
85.	Stainless Steel D-handles	D-line / Giesse /Dorma
86.	Stainless Steel Friction Stay	Earl Bihari / Securistyle / EBCO
87.	Stainless Steel Hinges	Hettich/ Godrej/ Dorma
88.	Sunken Portion Treatment	Choksey / Sika / CICO/ MC Bouchemie / MC Bouchemie / BASF
89.	Super plasticizer	CICO/ Roffes Construction Chemicals/ Pidilite Industries
90.	Tiles: Ceramic Tiles	Kajaria / Nitco / HR Johnson
91.	Tiles: Glass Mosaic Tiles	Mridul / Bisazza/ Italias/ NITCO
92.	Tiles: Glazed (Ceramic) tiles	Somany / Kajaria /NITCO
93.	Tiles: Heat Resistant Terrace Tiles	Thermatek or equivalent

94.	Tiles: Vitrified Tiles (Double / Multy Charged)/ Germ free	Kajaria / Nitco /RAK /Hindware
95.	Vacuum Dewatered Flooring	Tremix / Sun Build / Avcon technics
96.	Veneered Particle Board	Duro / Greenply / Century / Novapan / Action Tesa
97.	Water Proofing Materials (Bitumenistic)	BASF/ Fosroc / Sikka / CICO / STP/ Pidilite
98.	Wooden Laminated Flooring	NITCO /Euro / Pergo
2. <u>PLUMBING & SANITARY WORKS</u>		
S.No	Details of equipment/ material	Make/Manufacturer
1.	Automatic variable temperature control / fixed temperature control faucets	Jaquar / AOS-Robo-U-Tec/ Parry / Angash / Euronics
2.	Central Control	Rain Bird, USA/Toro/Nelson,
3.	Centrifugally C.I Rainwater Intel fitting , Bronze gratings	Sages Metals, GMGR, Electro Steel , Kesoram, NECO, Neer
4.	Centrifugally casted C.I. Pipes	Neco / Hepco / Anand/ Kapilash
5.	Chlorinator	Thermax Ltd/ Watcon, Ion exchange/ Sigma DH Combine Inc./ Siemens/ Techcon/ Jesco / Prominent Heidelberg
6.	Chlorine Dosing System	Toshcon / Chloromax
7.	Cockroach Trap	Chilly/ Player/ Camry
8.	Copper Fittings (Capillary)	Yorkshire Imperial, U.K./ Rajco Metal Works Mumbai / IBP Conex Ltd.
9.	Disc Filter	Azud, Spain/ Amaid / Arkal,
10.	Ductile Iron Fittings (IS:9523)	Electrosteel/Kesoram/Tisco/Jindal
11.	Ductile Iron Pipes (IS:8329)	Electrosteel/Kesoram/Tisco/Jindal
12.	E.P.D.M Gaskets	Anand Reddiplex / Enviro Seals / HANU
13.	Forged Steel Fittings & Flanges (For Welded joints)	Rohini /Kanwal/ Vijay Cycle & Steel (VS)
14.	Geyser	Spherehot / Racold / Usha Lexus /Bajaj
15.	Hand Drier	Kopal / Utech Systems / Euronics Automat
16.	HDPE Pipes / Moulded Fittings	Emco /Polyefins/Pioneer Plyfab/ Jain
17.	HDPE Solution tank	Watcon / Ion Exchange / Water Supply Specialist Pvt. Ltd.
18.	Inbuilt Drip Line	Azud/ Rainbrid-USA/ Netafim
19.	Insulation of Hot water pipes	Vidoflex insulation / Superion insulation Kaiflex – Kaimann/Armoflex/Thermaflex
20.	Liquid Level Controllers / Indicators	Advance Auto / Sridhan International / Minilec / Radar / Femac / Switzer / 21 st Century
21.	Liquid Soap Dispenser	Euronics/Utec/Kopal
22.	MS Saddle with G.I. Riser	Harvel/Alprene/Rain Bird, USA
23.	PVC flushing cistern	Commander / Parryware / Hindware/ Cera
24.	P.R.S. Dials	Rain Bird, USA/ Toro, USA/ Nelson,
25.	P.T.M.T. Fitting	Prince India / Symet
26.	Pipe coat material (pipe protection)	RPG Raychem/Pypkote/Makphalt/Lwl
27.	Pipe Fittings: G.I.	R/Unik/Zoloto/K.S./Sun/Swastik
28.	Pipe:- G.I.	Jindal / Tata / Prakash Surya

