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TECHNICAL SPECIFICATIONS

1. INTERNAL WIRING

1.1 System of Wiring

The system of wiring shall consist of PVC insulated copper stranded conductor flexible FRLS wires in metallic / non metallic (Rigid heavy Duty ISI -marked fire retarded PVC Conduits of minimum 2mm Wall thickness and Sizes starting from 20 mm diameter) conduits and shall be concealed or surface mounted above false ceiling as called for.

1.2 General

Prior to laying and fixing of conduits, the contractor shall mark the conduit route, carefully examine the working drawings prepared by him and approved by the Consultant indicating the layout, satisfy himself about the non interference in the route, sufficiency of number and sizes of conduits, location of junction boxes, sizes and location of switch boxes and other relevant details. Any discrepancy found shall be brought to the notice of the Owner's site representative. Any modifications suggested by the contractor should get written approval before the actual laying of conduits is commenced.

In laying of conduits it is important that not more than two right angle bends are provided for each circuit without a pull box. No junction box shall be provided in the entire length of conduit run for drawing of wires. Only switch outlets, lighting fixture outlets, equipment power outlets and socket outlets shall be considered for drawing of wires.

1.3 Metal Conduits & Accessories

1.3.1 Conduits

Conduits and Accessories shall conform to latest edition of Indian Standards IS-9537 part 1 & 2. 16/14 (16 gauge upto 32mm diameter & 14 gauge above 32 mm diameter) gauge screwed GI or MS conduits as specified on schedule of quantities shall be used. Joints between conduits and accessories shall be securely made by standard accessories, as per IS-2667, IS-3837 and IS-5133 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 Numbers and quantity mentioned in each such Challan.

1.3.2 JOINTS

All jointing shall be subject to the approval of the Owner's site representative. The threads and sockets shall be free from grease and oil. End termination of conduit on GI boxes shall be by means of hexagon check nuts & spring washer on both sides of the conduit. The joints in conduits shall be free of burrs to avoid damage to insulation of conductors while pulling them through the conduits. Rubberised bushes shall be used in the conduit entry and exit from DBs, switch boxes etc ,so that wires are protected from damage to insulation of the incoming and outgoing wires

1.3.3 RECESSED OR EXPOSED CONDUITS

All conduits shall be as per Schedule of Quantities.

1.3.4 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.

1.4 **PVC Conduit and Accessories**

PVC Conduit

Conduits and accessories shall conform to latest edition of IS-9537 part 3 and shall be heavy duty with minimum wall thickness of 2.0 mm rigid tubes which are unscrewed without coupling and with plain ends. All conduits used shall be ISI-marked and shall not be less than 20 mm diameter.

PVC conduit shall be used for all concealed / embedded installation.

PVC Conduit Accessories

Accessories used for conduit shall be of an approved brand and type complying to relevant IS code.

All accessories used shall be of standard white or black colour, identical to conduit used.

Plain conduits shall be jointed by slip type of couplers with manufacturer's standard sealing cement.

All conduit entries to outlet boxes, trunking and switchgear are to be made with adaptors female thread and screwed male bushes.

PVC-switch and socket boxes with round knockouts are to be used. The colours of these boxes and the conduits shall be the same.

Standard PVC circular junction boxes are to be used with conduits for intersection, Tee-junction, angle-junction and terminal. For the drawing-in of cables, standard circular through boxes shall be used.

Samples of accessories shall be submitted for approval prior to installation.

All jointing of PVC conduits shall be by means of adhesive jointing. Adequate expansion joints shall be allowed to take up the expansion of PVC conduits.

1.5 **Bends in Conduit**

Where necessary, bends or diversions may be achieved by means of bends and / or circular cast iron boxes with inspection cover and 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. For metallic conduits, bends of defined radius shall be made by compactly filling fine sand inside the conduit length, to avoid non-uniform shape, once the bend is done. Proper jigs shall be used to ensure that the Enameling /Galvanising of the Conduit is not damaged.

1.6 **Fixing of Conduits**

All conduits, shall be installed so as to avoid exposure to steam, hot water or any other process 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, rodents and insects, insects or any other 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 1000 mm, and 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 to the entire satisfaction of Owner

1.7 Switch outlets and Junction Boxes

All outlet boxes for switches, sockets and other receptacles shall be rust proof and shall be of 1.6 mm thick mild steel sheets with HOT dipped galvanizing (or as specified in SOQ), having smooth external and internal surfaces to true finish. All outlet boxes for receiving plug sockets and switches shall be fabricated to approved sizes. All boxes shall have adequate number of knock out holes of required diameter and earthing terminal screws. Outlet boxes shall be of a maximum depth of 65 mm.

1.8 Inspection Boxes

50 mm dia inspection boxes and pull boxes shall have smooth external and internal finish to facilitate removal and replacement of wires, where required.

1.9 Fish Wire

To facilitate subsequent drawing of wires in the conduit, GI fish wires of 2.0 mm (14 SWG) shall be provided alongwith the laying of recessed conduit.

1.10 Conductors

All PVC insulated copper conductor flexible FRLS wires shall conform in all respects to Standards as listed under sub-head Indian Standards and shall be IS approved and ISI marked.

1.11 Bunching of Wires

Wires carrying current shall be so bunched that the outgoing and return wires are drawn into the same conduit. Wires originating from two different phases shall not run in the same conduit. All wires shall have ferrules for identification. Lighting and power circuits shall be separate. Each Power/ Light Circuit's Neutral shall be individual per Circuit and shall not be looped from any other Circuit.

1.12 Drawing Conductors

The drawing and jointing of PVC insulated copper conductor wires shall be executed with due regard to the following precautions. While drawing wires through conduits, care shall be taken to avoid scratches and kinks which may cause breakage of conductors. There shall be no sharp bends. Wire reel stands to be used for pulling of wires to avoid kinks. Care shall be exercised while drawing the wires from reels, by taking appropriate measures to ensure that wires are not spread on ground, causing dust and dirt accumulation on the new wires.

Maximum permissible number of 1100 volt grade PVC insulated wires that may be drawn into metallic Conduits are given below :

Size of wires Nominal Cross section Area (Sq. mm.)	Maximum number of wires within conduit size(mm)				
	20	25	32	40	50
1.5	5	10	14	--	--
2.5	5	8	12	--	--
4	3	7	10	--	--
6	2	5	8	--	--
10	--	3	5	6	--
16	--	2	3	6	6
25	--	--	2	4	6
35	--	--	--	3	5

Maximum permissible number of 1100 volt grade PVC insulated wires that may be drawn into rigid non metallic or PVC Conduits are given below :

Size of wires Nominal Cross section Area (Sq. mm.)	Maximum number of wires within conduit size(mm)				
	20	25	32	40	50
1.5	7	12	16	--	--
2.5	5	10	14	--	--
4	4	8	12	--	--
6	3	6	8	--	--
10	--	4	5	6	--
16	--	3	3	6	6
25	--	--	2	4	6
35	--	--	--	3	5

Insulation shall be removed by insulation stripper only. Few Strands of wires shall not be cut/reduced for convenience in connecting into terminals. The terminals shall have sufficient cross sectional area to take all strands and it's connecting brass screws shall have flats ends. All looped joints shall be connected through terminal block/connectors. The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less. All light points shall be terminated through a connector.

Conductors having nominal cross sectional areas exceeding 10 sq.mm shall always be provided with cable sockets. At all bolted terminals brass flat washer of large area and approved steel spring washer shall be used. Brass nuts and bolts with brass washers shall be used for all connections.

Only licensed wiremen (Before doing the work or before appointing him on site contractor has to submit his wiring licence to Owner) and cable jointers shall be employed to do jointing work. Before entrusting cable jointing work to any technician, or before appointing Cable Jointers or Wiremen on Site, Contractor has to submit such Technicians' / Wireman's / Cable Jointer's licence to Owner.

All wires and cables shall be embossed with the manufacturer's label with ISI mark and shall be brought to site in original packing. For all internal wiring, PVC insulated wires of 1100 volts grade (FRLS) shall be used.

The sub-circuit wiring for point shall be carried out in loop system and no joints shall be allowed in the length of the conductors. No wire shall be drawn into any conduit until all defective work of conduit installation of any nature that may cause injury to wire is completed. Care shall be taken while pulling out the wires so that no damage occurs to conduits/wire itself, the conduits shall be thoroughly cleaned of moisture, dust, dirt or any other obstruction. The minimum size of PVC insulated copper conductor wires for all sub-circuit wiring for light points shall be minimum 2.5 sq.mm copper. Separate neutral to be pulled for each circuit.

1.13 Joints

All joints shall be made at main switches, distribution boards, socket outlets, lighting outlets and switches boxes only. No joints shall be made in conduits and in junction boxes. Conductors shall be continuous from outlet to inlet.

1.14 Mains and Sub-Mains

Mains and sub-mains cable or wires where called for shall be of the rated capacity and approved make. Every main and sub main wires shall be drawn into an independent adequate size of conduit. Earthing shall be in conformity with relevant IS codes and calculations shall be submitted for verification. An independent earth wire of the proper rating shall be provided for every single phase sub-main. For every 3 -phase sub-main, 2 Nos. earth wires of proper rating shall be provided alongwith the sub-main. The earth wires shall be drawn along with circuit wires through conduit. Where mains and sub-mains cables are connected to switchgear, sufficient extra lengths of cable shall be provided to facilitate easy connections and maintenance. Where ever necessary, powder-coated 1.6 mm thick sheet steel covering (also called trunking) shall be provided to cover the group of conduits and cables entering and exiting the Wall mounted/Floor mounted SubDBs, DBs, and FDBs ,so that the Installation looks neat .The colour of such sheet steel covering (trunking) shall be matching with the colour of the SDBs, DBs and FDBs

1.15 Load Balancing

Balancing of circuits in three phase installation shall be as planned by the Consultants in the tender drawings and shall be checked by the contractor before the commencement of wiring and shall be strictly adhered to.

1.16 Colour Code Of Conductors

Colour code shall be maintained as indicated by the Consultant for the entire wiring installations. Red, yellow, blue shall be for three phases, black for neutral and green with yellow band shall be for earthing.

2 (A) SWITCHES, RECEPTACLES (MODULAR), LIGHTING FIXTURES & LIGHTING CONTROL EQUIPMENT

2.1. Switches

All switches shall be enclosed type flush mounted suitable for 240 volts AC. All switches shall be fixed inside the switch boxes on adjustable flat M S strips/plates with tapped holes and brass machine screws, leaving ample space at the back and sides for accommodating wires. Switch controlling the light point shall be connected to the phase wire of the circuit and load on each switch shall be restricted to maximum **800 watts & maximum 1500 watts per circuit**. All wiring accessories shall be BIS approved. Perfect alignment shall be maintained while fixing of the back boxes.

2.2 Socket Outlet

Socket outlets shall be of the three pin. The switch controlling the socket outlet shall be on the phase wire of the circuit and not more than two socket outlets of 16 amps shall be connected on one circuit. An earth wire shall be provided alongwith the circuit wires and shall be connected to earthing screw inside the box.. All sockets shall be shuttered type.

- a. Every socket outlet shall be controlled by an individual switch unless mentioned otherwise.
- b. The switch controlling the socket outlet shall be on the 'Live' side of the line.
- c. 6 amps and 16 amps socket outlet shall normally be fixed at any convenient height above the floor level as desired by the Architect. The switch for 6 and 16 amps, socket outlet shall be kept alongwith the socket outlet. However, in special case, if desired by the Architect the 6 amp. socket outlet can be placed at the normal switch level.

16 amps socket outlet in the kitchen of the residential or commercial buildings shall be fixed at any convenient height above working platform or as specified in drawings / schedule of equipments.

In a room containing a fixed bath or shower, there shall be no socket outlet and there shall be no provision for connecting a portable appliance. Any stationary appliance connected permanently in the bath room shall be controlled by an isolator switch or circuit breaker having outlets at such location where water / moisture does not effect. Generally, switches and outlets shall be planned at a minimum distance of 1.5 Metre away from any water supply outlet, so that splashed water may not affect the live installation.

- d. Where socket outlets are placed at lower level, they shall be enclosed in a suitable metallic box with the system of wiring adopted or shutter type sockets shall be provided as specified.
- e. In an earthed system of supply, a socket outlet and plug shall be of three pin type, the third terminal shall be connected to earth.
- f. Conductors connecting electrical appliance with socket outlet shall be flexible twin cord with an earthing cord which shall be secured by connecting between the earth terminal of plug and the metallic body of the electrical appliance.
- g. Where use of shutter type of interlocking type of socket is required for any special installation, the items should be separately and specifically listed in the Schedule of Quantities of that particular work.

2.3 Lighting Fixtures & Accessories

The light fixtures and fittings shall be assembled and installed in position complete and ready for service, in accordance with details, drawings, manufacturer's instructions and to the satisfaction of the Project Manager.

2.3.1 Scope :

Scope of work under this section shall include inspection at suppliers/manufacturer's premises at site, receiving at site, safe storage, transportation from point of storage to point of erection, erection and commissioning of light fittings, fixtures and accessories including all necessary supports, brackets, down rods and painting etc as required.

2.3.2 Standards :

The lighting and their associated accessories such as lamps, reflectors, housings, ballasts etc., shall comply with the latest applicable standards, more specifically the following:

General and safety requirements for Luminaires :

Part-1 Tubular fluorescent lamps	-	IS – 1913 (Part-1)
Industrial lighting fittings with metal reflectors	-	IS - 1777
Decorative lighting outfits	-	IS - 5077
Bayonet lamp holders	-	IS - 1258
Bi-pin lamp holders for tubular fluorescent lamps	-	IS - 3323
Electronic Ballasts for fluorescent lamps – General & Safety requirement	-	IS – 13021 (Part-1)
Electronic Ballasts for fluorescent lamps – Performance requirement	-	IS – 13021 (Part-2)
Ballast for HP MV lamps	-	IS - 6616
Tubular Fluorescent lamps	-	IS - 2418 (Part-1 to 4)
Luminaries – General requirement	-	IS – 10322 (Part-1)
Luminaries – Constructional requirement	-	IS – 10322 (Part-2)
Luminaries – Screw and Screwless termination	-	IS – 10322 (Part-3)
Luminaries – Methods of Tests	-	IS – 10322 (Part-4)
Particular requirement – General purpose Luminaries	-	IS – 10322 (Part-5/Sec-1)
Particular requirement – Recessed Luminaries	-	IS – 10322 (Part-5/Sec-2)
Particular requirement – Luminaries for Road and Street lighting	-	IS – 10322 (Part-5/Sec-3)
Particular requirement – Portable General purpose Luminaries	-	IS – 10322 (Part-5/Sec-4)
Particular requirement – Flood Lighting	-	IS – 10322 (Part-5/Sec-5)
High pressure mercury vapour lamps	-	IS – 9900 (Part-1)

2.3.3 Light Fittings-General Requirements :

- a). Fittings shall be designed for continuous trouble free operation under atmospheric conditions without reduction in lamp life or without deterioration of materials and internal wiring. Degree of protection of enclosure shall be IP-65 for outdoor fittings except bulkhead fitting. Bulkhead fitting shall be provided with IP-54 protection.
- b). Fittings shall be so designed as to facilitate easy maintenance including cleaning, replacement of lamps/ ballasts.
- c). All fittings shall be supplied complete with lamps. All mercury vapour and sodium vapour lamp fittings shall be complete with accessories like ballasts, power factor improvement capacitors, starters, etc. Out door type fittings shall be provided with weather proof junction boxes (IP-55) and IP-54 Control gear boxes. All fluorescent and CFL fittings shall be provided with electronic ballast as per schedule of quantities.
- d). Each fitting shall have a terminal block suitable for loop-out connection by 1100 V PVC insulated copper conductor wires upto 4 sq.mm. the internal wiring should be completed by the manufacturer by means of standard copper wire and terminated on the terminal block.
- e). All hardwares used in the fitting shall be suitably plated or anodized and passivated.
- f). Earthing : Each lighting fitting shall be provided with an earthing terminal. All metal or metal enclosed parts of the housing shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity throughout the fixture.
- g). Painting/Finish : All surfaces of the fittings shall be thoroughly cleaned and degreased and the fittings shall be free from scale, rust, sharp-edges, and burns.
- h). The housing shall be powder coated/stove-enamelled or anodised as required. The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90 deg. over 12 mm dia mandrel.
- i). Metal used in BODY of lighting fixtures shall be not less than 22 SWG or heavier if so required to comply with specification of standards. Sheet steel reflectors shall have a thickness of not less than 20 SWG. The metal parts of the fixtures shall be completely free from burns and tool marks. Solder shall not be used as mechanical fastening device on any part of the fixture.

2.3.4. Light Fittings – Special Requirements

Box Channel Type Industrial Fittings

Box type slim line channel must be in screwless construction manufactured from M.S. CRCA sheet steel powder coated with MS CRCA cover, powder coated white. Light reflection surface in Box/Channel type fittings shall be in a POLYESTER PRECOATED STEEL having a reflection factor of not less than 80%. SCREWLESS DESIGN & CONSTRUCTION Light fixtures shall be preferred due to their ease of maintenance, especially for box/channel for box/channel type fixtures.

Moisture Proof Industrial Fittings

Surface mounted totally enclosed moisture proof fixtures must be in polycarbonate body and diffuser with transparent prismatic interior and smooth exterior and frosted end. Fixture must be completely sealed with polyurethane double gasket to achieve IP 65 protection. Fixture is complete with CRCA steel white powder coated / enameled finish reflector.

18 W / 36 W Fluorescent and 36 W CFL Low Glare Light Fittings

Recessed mounted, modular fluorescent lighting fixture made of CRCA Sheet steel powder coated (white) housing, electro chemically brightened and anodised reflector, three dimensional cross louvers with concave contours, fresnel top at louver saddle to increase efficiency. The luminance of <200 cd/M² at 63 degree viewing angle in all directions so as to confirm Cat-2 classification of CIBSELG3

Highbay Industrial Fittings

Industrial Highbay luminaries shall be provided with pressure die cast housing along with all accessories, orthocyclically woundopien construction ballast, capacitor & semi parallel ignitor connected to terminal block and mounted on the gear plate. The gear shall have side entry for ease in maintenance. The spun aluminium reflector is suitable for narrows well as wide beam distribution as specified in schedule of quantities. The luminaire will be suitable for metal halide lamp HPI BU + 250 W which has 25500 lumens or similar 400W lamp and 2.5 minutes restrike time (when operate with son gear).

2.3.5 Accessories for Light Fittings - Reflectors

The reflectors shall be made of CRCA sheet steel/aluminium /Silvered glass/Chromium plated sheet copper as specified. The thickness of reflectors shall be as per relevant standards. Reflectors made of steel shall have stove enameled/ vitreous enameled/epoxy coating finish. Aluminium used for reflectors shall be anodized/epoxy stove enameled /mirror polished. The finish for the reflector shall be as specified. The reflectors shall be free from scratches / blisters and shall have a smooth and glossy surface having optimum light reflecting coefficient. Reflectors shall be readily removable from the housing for cleaning and maintenance without use of tools.

2.3.6 Lamps

2.3.6.1 TLD

Lamp shall be environment friendly low pressure mercury discharge lamp with mercury content less than or equal to 5 mg. The lamp shall have minimum lumen maintenance of 85 and CRI of 85. The lamp must comply to ROSH (Restriction of Hazardous substances) and covered by WEEE. Lamp should be fully re-cyclable. The lamp should be low on maintenance with life of 40 K hours in case of electromagnetic ballast and 65 K hours in case of HF ballast upto 10% failure. The discharge glass shall be lead free.

TLD Lamps shall be minimum tri-phosphor type and have bi-pin bases. Colour spectrum of light shall be equivalent to "PHILIPS color 84 or color 86 color 82 or "OSRAM color 21 or color 11 or color 41 (as required at site)".

The fluorescent Tubes (TLD) should have cool daylight colour designation. But Architects reserve the right to prescribe either Cool Daylight or Bright White or Incandescent Colour Designations for TLD. NO extra payment will be made over the quoted rate of bidder for this. The 36 W fluorescent tubes will have Nominal Luminous Flux of not less than 3350 lumens whether so mentioned in the Schedule of Quantities or not.

T 5 – High Efficiency ECO-Friendly Lamps

T-5 lamp shall be environment friendly low pressure mercury discharge lamp with mercury content less than or equal to 3 mg. lamp should have lowest CO2 emission compared to any other comparable light source (40% less than a TL-D standard lamp, 26% less than TL-D / 80). T-5 lamp shall be 100% lead free. T-5 lamp shall be designed for operation with electronic gear and well suited for dimming. Maximum lumen output to be reached at approx 35°C in free burning position. T-5 lamp can be ignited from -15°C to + 50°C. Lamp should be fully recyclable and must comply to ROSH (Restriction of Hazardous substances) and shall be covered by WEEE. T-5 shall have 16 mm in diameter service life of TL-5 lamp should be 10% more than TL-D lamps. T-5 lamp shall have lumen efficacy of up to 104 Lumens / W and shall have excellent colour rendering to En 12464 (Ra 80 to 89).

2.3.6.2 Compact fluorescent lamp shall have same luminous flux and power consumption as fluorescent tubes but less than half the length and more compact than U-shaped and circulator lamps. CFL shall be suitable for use with conventional control gear & standers and for HF electronic control gear. CFL lamp shall be non integral type of OSRAM / GE / PHILIPS/ Havells Sylvania only.

2.3.7 High Frequency Electronic Ballast

High frequency electronic ballast shall be used with fluorescent / Compact Fluorescent Lamps wherever specified in the schedule of quantities. High frequency electronic ballast shall comply to the following:

- IEC 927, IEC 928 for $\leq 10\%$ total harmonic distortion.
- EMI / RFI – Confirming to FCC / VDE Class A/B.
- Line Transient as per IEEE C62.41.
- Ballast Crest Factor C1.7%.
- No Stroboscopic Effect
- Constant Wattage / Light output between 240 V \pm 10%.
- Circuit protection for surge current and inrush current.
- Short circuits, open lamp protection
- PF > 0.99 for fluorescent / T5 lamp and 0.95 for CFL.
- Deactivated lamp protection
- Suitable for use with single and twin lamps
- RFI < 30 MHz EN 55015
- Total Harmonic Distortion (THD) $\leq 10\%$
- Immunity to interference EN 61547
- Safety EN 60928 / IEC 928 / IS 13021 (Part I)
- Performance EN 60929 / IEC 929 / IS 13021 (Part II)
- Vibrations & Bump tests IEC 68-2-6 FC
IEC 9001
- Quality Standard ISO 9001
- Environmental Standard ISO 14001
- DC Operation EN 60924
- Emergency Lighting Operation VDE 0108

Total System consumption (lamps + ballast) for

- 1 x 36 W TLD, shall not exceed 36 W
- 1 x 28 W T-5, shall not exceed 28 W
- 1 x 35 W T-5, shall not exceed 35 W
- 1 x 14 W T-5, shall not exceed 14 W
- 1 x 18 W CFL, shall not exceed 18 W
- 1 x 36 W CFL, shall not exceed 36 W

2.4 Lighting Control Equipment

2.4.1 General

The lighting control system shall be based on a decentralized bus technology. There shall be an EEPROM storing the physical address, group addresses & other software parameters for every device, thus making it intelligent. No centralized processors or centralized memory storage devices shall be permitted.

2.4.2 Control System Bus Protocol

The system protocol shall utilize communication algorithms based on Synchronous Carrier Sense, Multiple Access with Collision Detection, implemented with Collision Avoidance (CSMA/CD-CA) standards (IEEE Standard 802).

The control system protocol shall implement the International Standards Organization (ISO) 'Open Systems Interconnection' seven-layer reference model for communication protocol.

There shall be no visible delay between command being issued and action executed. It shall typically be less than 2mS. The control system shall utilize a data transfer rate of at least 4,500 Baud.

The system protocol shall be available to third party companies to develop interfaces to the installed system.

The system shall be capable of 'high-level' integration to Building Management Systems and other proprietary control systems.

2.4.3 Addressing Capabilities

The entire system shall consist of bus lines each consisting of up to 64 devices, which can be extended up to 255 devices by using repeaters and shall have a topology supporting more than 57000 devices.

2.4.4 Interfacing to the Control System

The system shall allow multiple RS232 or USB access points to perform control, maintenance or reprogramming from multiple locations on the network, or from any single point on the network.

2.4.5 System Control Requirements

The system shall be able to perform control in all of the following ways.

- Centralized control from a PC enabling over-ride control of individual units, groups, zones, buildings, sites.
- Any input device shall be able to be programmed as a master control point. Master overrides shall be able to be positioned anywhere in the network, and control any other unit or units on any connected network.
- An unlimited number of master or override controls.
- The system shall allow unlimited switching configurations. Any number of switches shall be able to program for a common load or loads (i.e. multi-way switching) and all switches shall indicate the load status.
- The system shall have a multiple over-ride control hierarchy allowing zonal control, area master control, building master control and site master controls.

- Over-rides shall be able to be re-programmed at any time without any wiring changes.

2.4.6 Distributed Intelligence

The system shall operate without a computer connected, including the operation of all manual switches, detectors, photoelectric cells, etc. For the logical relationship between input devices and output loads to be fully reliant on a computer being connected shall not be acceptable.

All devices shall be able to communicate directly with each other without the need for a computer or a centrally based processor to receive and transmit signals.

2.4.7 Reconfiguration requirements

It shall be possible for additional system modules or control requirements to be added or changed without powering down the control bus or any other device.

No reconfiguration of existing units or network shall be required during any system reconfiguration. All existing units shall be left undisturbed.

No additional wiring or connections shall be required during reconfiguration.

2.4.8 Safety requirements

The bus shall be short circuit protected to ensure that accidental short circuit will not damage any system components.

The system shall have a fail-safe default mode.

The failure of a module on the system shall not affect any other module.

Modules shall be able to be programmed to re-start to 'on', 'off', or resume in previous state after a power failure.

2.4.9 Networking and Expansion Capabilities

The system shall have a software controlled network structure. Any input device shall be able to control any output device, or any group of devices. The devices shall be able to be located anywhere on the network without a direct connection. The relationship shall be able to be changed at any time without re-wiring.

There shall be no requirements for end-of-line bus terminations for impedance matching.

The System shall be able to be easily expanded. Additional units shall be able to be added at any time at any point without re-configuration of any other component or the control devices. An existing system shall not need to be powered down if expansion is being carried out in the future.

The total bus cable length per sub-Network shall be 1000 meters.

The entire system shall consist of bus lines each consisting of up to 64 devices, which can be extended up to 255 devices by using line repeaters.

The system shall be capable of operating on a bus voltage of 21-30V dc.

System modules (input and output devices) shall be able to be located up to 1000m apart on the bus cable. Only one control bus cable shall be required to link any number of rooms, buildings, projects or sites. Localized input devices (e.g., switches or PIR Sensors) shall be able to be added at any time, and shall be able to be programmed to perform any function.

Output relay units shall be able to be connected to different phases or voltage sources, yet be controlled from any location on the network.

The system shall have distributed intelligence to allow full control over any module even if on another electrical sub-system.

2.4.10 Input and output Configurations

It shall be possible to provide input control of the system via the following system devices.

- 0-1V, 0-5V, 0-10V and 4-20mA analogue
- Digital Contact Closures (programmable functions)
- Motion detectors
- Temperature sensors
- Electronic Delay Time switches (software imbedded)
- Light Level - analogue and digital

It shall be possible to provide output control of the system via the following system devices.

- 0-10V dc analogue outputs
- DSI outputs
- Relay switch digital outputs
- Phase control leading edge dimmed outputs (incandescent and 12V ELV lighting)
- Configuration and commissioning software

The commissioning tool software will be used to:

- Individually address all control units on an installed system.
- Set the required control relationships between input and output devices.
- Define the Functional Control
- Set dimmer unit fade rates.
- Set photocell unit control points.
- Set temperature sensor unit control points.
- Set Power-Up status of Loads

All the above parameters will be set from within a graphical user interface, with separate configuration templates being provided for each type of control unit.

The software shall have the ability to export and import complete databases from within the software interface.

There shall be the ability to automatically detect and resolve address conflicts between any control units in an installation.

The software shall allow project names, system topology, application names and address names to be setup.

The software shall have the ability to interrogate an attached installation, upload individual unit parameters from all attached equipment, change these parameters and download the new information to the units.

The software shall allow for multiple configurations of any installation to be maintained.

The software shall allow for offline design/modification/manipulation, and then download.

The software shall allow for live design/modification/manipulation.

The software shall allow for real-time interrogation of sensor readings from the network, for example light level readings (in lux).

2.5 Lighting Control Equipment Product Specifications (Option-1)

2.5.1 Key Input Units

Wall mount, programmable 'Key Input Units', designed to control lighting applications and other electrical services shall be available from the manufacturer of the overall control system. The units shall be able to control any system output device including relays, dimmers, and analogue output units to switch or dim loads.

The units shall be available with one, two or four tactile switches.

The unit functions shall be customizable at any time before or after installation. Each key shall be capable of being programmed to achieve various functions including, toggle switch, dimmer control, timer or pre-set. In the event of power failure, a non-volatile memory (NVM) shall retain all programmed information relating to each unit's current operating status.

Each key input shall have the capacity to be programmed with both 'short press' and 'long press' functions. For example, it shall be possible for a short-press to send a toggle command and a long-press to issue dim commands.

Each key input unit shall have an integral LED on each individual button. The LED's shall be programmable from the software to be permanently on or off, or indicate and change with load status.

Each Key Input Unit shall be capable of controlling a combination of loads associated with a system Group Address. Key Input Units shall be capable of providing multi-point switching, dimming and master on/off switching and dimming.

Key Input Units shall communicate with all other system units and obtain power via the UTP Communication Bus cable.

The Supply Voltage to each Key Input Switch shall be nominally 36VDC @ 18mA. No additional 240V supply to a Key Input Switch shall be required.

A Key Input Switch shall be suitable for more than 100,000 operations.

A Key Input Switch shall have an on-board Timer with a range between 1 second and 18 hours 12 minutes and 15 seconds. This range shall be selectable via the system PC programming software. The Timer resolution shall be 1 second.

A Key Input Switch shall be capable of dimmer control of 255 possible levels.

Key input units shall be available in a wide variety of colors and finishes, including multi-gang brass or stainless steel style flat plates. Stainless Steel utilized shall be 304 Grade, 1.6mm (16 Gauge) plate with "Number 2" Linish.

The unit shall be suitable for operating temperatures between 0-50 Degree C.

2.5.2 Multigang Key Input Units Panels

A Multigang Key Input Units Panel, as a standard item from the system manufacturer, shall consist of multiples of four positive feel tactile switches, starting at eight switches, mounted to either a stainless steel or polished and lacquered brass fascia. Each switch shall contain a red light emitting diode and shall be programmed to provide on/off, dimmer or timer functions. Custom variations of multi-gang panels shall be detailed in drawings with respect to layout and functionality.

Specifications for a Multigang Key Input Units Panel shall be as per a Four Key Input Module for each four switch multiple incorporated within the panel.

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

2.5.3 Four key and four channel infrared receiver

This unit shall consist of four positive feel tactile switches with a red light emitting diode recessed in each switch and an Infrared receiver is capable of mimicking the functions of each of the switches. Each switch can be programmed to provide on/off, dimmer or timer functions.

The Supply Voltage to each four-key/four-channel infrared receiver shall be 36VDC @ 18mA. No additional 240V supply shall be required.

A four-key/four-channel infrared receiver shall be suitable for more than 100,000 operations.

A four-key/four-channel infrared receiver shall be having a suitable Operating Temperature range of 0-50 Degree C.

A four-key/four-channel infrared receiver shall be capable of dimmer control of 255 possible levels.

The Ramp Rate shall be programmable from 0 to 1024 seconds. The Ramp Level shall be programmable from 0 to 100%.

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

2.5.4 Four Key Infrared Transmitter

The Four Key Infrared Transmitter shall consist of four push buttons, which are mapped to the four keys on the receiver. The Four Key Infrared Transmitter shall be able to control up to four group addresses from each remote control. The IR codes shall be able to be learnt by propriety Learning Remote Controls for integration into other systems.

The remote control shall be powered by 2, AAA, 1.5V batteries.

2.5.5 Seven Day Cycle Clock

The clock module shall consist of a basic 7-day real time controller with two channels of output for control of up to four group addresses. The 7-day timer shall be able to be programmed from the front of the clock (independent of the installation software) whilst the outputs are configured in software (as per other system components).

The unit shall be capable of issuing on, off, dimming and delay-off timer commands.

The clock shall sustain its settings for 24 hours in the event of loss of supply.

Daylight savings, Holiday and Random modes shall be incorporated on the front of the clock.

The Supply Voltage to each Seven-Day Cycle Clock shall be 36VDC @ 18mA. No additional 240V supply shall be required.

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

The Seven-Day Cycle Clock shall be having a suitable Operating Temperature range of 0-50 Degree C.

The Seven-Day Cycle Clock shall have an accuracy of 2.5 seconds/day @ 20 Degree C.

The Seven-Day Cycle Clock shall have 42 Memory Locations.

Version for horizontal or vertical mounting shall be available.

2.5.6 Touch Screen

The touch screen shall provide a touch sensitive LCD screen that displays pages of graphical items to perform a particular function when pressed.

The touch screen shall be programmed via a software based configuration tool. This Configuration Software shall be Microsoft Windows™ based and shall provide the ability to program the appearance and operation of the touch screen.

The touch screen hardware shall be as follows:

- The touch screen shall connect directly to the control system network and shall be powered from the network. No extra power pack or other power supply shall be required.
- The touch screen shall be capable of being programmed via a control system network connection or via an RS232 connection directly to the touch screen.
- The touch screen shall incorporate a touch sensitive ¼ VGA (240 x 320) monochrome LCD screen, 80 mm wide and 62 mm high.
- The touch screen shall incorporate a backlight.
- The touch screen shall be capable of generating a network system clock and applying a network burden.
- The network voltage shall be monitored.
- The ambient light level shall be monitored for automatic backlight control.
- The touch screen shall be able to receive and act on NEC IR commands.
- The touch screen shall have a buzzer to provide audible feedback.
- The touch screen shall incorporate a Real Time Clock, accurate to 60 seconds per month and shall maintain the correct time for a minimum of 12 hours in the event of a power failure.
- The touch screen shall include the facility to receive and act upon industry standard 'NEC' infrared commands.
- The touch screen shall be supplied complete with a hand held, credit card sized infrared control unit with a minimum of eight control buttons.

The touch screen Configuration Software shall be as follows:

- The software shall be developed for 32 bit Microsoft Windows™ operating systems and shall be compatible with Windows 95™, Windows 98™, Windows 2000™, Windows Me™, Windows NT™ and Windows XP™.

Details of the installation, installer and owner shall be recorded in the configuration project file.

- The software shall be capable of re-programming the touch screen firmware and setup data either via a serial link or via a control system network link.
- The software shall allow the configuration of each page to be set up, with components placed where required.

The following special purpose pages shall be included:

- A Diagnostics page including password protection, network traffic information, built-in Test and touch screen status information.
- Touch screen Calibration
- Backlight setup & control
- Time Setting
- Date Setting
- A Splash Screen, displaying hardware version, software version, part number and serial number.
- Contrast Setting

The touch screen shall have the ability for the following components to be placed on a touch screen page:

- Buttons (keys) with text and/or images
- Text
- Images
- Shapes (rectangles, triangles, ellipses)
- Sliders
- Clocks
- Percent Indicator
- Backlight control
- Contrast control

The following visible properties of a component shall be able to be setup:

- Position
- Size
- Font style
- Images
- Text and Image alignments
- Border width, color, line style, shape and status indication
- Background color, shading style and status indication

The touch screen shall have the ability to action a complete scene. Scenes shall be able to be setup as follows:

- Up to 100 system addresses controlled per scene
- Level and ramp rate shall be selectable
- Activated by a particular system Address/Level combination.

The touch screen shall have the ability to action Schedules. Schedule details shall be able to be setup as follows:

- Command (on / off / ramp & ramp rate, pulse or set scene)
- Time of event
- Repeat cycle of event (once / daily / weekly / week days / weekends / monthly and complex combinations)
- A list of scheduled events shall be displayed in the configuration software.

A component shall be able to have the following actions associated with it when pressed by the user:

- System Command (on/off/ramp, pulse)
- Scene activation
- Schedule enabling
- Audio output
- Link to another page, with optional password protection
- Activated by a particular system Address/Level combination.

The following special functions shall be included:

- Open Time Setting page
- Open Date Setting page
- Open touch screen Calibration page
- Open Diagnostics page
- Show Splash Screen
- Backlight light level threshold setting and on/off control
- Contrast adjustment (up & down)
- Go back one page

The configuration software shall support a "simulation mode" where clicking on components on the screen will execute the programmed actions.

The following time-out functions shall be supported:

- The time-out duration shall be selectable.
- A specific page shall be selectable after touch screen has not been touched for a time-out duration
- When dark, a different page shall be selectable to enable the user to have backlight control page shown at night.

Buttons on a hand infrared remote unit with support for NEC codes shall be able to be associated with on-screen keys.

A means of monitoring the amount of memory required by the touch screen configuration shall be incorporated to ensure that the configuration will fit in the memory available.

Page templates and an image library shall be provided with the touch screen.

2.5.7 PC Interface

The PC Interface shall provide the medium for an external PC to communicate with the control system network, including monitor and control functions. It shall also be used to program all other system units and generate the system clock for synchronized data communications.

It shall be possible to connect multiple PC Interfaces to the system at a time to allow programming and/or control from multiple PC's.

The clock waveform generated by the PC interface or Bridge unit shall consist of a bipolar 2.5V rectangular pulse of 296ms duration. Rise and fall times for the clock waveform, as well as for all the other communication on the system, shall be controlled to reduce the generation of unwanted electromagnetic interference.

The System Clock Pulse Repetition Rate shall be 2mS. The Communication Protocol for the PC Interface shall be RS232C with a Baud rate of 9600. The data format shall be 1 start bit, 8 data bits, no parity and 1 bit stop.

2.5.8 Power Supply

The Power Supply shall provide safe extra low voltage (36V dc) to the control system bus.

The Power Supply shall be capable of supporting at least 17 control system units (Key inputs, Relay Units, Dimmer Units etc.). Multiple Power Supplies shall be paralleled to support any system load.

The output current of the Power Supply shall be 320mA (nominal).

The Power Supplies shall be installed on dedicated 'control' Circuit Breakers, rather than general light and power circuits.

2.5.9 Four Channel Dimmer

The four channel dimmer unit shall be suitable for switching or dimming loads that are controlled by the system. The unit shall be capable of independent control of four dimmed active outputs. Electrical isolation between the Extra Low (Bus) Voltage and the Low (mains) voltage side of the unit shall be provided with the use of optical isolators.

As well as controlling 240V loads (e.g., incandescent lighting), the dimmer units shall be capable of controlling Extra Low Voltage (12V) lighting utilizing iron core transformers or electronic transformers implementing leading edge technology (e.g., The 'Osram Mouse' 12V electronic Transformer or equivalent).

The dimmer unit shall incorporate continuous triac drive circuitry. The dimmer unit shall be capable of retaining programmed information relating to operating status.

The dimmer shall have the facility to program (via the software) a minimum level setting.

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

The unit shall have a frequency range of 47-53Hz and 57-63Hz.

The load rating shall be 500VA per channel and 4000VA in total. Unless otherwise specified

Every dimmer should have individual MCB for over load protection as part of dimmer rack.

The unit shall provide an Electrical Isolation Rating of 3500VAC RMS, 1 minute.

The units' mains voltage terminals shall be suitable to accommodate 4 x 2.5mm square cable.

The unit shall have suitable operating temperatures between 0-50 Degree C.

2.5.10 Eight Channel Dimmer

The eight channel dimmer unit shall be suitable for switching or dimming loads that are controlled by the system. The unit shall be capable of independent control of four dimmed active outputs. Electrical isolation between the Extra Low (Bus) Voltage and the Low (mains) voltage side of the unit shall be provided with the use of optical isolators.

As well as controlling 240V loads (e.g., incandescent lighting), the dimmer units shall be capable of controlling Extra Low Voltage (12V) lighting utilizing iron core transformers or electronic transformers implementing leading edge technology (e.g., The 'Osram Mouse' 12V electronic Transformer or equivalent).

The dimmer unit shall incorporate continuous triac drive circuitry. The dimmer unit shall be capable of retaining programmed information relating to operating status.

The dimmer shall have the facility to program (via the software) a minimum level setting.

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

The unit shall have a frequency range of 47-53Hz and 57-63Hz.

The load rating shall be 250VA per channel and 4000VA in total. unless otherwise specified

Every dimmer should have individual MCB for over load protection as part of dimmer rack.

The unit shall provide an Electrical Isolation Rating of 3500VAC RMS, 1 minute.

The units' mains voltage terminals shall be suitable to accommodate 8 x 2.5mm square cable.

The unit shall have suitable operating temperatures between 0-50 Degree C.

2.5.11 Four Channel Relay with 10A Voltage Free Contacts

This unit shall allow control of four independent loads, with a total capacity of at least 40A, independent from supply. The individual channel load shall be rated at least 10A (inductive and resistive).

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

The Relay Unit shall have the facility to program (via the software) a minimum threshold setting.

The unit shall have an input voltage operating frequency range of 47-53Hz and 57-63Hz.

The unit shall provide an Electrical Isolation Rating of 3500VAC RMS, 1 minute.