29.	Pipes & fitting: PVC for SWR Soil, Waste & Vent Pipes and fittings, Type B PVC Casing & Screen Pipes	Prince / Supreme / Finolex
30.	Pipes & Fittings: CPVC	Flowguard/ Astral/ Ashrivad
31.	Pipes & fittings: UPVC	Finolex / Prince / Supreme / AKG / Kasta / Vector / Astral
32.	Pipes & Gully Trap: Stone ware	Perfect / R.K/ Hind / Anand
33.	Pipes and Accessories: PE-AL-PE	Kitec/ Jindal/ Kissan/Vista
34.	Pipes: Copper	Rajco Metal works, Mumbai / IBP Conex Ltd.
35.	Pipes: M.S.	Jindal / Prakash – Surya /TATA
36.	Pipes: PP-R (PN – 16)	Amitex Polymers Pvt. Ltd. / Prince/ Supreme
37.	Pipes: R.C.C	Indian Hume Pipe / Pragati Concrete Udyog Daya/KK / JSP
38.	Plastic seat cover of W.C	Commander/Hindware / Parryware
39.	Polyethylene Storage Tank	Sintex / Polycon/ Fusion
40.	Pop up Connecting Assembly	Rain Bird/Dura/Lasco,
41.	Popup Spray Head	Rain Bird/Toro, USA/Nelson,
42.	Powder Coating Material pure Polyester	Jotun / Berger / Goodlass Nerolac
43.	PVC Water Stops	Prince /Supreme/ Finolex
44.	RQRC Hydrant	Harvel/Alprene/Rain Bird, USA
45.	RQRC Key	Harvel/ Aqua/ Drip& Drip
46.	Sensor Operated Auto Flushing System Urinals	Jaquar / AOS-Robo/U-tec/Angash/Euronics
47.	SS Gratings/ Soap Dish/Towel Rail etc.	Camry/Glacier/Gem
48.	Stainless Steel Sink	Hindware / Neelkanth / Nirali
49.	Valve Box	Rain Bird, USA/Carson Brook, USA/Dura,
50.	Valve: Air Release	Azud/ API/ Bermad/ BIR/ Kirloskar / Venus / Zoloto
51.	Valve: Butterfly	Zolato/Audco / AIP /Sant/ KSB
52.	Valve: Flush	Gem/ Jaquar / Marc
53.	Valve: Mainline Isolation	Sant /Leader /Zoloto,
54.	Valve: Pressure Relief	Omega/ Sant/Leader/ Zolato / Upadhyay / Audco
55.	Valve: Sluice / NRV	Kirloskar/IVC/Kilburn /Zoloto/Castle/ Leader / L&T/Audco
56.	Valve: Solenoid	Rain Bird, USA/Toro/Nelson,
57.	Valve: Non Return	Sant/ Leader/ Zoloto / AIP / Kirloskar/ IVC/ Leader/ Audco
58.	Valves: Gunmetal / C.P brass angle	Zoloto / Leader / Kilburn / Sant / Kartar/ AIP/ Audco
59.	VFD Pump	Jyoti / Crompton/ Kirloskar/ KSB/ Grundfos/ Mather & Platt
60.	Vibration Eliminator Resisto-flex Pads & Connections	Relay Corpn./ Kanwal
61.	Vitreous China/ Sanitary wares	Hindware / Parryware / Cera
62.	Water Cooler	Blue Star/ Voltas/ Usha/ Godrej
63.	Water Meter	Capstan / Kranti/ Anand/ Kant
64.	Water supply pumps	KSB/ Grunfos/ Kirloskar/ Crompton/ Mather & Platt
65.	White Glazed Fire Clay Sink	Hindware / Parryware / Cera

3. ELECTRICAL WORKS

S.No	Details of equipment/ material	Make/Manufacturer
1.	MCBs / RCCB/Isolaters / RCBO / Change over switch	Legrand/ Schneider/ Siemens/ ABB/ L&T (Hager)/ Socomec
2.	FRLS PVC wires (Copper)	Finolex, RR Kable, Polycab, Havells
3.	Moduldar switch, Socket, face plate & modular box	Legrand, Siemens, Schneider, MK, WIPRO
4.	Telephone wires (FRLS)	Polycab, RR kable, Bonton , Finolex, Anchor
5.	Telephone socket	Legrand, MK, Krone
6.	PVC conduit & accessories	Avon Plast, Precision, AKG
7.	MS conduit & accessories	BEC/ AKG/ Steel Kraft
8.	Light Fixtures	Philps, WIPRO, Havells, Crompton
9.	Refrigerators	Samsung, LG, Whirpool
10.	Washing machine	Samsung, LG, BOSCH, IFB
11.	Geyser	Racold, Usha, Bajaj, Crompton
12.	RO Plant	Ion Exchange, Thermax, Pentair, PAMM,AWMS or equivalent
13.	LED Tv	Samsung, LG, Sony
14.	Stabilizer	V Gaurd, Everest, Havells
15.	TV Set top box	Airtel, Videocon, Tata sky
16.	Casing capin	Legrand, Modi or equivalent

Note:-	
1.	The contractor will use one of the approved makes as approved by the HLL / Engineer -in-charge.
2.	In case of different quality / pattern of same make, the pattern/ quality shall be approved by the HLL / Engineer – in – charge.
3.	All the items included in the list or otherwise to be used in the work should conform to CPWD and relevant BIS specifications / relevant codes, as applicable.
4.	If any item is missing in the above list, its make will be decided by the HLL./ Engineer –in-charge.
5.	If any major equipment is using a small component of make other than that given as a standard component with the equipment, the same shall be accepted.
6.	Similar Makes for the same items may be used for all the subheads.