The units' mains voltage terminals shall be suitable to accommodate 4 x 2.5mm square cable.

The unit shall have suitable operating temperatures between 0-50 Degree C.

The Four Channel Relay shall be EMC 'C-Tick' compliant and be labeled as such.

The Four Channel Volt Free Relay shall be as a Clipsal C-Bus 5504RVF

2.5.12 Twelve Channel Relay with 10A Voltage Free Contacts

This unit shall allow control of four independent loads, with a total capacity of at least 40A, independent from supply. The individual channel load shall be rated at least 10A (inductive and resistive).

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

The Relay Unit shall have the facility to program (via the software) a minimum threshold setting.

The unit shall have an input voltage operating frequency range of 47-53Hz and 57-63Hz.

The unit shall provide an Electrical Isolation Rating of 3500VAC RMS, 1 minute.

The units' mains voltage terminals shall be suitable to accommodate 12 x 2.5mm square cable.

The unit shall have suitable operating temperatures between 0-50 Degree C.

2.5.13 Scene Master Specification

A wall mounted Lighting Scene Controller shall be provided to allow the user of the lighting system to access the lighting in the area, switch the lighting on and off, ramp the lighting up and down and manually assign a number of preset lighting scenes as required.

Mechanical

The Scene Controller shall include facilities for attachment to an International Standard Electrical Wall Box.

The unit shall also allow for mounting the Controller directly to a flat wall surface. This shall be carried out with a supplied mounting bracket. It shall be possible to securing the bracket to the wall first, then the controller to the bracket.

The only cable termination requirements shall be a twisted pair Category 6 data cable. There shall be no additional requirements to terminate 240V or extra low voltage cabling at the Lighting Controller.

For ease of maintenance, the lighting outputs (dimmers, relays, etc) controlled by the unit shall be mounted remotely. Output devices mounted in the wall (either as an integral part of the Lighting Controller or as a separate unit) will not be accepted.

The Lighting Controller shall form an integral part of the lighting system and shall have the capabilities to communicate with other input and output devices attached directly to the systems communication bus, including (but not limited to) Relay Units, Dimmer Units, Wall mounted Switches, Light Level Sensors and Passive Infrared Movement Detectors.

Output Load Control

The controlled lighting loads shall be dependent on the output devices connected to the system, rather than being dependent on the load capacity of the Scene Controller itself. Thus, the scene controller should be able to control various load types including incandescent, Extra Low Voltage Tungsten Halogen Dichroic, Fluorescent (via High Frequency Electronic 0-10V or Digital Ballast's) on the same group address.

User Interface/Control

The wall-mounted controller shall include separate buttons to allow the user to individually dim up or dim down three separate groups of output loads. A series of LED's shall be associated with the group to indicate the current lighting ramp level for that group. The controlled output groups shall be programmable via a software assignable addressing system and shall not be limited to any hardwired groups of outputs.

Lighting Preset Scenes

The Lighting Controller shall incorporate a minimum of five programmable scene buttons and five associated LED's. The LED's shall indicate which lighting scene is active or inactive. The user shall be able to assign and recall a preset lighting scene directly from the unit. Whilst acceptable for testing and commissioning proposes, Controllers that require the user to attach a separate device (e.g. a PC) to program and re-program scenes on an ongoing basis will not be accepted.

The Lighting Controller shall have the facility to include as part of the 5 preset lighting scenes, six extra lighting output group addresses not directly accessible from the three dim up/down buttons. This shall be achieved by utilizing other input devices (e.g. wall switches) connected to the system control bus to set the required lighting levels and having the facility on the Lighting Controller to 'learn' these levels. Thus, a minimum of 9 addressable groups shall be assignable to each preset.

A maximum of three of these nine groups (the 'primary groups') shall be fixed across all five scenes. The other six groups (the 'secondary groups') shall be definable per scene. Thus the Lighting Controller shall have the facility to control a minimum of thirty-three programmable groups across the five presets, with these thirty-three groups able to be associated with multiple output loads.

It shall be possible to trigger the preset lighting scenes set in the Controller from an external input device which form part of the control system. These external devices capable of triggering scenes shall including additional Scene Controllers, as well as wall mounted input switches connected to the bus system.

Power-up

If power to the unit is lost, the lighting shall automatically return to a preset level. All scenes, fade rates, etc shall be stored in non-volatile memory.

Scene Fade Rate

When programming a Lighting Scene, the user shall also have a button available to manually select the fade (ramp) rate for that scene. As a minimum, the fade rate shall be selectable as 0 seconds, 4 seconds, 12 seconds, 60 seconds and 10 minutes. Other fade rates times between 0 and a minimum of 1020 seconds shall be assignable through the systems software. The fade rate button shall have an associated series of LED's to indicate the chosen fade rate.

A second press of each scene button (press on the scene button when that scene is already active) shall cause the pre-programmed fade-in rates to be overridden and the target levels are established 'instantly'.

Master OFF

A 'Master Off' button shall be available on the Lighting Controller. This Master Off button shall be programmable to allow the user to select controlled output groups. Pressing the Master Off button shall turn off all three of the primary groups.

Additionally, the Master Off button shall selectively turn off a variable number of the controlled secondary output groups. These groups should not necessarily need to be associated with the previously selected scene and can include any of the thirty secondary groups.

A special fade rate shall be associated with the Master off button. The Master Off fade rate shall be indicated following a press on the Master Off button and shall be adjusted in this condition using the Fade button. This master off fade rate indicator shall be automatically turned off 10 seconds after the Master Off command is executed or after the adjustment of the fade rate is completed. The indicator shall automatically turn on to show the current fade rate, if the fade or Master Off buttons are pressed again.

Night Light function

There shall be provision for a "night light" function on the Controller. This shall be programmable via the installation software to be enabled or disabled. When enabled, if no indicator other than the fade rate is active on the Lighting Controller (all primary groups are off), then all five scene indicators will be dimly lit.

Infra-red Interface

The hand held Remote control Scene buttons (1 to 5) shall function as the scene buttons on the Lighting Controller. The IR controller shall effectively mimic the press scene buttons on the unit.

The Remote control 'All Off' button shall function exactly the same as the master off button on the Lighting Controller.

The Master Up/Down buttons shall ramp the 3 primary groups simultaneously. The master up/down buttons on the IR controller shall mimic the functions of the individual up/down buttons on the Lighting Controller.

The level change performed by the Master Up/down buttons on the IR Remote shall only be temporary and should not affect the preset levels.

All the scene button indicators shall flash when the scene controller is receiving valid data from the remote control Lighting Controller.

Self-Testing

A self-test routine shall be also added to help in manual testing. Holding the first UP key during the power-up of the unit shall activate this routine. The self-test routine will help in checking the indicators and keys by activating all indicators and interactively reading all keys in sequence.

8 Channel DSI Gateways

The DSI Gateway is based on the 12 M wide DIN rail enclosures, and shall be available in 110/120Vac and 220/240Vac ratings, 50Hz operation.

The unit shall regulate the mains voltage to generate the DSI outputs, the C-Bus electronics shall be powered from the mains as well, but the unit shall not incorporate a C-Bus power supply, there is no need for the unit to source C-Bus current to the network.

The units developed shall incorporate Override switches as well as Load Status, C-Bus and Mains Power Status indicators.

The 8 Channel Modules shall be based on a DIN Rail enclosure and shall consist of 8 Channels of output, with each channel sourcing approximately 200mA.

Electrical Characteristics

- a. The DSI interface complies with the DSI standard, and only one channel at any time is sourcing current to the ballast.
- b. Nominal operating voltage ranges, 110/120Va.c. And 220/240Va.c.,
- c. Operating frequency ranges, 47 - 53Hz and 57 - 63Hz minimum.
- d. Each channel has a source rated output 200mA and a maximum output of 270mA. Each output is capable of driving Digital ballasts in DSI mode.
- e. A current limit for each channel applies between the ranges 270 – 330mA. If the unit goes into current limit mode, the outputs go into a high impedance state.
- f. Outputs are able to withstand continuous short circuit conditions, including short circuit from channel output to common and short circuit from one channel output to any other channel output. Output channels recover automatically following the removal of the short circuit condition.
- g. The unit is capable of being programmed without the needs for the mains connection. The unit draws no more than 18mA when the unit is being programmed and no mains connection is made.
- h. The unit features overheat protection, which trips if any channel is overloaded for more than 500uS, restores in less than 1 minute.
- i. Output voltage range 0.0 – 0.8V (low) to 11.0 – 13.0V (high)
- j. The output control range is controllable from 0% to 100%.
- k. The product shall incorporate an electronic circuit, which is used to regulate the mains voltage to provide its own power requirements on the low voltage sides (C-Bus and DSI). The non-P version is capable of sourcing 200mA to the C-Bus network.
- l. If mains power is lost to the unit all channels go to a high impedance state, the ballast behavior depends on ballast type DSI ballasts stay in their current state.
- m. The low voltage sides and mains input are electrically isolated.
- n. The equipment is designed to operate from a single-phase supply.
- o. A remote (panic) switch input, which allows control of the C-Bus dimmer outputs from the remote switch. The switch shall be used to turn all outputs to the ON or OFF states, irrespective of the current state of the C-Bus, including no C-Bus. Up to 100 P version units may be connected via this remote input on the same network, up to 10 non-P version units may be connected via this remote switch on the same network.

- p. The quiescent power of the device does not exceed 10 watts.
- q. The unit shall incorporate the following status indicators.
 - Network status
 - Mains power status
 - Load status indicators (8)
- r. The unit incorporates 8 momentary switches, which are used to locally control, the state of the outputs, with or without the presence of central unit. The status indicators report the actual state of the output, either OFF or ON.
- s. The lifetime of the momentary switches exceeds 100,000 operations.
- t. Up to 100 P version and 10 non-P version units are permitted on any one C-Bus network.
- u. The device incorporates the C-Bus clock signal.
- v. A network burden is incorporated on the electronic assembly.

Mechanical Characteristics

- a. The enclosure used shall be based on the DIN Rail Mount enclosure. The enclosure shall be suitably modified to accommodate the C-Bus products.
- b. The dimensions of the enclosure shall be 12M (1M = 17.5 +0.5 / -0.0 mm) wide.
- c. 2 x RJ45 sockets shall be incorporated to facilitate the C-Bus connection, a 0.3m patch lead shall be provided with each unit. The cable and plugs shall be suitably rated for its intended use. (The catalogue number of the patch lead, available as a spare shall be RJ5CB300PL)
- d. The output terminals shall accommodate 2 x 1.5mm² or 1 x 4.0mm² cable.
- e. Combination head screws shall be used on the output terminals and mains connections.

Environmental

Operating Temperature Range	0°C - 45°C
Operating Humidity Range	10 – 95% RH
Storage Temperature Range	0°C to 60°C

Transportation and Handling the equipment shall be designed to survive road transportation and warehouse storage.

The equipment packaging shall be developed to protect the equipment during normal factory, warehouse and field handling

EMC Compliance The equipment shall be designed to meet the requirements for marking with the CE and RCM marks.

Light Level Sensor

The Light Level Sensor shall be capable of measuring ambient light levels in the range of 20 to 3000 lux (40 lux to 1600 lux controllable).

The ambient light level shall be measured by the Light Level Sensor and output devices (such as Dimmer Units) shall be controlled to maintain constant luminance in a given area, under varying conditions.

The target luminance level as well as the Margin shall be set using the control system Installation Software.

The Margin shall represent the maximum allowed variation (dead band) of the luminance level value in respect to the preset Target value. If the luminance level stays within the Margin, no action shall be taken by the sensor. The light level sensor shall incorporate filtering and hysteresis functions to suppress noise and compensate for rapid light intensity fluctuations.

If the natural ambient luminance level is such that extra illumination is not necessary, an off command shall be transmitted by the Light Level Sensor to the designated Output devices.

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

The field of View of the light level sensor shall be 180 degrees.

The Supply Voltage to each light level sensor shall be 36VDC @ 18mA. No additional 240V supply shall be required.

The light level sensor shall have an operating temperature range of 0-50 Degree C.

Temperature Sensor

The Temperature Sensor shall be suitable for measuring ambient temperature and issuing on or off commands to one (1) group address for heating or cooling purposes. The unit shall measure in the range 0 - 50 degree C with selectable offset (dead-band) within the installation software

The Temperature Sensor shall have the ability to change its target temperature to a different point (and to reset the target) by receiving bus commands from another system devices.

The unit shall have an Economy mode, which when set active shifts the whole operating range up or down (up for Cooling or down for Heating).

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

The Supply Voltage to each Temperature Sensor shall be 36VDC @ 18mA. No additional 240V supply shall be required.

PIR Occupancy Sensor

The PIR Occupancy Sensor shall detect passive infrared energy for control of any number of independent electrical loads. The light level shall be adjustable from the front of the unit and shall be used to disable the Occupancy Sensor. Timer settings shall be adjustable from 1 second to 18 hours, in one-second increments. A weatherproof version shall be available for outdoor or industrial use.

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

The Supply Voltage to each PIR Sensor shall be 36VDC @ 18mA. No additional 240V supply shall be required for the unit to operate.

The unit shall have suitable operating temperatures between 0-50 Degree C.

The unit shall be suitable for wall or ceiling mounting, up to mounting heights of 2.4m.

The Indoor unit shall have a field of view of 90 degrees. The outdoor unit shall have a field of view of 110 degrees.

The Indoor unit shall have an effective detection area of 6m x 6m. The outdoor unit shall have an effective detection area of 18m radius x 110 degrees.

The Indoor unit shall have 12 overlapping detection zones. The outdoor unit shall have 18 long range, 16 intermediate range, 10 short range and 4 ultra short-range detection zones.

Ultrasonic Occupancy Sensor

The unit shall be an active device utilizing Doppler wave technology as its means of detection. The unit shall include two air transducers to provide volumetric occupancy detection.

The unit shall be suitable for occupancy detection of larger areas, typically 12m x 12m and 2.7m mounting height. The unit shall include its own independent 240V power supply and shall require a socket outlet adjacent to installation point (typically in the lighting wiring loom). To enable the unit to communicate with the control system network, an Auxiliary Switch Input Unit shall be utilized. Each auxiliary unit will allow control of up to four detectors.

The unit will have easily accessible sensitivity adjustment that can be used to accommodate various room sizes.

The unit will have an indicator LED for walk-testing the unit.

The unit shall be ceiling mounted and a 360-degree field of view.

The unit shall utilize an ultrasonic frequency of 32.7 kHz.

The unit shall have suitable operating temperatures between 0-50 Degree C.

Combined Technology Ultrasonic/PIR Occupancy Sensor

The unit shall consist of two air transducers and four PIR detectors with a special lens to provide both volumetric and line of sight detection.

The unit shall be suitable for occupancy detection of larger areas, typically 15m x 15m and 2.7m mounting height. The unit shall include its own independent 240V power supply and shall require a socket outlet adjacent to installation point (typically in the lighting wiring loom). To enable the unit to communicate with the control system network, an Auxiliary Switch Input Unit shall be utilized. Each auxiliary unit will allow control of up to four detectors.

The unit shall be ceiling mounted and a 360-degree field of view.

The unit will have easily accessible sensitivity adjustment that can be used to accommodate various room sizes.

The unit will employ programmable walk-testing LED indicators: Red LED for Passive Infrared and Green LED for Ultrasonic modes.

The unit shall utilize an ultrasonic frequency of 32.7 kHz.

The unit shall have suitable operating temperatures between 0-50 Degree C.

Ultrasonic Occupancy Sensor for Corridors and Hallways

The unit shall be suitable for occupancy detection of Corridors and Hallways, typically up to 4.6m x 30m and 2.7m mounting height. The unit shall include its own independent 240V power supply and shall require a socket outlet adjacent to installation point (typically in the lighting wiring loom). To enable the unit to communicate with the control system network, an Auxiliary Switch Input Unit shall be utilized. Each auxiliary unit will allow control of up to four detectors.

The unit shall be ceiling mounted and a 360 degree field of view.

The unit will have an indicator LED for walk-testing the unit.

The unit shall utilize an ultrasonic frequency of 32.7 kHz.

The unit shall have suitable operating temperatures between 0-50 Degree C.

2.6 Lighting Control Equipment Product Specifications (Option-II)

Lighting control modules for On/Off switching shall be:

DIN rail mounted consisting of two (2), four (4) or eight (8) or (12) individually programmable integral relays (contactors). The relay shall guarantee a life of >100000 switch operations as per IEC 60947. Relay modules requiring external 220V supply in addition to bus connection shall not be acceptable.

Each of these relays shall be rated 16AC3 suitable to switch Resistive, inductive and fluorescent loads together with an inrush current carrying capacity of 600 A suitable for switching loads with high switch-on peaks(e.g. fluorescent loads). The contactors should also have a capacitive load rating of at least 200 microfarads.

The output states of each of these relays shall be displayed on the front via true mechanical indication. LED status indicators shall not be acceptable. Each of these relays shall be latch-on type with manual operation (override) possible even without power to the system & without having to remove the cover of the control module.

In the event of power failure or bus wiring failure or control module failure, each of the relays shall attain a pre-programmed fail-safe position ('On', 'off' or 'as it is Last status') at the time of commissioning.

The actuators shall be with integrated current detection feature. This functionality shall allow for the monitoring of the load current, and operating hours for load management .It shall be possible to set threshold values of the current in order to detect any lamp failures for facilities management.

The control modules shall be capable of being programmed with different applications to suit site requirements for e.g. staircase lighting function that switches 'Off' the relays after a preprogrammed time from the time it has switched 'On'. The application for which a relay has been programmed shall apply irrespective of the signal from which it is controlled.

Each of the relays shall be capable of being programmed with its own 'On' and 'Off' delays that shall be applicable irrespective of the signal from which the relays are controlled.

The control modules shall receive its operating power supply from the same bus cable without any other power supply. It should not operate on any 220/240 V AC supply to avoid possible fire hazards. Relay modules with additional power supply to feed other devices in the network shall not be acceptable.

Each of the channels shall have 6 mm. sq. terminals with combi head screws for ease of termination with larger cross sections.

Scenes & Logical functions of Gates like AND, OR EXOR shall be integrated to the switch actuators.

Width: The Relay modules shall be compact in size 2-Channel (2MW); 4-Channel (4MW); 8-Channel (8MW); 12-Channel (12MW) suitable for installation on 35 mm mounting rail, EN 60 715

There shall be DIN rail mounted Dimmer modules to allow for dimming of the related lighting loads. The Dimmer modules shall be selected in accordance with the type of light fittings to allow dimming of all type of light

Wall mounted motion sensor:

The sensor shall be able to control up to 21 different EIB group addresses

Sensor angle – 180°, mounting height ~ 1.1 m.

Range: frontally up to 12 m, laterally up to 8 m (upon tangential approach).

Dusk sensor and over travel time adjustable via software and potentiometers on the device (5-1000 Lux/10 sec to 32 min). With manual operating facilities for ON/AUTOMATIC/OFF.

Mounting height :(1.1-2.5 m), providing a larger detection zone (max. 10 x 15 m).

Type of protection IP 20, EN 60 529

Ceiling mounted Presence detector:

The sensor shall be able to control up to 29 different EIB group addresses

Sensor angle 360°.

Detection range at 2.50 m mounting height:
6 m in dia. at a height of 1 m

Adjustable brightness 5 to 1000 Lx

Product standard EN 60669-2-1

Type of protection IP 20, EN 60 529

Wall/Ceiling mounted motion sensor:

The sensor shall be able to control up to 30 different EIB group addresses

Surveillance zone:	220° horizontal
Maximum range:	approximately 16 m (at installation height of 2.5 m and horizontal alignment)
Surveillance density:	92 sectors / 368 switching segments n
Dusk brightness sensor:	0.5 – 1000 lux
Delay time:	10 sec – 32 min
Slewing range	
- horizontal:	+ - 30°
- vertical:	90° upward; 40° downward
Protection class:	IP 55 per DIN 40 050 post installation
Operating temperature range	-25 °C to 55 °C

Brightness Sensor, 3-channel, MDRC

The sensor shall be able to control upto 5 different EIB group addresses

Setting range	1...20,000 lx
Inputs	1, for light sensor
Connection	Screw terminals
Bus connection	Bus connection terminal
Type of protection	
Control device	IP 20, EN 60 529
Light sensor	IP 54, EN 60 529

Smart switches with integrated Room Thermostat

The Smart switches shall be 3gang and 5gang and programmed to send switching, dimming or curtain, FCU control telegrams to EIB actuators. The smart switch interface shall have the following

- Status LEDs under the operating element (red and green for the current status and configurable for display as per requirement).
- Operating element with backlit LED for labeling field.
- Integrated Room Thermostat.
- Scene recalling.
- With inbuilt IR Receiver.

One such smart switch shall be located in each of the Rooms.

IR Handheld transmitter

In addition to using the rockers on the Smart switch described above , the switch sensor can also be controlled remotely via the infrared handheld transmitter to achieve all the functionality available with the switch interface directly. Optionally with the same remote it would be also possible to control other third party AV systems.

Wall Mounted Smart Touch Color panel

The SMART touch color panel shall be a flush mounted 6 inch display to be used for centralized control to offer a number of functionality like switching, dimming, curtain control, switch time control, light scene control etc. Operation of the touch panel shall be simple and intuitive by means of a PDA pen, the functions shall be carried out by means of the touch screen buttons labeled in clear text. Control of the functions shall be facilitated by a clear menu structure. The touch panel shall be extra silent (without any fan), user friendly and with direct connection to the i-bus® EIB. Panel PCs with Windows based operating system shall not be acceptable. The touch panel shall have the following functionality:

- ❖ Switching: The individual and flexible configuration of the touch buttons shall allow switching all electrical units which are integrated into the EIB system, especially lamps. The respective switching statuses shall be available in the display either as plain text or as symbols.
- ❖ Scenes : Individual light atmospheres can be called up using e.g. light scenes, i.e. different lights shall be automatically set to different brightness values in a given room. At the same time, e.g. the blind or linen is rolled down or temperature shall go to standby. In this way, individual lighting scenes for the most varied situations, e.g. reading, watching TV or for presentations and demonstrations shall be realized.
- ❖ Authorization: Access to the time programs shall be completely blocked or safeguarded by a PIN code.
- ❖ Schedules: All switching functions for lighting, blinds or the cooling system shall also be controlled automatically using time programmes. A consumer, e.g. a lamp shall be switched ON or OFF on certain days, every day or during the weekend only if desired.
- ❖ Astro function: The astro function shall automatically adapts the switching times to the course of the year (e.g. the blinds open earlier during summer than during winter).
- ❖ Holiday schedules : If certain time programmes are to be carried out only during your holidays (e.g.temperature reduction) or not during your holidays (e.g. automatic outdoor lights), the holiday function shall allow setting this in the time programmes.

- ❖ Presence simulation : To make your house appear as if there are people living in it although when it is vacant, the integrated presence simulation function shall be enabled. This function shall allow switching up to 10 units on and off during the day or opening and closing the blinds.
- ❖ Alarms : The user shall be notified by faults in the EIB system or triggered alerts, the room/control panel shall generate and manage messages and show them on the display.
 - The following status shall be provided on the touch screen for each FCU for monitoring purpose
 - Drip tray monitoring status
 - Filter dirty monitoring status(2 byte value)
- ❖ Messages: It shall be possible to leave a text message for someone by using the info function.

The touch panel shall be located centrally (e.g. entrance lobby) for centralized operation of the controls in the apartment.

Wireless Touch Screen

Above controls shall be possible to be implemented from a Wireless Touch screen over Wireless LAN.

Remote Access via Internet Gateway

The Internet Gateway shall enable access to the electrical installation from any Internet access point. The installation shall be conveniently operated and monitored remotely. Optionally it shall be possible to transmit Live images with an additional module and a video camera.

The Internet Gateway shall also alert automatically via e-mail. These e-mail messages shall be sent to suitable mobile devices, e.g., mobile phones.

The gateway shall be easily configurable with a web browser (MS Internet Explorer® or Netscape Communicator).

The analog/digital inputs(if provided in the system) can be recorded and measured values can be displayed. The historical data memory for binary inputs and analog values enables the representation of waveforms.

Room Temperature controls of FCU

There shall be a 3-speed fan coil controller which shall regulate the Fan Coil Unit fan speed as required to maintain the guest room temperature at the desired value. The FCU Controller shall be DIN rail mounted device and to be located in the false ceiling. The 3-level fan speed control is operated via a change-over switch. The fan ventilator levels shall be switched depending on the cooling demand. It shall be possible to define the threshold values in the parameters settings (between, 0-100%) for the 3 levels fan speed change-over as per the client's requirements.

The Fan Coil Controller shall be capable of controlling thermal On/Off cooling valves.

Blinds/Shutter/Curtain controls

The Shutter Actuators shall be capable of controlling either 240V AC or drives for positioning shutters, blinds, awnings and other hangings as well as for controlling doors, windows and ventilation flaps. The Shutter Actuator shall be DIN rail mounted device for insertion in the HACP. The connection to i-bus® EIB shall be established via a bus connecting terminal.

The output contacts for the directions UP and DOWN shall be mechanically interlocked for all the Shutter Actuators so that voltage cannot be applied at both contacts at the same time.

The actuators shall have the features for selecting the bus voltage failure/recovery as well as after programming status in the parameters settings. In addition there shall be following functions features in the shutter actuators:

– Movement UP/DOWN

- Stop/louver adjustment
- Move into position (up to 4 preset positions)
- Set position (modification of the preset position during operation)
- Move to position 0...255

3. MEDIUM VOLTAGE 1.1 KV GRADE XLPE / PVC CABLES

3.1 General

The MV cables shall be supplied, inspected, laid, tested and commissioned in accordance with drawings, Specifications, relevant Standard Specifications and cable manufacturer's instruction.

3.2 Material

The MV cables shall be cross linked polyethylene (XLPE) insulated PVC sheathed of 1100 volts grade as asked for in the schedule of quantities. Cables upto 16 sq.mm shall be with copper conductor and 25 sq.mm and above shall be with aluminium conductor.

3.3 Technical Requirements:

- 3.3.1 All XLPE Aluminium/Copper Power cables shall be 1100 Volts grade, multi core constructed as per IS : 7098 Part-I of 1988 as follows :
- a) Stranded Aluminium /Copper conductor in case of 10 sq.mm. and above whereas solid conductor in case of 10 sq.mm. and below.
 - b) Cores laid up
 - c) The inner sheath should be bonded over with thermo-plastic material for protection against mechanical and electrical damage.
 - d) Armoring should be provided over the inner sheath to guard against mechanical damage. Armoring should be Galvanised steel wires or galvanised steel strips. (In single core cables used in A.C. system armoring should be non-magnetic hard aluminium Wires/Strips. Round steel wires should be used where diameter over the inner sheath does not exceed 13 mm; above 13 mm flat steel armour should be used. Round wire of different sizes should be provided against specific request.)
 - e) The outer sheath should be specially formulated heat resistant black PVC compound conforming to the requirement of type ST2 of IS : 5831-1984 extruded to form the outer sheath.
- 3.3.2 Conductor shall be of electrolytic Aluminium/Copper conforming to IS : 8130 and are compact circular or compact shaped.
- 3.3.3 Insulation shall be of XLPE type as per latest IS general purpose insulation for maximum rated conductor temperature 70 degree centigrade.
- 3.3.4 In Inner sheath laid up cores shall be bonded over with thermoplastic material for protection against mechanical and electrical damage.
- 3.3.5 Insulation, inner sheath and outer sheath shall be applied by extrusion and lapping up process only.
- 3.3.6 Armoring shall be of galvanised steel wire/flat.
- 3.3.7 Repaired cables shall not be used.
- 3.3.8 Current ratings of the cables shall be as per IS : 3961.

- 3.3.9. The XLPE insulated cables shall conform to latest revision of IS and shall be read along with this specifications. The Conductor shall be stranded Aluminium/Copper circular/ sector shaped and compacted. In multi core cables the core shall be identified by red, yellow, blue and black coloring of insulation.
- 3.3.10 The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.
- 3.3.11 Progressive automatic in line sequential marking of the length of cables in meters at every one meter shall be provided on the outer sheath of all cables.
- 3.3.12 Cables shall be supplied in non returnable wooden drums as per IS : 10418.

Both ends of the cables shall be properly sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation, storage and erection.

- 3.3.13 The product should be coded as per IS :- 7098 Part-I as follows :-

Aluminium Conductor	A
XLPE Insulation	2X
Steel round wire armour	W
Steel strip armour	F
Steel Double round wire armour	WW
Steel Double strip armour	FF
Non-magnetic (Al.) round wire armour	Wa
Non-magnetic (Al.) strip armour	Fa
PVC outer sheath	Y

3.4 Inspection

All cables shall be inspected by the contractor upon receipt at site and checked for any damage during transit.

3.5 Joints in Cables

The Contractor shall take care to see that all the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilization and avoid cable jointing. This apportioning shall be got approved by the Owner's site representative before the cables are cut to lengths. Where joints are unavoidable heat shrinkable type joints shall be made. The location of such joints shall be got approved from the Owner's site representative and shall be identified through a marker.

3.6 Jointing Boxes for Cables

Cable joint boxes shall be installed with heat shrinkable sleeve and of appropriate size, suitable for XLPE armoured cables of particular voltage rating.

3.7 Jointing of Cables

All cable joints shall be made in suitable, approved cable joint boxes and the filling in of compound shall be done in accordance with manufactures' instructions and in an approved manner. All straight through joints shall be done in epoxy mould boxes with epoxy resin.

All cables shall be joined colour to colour and tested for continuity and insulation resistance before jointing commence. The seals of cables must not be removed until preparations for jointing are completed. Joints shall be finished on the same day as commenced and sufficient protection from the weather shall be arranged. The conductors shall be efficiently insulated with high voltage insulating tape and by using of spreaders of approved size and

pattern. The joints shall be completely topped up with epoxy compound so as to ensure that the box is properly filled.

3.8 Cable End Terminations

Cable end termination shall be done in cable terminal box using crimping sockets and proper size of glands of double compression type

3.9 Bonding of Cables

Where a cable enters any piece of apparatus, it shall be connected to the casing by means of an approved type of armour clamp and gland. The clamps must grip the armouring firmly to the gland or casing, so that no undue stress is passed on to the cable conductors.

3.10 Cable Installation

Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable. The cable drums shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming kinks.

3.10.1 Laying of Cables on Cable Trays

The relative position of the cables, laid on the cable tray shall be preserved and the cables shall not cross each other. At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius as recommended by the manufacturer's. All cables shall be laid with minimum one diameter gap and shall be clamped at every metre to the cable tray. Cables shall be tagged for identification with aluminum tag and clamped properly at every 20M. Tags shall be provided at both ends and all changes in directions both sides of wall and floor crossings. All cable shall be identified by embossing on the tag the size of the cable, place of origin and termination.

All cables passing through holes in floor or walls shall be sealed with fire retardant Sealant and shall be painted with fire retardant paint upto one meter on all joints, terminations and both sides of the wall crossings by "VIPER CABLE RETARD".

3.10.2 Laying of Cables in Ground

The width of trench for laying single cable shall be minimum 350 mm. Where more than one cable is to be laid in horizontal formation, the width of the trench shall be worked out by providing 200 mm gap between the cables, except where otherwise specified. There shall be clearance of 150 mm between the end cable and the side wall of the trench. The minimum depth of the cable trench shall not be less than 750 mm for single layer of cables. When the cables are laid in more than one tier the depth of the trench shall be increased by 300 mm for each additional tier.

Excavation of trenches : The trenches shall be excavated in reasonably straight lines. Wherever there is a change in direction, suitable curvature shall be provided. Where gradients and changes in depth are unavoidable, these shall be gradual. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench. The bottom of the trench shall be levelled and shall be made free from stone, brick bats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 100 mm in depth. Prior to laying of cables, the cores shall be tested for continuity and insulation resistance. The cable drum shall be properly mounted on jacks, at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum and the spindle is horizontal. Cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire drum length shall be laid in one stretch. However, where this is not possible the remainder of the cable shall be

removed by 'Flaking' i.e. by making one long loop in the reverse direction. After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted off the rollers beginning from one end by helpers standing about 10 meters apart and laid in a reasonably straight line. Cable laid in trenches in a single tier formation shall have a cover of clean, dry sand of not less than 150 mm. above the base cushion of sand before the protective cover is laid. In the case of vertical multi-tier formation after the first cable has been laid, a sand cushion of 300 mm shall be provided over the initial bed before the second tier is laid. Finally the cables shall be protected by second class bricks before back filling the trench. The buried depth of uppermost layer of cable shall not be less than 750mm.

Back Filling : The trenches shall be back filled with excavated earth free from stones or other sharp edged debris and shall be rammed and watered, if necessary, in successive layers not exceeding 300 mm. Unless otherwise specified, a crown of earth not less than 50 mm in the centre and tapering towards the sides of the trench shall be left to allow for subsidence.

3.11 Cables inside Building

Cables inside buildings shall be laid on the cable trays. All cables passing through walls shall run through GI Pipes sleeves of adequate diameter 50 mm apart maintaining the relative position over the entire length.

3.12 Route Marker

Route marker shall be provided along straight runs of the cables not exceeding 30 meters also for change in the direction of the cable route and underground joints.

Route marker shall be of cast iron painted with aluminum paint. The size of marker shall be 100 mm dia with "Cable" and voltage grade inscribed on it.

3.13 Cable Trays

Cable Trays shall be Galvanized and factory fabricated out of MS channels, angle iron, tee, bends, sections, flats and perforated sheet for different loads and number and size of cables as given below :

Cable trays shall be galvanized as per Specification given elsewhere.

- a. 1500 mm wide
Runners 25 x 100 x 25 x 3 mm
Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C
Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.
- b. 1200 mm wide
Runners 25 x 100 x 25 x 3 mm
Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C
Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.
- c. 1000 mm wide
Runners 25 x 100 x 25 x 3 mm
Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C
Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.
- d. 750 mm wide
Runners 20 x 75 x 20 x 2.5 mm

Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
Suspenders 2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base support of 40x
40 x 5mm GI angle.

- e. 600 mm wide
Runners 20 x 75 x 20 x 2.5 mm
Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
Suspenders 2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.
- f. 450 mm wide
Runners 20 x 75 x 20 x 2.5 mm
Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
Suspenders 2 Nos. 25 x 25 x 4 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.
- g. Supply and fixing of perforated type cable trays of the following sizes of pre-galvanized iron.
 - i. 600 x 40 x 40 x 2 mm thick
 - i. 450 x 40 x 40 x 2 mm thick
 - i. 300 x 40 x 40 x 2 mm thick
 - ii. 150 x 40 x 40 x 2 mm thick

Note : Suitable length of 10 mm dia GI rod suspenders at 1800 mm interval shall be included in the item for perforated type cable tray.

3.14 Specification for Hot Dip Galvanizing Process for Mild Steel Used For Earthing, Cable Trays Or Junction Boxes For Electrical Installation.

General Requirements

I. Quality of Zinc

Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS:209-1992.

II. Coating Requirement

Minimum weight of zinc coating for mild steel flats with thickness upto 6 mm in accordance with IS:6745-1972 shall be 400 g/sqm.

The weight of coating expressed in grams per square metre shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs, rust stains bulky white deposits, blisters.

Mild steel flats / wires shall undergo a process of degreasing pickling in acid, cold rinsing and then galvanizing.

3.15 Testing of Cables

Cables shall be tested at works for all routine tests as per IS including the following tests before being dispatched to site by the project team.

- a) Insulation Resistance Test.
- b) Continuity resistance test.
- c) Sheathing continuity test.
- d) Earth test.(in armoured cables)
- e) Hi Pot Test.

Test shall also be conducted at site for insulation between phases and between phase and earth for each length of cable, before and after jointing. On completion of cable laying work, the following tests shall be conducted in the presence of the Owner's site representative.

- a) Insulation Resistance Test(Sectional and overall)
- b) Continuity resistance test.
- c) Sheathing continuity test.
- d) Earth test.

All tests shall be carried out in accordance with relevant Standard Code of Practice and Electricity Rules. The Contractor shall provide necessary instruments, equipment and labour for conducting the above tests and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the Owner's site representative, results will be noted and signed by all present and record be maintained.

4(A) DISTRIBUTION PANELS/BOARDS

Main Distribution Panels, Sub-Distribution Panels and Final Distribution shall be covered under this section. Panels/Boards shall be suitable for operation on 3 Phase/single phase, 415/240 volts, 50 cycles, 4 wire system with neutral grounded at transformer. All Distribution panels shall be CPRI tested design and manufactured by a approved manufacturer. **CPRI certificate shall be made available.**

Distribution panels shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1993.

4.1 Construction Features

Distribution panels shall be 2 mm thick sheet steel cabinet for indoor installation, dead front, floor mounting/wall mounting type and shall be form 3b construction. The Distribution panels shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors and folded covers, Neoprene gasket, padlocking arrangement and bolted back. All removable/ hinged doors and covers shall be grounded by flexible standard connectors. Distribution panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of Distribution panels shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of Distribution panels. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. Minimum **operating** clearance of 275 mm shall be provided between the floor of Distribution panels and the lowest feeder compartment.

Distribution panels shall be of adequate size with a provision of spare switchgear as indicated on the Single Line Diagram. Feeders shall be arranged in multi-tier. Knockout holes of appropriate size and number shall be provided in the Distribution panels in conformity with the location of cable/conduit connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required.

Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram engraved on PVC sheet. All live accessible connections shall be shrouded and shall be finger touch proof and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.

4.2 Bus Bar Connections

Bus bar and interconnections shall be of high conductivity electrolytic grade aluminium / copper as indicated in the bill of quantities complying with requirement of IS : 5082 – 1981 and of rectangular cross section suitable for carrying the rated full load current and short circuit current and shall be extendable on either side. Bus bars and interconnections shall be insulated with heat shrinkable sleeve of 1.1 KV grade and shall be colour coded. Bus bars shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system. All bus bars shall be provided in a separate chamber and all connections shall be done by bolting. Additional cross sectional area to be added to the bus bar to compensate for the holes. All connections between bus bars and breakers shall be through solid copper / aluminium strips of proper size to carry full rated current and insulated with insulating sleeves. Maximum current density for the busbars shall be 1A/sq.mm for aluminium and 1.4 A/sq.mm for copper busbars.

Maximum allowable temperature for the Bus bar to be restricted to 85 deg C

4.2.1 Temperature - Rise Limit

Unless otherwise specified, in the case of external surface of enclosures of bus bar compartment which shall be accessible but do not need to be touched during normal operation, an increase in the temperature rise limits of 25° C above ambient temperature shall be permissible for metal surface and of 15° C above ambient temperature for insulating surfaces as per IS 8623(Part-2) 1993.

All main distribution panels and sub distribution panels shall be provided with MCCB of appropriate capacity as per Single Line Diagram. All final Distribution boards shall be provided with Miniature Circuit Breakers. Final Single Phase Distribution boards shall be connected to the incoming supply through double pole MCB units & earth leakage circuit breakers. All wiring for final distribution boards shall be concealed behind 5 mm thick bakelite sheet or M S sheet cover. All Distribution boards shall be completely factory wired, ready for connection. All the terminals shall be of proper current rating and sized to suit individual feeder requirements. Each circuit shall be clearly numbered from left to right to correspond with wiring diagram. All the switches and circuits shall be distinctly marked with a small description of the service installed.

Continuous earth bus sized for prospective fault current shall be provided with arrangement for connecting to station earth at two points. Hinged doors/ frames shall be connected to earth through adequately sized flexible braids.

4.3 Cable Compartments

Cable compartment of adequate size shall be provided in the Distribution panels for easy clamping of all incoming and outgoing cables entering from the top/bottom. Adequate supports shall be provided in cable compartment to support cables.

4.4 Air Circuit Breakers (ACB)

- 4.4.1 The ACB shall conform to the requirements of IEC 60947-2 / IS 13947-2 and shall be type tested & certified for compliance to standards from CPRI, ERDA/ any accredited international lab. The circuit breaker shall be suitable for 415 V \pm 10%, 50 Hz supply system. Air Circuit Breakers shall be with moulded housing flush front, draw out type and shall be provided with a trip free manual operating mechanism or as indicated in drawings and bill of quantities with mechanical "ON" "OFF" "TRIP" indications.

The ACB shall be 3/ 4 pole with modular construction, draw out, manually or electrically operated version as specified. The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity (Ics) shall be as specified on the single line diagram and should be equal to the Ultimate breaking capacity(Icu) and short circuit withstand values(Icw) for 1 sec.

Circuit breakers shall be designed to 'close' and 'trip' without opening the circuit breaker compartment door. The operating handle and the mechanical trip push button shall be at the front of the breakers panel. Inspection of main contacts should be possible without using any tools. The ACB shall be provided with a door interlock. i.e. door should not be open when circuit breaker is closed and breaker should not be closed when door is open.

All current carrying parts shall be silver plated and suitable arcing contacts with proper arc chutes shall be provided to protect the main contacts. The ACB shall have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhanced safety and in accessibility to live parts. All electrical closing breaker shall be with electrical motor wound stored energy spring closing mechanism with mechanical indicator to provide ON/OFF status of the ACB.

The auxiliary contacts blocks shall be so located as to be accessible from the front. The auxiliary contacts in the trip circuits shall close before the main contacts have closed. All other contacts shall close simultaneously with the main contacts. The auxiliary contacts in the trip circuits shall open after the main contacts open. Minimum 4 NO and 4 NC auxiliary contacts shall be provided on each breaker.

Rated insulation voltage shall be 1000 volts AC.

4.4.2 Cradle

The cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. The movements shall be free from jerks, easy to operate and shall be on steel balls/rollers and not on flat surfaces.

There shall be 4 distinct and separate position of the circuit breaker on the cradle.
Racking Interlock in Connected/Test/Disconnected Position.

Service Position : Main Isolating contacts and control contacts of the breaker are engaged.

Test Position : Main Isolating contacts are isolated but control contacts are still engaged.

Isolated Position : Both main isolating and control contacts are isolated.

There shall be provision for locking the breaker in any or all of the first three positions.

The following safety features shall be incorporated :

- a. Withdrawal or engagement of Circuit breaker shall not be possible unless it is in open condition.
- b. Operation of Circuit breaker shall not be possible unless it is fully in service, test or drawn out position.
- c. All modules shall be provided with safety shutters operated automatically by movement of the carriage to cover exposed live parts when the module is withdrawn.
- d. All Switchgear module front covers shall have provision for locking.
- e. Switchgear operating handles shall be provided with arrangement for locking in 'OFF' position.

4.4.3 Protections

The breaker should be equipped with micro-controller based , communicable type release with RS 485 port for communication to offer accurate and versatile protection with complete flexibility and shall offer complete over current protection to the electrical system in the following four zones :

- Long time protection.
- Short time protection with intentional delay.
- Instantaneous protection.
- Ground fault protection.

The protection release shall have following features and settings:

a. True RMS Sensing

The release shall sample the current at the rate of 16 times per cycle to monitor the actual load current waveform flowing in the system and shall monitor the true RMS value of the load current. It shall take into account the effect of harmonics also.

b. Thermal Memory

When the breaker shall reclose after tripping on overload, then the thermal stresses caused by the overload if not dissipated completely, shall get stored in the memory of the release and this thermal memory shall ensure reduced tripping time in case of subsequent overloads. Realistic Hot/Cold curves shall take into account the integrated heating effects to offer closer protection to the system.

c. Defined time-current characteristics :

A variety of pick-up and time delay settings shall be available to define the current thresholds and the delays to be set independently for different protection zones thereby achieving a close-to-ideal protection curve.

d. Trip Indication

Individual fault indication for each type of fault should be provided by LEDs for faster fault diagnosis.

e. Self powered

The release shall draw its power from the main breaker CTs and shall require no external power supply for its operation.

f. Zone Selective Interlocking

The release shall be suitable for communication between breakers to enable zone selective interlocking. This feature shall be provided for both short circuit and ground fault protection zones to offer intelligent discrimination between breakers. This feature enables faster clearance of fault conditions, thereby reducing the thermal and dynamic stresses produced during fault conditions and thus minimises the damage to the system. To implement ZSI manufacturer should supply all related equipment like power supply, wiring etc.

On-Line change of settings should be possible. It should be possible to carry out testing of release without tripping the breaker.

g. The release shall meet the EMI / EMC requirements.

h. The setting range of release shall be generally as follows :

Type of Protection	SETTING RANGE OF RELEASE	
	PICK-UP CURRENT	TIME DELAY
Long Time	0.4 to 1.0 times I_n (I_r) Steps : 0.4, 0.5, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.00. Operating Limit : 1.05 to 1.2 times I_r	0.5 to 30 sec at $6 I_r$ Steps 0.5,1, 2,4, 6, 8,12,18,24 and 30 secs Tolerance : Corresponding to $\pm 10\%$ of current.
Short Time	2 to 10 times I_r Steps : 2,3,4,5,6,7,8,9 & 10 Tolerance : $\pm 10\%$	20 ms to 600 ms Steps 20,60,100,160,200,260,300 400,500 and 600 ms Tolerance : $\pm 10\%$ or 20ms whichever is higher
Instantaneous	2 to 12 times I_n Steps : 2,3,4,6,8,10,12 Tolerance : $\pm 10\%$	
Ground Fault	0.2 to 0.6 time I_n Steps : 0.2,0.3,0.4,0.5,0.6 Tolerance : $\pm 10\%$	100 ms to 400 ms Steps : 100,200,300,400ms Tolerance : $\pm 10\%$ or 20 ms whichever is higher.

All **incomer** ACBs shall have following additional protections other than mentioned above.

- Under and over voltage
- Under and over frequency
- Restricted Earth Fault protection
- Trip Circuit supervision with PS class CT's.
- Undercurrent, (for DG set only)
- Reverse power (for DG set only)
- Phase sequence reversal (for DG set only)
- Load shedding and reconnection thru programmable contacts.
- Release should display the Contact wear indication.

The release should provide local indication of actual %age loading at any instant. The release should be able to communicate on MODBUS RTU protocol using inbuilt RS485 port and shall be integral part of supply with trip unit. Parameters of the Protection Release should be changeable from Release as well as thru communication network. Release should have graphical LCD for display of power parameters. The release of incoming breakers should provide comprehensive metering with the following parameters

- Phase currents (running, avg & max) – All parameters in single window.
- Release should be able to capture short circuit current on which ACB has tripped. The last ten trips and alarms shall be stored in memory with the date & time stamping along with type of fault and alarm. The sensing CT Should be Rogowsky type with measurement precision of 1%.
- Release should be self powered .
- Release should have facility to select different type of IDMTL protection(DT,SIT,VIT,EIT,HVF) for better co-ordination with HT Breaker/Fuse.
- Phase voltages (running, avg & max)
- Energy & power parameters (active, reactive and apparent)
- PF
- Frequency
- Maximum Demand (KVA & KW)
- Total Harmonics distortion

All O/G ACBs shall have following functions.

Protection

- The ACB control unit shall offer the following protection functions as standard:
 - Long-time (LT) protection with an adjustable current setting and time delay;
 - Short-time (ST) protection with an adjustable pick-up and time delay;
 - instantaneous (INST) protection with an adjustable pick-up and an OFF Position.
- Current and time delay setting shall be indicated in amperes and seconds respectively On a digital display.
- Earth-fault protection with an adjustable pick-up and time delay shall be provided if indicated on the appended single-line diagram.

Measurements

- An ammeter with a digital display shall indicate the true rms values of the currents for each phase. Release shall acknowledge the current & time delay settings done by user on the LCD display.
- A LED bargraph shall simultaneously display the load level on the three phases.
- A maximeter shall store in memory and display the maximum current value observed since the last reset. The data shall continue to be stored and displayed even after opening of the circuit breaker.

4.4.4 Safety Features

- I. The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.
- II. It shall not be possible to interchange two circuit breakers of two different thermal ratings. For Draw-out breakers, an arrangement shall be provided to prevent rating mismatch between breaker and cradle.
- III. There shall be provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism. Earthing bolts shall be provided on the cradle or body of fixed ACB.

- IV. The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, digital voltmeter and ammeter of size not less than 96 mm x 96 mm, selector switches, MCB for protection circuit and measuring instrument circuits.
- V. It shall be possible to bolt the draw out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.
- VI. Draw out breakers should not close unless in distinct Service/Test/Isolated positions.
- VII. The insulation material used shall conform to Glow wire test as per IEC60695.
- VIII. The ACB shall provide in built electrical and mechanical anti-pumping.
- IX. All EDO ACB's Shall have Ready to Close Contact to ensure that the ACB gets a command only when it is ready to close for applications of Remote Control, AMF, Synchronization and Auto Source Change Over Systems.

4.5 Moulded Case Circuit Breaker (MCCB)

The MCCB should be current limiting type with trip time of less than 10 msec under short circuit conditions. The MCCB should be either 3 or 4 poles as specified in BOQ. MCCB shall comply with the requirements of the relevant standards IS13947 – Part 2/IEC 60947-2 and should have test certificates for Breaking capacities from independent test authorities CPRI / ERDA or any accredited international lab.

MCCB shall comprise of Quick Make -break switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses

The breaking capacity of MCCB shall be as specified in the schedule of quantities. The rated service breaking capacity (Ics) should be equal to rated ultimate breaking capacities (Icu). MCCBs for motor application should be selected in line with Type-2 Co-ordination as per IEC-60947-2, 1989/IS 13947-2. The breaker as supplied with ROM should meet IP54 degree of protection.

4.5.1 Current Limiting & Coordination

- The MCCB shall employ maintenance free minimum let-through energies and capable of achieving discrimination up to the full short circuit capacity of the downstream MCCB. **The manufacturer shall provide both the discrimination tables and let-through energy curves for all.**

Protection Functions

- MCCBs with ratings up to 200 A shall be equipped with Thermal-magnetic (thermal for overload and magnetic for short-circuit protection) trip units
- Microprocessor MCCBs with ratings 250A and above shall be equipped with microprocessor based trip units.
- Microprocessor and thermal-magnetic trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorised access to the settings
- Microprocessor trip units shall comply with appendix F of IEC 60947-2 standard (measurement of rms current values, electromagnetic compatibility, etc.)
- Protection settings shall apply to all poles of circuit breaker.
- All Microprocessor components shall withstand temperatures up to 125 °C

4.5.2 Testing

- a) Original test certificate of the MCCB as per IEC 60947-1 & 2 or IS13947 shall be furnished.
- b) Pre-commissioning tests on the switch board panel incorporating the MCCB shall be done as per standard specifications.

4.5.3 Interlocking

Moulded, case circuit breakers shall be provided with the following interlocking devices for interlocking the door of a switch board.

- a) Handle interlock to prevent unnecessary manipulations of the breaker.
- b) Door interlock to prevent the door being opened when the breaker is in ON position.
- c) Defeat-interlocking device to open the door even if the breaker is in ON position.
 - The MCCB shall be current limiting type and comprise of quick make – Break switching mechanism. MCCBs shall be capable of defined variable overload adjustment. All MCCBs rated 200 Amps and above shall have adjustable over load & short circuit pick-up both in Thermal magnetic and Microprocessor Trip Units.
 - All MCCB with microprocessor based release unit, the protection shall be adjustable Overload, Short circuit and earth fault protection with time delay.
 - The trip command shall override all other commands.

4.6 Motor Protection Circuit Breaker (MPCB)

Motor circuit breakers shall conform to the general recommendations of standard IEC 947 -1,2 and 4 (VDE 660, 0113 NF EN 60 947-1-2-4, BS 4752) and to standards UL 508 and CSA C22-2 N°14.

The devices shall be in utilization category A, conforming to IEC 947-2 and AC3 conforming to IEC 947-4. MPCB shall have a rated operational and insulation voltage of 690V AC (50 Hz) and MPCB shall be suitable for isolation conforming to standard IEC 60947-2 and shall have a rated impulse withstand voltage (U_{imp}) of 6 kV. The motor circuit breakers shall be designed to be mounted vertically or horizontally without derating. Power supply shall be from the top or from the bottom. In order to ensure maximum safety, the contacts shall be isolated from other functions such as the operating mechanism, casing, releases, auxiliaries, etc, by high performance thermoplastic chambers. The operating mechanism of the motor circuit breakers must have snap action opening and closing with free tripping of the control devices. All the poles shall close, open, and trip simultaneously. The motor circuit breakers shall accept a padlocking device in the “isolated” position.

The motor circuit breakers shall be equipped with a “PUSH TO TRIP” device on the front enabling the correct operation of the mechanism and poles opening to be checked. The auxiliary contacts shall be front or side mounting, and both arrangements shall be possible. The front-mounting attachments shall not change the breaker surface area. Depending on its mounting direction the single pole contact block could be NO or NC. All the electrical auxiliaries and accessories shall be equipped with terminal blocks and shall be plug-in type. The motor circuit breakers shall have a combination with the downstream contactor enabling the provision of a perfectly co-ordinated motor-starter. This combination shall enable type 1 or type 2 co-ordination of the protective devices conforming to IEC 60947-4-1. Type 2 co-ordination shall be guaranteed by tables tested and certified by an official laboratory: LOVAG (or other official laboratory). The motor circuit breakers, depending on the type, could be equipped with a door-mounted operator which shall allow the device setting. The motor circuit breakers shall be equipped with releases comprising a thermal element assuring overload protection and a magnetic element for short-circuit protection. In order to ensure

safety and avoid unwanted tripping, the magnetic trip threshold (fixed) shall be factory set to an average value of 12 Ir.

All the elements of the motor circuit breakers shall be designated to enable operation at an ambient temperature of 60°C without derating. The thermal trips shall be adjustable on the front by a rotary selector. The adjustment of the protection shall be simultaneous for all poles. Phase unbalance and phase loss detection shall be available. Temperature compensation (-20°C to +60°C)

4.7 Miniature Circuit Breaker (MCB)

Miniature Circuit Breaker shall comply with IS-8828-1996/IEC898-1995. Miniature circuit breakers shall be quick make and break type for 240/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B,C,D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values. MCB shall ensure complete electrical isolation & downstream circuit or equipment when the MCB is switched OFF.

The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP, TPN and 4 Pole miniature circuit breakers shall have a common trip bar independent to the external operating handle.

Coordination Study in LV Network

LV Switchgear Manufacturer shall submit coordinated & Discriminated solution for LV Network protection devices i.e. **ACB, MCCB, MPCB & MCB** for all Incoming and outgoing devices for all Panels/ DB's as per BOQ with the help of published discrimination tables. Total discrimination shall be provided up to the short circuit breaking capacity of most downstream circuit Breakers .

4.8 Residual Current Circuit Breaker Current Operated Type (RCCB)

I. System of Operation

Residual Current Circuit Breaker shall conform to IEC 61008. RCCB shall work on the principle of core balance transformer. The incoming shall pass through the toroidal core transformer. As long as the currents in the phase and neutral shall be the same, no electro motive force shall be generated in the secondary winding of the transformer. In the event of a leakage to earth, an unbalance shall be created which shall cause a current to be generated in the secondary winding, this current shall be fed to a highly sensitive miniature relay, which shall trip the circuit if the earth leakage current exceeds a predetermined critical value. RCCB shall be current operated independent of the line voltage, current sensitivity shall be of 30 mA at 240/415 volts AC and shall have a minimum of 20,000 electrical operations.

II. Mechanical Operation

The moving contacts of the phases shall be mounted on a common bridge, actuated by a rugged toggle mechanism. Hence, the closing /opening of all the three phases shall occur simultaneously. This also shall ensure simultaneous opening of all the contacts under tripping conditions.

III. Neutral Advance Feature

The neutral moving contact shall be so mounted on the common bridge that, at the time of closing, the neutral shall make contact first before the phases; and at the time of opening, the neutral shall break last after allowing the phases to open first. This is an important safety feature which is also required by regulations.

IV. Testing Provision

A test device shall be incorporated to check the integrity of the earth leakage detection system and the tripping mechanism. When the unit is connected to service, pressing the test knob shall trip the ELCB / RCCB and the operating handle shall move to the "OFF" position.

4.9 Earthing

Earthing shall be provided as per IS:3043-1987.

4.10 Painting

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be as per BOQ confirming to IS Code No.5.

4.11 Labels

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the distribution panels shall be pasted on inside of the panel door and covered with transparent plastic sheet.

4.12 Meters

- i. All voltmeters and indicating lamps shall be through MCB's.
- ii. Meters and indicating instruments shall be flush type.
- iii. All CT's connection for meters shall be through Test Terminal Block (TTB).
- iv. CT ratio and burdens shall be as specified on the Single line diagram.

4.13 Current Transformers

Current transformers shall be provided for Distribution panels carrying current in excess of 60 amps. All phase shall be provided with current transformers of suitable VA burden with 5 amps secondaries for operation of associated metering.

The CTs 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. Secondary terminals of CTs shall be brought out suitable to a terminal block which shall be easily accessible for testing and terminal connections. The protection CTs shall be of accuracy class 5P10 and measurement CTs shall be of accuracy class I.

4.14 Potential Free Contacts

Potential free contacts shall be provided for connection to Building Automation System in panels indicated in Schedule of Quantities.

4.15 Indicating Panel

All meters and indicating instruments shall be in accordance with relevant Indian Standards. Meters shall be flush mounted type. Indicating lamps shall be of low burden, and shall be backed up with 2 amps MCB/MPCB as per relevant fault level and toggle switch.

4.16 Prepayment Energy Metering System/ Postpaid Centralized Metering Billing System
(Applicable for Shopping Mall/ Multiplexes & Residential Project)

4.16.1 Pre- Payment Energy Metering System (Option-I)

This section covers the design, and supply & implementing of the Tree Phase (Dual) Pre-payment energy meter. The meter shall have switching device and a keypad to transfer the codes to the meter generated by a vending station.

4.16.1.1 Applicable standard

The pre-payment energy meter confirms to class 1 accuracy limits as per IEC 61036 / IS : 13779. All other requirement of the standard are met with respect to IEC 61036 / IS : 13779 (BIS marked).

Electrical characteristics

Reference current	10A I_{Basic} 60 A I_{Basic}
Reference voltage	240V (P-N)
Current variation	10A (100%) to 60A (600%)
Burden	Current Circuit < 2.5 VA per phase Voltage circuit 10VA per phase
Frequency reference and variation	50 Hz \pm 5%

Mechanical characteristic

Terminal block	The terminal block shall be made up of high grade engineering plastic.
Clearance and Creep-age	The clearance and creep age distance of the terminal block cover those between the terminals shall not be less than 6 mm.
Material of the body	The meter body shall be made up of high grade engineering plastic.
Sealing arrangement	The meter shall have two screws fixed on the terminal cover and one screw on the terminal cover. The meter shall be sealed with steel wires.
EMI/EMC compatibility	The meter shall meet the requirements of applicable standards.
Switching device	The meter shall have a build in switch to cut off the power supply to a consumer in the conditions as detailed in the specification.
Credit entry device	The meter shall have a 12 key, key pad to enable the customer to enter the vending code.

Credit entry and Rejection	The meter shall accept only valid tokens and shall reject invalid tokens. Tokens (if lost) can be reissued but not reused.
Emergency credit	The meter shall work even when the credit falls down to zero to prevent disconnection. This limit can be set by the user by a set limit transaction.
Low credit alarm	The meter shall give an alarm in case the credit in the meter goes down below a predefined limit.
Current limit	The meter shall disconnect the load in case the current exceeds a predefined limit provided the high current prevails for certain amount of time called the persistence time. The disconnecting switch can be reconnected by pressing any key.
Load limit	The meter manages and monitors the load connected to it and also provides the load limiting feature by disconnecting the load in case it exceeds the predefined load.
Test mode for utility	In test mode the meter displays the software version of the meter, number of transactions accepted and rejected, power on hours, number of switch open or close operations, start and end time of friendly credit hours, maximum current and load limit set in the meter etc..

Tariff application details :

The pre payment energy meter shall be used to implement following types of tariff application:

- i. 4 slabs of energy / Flat rate of energy
- ii. 4 slabs of time of use of energy
- iii. Energy / VAT tax on fixed percentage basis
- iv. Standing charges (like fixed KW charges & monthly maintenance charges)
- v. Happy hours definition:
The energy meter shall not disconnect supply in these defined hours of the day. For example if evening 10 pm to morning 8 am is defined as happy hours then the meter shall not disconnect during this time period even when the energy meter runs out of credit.
- vi. Holiday definition :
The supply shall not be terminated on these specified days, for example if Sunday is defined as a holiday then the switch will remain closed on Sunday even if the pre payment energy meter runs out of credit.

Implementation of the Register switching using Pulse Input in case of dual register (for DG consumption measurement):

The Objective of the technology shall be to switch the Energy register from Mains to DG. A control wiring (2 core 2.5 sq.mm armoured cable) shall be provided from DG Panel to the individual meter board of each block. The 24 volts bus bar shall be made in each meter board and switch shall be further connected to meters for shifting the energy register. The battery of the DG set shall be used for generating the 24 volts, which shall be looped from the auxiliary contact of the ACB of the AMF Panel of the DG Set.

The Meter

Measures electricity consumption and decrements the credit based on the cost per unit of electricity.

Keypad Unit

A remote display which when connected to the meter allows all features to be conveniently accessed from any room in the house. Both these shall be connected with the help of RG-11 cable.

Prepayment for mains and DG :

In prepayment meter there shall not be a problem of deducting money from the consumers account because of the fact that DG shall have different tariff and mains shall have different tariff. With the use of Pulse Input Logic, meter shall be intelligent to identify the DG & mains. And the meter shall deduct the amount according to DG and mains both.

Feature of Pre-paid metering system

The pre payment metering system shall be essentially “a pay as you go” System, which means that the system shall help the consumer to choose when and how much of electricity to be purchased. Also it shall enable a system of trouble free purchase of electricity with multiple options to the consumer.

Features of the pre payment meter shall be as follows:

1. Monitory
 - i. Reduced cash flow cycle
 - ii. Reduced cost of revenue collection
 - iii. Reduction in administrative cost (Record keeping etc..)
2. Operation
 - i. Introduction of an automatic revenue collection system
 - ii. Reports on revenue management available daily
 - iii. Error free reporting
3. Consumer relationship improvement
 - i. No complains for defective meter reading
 - ii. Friendly credit purchase hours
 - iii. Budgeting

4.16.2 Post Paid Centralized Metering Billing System (Option-II)

4.16.2.1 For Commercial Complexes, Malls and Residential Buildings Energy Billing Software should fulfill the following:

- Computerized energy billing data of consumers avoiding meter reading of each premise by manual means. Detection of any malfunctioning meter shall be detected immediately.
- Separate recording of electricity board supply and diesel generator giving different tariff rates.
- Common or service area recording / billing.
- Daily load balancing and calculating of T&D loss - auditing the energy received and revenue realized through the system.

Specifications for Energy Billing System

S.No		Specification
4.16.2.2	Dual Energy Meter	Dual function meters class 1.0 accuracy with RS 485 port with programmable CT/PT in size 96x96 mm (Parameters – KVA* or KW*, KVAH* or KWH*, ON hours] True rms register energy separately for Mains and DG *As per EB tariff
4.16.2.3	Energy Billing Software	Energy Billing Software customized as per requirement of client [DG load restriction optional]data logging, generation of reports.T&D loss calculation, common area consumption
4.16.2.4	Data Cable	Data cable suitable for RS485 Belden or eqvt
4.16.2.5	Convertor	Data Converter RS485/232
4.16.2.6	PC Specification	Dedicated Computer for EBS,Pentium IV PC with 3.2 GHz,1GB RAM, 80 GB HDD, 3.5 FDD, 2 Serial and 1 parallel ports,1 LAN port, Windows XP with service pack 2,Office XP/2000,Antivirus Software,CD ROM & Colour Monitor 15" VGA

4.17 Testing

Testing of panels shall be as per following codes:

- I. IS: 8623 (Part -I) 1977 for factory built assemblies of switch gear for voltages upto and including 1000 VAC.
- II. IS: 13947 : 1993 Degree of protection
- III. IS: 5578 & 11353:1985 Arrangement of bus bars.

4.18 Wiring

In wiring a distribution panel it shall be insured that total load of various distribution panel and/or consuming devices is divided evenly between the phases and number of ways as per Consultants drawing.

4.19 Anti-Condensation Space Heaters

1 No. 100 W, 240 volts, single phase, 50 Hz AC Anti Condensation space heaters controlled by thermostat and protected by 6 amps MCB's or MPCB's as per fault level at the panel shall be provided in each vertical section of main LT panel and 1 No. 60 watt Anti Condensation space heater with thermostat shall be provided in each cable alley of main distribution boards and sub distribution boards.

4.20 Installation

Installation of all LT panels shall include but not limited to the following to complete the installation, testing and commissioning:

- a) Transporting materials from stores to exact location of installation.
- b) Supply and installation of required base frame made of MS angle or channel sections and duly painted with black paint.
- c) Positioning, aligning, fixing, assembling, and installation of LT panel issued free of cost by Client after carrying out proper cleaning and inspection.

d) Site supervision, testing for proper functioning / operation, and pre-commissioning tests.

4.21 Commissioning and Onsite Testing

- a) All switchboards shall be tested for dielectric test with 1000V megger.
- b) All earth connections shall be checked for continuity.
- c) All busbar connections shall be checked and tightened properly.
- d) All cable terminations and terminal shrouding shall be checked if they are properly done.
- e) The operation of protective devices shall be tested by secondary injection test.
- f) The operation of circuit breaker shall be tested for all interlocks.
- g) Functional test shall be done for all ACBs, MCCBs and other components.
- h) Indicating lamps and meters shall be checked for proper working.

4(B) FINAL DISTRIBUTION BOARDS(FDB's)

Final Distribution Boards (FDBs) shall be suitable for operation on 3 Phase/single phase, 415/240 volts, 50 cycles, neutral grounded at transformer. The DB shall be minimum dielectric strength of 2.5 KV / Sec. All Distribution Boards shall be manufactured by a manufacturer listed in Appendix-I.

FDB's shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1993.

4.1 Construction Features

FDB's shall be made out of 1.6 mm thick high quality CRCA sheet steel and shall be pre-treated and powder coated sheet steel used in the construction of FDB shall be folded and braced as necessary to provide a rigid support for all component. FDB shall be suitable for indoor / outdoor installation, wall mounting free standing type, in double door construction. The Final Distribution Boards shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket, padlocking arrangement. All removable/hinged doors and covers shall be grounded by 4.0 sqm tinned stranded copper connectors. Final Distribution Boards shall be suitable for the climatic conditions. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall conform to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of FDBs.

Knockout holes of appropriate size and number shall be provided in the FDB's in conformity with the location of cable/conduit connections. Detachable sheet steel gland plates shall be provided at the top / bottom to make holes for additional cable entry at site if required.

Final Distribution Boards shall comprise of the following:

- 4.1.1.1 A panel for mounting where appropriate incoming supply circuit breaker & other auxiliaries for Control & distribution as required.
- 4.1.1.2 Installation accessories shall be part of the DB for fixing conductor and rails for mounting MCB's and RCCB's etc.. neutral bus bars & earthing bus bars required in the circuit. All busbars in the FDB shall be insulated type.
- 4.1.1.3 Service cable /interconnection shall be part of the Distribution Boards.
- 4.1.1.4 The board shall be installed at a height such that the operating is within reach of the normal human height i.e. 1.2 to 1.8 meters from finish floor level.
- 4.1.1.5 Degree of protection shall be IP-52 for indoor application, IP-54 for kitchen & laundry and IP-55 for outdoor application.
- 4.1.1.6 All three phase distribution boards shall have 4 rows and single phase distribution boards shall have single rows for housing of MCB's and RCCB's unless noted otherwise.
- 4.1.1.7 Phase segregation to be maintained in all three phase distribution boards.
- 4.1.1.8 Earthing shall be provided in each FDB's.

4.1.2 **Miniature Circuit Breaker (MCB)**

For specifications refer Section 4A, clause 4.7

4.1.3 **Residual Current Circuit Breaker Current Operated Type (RCCB)**

For specifications refer Section 4A, clause 4.8

4.1.4 **Earthing**

Earthing shall be provided as per IS:3043-1987.

4.1.5 **Painting**

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be of Siemens gray paint shade no. RAL-7032 of IS Code No.5.

4.1.6 **Labels**

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the distribution panels shall be pasted on inside of the panel door and covered with transparent plastic sheet.

4.1.7 **Testing**

Testing of panels shall be as per following codes:

- IV. IS: 8623 (Part -I) 1977 for factory built assemblies of switch gear for voltages upto and including 1000 VAC.
- V. IS: 13947 : 1993 Degree of protection

4.1.8 **Wiring**

In wiring a distribution panel it shall be insured that total load of various distribution panel and/or consuming devices is divided evenly between the phases and number of ways as per Consultants drawing.

6. POWER FACTOR CORRECTION SYSTEM

6.1 Power Factor Correction System Without Detuned Filter (Option -I)

6.1.1 Scope

Design, manufacture, supply, erection, testing and commissioning of Indoor type power correction capacitor banks for power factor improvement as per specification given below :

6.1.2 Standard

Unless otherwise stated below, the capacitor shall comply with the following standards (and their latest amendments) : IS 13340-1993, IS 13341-1992, IEC 60831-1+2

6.1.3 Rating

50 KVAR (or less) capacitor units as specified in the BOQ shall be used to form a bank of capacitors of desired capacity.

6.1.4 Enclosure

The panel shall be indoor type, free standing, and floor mounting with IP42 degree of protection. It shall be completely made of CRCA sheet steel. The enclosure shall have sturdy support structure with angle supports as necessary and shall be finished with powder coating in the approved colour shade/s to match the colour of the other panels. The thickness of powder coating should be minimum 60-80 microns.

Suitable provisions shall be made in the panel for proper heat dissipation. Air aspiration louvers for heat dissipation shall be provided as a necessary.

The front portion shall house the switchgear and the rear portion shall house capacitors and series reactors. The enclosure is to be suitably sized to accommodate all the components, providing necessary air clearance between live and non-live parts, providing necessary working clearance.

6.1.5 APFC Relay / Controller

Microprocessor based APFC relay (Intelligent VAR controller) shall sense the PF in the system and automatically switch ON / OFF the capacitor unit or stage to achieve the preset target PF. The controller shall have the following features :

- Digital settings of parameters like PF, Switching time delay, Step limit etc.
- Indication of PF, preset parameters.
- Minimum threshold setting of 1% of CT current.
- No-volt release.
- Protective shut down in case of harmonic overload.
- Indication for Failure to achieve the target PF, Harmonic overloading, Step failure etc.

6.1.6 Capacitor Unit

Each basic unit of mixed dielectric extra low loss / All Poly Propylene (APP) capacitor shall be built with a number of elements. These elements shall be combination of capacitor tissue paper and biaxially oriented polypropylene film impregnated with non PCB bio-degradable impregnant or Film Foil capacitor manufactured using Poly propylene film placed between 2 layers of metal foil and winding. The elements shall be connected to the external bus bars through these leads in a series parallel connection to form a three phase unit.

The capacitor units shall be floor mounting type using minimum floor space. The container of capacitors shall be made out of 2 mm thick M S sheet steel of polyester paint coated finish. Each standard unit shall be provided with internal fuses (operation co-ordinated with case-rupture characteristics to avoid rusting).

Total Harmonic Distortion (THD) of upto 5% on voltage and current waveforms shall not affect the life of capacitors. $660 \pm 10\%$ variation in line voltage shall not affect the life of the capacitors.

6.1.7 Capacitors

- General specifications : 3 phase, delta connected, 50 Hz.
- Voltage : Shall be designed for **520V** and shall withstand system over voltage, increased voltage due to series reactor and harmonics.
- Capacitor type : Super heavy duty with double side metallised capacitor tissue paper. Oil impregnated and self-healing type with bi-axially oriented polypropylene film shall be fitted with pressure sensitive disconnecter in each individual capacitor cell.
- Overvoltage +10% (12h / 24h), + 15% (30m / 24h), + 20% (5m), +30% (1m) as per Clause 6.1 of IS 13340-1993.
- Overcurrent : $2.5 \times I_n$
- Peak Inrush current withstand : $350 \times I_n$
- Total watt-losses including discharge resistors : $\leq 0.45 \text{ W / k V Ar}$.
- Temperature category : -25 deg.C to 70 deg.C.
- Capacitor shall be self-heating type and oil impregnated for longer life. The impregnant shall be non-PCB, biodegradable type, must be properly treated and de-gasified, so as not to have any degeneration properties and shall be non-oxidizing.
- The design shall be modular for simple mechanical assembly, no extra accessories / metal parts to be required. Unit must be free standing with an IP 41 protection level.

6.1.8 Discharge Resistance

Capacitors shall be provided with permanently connected discharge resistors so that residual voltage of capacitors is reduced to 50 volts or less within one minute after the capacitors are disconnected from the source of supply.

6.1.9 Terminals

Each capacitor bank shall be provided with a terminal chamber and cable glands suitable for PVC insulated aluminum conductor armoured cables as specified.

6.1.10 Earthing

Two separate earthing terminals shall be provided for earth connection of each bank.

6.1.11 Switchgear & Protection

Incomer switchgear shall be TP&N breaker appropriate rating (**minimum 1.8 times** the normal current to take care of inrush switching current). Suitable contactor for each step shall be used and must be capable of capacitor switching duty at each step for short circuit protection. The switching of capacitors shall be thyristor based at zero cross over to avoid surges in the system. The system will be acceptable subject to demonstration of switching at zero cross over during the inspection.

Busbars shall be suitably colour coded and must be mounted on appropriate insulator supports.

Power cables used shall have superior mechanical, electrical and thermal properties, and shall have the capability to continuously operate at very high temperatures upto 125 deg.C.

Internal wiring between main bus-bars, breaker, contactor and capacitors shall be made with 1100 V grade, PVC insulated, copper conductor cable of appropriate size, by using suitable copper crimping terminal ends etc.

Suitable bus links for input supply cable termination shall be provided.

6.1.12 Control Circuit & General Protection

The control circuit shall be duly protected by using suitable rating MCB.

An emergency stop push button shall be provided to trip the entire system (22.5 mm dia, mushroom type, press to stop and turn to reset).

Wiring of the control circuit shall be done by using 1.5 sq.mm, 1100 V grade, PVC insulated, multi-stranded copper control wire.

Inspection terminal strip, number ferruling, labeling etc. shall be provided.

440 V caution board on the panel shall be provided.

6.1.13 Testing

The capacitor bank shall be subject to tests as specified in relevant Indian Standards at the factory and the test certificates shall be furnished in quadruplicate.

6.1.14 Installation

- I. Capacitors banks shall be installed as per installation manual of supplier and shall conform to relevant Indian Standards.
- II. All interconnections in the control panel shall be checked before commissioning.
- III. Cable end boxes shall be sealed after cable connections to prevent absorption of moisture.
- IV. 15 mm thick rubber matting of an approved make over a 100 mm high Timber platform shall be provided in front of the full length of the capacitor bank and control panel.

6.1.15 Testing And Commissioning

- I. Insulation resistance shall be tested with a 1000 volts meagger between phases and phase to earth.
- II. Residual voltage shall be measured after switching of the capacitors and the same shall not be more than 50 volts after one minute.
- III. Each discharge resistor shall be tested for its working.

6.2. Power Factor Correction System With Detuned Filter (Option-Ii)

6.2.1 Scope

Design, manufacture, supply, erection, testing and commissioning of Indoor type power correction capacitor banks for power factor improvement as per specification given below :

6.2.2 Standard

Unless otherwise stated below, the capacitor shall comply with the following standards (and their latest amendments) : IS 13340-1993, IS 13341-1992, IEC 60831-1+2

6.2.3 Rating

50 KVAR (or less) capacitor units as specified in the BOQ shall be used to form a bank of capacitors of desired capacity.

6.2.4 Enclosure

The panel shall be indoor type, free standing, and floor mounting with IP42 degree of protection. It shall be completely made of CRCA sheet steel. The enclosure shall have sturdy support structure with angle supports as necessary and shall be finished with powder coating in the approved colour shade/s to match the colour of the other panels. The thickness of powder coating should be minimum 60-80 microns.

Suitable provisions shall be made in the panel for proper heat dissipation. Air aspiration louvers for heat dissipation shall be provided as a necessary.

The front portion shall house the switchgear and the rear portion shall house capacitors and series reactors. The enclosure is to be suitably sized to accommodate all the components, providing necessary air clearance between live and non-live parts, providing necessary working clearance.

6.2.5 APFC Relay / Controller

Microprocessor based APFC relay (Intelligent VAR controller) shall sense the PF in the system and automatically switch ON / OFF the capacitor unit or stage to achieve the preset target PF. The controller shall have the following features :

- Digital settings of parameters like PF, Switching time delay, Step limit etc.
- Indication of PF, preset parameters.
- Minimum threshold setting of 1% of CT current.
- No-volt release.
- Protective shut down in case of harmonic overload.
- Indication for Failure to achieve the target PF, Harmonic overloading, Step failure etc.

6.2.6 Capacitor unit

Each basic unit of mixed dielectric extra low loss / All Poly Propylene (APP) capacitor shall be built with a number of elements. These elements shall be combination of capacitor tissue paper and biaxially oriented polypropylene film impregnated with non PCB bio-degradable impregnant or Film Foil capacitor manufactured using Poly propylene film placed between 2 layers of metal foil and winding. The elements shall be connected to the external bus bars through these leads in a series parallel connection to form a three phase unit.

The capacitor units shall be floor mounting type using minimum floor space. The container of capacitors shall be made out of 2 mm thick M S sheet steel of polyester paint coated finish. Each standard unit shall be provided with internal fuses (operation co-ordinated with case-rupture characteristics to avoid rusting).

Total Harmonic Distortion (THD) of upto 5% on voltage and current waveforms shall not affect the life of capacitors. $660 \pm 10\%$ variation in line voltage shall not affect the life of the capacitors.

6.2.7 Capacitors

- General specifications : 3 phase, delta connected, 50 Hz.
- Voltage : Shall be designed for minimum **520V** and shall withstand system over voltage, increased voltage due to series reactor and harmonics.
- Capacitor type : Super heavy duty with double side metallised capacitor tissue paper. Oil impregnated and self-healing type with bi-axially oriented polypropylene film shall be fitted with pressure sensitive disconnecter in each individual capacitor cell.
- Overvoltage +10% (12h / 24h), + 15% (30m / 24h), + 20% (5m), +30% (1m) as per Clause 6.1 of IS 13340-1993.
- Overcurrent : 2.5 x In
- Peak Inrush current withstand : 350 x In
- Total watt-losses including discharge resistors : $\leq 0.45 \text{ W / k V Ar}$.
- Temperature category : -25 deg.C to 70 deg.C.
- Capacitor shall be self-heating type and oil impregnated for longer life. The impregnant shall be non-PCB, biodegradable type, must be properly treated and de-gasified, so as not to have any degeneration properties and shall be non-oxidizing.
- The design shall be modular for simple mechanical assembly, no extra accessories / metal parts to be required. Unit must be free standing with an IP 41 protection level.

6.2.8 Discharge Resistance

Capacitors shall be provided with permanently connected discharge resistors so that residual voltage of capacitors is reduced to 50 volts or less within one minute after the capacitors are disconnected from the source of supply.

6.2.9 Terminals

Each capacitor bank shall be provided with a terminal chamber and cable glands suitable for PVC insulated aluminum conductor armoured cables as specified.

6.2.10 Earthing

Two separate earthing terminals shall be provided for earth connection of each bank.

6.2.11 Low Voltage Filter Reactor

Filter reactor shall be series type having a three phase, iron core construction suitable for indoor use. The reactor shall be air cooled and the layout shall be in accordance with IEC 76. The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin and shall be suitable for temperature class H operation. The reactor coils shall be wound with high grade aluminum / copper and termination shall be provided with suitably designed copper bars.

6.2.12 Testing

The reactor shall be tested using a separate source voltage test of 3 KV (coil to core) for one minute as per IEC 76/3. The reactor shall be fitted with a temperature sensitive micro-switch in the centre coil (normally open) for connection to trip circuit in case of high operating temperature.

6.2.13 Series Reactor

Application

LV Harmonic Filters shall be used with harmonic filter duty power capacitors to mitigate harmonics, improve power factor and avoid electrical resonance in LV electrical networks.

Construction, Testing & Protection

The low voltage filter reactor shall be series type having a three phase, iron core construction suitable for indoor use (IP 00). The reactor shall be air cooled and the layout shall be in accordance with IEC 60076.

The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin and shall be suitable for temperature Class H (T60/H) operation.

The reactor shall be tested using a separate source voltage test of 3.0kV (coil to core) for 1 minute as per IEC 60076/3.

The permitted tolerance of inductance shall be + 3% of rated inductance value.

Reactor tuning factor shall be 7% and the current rating of the reactor shall include the effects of harmonics and other possible over-currents.

The limit of linearity of inductance of the filter reactor shall be as follows $1.2 \bullet \sum I_n$ with $L = 0.95 L_N$

The reactor shall be fitted with a temperature sensitive micro-switch in the centre coil (normally open) for connection to trip circuits in case of high operating temperatures.

6.2.14 Switchgear & Protection

Incomer switchgear shall be TP&N breaker appropriate rating (**minimum 1.8 times** the normal current to take care of inrush switching current). Suitable contactor for each step shall be used and must be capable of capacitor switching duty at each step for short circuit protection.

Busbars shall be suitably colour coded and must be mounted on appropriate insulator supports.

Power cables used shall have superior mechanical, electrical and thermal properties, and shall have the capability to continuously operate at very high temperatures upto 125 deg.C.

Internal wiring between main bus-bars, breaker, contactor and capacitors shall be made with 1100 V grade, PVC insulated, copper conductor cable of appropriate size, by using suitable copper crimping terminal ends etc.

Suitable bus links for input supply cable termination shall be provided.

6.2.15 Control Circuit & General Protection

The control circuit shall be duly protected by using suitable rating MCB.

An emergency stop push button shall be provided to trip the entire system (22.5 mm dia, mushroom type, press to stop and turn to reset).

Wiring of the control circuit shall be done by using 1.5 sq.mm, 1100 V grade, PVC insulated, multi-stranded copper control wire.

Inspection terminal strip, number ferruling, labeling etc. shall be provided.

440 V caution board on the panel shall be provided.

6.2.16 Testing

The capacitor bank shall be subject to tests as specified in relevant Indian Standards at the factory and the test certificates shall be furnished in quadruplicate.

6.2.17 Installation

- I. Capacitors banks shall be installed as per installation manual of supplier and shall conform to relevant Indian Standards.
- II. All interconnections in the control panel shall be checked before commissioning.
- III. Cable end boxes shall be sealed after cable connections to prevent absorption of moisture.
- IV. 15 mm thick rubber matting of an approved make over a 100 mm high Timber platform shall be provided in front of the full length of the capacitor bank and control panel.

6.2.18 Testing & Commissioning

- I. Insulation resistance shall be tested with a 1000 volts megger between phases and phase to earth.
- II. Residual voltage shall be measured after switching of the capacitors and the same shall not be more than 50 volts after one minute.
- III. Each discharge resistor shall be tested for its working.

7. EARTHING

7.1 Earthing

The system shall be TNS with four wire supply system (R,Y,B,N and 2 Nos. E) brought from the main L T Panel. All the non-current carrying metal parts of electrical installation and all metal conduits trunking, cable sheaths, switchgear, distribution panels, light fittings and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All metal work such as pipe lines, ducts, cable trays, stair case railing etc shall be bonded to earth.

All earthing shall be in conformity with IS:3043 1987, and the basic system of earthing shall be TNS.

7.2 Earthing Conductors

Earthing conductors shall be of copper / GI as mentioned in schedule of quantities and shall be protected against mechanical injury and corrosion.

7.3 Sizing of Earthing Conductors

The cross sectional area of earthing conductor shall not be smaller than half of the largest current carrying conductor subject to an upper limit of 80 Sq.mm. If the area of the largest current carrying conductor or bus bar exceeds 160 sq.mm then two or more earthing conductors shall be used in parallel, to provide at least half the cross sectional area of the current carrying conductor or bus bars. All fixtures, outlet boxes, junction boxes and power circuits upto 15 amps shall be earthed with PVC insulated copper wire.

7.4 Connection of Earthing Conductors

Main earthing conductors shall be taken from the earth connections at the main L T panel to an earth electrode with which the connection is to be made. All joints in tapes shall be with four rivets and shall be brazed in case of copper and by welding bolting in case of GI, wires shall be connected with crimping lugs, all bolts shall have spring washers. Sub- mains earthing conductors shall run from the main distribution panel to the sub distribution panel. Final distribution panel earthing conductors shall run from sub-distribution panel.

Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution panel. Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to distribution panel at which they originate, or otherwise at the commencement of the run by an earthing conductor in effective electrical contact with cable sheathing. Where equipment is connected by flexible cord, all exposed metal parts of the equipment shall be earthed by means of an earthing conductor enclosed with the current carrying conductors within the flexible cord. Switches, accessories, lighting fitting etc. which are rigidly secured in effective electrical contact with a run of metallic conduit shall not be considered as a part of the earthing conductor for earthing purposes, even though the run of metallic conduit is earthed. The installation shall be complete in all respects for efficient and trouble free service. All work shall be carried out in a first class quality and neat workmanship. Grounding conductors shall be handled carefully to avoid kinking and cutting of the conductors during their installation. All exposed ground conductors run shall be taken in a neat manner horizontal, vertical and parallel to the building walls or columns and shall not be laid haphazardly. All connections to the grounding grid shall be made with **earthing** strip welded to grid and bolted at equipment ends.

7.5 Prohibited Connections

Neutral conductor, sprinkler pipes, or pipes conveying gas, water or inflammable liquid, structural steel work, metallic enclosures, metallic conduits and lightning protection system conductors shall not be used as a means of earthing an installation or even as a link in an earthing system. The electrical resistance measured between earth connection at the main L T panel and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate or circuit breakers, and shall not exceed 1 ohm. All switches carrying medium voltage shall be connected with earth by two separate and distinct connections. The earthing conductors inside the building wherever exposed shall be properly protected from mechanical injury by running the same in G I pipe of adequate size. The overlapping in strips at joints where required shall be minimum 75 mm. The joints shall be riveted and brazed in case of copper and by welding / bolting in case of GI in an approved manner. Sweated lugs of adequate capacity and size shall be used for termination of all conductor wires above 6 sq.mm size. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substances and properly tinned. Equipotential bonding of all metallic structures shall be done.

7.6 Earthing

The following must always be ensured in earthing system.

- All earths must be interconnected at the earth pits. This includes generator neutrals, transformer neutrals, transformer body, lightning protection system earths, UPS earths etc.
- Extraneous conductive parts such as gas pipes, other service pipes and ducting risers and pipes of fire protection equipment and exposed metallic parts of the building structure.

7.7 The Contractor shall get the soil resistivity test done at his own cost of the area where earthing pits are to be located before starting the installation.

7.8 Resistance to Earth

The resistance of earthing system shall not exceed 1 ohm.

7.9 Specification for Hot Dip Galvanizing Process for Mild Steel Used for Earthing for Electrical Installation

General Requirements

I. Quality of Zinc

Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS:209-1992.

II. Coating Requirement

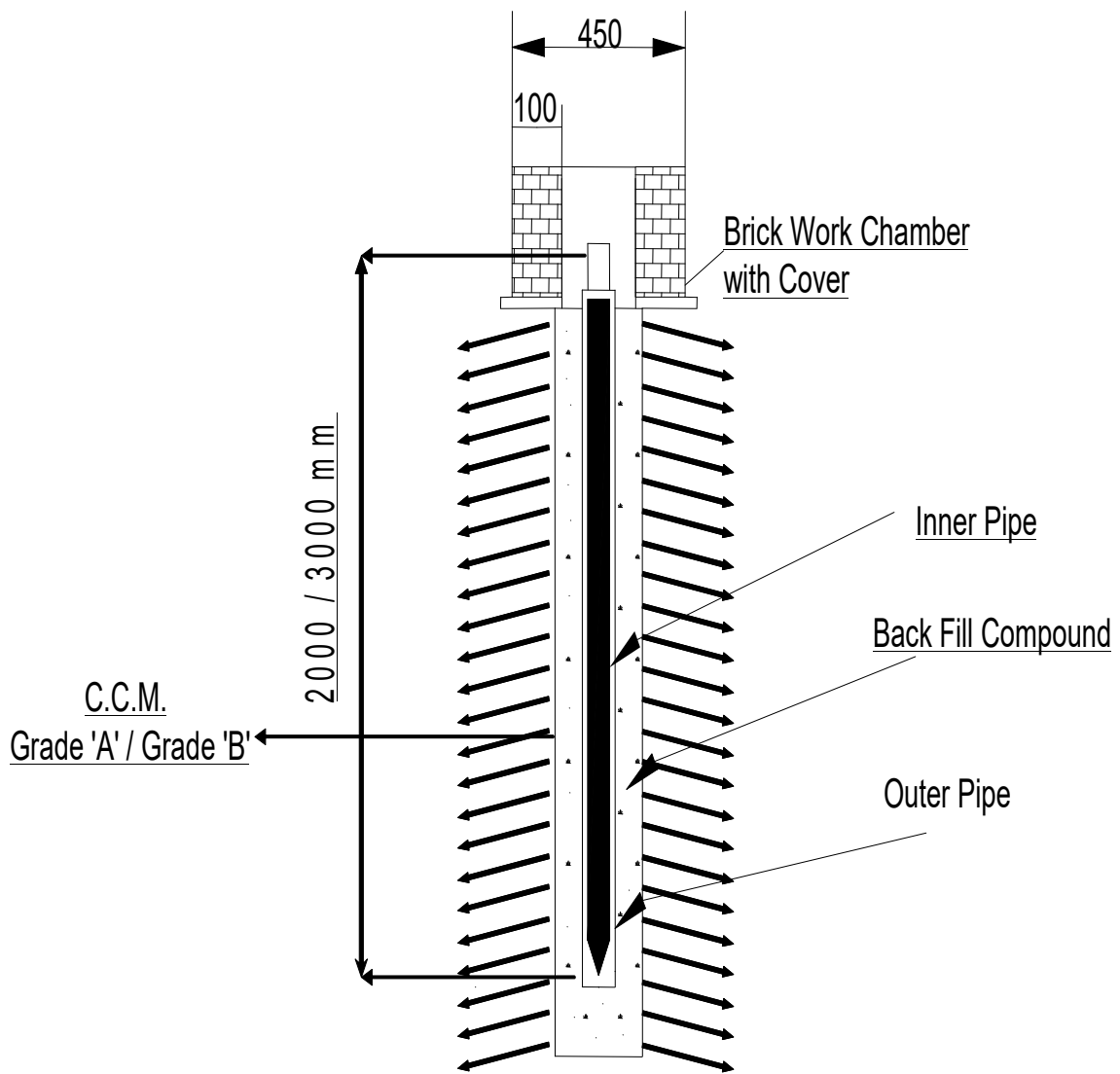
Minimum weight of zinc coating for mild steel flats with thickness upto 6 mm in accordance with IS:6745-1972 shall be 400 g/sqm.

The weight of coating expressed in grams per square metre shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs, rust stains bulky white deposits, blisters.

Mild steel flats / wires shall undergo a process of degreasing pickling in acid, cold rinsing and then galvanizing. Jointing of earthing tape shall be by welding. All joints and cut ends shall be properly painted with aluminium paint.

(Note : Please specify only one type as per project requirement)



S.E.E. T - 39, Dia. 80 mm.

SCALE: NOT TO SCALE

“ASHLOK - SAFE EARTHING ELECTRODE”

8. LIGHTNING PROTECTION SYSTEM

8.1 Lightning Protection System (Conventional Type - Option – I)

8.1.1 General

Installation of Lightning Protection System shall be strictly in accordance with IS:2309-1989.

Zone of Protection

The zone of protection of a lightning conductor define the space within which a lightning conductor provides protection against a direct lightning stroke by diverting the stroke to itself. For a single vertical conductor, this zone is described as a cone with its apex at the highest point of the conductor and with an angle called as protective angle. For the purpose of providing an acceptable degree of protection the protective angle of termination network shall be considered as 45°. Between two or more vertical conductors of equal height spaced at a distance not exceeding twice their height, the protective angle within the space bounded the air termination shall be taken as 60° to the vertical, while the protective angle away from the conductor will be taken as 45° to the verticals.

8.1.2 Material and Dimensions

The materials of lightning conductor, down conductors, earth termination etc. shall be copper / GI as per schedule of quantities and shall be protected against corrosion.

All air terminations and down conductors shall be of copper / GI as per schedule of quantities and shall conform to IS : 2309-1989.

8.1.3 Joints and Bonds

The lightning protective system shall have as few joints as far as possible. Wherever joints in the conductor are necessary they shall be mechanically and electrically effective, and shall be riveted and brazed in case of copper and by welding / bolting in case of GI in an approved manner.

8.1.4 Earth Terminations

Each down conductor shall have an independent earth termination. All the earth termination shall be inter connected and shall be capable of isolation for testing.

8.1.5 Earth Electrode

Earth pits shall be installed in accordance with IS : 3043-1987.

The resistance of earthing system shall not exceed 1 ohm.

8.1.6 Air Terminations Mesh (On the Terrace)

As an alternative to vertical air termination, grid of horizontal air termination may also be provided as per IS 2309. Often combination of both may be provided when structure to be **protected for high** ratio of length to height. Air termination mesh shall be provided not greater than 10mx20m. Down conductor shall be not more than 10 m apart where the building height in more than 20 m.

8.1.7 Fasteners

Conductors shall be securely fixed to the building to be protected by fasteners which shall be not more than 1.20 meter apart for horizontal run and 1.0 meters for vertical run.

8.2. Lightning Protection System (Advanced Lightning Protection System - Option –II) - Alternative – I (Based on NZA/AS/1768)

8.2.1 Scope of Work

The work to be done under this section comprises the supply and installation necessary for the complete installation of the lightning protection system.

The lightning protection system shall be installed in accordance with NZA/AS/1768:1991 standard and additional requirements of local authority. The system shall consist of air terminations, down conductors, joints and bends, testing joints, earth terminations and earth electrodes. The general arrangements shall be as indicated on the drawings. The coverage radius should be 109 meters radius.

Advanced lightning protection system shall include components as follows: air termination (s), mechanical support (s), low impedance insulated down conductor (s), performance recording equipment, and a low impedance grounding system.

The lightning protection system shall comprise:

- Air Terminations
- Down Conductors
- Joints and Bonds
- Earth Terminations

8.2.2 Standards

Complete installation shall be engineering and constructed in accordance with the latest revision of the following :

- NZS/AS/1768-1991
- IEC 61204

The details of the lightning protection system shall also conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in this specification and drawings, whichever is more stringent and acceptable to the engineer.

8.2.3 Air Termination

The air termination shall respond dynamically to the appearance of a lightning down-leader, shall be designed to trigger in relation to the optimum pre-determined conditions for upward leader inception, the triggering conditions must dynamically adjust to reflect the down leader intensity, building height above ground and the other factors that effect the electric field intensification above the air terminal.

The air terminal shall incorporate a curved conductive surface spaced from a permanently grounded central finial. During triggering of the air terminal the curved conductive surface shall be temporarily grounded, thereby producing a “snap” increase in electric field directly above the air terminal.

The air termination shall be designed with a range of optimal finial tip radii to match the different electric field conditions the terminal will be subjected to at various installation heights above the ground plane, or different positions on a structure for optimum performance.

Arcing at the finial tip is not to be continuous and shall only occur during the process of lightning leader approach. Arcing shall not occur solely due to electro-static field build-up created by the presence of charged overhead thunderclouds.

The materials of the air terminal shall be non-corroding in hostile environments. The centre grounded electrode tip shall be at least 20mm diameter, the curved conductive surface shall be of a conductive material of minimum thickness for air terminations as defined in IEC61024.

The size of the collection volume and attractive radius of the air termination shall be traceable to known and acceptable lightning research and statistics.

The air terminal shall be installed strictly to the manufacturer’s instructions.

The isolating material supporting the curved conductive surface from the centre grounded electrode is to be manufactured from a glass/mineral reinforced polypropylene. This material shall exhibit the following properties, high impact strength, UV stabilized, high electrical dielectric, high comparative tracking index and operating heat capability up to 120°C continuous.

The protective zone provided by the air termination shall be such that it becomes the preferred strike point for all discharges exceeding a peak amplitude return strike current of X kA according to the statistical level Y per IEC61024. The design shall take account of upward leader competing projections on the structure.

Strike Current (X)	Levels of Protection (Y)	Exceedance Probability
2.9 kA	Protection Level I – Very High	99%
5.4 kA	Protection Level II- High	97%
10.1 kA	Protection Level III – Medium	91%
15.7 kA	Protection Level IV – Standard	84%

8.2.4 Air Termination Support

The air terminal support shall consist of a minimum of 2m of insulating re -enforced fibreglass cylindrical mast. The conductor shall pass through the centre of the mast, with the high voltage termination contained to the upper 1m of the mast.

The support shall be securely bolted to other mast materials with guy wires used where necessary to enable the air termination and mast system to withstand maximum locally recorded wind velocities.

8.2.5 Downconductor

The downconductor shall consist of a plastic filler, copper conductor, inner insulation, outer copper conductor, conductive sheath, all concentrically arranged.

The downconductor shall have a low characteristic impedance of 4.5 Ω (Ohms) and a maximum inductance of 22 nH/m.

The downconductor shall have the capacitance equal to 1100 or greater than 1000 pF/m and the resistance should be equal or less than 0.5 (mΩ/m).

The downconductor should be tested in a lab to withstand a lightning impulse rating of ≥250KV peak voltage between the core & screen based 1.2/50µs-wave shape as defined under ANSI C62.41.

The outer diameter of the downconductor shall be less than 37mm.

The main copper conductor shall be made of electrical grade copper of minimum cross sectional area of 50mm².

In the final 3m to the ground and where it is exposed to human intervention, the downconductor shall be placed in a protective PVC pipe of 3mm minimum wall thickness so as to avoid mechanical damage and increase human safety.

The main copper conductor shall be capable of direct connection to the base of the air termination by use of a compression coupling.

The downconductor shall be installed in accordance with the manufacturer's instructions and should not be subject to bends of less than 0.5 metres radius.

The downconductor after routing, must be kept in constant physical contact with the structure via conductive clamps. The top 10% of the installed length from the terminal must be anchored at least every 1 metre. The lower must be anchored at least every 2 metres.

The downconductor(s) shall be compliant to UL-96: Lightning Protection Components (Standard for safety)

8.2.6 Performance recording equipment

Each protection system shall be supplied with a lightning event counter. The lightning event counter shall have an register that activates one count for every discharge where the peak current exceeds 1500A. The test wave shape shall be the 8/20us standard as defined by ANSI C62.41

The lightning event counter shall be robust, easy to install and housed in a IP67 rated enclosure. The counter shall operate from the energy of the lightning discharge and not rely on external or battery power to operate.

The lightning event counter shall be installed to the manufacturer's instructions in a readily accessible manner so that readings can be taken at regular intervals. It shall be positioned such that its operating temperature is within the range -10°C to +50°C.

8.2.7 Grounding

The grounding system reading shall not exceed 10 ohms static impedance except with prior approval by the site engineer or manufacturer of the Advanced

Lightning protection system.

Grounding shall be affected by copper wire or tape buried below the frost line (or to approximately 600mm deep in non freezing locations) or by deep driven UL listed copper bonded steel core ground rods with at least 10mil copper thickness.

Bonding of the grounding system to metallic parts of the building, the structural reinforcing steel of the building and to arriving services is recommended. The resistance should be measured and the 10-ohm requirements achieved before such bonding is affected.

Electrically conductive Ground Enhancing Materials may be used to achieve low ground resistance provided the materials are mixed and strictly in accordance with the manufacturer's instructions.

8.3 Lightning Protection System ESE Advanced Lightning Protection System Option –II Alternative II (Based on NFC17-102)

8.3.1 Scope of Work

The work to be done under this section comprises the supply & installation necessary for the complete installation of the lightning protection system.

The design of the components shall be traceable to field research, laboratory testing, fundamental analysis, and statistical levels of the lightning event.

The design of the components shall be traceable to long term practical field studies laboratory testing, fundamental scientific principles and statistical levels of the lightning event as documented in international standard.

The lightning protection system should comply in accordance with NFC 17-102 standard and shall be installed strictly to the manufacturer's instructions.

The advanced lightning protection system shall include components as follows:

ESE Air terminal
Mechanical supports
Down-conductors
Performance Recording Equipment
A low impedance Grounding system.

8.3.2 Standards

Complete installation shall be engineering and constructed in accordance with the latest revision of the following :

- NFC-17-102
- IEC 61204

The details of the lightning protection system shall also confirm to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in this specification and drawings, whichever is more stringent and acceptable to the engineer.

8.3.3 Air Terminal

The air termination shall be of the type that responds dynamically to the appearance of a lightning downleader by creating free electrons between outer surfaces and an earthed central finial rod.

The Airterminal should work under **Early Streamer Emission (ESE) Technology** and the attractive radius of the air termination shall be traceable to known and acceptable lightning research and statistics.

The Lightning conductor should deliver a unique gain time in efficiency, anticipating the natural formation of an upward leader. The Airterminal generates a leader that propagates rapidly to capture the Lightning stroke and conduct it towards the ground.

Arcing is not to be continuous and shall only occur during the progress of the lightning leader.

The air termination shall not cause high frequency radio interference except during the millisecond intervals associated with the progress of the lightning leader and during the main return strike of lightning events in the region.

The materials of the air termination shall be non-corroding in normal atmosphere.

The air termination shall not be dependent upon batteries or external power supplies for any part of its operation.

The Height of the air terminal support mast should be minimum 2mts and the height will be increased as per the coverage design.

The support shall be securely installed and guy wires shall be used where necessary to enable the air termination and mast system to withstand maximum locally recorded wind velocities.

8.3.4 Down Conductor

The downconductor should be used 25 x 3 mm copper strip. Two downconductors shall be used in case of the structure height is above 28mts and both should be connected with maintenance-free Grounding system.

The main copper conductor shall be connected directly to the air termination.

The down conductor shall be installed in accordance with the manufacturer's instructions and should not be subject to sharper bends.

The downconductor must be kept in constant physical contact with the structure via conductive mounting clamps.

8.3.5 Lightning Flash Counter

Each protection system shall be supplied with Lightning strike counter. The counter shall have a register that activates one count for every discharge where the peak current exceeds 400A at the 8/20us standard.

The lightning flash counter shall be robust and easy to install. The counter shall operate from the energy of the lightning discharge and should not work on external or battery power to operate.

The lightning flash counter shall be installed to the manufacturer's instructions in a readily accessible manner (always 2mts above the Ground) so that reading can be taken at regular intervals. It shall be positioned such that its operating temperature is within the range -20°C to + 60°C.

8.3.6 Grounding System

The Lightning arrester grounding system reading shall not exceed 10 ohms static impedance except with prior approval by the specifying engineer or manufacturer of the lightning protection system.

Grounding will be done by copper bonded steel core ground rods especially designed for electrical grounding.

Bonding of the grounding system to metallic parts of the building, the structural reinforcing steel of the building to arriving services is recommended.

Electrically conductive, non soluble TEREC Powder should be used to achieve low ground resistance. Provided the materials are mixed and installed strictly in accordance with the manufacturer's instructions.

8.4 Lightning and Surge Voltage Protection

8.4.1 Scope

The work required under this section shall include all material, labour and auxiliaries required to furnish and install complete Surge Protection Devices at main LT Panel incoming feeders (Stage I / Class B) & Distribution Boards (Stage II / Class C) for the protection of Building electrical and Electronics system from the effect of Lightning discharges, line induced transient surge voltage or switching surges as per the details mentioned in the BOQ.

8.4.2 Codes & Standards

The following standards & publications as referred in the various parts of this Specification shall apply.

IEC-61643-11, IEC-61643-12

IEC 60 364 – 5 – 5 53

IEC 62 305 - 4

8.4.3 Product Specifications

8.4.3.1 Surge Protector at Stage I / Class B (L T Panel Protector)

The Surge Protection Device (SPD) manufacturer shall offer a complete line of Surge Protection Devices to support the requirements for Main LT Panel Incoming feeders. The surge protector at this stage shall be provided to protect the down stream electrical and electronics against any lightning discharges surges that may enter into the system through Mains panel.

The Protection unit shall be based on single arc spark gap technology and shall be able to withstand 10/350 microsecond surge currents associated with external lightning discharges.

8.4.3.2 Protection Network Configuration

The work required under this section consists of furnishing, installing and connecting SPD device as specified and as asked for in BOQ. The SPD device shall be installed in a NETWORK configuration, consisting of one set of SPD panel device at the service entrance of switchboard. All SPD device in this network configuration shall be of same manufacturer. All SPD device shall be modular, mountable on 35 mm DIN rail.

Unit status indicator shall be provided to indicate the status of complete Protection unit.

Protection shall be manufactured for the specific type and voltage of the electrical Service and shall provide clamping for both normal (L-N) and common (N-G) mode operation.

Protection shall be manufactured to withstand a maximum continuous operating voltage of not less than 115% of normal RMS Line voltage of 240 V.

The Protection shall be provided with safety MCB's to be connected in series between Line/s to neutral & neutral to earth as per the TNS configuration of wiring. It shall be testable on line for routine maintenance, module failure and in order to prevent catastrophic failure modes.

Protection shall be a fail-safe type device, shall have a follow through current quenching capacity upto 25 KA r.m.s., shall have repeated surge capability state, shall be self restoring and be fully automatic in all mode of operation.

Protection shall comply with IEC 61643 and shall be approved for the location in which they are listed.

Protection shall have an operating temperature ranges from -20°C to 60°C.

8.4.3.3 Protection Criteria

- The maximum continuous operating voltage (Rated Voltage) for SPD devices connected to phase-neutral shall not be less than the values shown in table:

Nominal Voltage Rating per phase (Vrms)	Maximum Continuous Operating Voltage (Vrms)
240	320

- Listing
- The surge protective device and associated hardware must comply with IEC 61643-11.
- The Protection voltage of the complete rail mount surge protective device shall be type test to the figures as indicated in table below, which must not exceed the values shown.

Service Voltage / per phase	Protection Voltage @ In (Nominal discharge current) / Protection Level
240 V	< 2.5 k V (between Line to Neutral) 1.5 kV (between Neutral to Earth)

- Surge protective device application at Low Voltage AC main LT Panel incoming feeder surge impulse current withstanding capacity as shown in table below.

Application Panel Location	Max. Single Withstand Surge Current (of 10/350 μs Impulse)
Service Entrance (Main LT Panel)	25 KA, 10/350μs (between Line to Neutral) 100 KA, 10/350 (between neutral to Earth)

- Compliance to this specification must be provided in the form of a certificate from an independent testing laboratory.
- Response time of stage-I class –B arrester should not be < 100 ns.

8.4.3.4 Surge protector at Stage II / Class C (Final Distribution Board Protector)

- The surge Protection manufacturer shall offer a complete line of surge Protection product to support the requirements for the Distribution Board. The surge protector at this stage shall be provided to protect the down stream electrical and electronics against any induced switching surges that may be passed on to the down stream electrical & electronic system.
- The Protection unit shall be based on Single High Capacity Metal Oxide Varistors (MOV), capable of handling 8/20 μs surges and shall be able to give an indication in the event module failure and be pluggable to facilitate the in-service replacement without distributing the lines. One extra set of replacement module shall be furnished to the job site.
- **Protection Network Configuration.** The work required under this section consists of furnishing, installing and connecting SPD device as specified and as shown in the drawings. The SPD device shall be installed in a NETWORK configuration, consist of one set of SPD panel device at the service entrance of switchboard. All SPD device in this network configuration shall be of same manufacturer. All SPD device

shall be modular, mountable on 35 mm DIN rail and be field replaceable without interruption of electrical distribution circuit.

- Unit status indicator shall be provided to indicate the status of complete Protection unit on the product as well as provision for remote indication must be provided.
- Protection shall be manufactured for the specific type and voltage of the electrical Service and shall provide clamping for both normal (L-N) and common (N-G) mode operation.
- Protection shall be manufactured to withstand a maximum continuous operating voltage of not less than 115% of normal RMS Line voltage of 240 VAC.
- The Protection shall be provided with internal safety fusing if required, to be connected in parallel between Line/s to neutral & neutral to earth as per the TNS configuration of wiring. It shall be testable on line for routine maintenance, module failure and in order to prevent catastrophic failure modes.
- Protection shall be a fail-safe type device, shall have no follow through current shall have repeated surge capability, shall be solid state, shall be self restoring and be fully automatic in all mode of operation. It shall have thermal disconnection and indication against overloading of the device.

Protection shall comply with IEC 61643 standards.

Protection shall have an operating temperature ranges from -20°C to + 60°C.

Protection Criteria

The maximum continuous operating voltage (Rated voltage) for SPD devices connected to phase-neutral shall not be less than the values as shown in table below:

Nominal Voltage Rating per phase (Vrms)	Maximum Continuous Operating Voltage (Vrms)
120	150
240	320
350	440
480	600

Listing

The surge protective device and associated hardware must comply with IEC 61643-11.

The Protection voltage of the complete rail mount surge protective device shall be type test to the figures as indicated in table below, which must not exceed the values shown.

Service Voltage / per phase	Protection Voltage @ In (Nominal discharge current) / Protection Level
240 V	1500 V

Nominal Withstand Surge Current.

Surge Protective device (including all fusing and over current protection) for application at sub-Distribution Panels shall have a Nominal surge current withstand capacity as shown in table below. The failure or operation of any fuse / over – current device during the test is not permissible.

Application Panel Location	Max. Single Withstand Surge Current Of 8/20 μs Impulse)
Sub-Distribution Panel Final Distribution Board	10KA for 8 / 20 μs (between Line to Neutral) 25 KA for 10/350 μs (between Neutral to Earth)

- Compliance to this specification must be provided in the form of a certificate from an independent testing laboratory.

- Response time of Class C arrestor should not be <25 ns.

9. 6.6 / 11 / 22 / 33 KV SWITCHGEAR

9.1 VCB

9.1.1 Scope

Manufacturing, testing and supplying of integrated cubicle type metal clad, form 3 a, floor mounted and draw out type free standing, front operated indoor type 6.6/ 11 / 22 / 33 KV switchgear as per specifications given below:

System

The switchgear enclosure shall conform to degree of protection IP 4 X.

The switchgear shall be made from MS 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.

9.1.2 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.

9.1.3 Bus Bar Compartment

Bus bars of rectangular cross section of copper conductor supported by cast epoxy insulator to withstand full short circuit currents upto 18.4 KA for one second for 6.6 KV /11 KV system / 26.3 for 1 sec. for 22 KV & 33 KV system shall be provided at the rear. Bus bar chamber shall be provided with inter panel barriers with epoxy cast seal off bushings.

9.1.4 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.

9.1.5 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.

9.1.6 Technical Particulars of VCB Circuit Breaker

S.NO.	DESCRIPTION	6.6 KV	11 KV	22 KV	33 KV
A	Rated Current	630 A	630 A	630 A	630 A
B	Rated Voltage	7.2 KV	12 KV	24 KV	36 KV
C	Rated Frequency	50Hz	50 Hz	50Hz	50Hz
D	Rated Short Circuit breaking Current	18.4 KA for 1 sec.	18.4 KA for 1 sec.	26.3 KA for 1 sec	26.3 KA for 1 sec
E	Rated short circuit making current (KAP)	50 KA	50 KA	66 KA	66 KA
F	Insulation level (KV rms/KVP)	20 KV / 60 KV	28KV / 75 KV	50 KV / 125 KV	70 KV / 170 KV

9.1.7 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.

9.1.8 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.

9.1.9 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

9.1.10 Interlocks and Safety Devices

The following interlocks shall be provided :

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

9.1.11 Safety Devices

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

- a. 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.
- b. Cubicle with front plate to withstand the pressure for internal arc fault as per PEHLA recommendation.
- c. Circuit breaker and sheet metal enclosure shall be fully earthed.
- d. 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.

9.1.12 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.

9.1.13 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 secondaries.

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

The CTs 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

9.1.14 Potential Transformers

The potential transformers shall be conforming to IS 3156/ IEC 60185. 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 conforming to IS – 9385/ IEC –60282. Miniature Circuit breaker shall comply with IS – 8828/ IEC – 60898.

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

The potential transformer shall be as specified below:

Ratio	:	6600 / 11000/ 22000 / 33000 V3/ 110/ V3/ 110 V
V A Burdan	:	100 V A for 100/V3 and 110 V winding
Class	:	CL –1 for both the windings.
Basic Insulation level	:	Same as mentioned for VCB in clause -6.
Over voltage factor	:	1.2 Continuous

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

9.1.15 Protection and Tripping Arrangement

Protection

All protection relay shall be numeric type of approved make.

The protection and tripping arrangement of circuit breaker shall be :

- i. Numeric type instantaneous short circuit protection Device No.50 Range 500 – 2000% shall be provided on all phases.
- ii. Numeric type back up over current protection for Phase faults Device No.51 Range 50 – 200% shall be provided on all phases.
- iii. Numeric type ground fault protection Device No.50G. CT's. Range 20 – 80% shall be provided.
- iv. Lockout and trip supervisory relays etc shall be provided with manual reset facility.
- v. Auxiliary relay for transformer fault.
- vi. Surge Arrestor

9.1.16 Control Wiring

The control wiring shall be carried out with minimum 2.5 sq. mm. PVC insulated 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.

9.1.17 Metering Instrument Panel Accessories

I. Metering

Digital type Trivector meter of approved make (Smart demand controller) shall be provided on the incomer feeder. Specification of the meter shall be as follows:

Accuracy	:	Class 0.5, compliant to revenue class certification.
	:	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
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Logging & recording for all measurements:

:	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.
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Multiport

Communication	:	One each of RS 485 and RS 232 ports.
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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 Voltmeter of class 1.0 accuracy and 96 x 96 mm square in size as per IS-1248 shall be provided at incomer panel, with selector switch. The instrument shall be calibrated for the ranges specified.
- Digital type Power factor meter of class of 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 144 x 144 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 owner, 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 phas, 50 Hz A.C. for each cubicle and with thermostat control one incandescent lamp with switch and 3 pin 5 amps plug socket.

9.1.18. Drawings/Documents Required For Review/Approval

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

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

9.1.19. Inspection and Testing

After manufacturing of switchgear panels tests shall be carried out on the equipment as per relevant IS and Electricity Regulations.

9.1.20. 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.

10. AUXILIARY EQUIPMENT FOR SUB-STATION:

10.1 Battery Charger Unit

i. 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.

ii. Construction Feature

Float cum Boost charger and DC Distribution Board shall be housed in sheet steel cubicle with panels of 1.6 mm thickness, louvers for ventilation glands plate will be provided for cable entry from bottom. The cubicle shall be painted in Siemens grey shade RAL-7032. The battery charger is divided into two compartments. The upper compartment houses the battery charger with all the necessary controls. The lower compartment is suitable for housing the batteries.

iii. Performance

The D.C output voltage of Float / Boost charger shall be stabilized within $\pm 2\%$ for AC input variation of $230\text{ V} \pm 10\%$, frequency variation of $50\text{ Hz} \pm 5\%$ and DC load variation of 0-100%. The voltage regulation shall be achieved by a constant voltage regulator having fast response SCR control. The ripple content will be within 3% of DC output nominal voltage.

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.

The battery charger shall have automatic output current limiting feature.

iv. Components

The battery charger shall essentially comprise of the following

1 No. double pole ON/OFF MCB at AC input.

1 No. pilot lamp to indicate charger ON.

1 No. Main Transformer : Double wound, naturally air cooled, having copper winding.

1 set single phase full wave bridge rectifier consisting of 2 Nos. diodes and 2 Nos. SCRs, liberally rated, mounted on heat sinks and complete with resistor / condensor network for surge suppression.

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.

1 set solid state constant potential controller to stabilize the DC output voltage of the float cum boost charger at $\pm 2\%$ of time set value for AC input voltage variation of $230\text{ V} \pm 10\%$, frequency variation of $\pm 5\%$ from 50 Hz 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.

1 No. electronic controller to automatically changeover battery charging from boost to float and vice versa..

1 No. DC ammeter and toggle switch to read charger output current and battery charge / discharge current.

1 No. moving coil DC voltmeter to read the DC output voltage.

2 set potentiometer to adjust the output voltage during manual /auto float and boost modes.

1 No. double pole ON/OFF MCB for Charger Output (24 V DC Rating).

2 set DC output terminals. 1 set for the load and the other set for the battery.

Alarm Annunciation : Visual and audible alarm with manual accept reset facility shall be provided for the following :

- a. AC mains fail
- b. Charger Fail
- c. Load / Output overvolt.

Rating

AC Input	:	230 V \pm 10% AC 50 Hz single phase.
DC Output	:	To float / boost charge 24 V / 200 AH batteries and also supply a continuous load.
Current Rating	:	30.0 Amps
Float Mode	:	27.0 V nominal (Adjustable) between 24-28.0 V.
Boost Mode	:	28.2 V nominal (Adjustable) between 24-29.0 V.
Voltage Regulation	:	$\pm 2\%$ for AC input variation of $230\text{ V} \pm 10\%$. Frequency Variation of $50\text{ Hz} \pm 5\%$ and DC load variation 0-100%
Ripple	:	Less than 5%

v. **DC Distribution Board**

It shall be provided in the charging cubicle, it will comprises of the following:

Incoming	:	1 No. 63 A DP MCB
Outgoing	:	10 Nos. 16 A DP MCB

10.2 Safety Equipment

Danger Plate

Danger plate shall be provided on HV and MV equipment. MV danger notice plate shall be 200 mm x 150 mm made of mild steel atleast 2 mm thick with vitreous enamelled white on both side and with inscription in red colour on front side.

Fire Extinguishers

Portable CO₂ conforming to IS:2878-1976, and dry chemical conforming to IS:2171-1967 shall be provided in the Sub-station.

Rubber Mats for Electrical Purpose

Materials :

Mats shall be of vulcanized rubber compound free from fabric insertions and fibrous materials.

The upper surface shall have ribbles or any other pattern, the thickness shall not be less than 6.5 mm at the root of the pattern.

The material shall be free from blisters, pin holes, cracks, embeded foreign matters and other defects.

12. TECHNICAL DATA FOR SWITCHGEAR CUBICLE TYPE WITH VCB BREAKER

TENDERER MUST FILL IN THE FOLLOWING TECHNICAL DATA

	<u>VCB BREAKER</u>	<u>COMPACT SWITCHGEAR</u>
12.1 Switchgear Cubicle		
i. Make		
ii. Type		
iii. Reference Standard		
iv. Voltage (System/Rated)		
v. Phase/Frequency		
vi. Short Circuit Rating		
a. Interrupting Symmetrical		
b. Short time for 1/3 sec.		
12.2 Construction		
i. Drawout feature for Circuit Breaker with Service Test & Disconnected		
ii. Minimum clear space required at :		
a. Front for breaker withdrawal		
b. Rear		
iii. Overall dimension & Operating weight		
12.3 Bus Bar		
i. Material & grade		
ii. Reference standard		
iii. Cross sectional area size		
iv. Continuous current at 40 deg C		
v. Max temp rise over for 40 deg C		
vi. Short time current for 1/3 sec.		
vii. Min clearance of bare bus bar & connection		
a. Phase to phase		
b. Phase to ground		

VCB BREAKER

COMPACT SWITCHGEAR

12.4 Circuit Breaker

- i. Make
- ii. Type
- iii. Rated voltage
- iv. Rated frequency
- v. No. of poles
- vi. Rated current
 - a. Continuous at 40 deg C & within cubicle
 - b. Short time current for 1 sec/3 sec

12.5 Max. temp rise over 40 deg C ambient

12.6 Rated operating duty

12.7 Interrupting capacity at rated voltage and operating duty

- a. Symmetrical

12.8 Rated making current

12.9 No. of breaker operations permissible without requiring inspection for refilling SF6 gas replacement of contacts & other main parts. Not Applicable

- a. At 100% rated current
- b. At 100% rated short circuit current

12.10 Type of contacts

- a. Main
- b. Arcing

12.11 Min clearance in air

- a. Between poles
- b. Between live parts & ground

12.12 Operating mechanism

- a. Type
- b. No. of breaker operations stored
- c. Trip free or fixed trip?
- d. Antipumping features provided

VCB BREAKER

COMPACT SWITCHGEAR

- 12.13** Closing Coil
- a. Voltage
 - b. Permissible voltage variation
 - c. Power required at rated voltage
- 12.14** Breaker/breaker cubicle provided with the following :
- a. Mech. safety interlocks
 - b. Automatic safety shutter
 - c. Emergency manual trip
 - d. Mech. ON/OFF indicator
 - e. Operation counter
 - f. Spring charge/discharge indications
 - g. Manual spring charging facility
 - h. Mechanical Antipumping
- 12.15** Net weight of the breaker
- 12.16** Impact load for foundation design
- 12.17** Overall dimensions in mm

13. POWER TRANSFORMERS

13.1 Dry Type Cast Resin Transformers with off Load Tap Changing Link

Scope

Design, manufacture, testing, supplying and commissioning of 6.6/11/22/33 KV/433 volts step down, transformer complete with all the accessories and fittings for efficient and trouble free operation.

Codes and Standard

Transformer shall Conform to Indian Standard IS:2026-1977 (Part I to IV),IS : 11171 - 1985 IEC 60726, ECBC-2007.

Rating

Transformer shall be suitable for continuous operation and maximum rating shall be as given in the schedule of quantities.

Connections and Vector Group

Delta on High Voltage side and star on low voltage side with neutral terminal brought out for solid earthing corresponding to the Vector Symbol Dyn - 11.

System of Supply

3 phase, 50 Cycles, 6.6 / 11 / 22 / 33 KV earthed system.

Tappings

Off load tap changing links on HV side. The tappings to be provided for variation on HV side from +5% to -7.5% in steps of 2.5 % each.

Temperature Rise

Continuously rated for full load, temperature rise not exceeding 90° C corresponding to Class "F".

Type

Indoor type.

Terminals

The cable box with glands on H T side shall be suitable for 3 core XLPE cable of specified capacity. Flanges with cable box / bus duct on LT side shall be suitable for aluminium conductor armoured cables / LT bus duct of size mentioned in BOQ. All cable glands shall be earthed.

Cooling

A N Cooled

Insulation

Glass fibre reinforced epoxy cast resin type and class 'F'.

Earthing

Two earthing terminals shall be provided at the bottom on both sides.

Fittings and Accessories

The following fittings and accessories shall be provided.

- a. Transformer shall be provided with 4 Nos bi-directional rollers fitted on cross channels to facilitate the movement of the transformer in both direction.
- b. Lifting lugs
- c. Diagram and rating plate shall be provided indicating the details of transformer, connection diagram, Vector group, tap changing diagram etc.
- d. 6 channels temperature scanner with alarm and trip contacts, and Thermistors
- e. HV Cable terminating facility for XLPE cable.
- f. LV Cable terminating facility /bus duct termination flange.
- g.

Iron Core

The core shall consist of grain oriented laminations which shall be insulated on both sides for low losses.

Winding

High Voltage and Low Voltage windings shall be made of copper and insulation shall be of class F. High voltage and low voltage windings, shall be completely impregnated and cast under vacuum into moulds. This process shall form the insulation system of uniform glass fibre epoxy laminate of highest electrical and mechanical quality, into which windings shall be voidlessly embedded.

Both the high voltage and low voltage windings of each phase shall be separately cast as one rigid tubular coil.

Enclosure

The transformer shall be housed in 2 mm thick CRCA sheet steel enclosure mounted on bi-directional rollers. Enclosure shall be provided with metal screen at top and bottom for ventilation. Degree of protection of enclosure shall be IP-28. Transformer enclosure/doors shall be openable type and shall be provided with limit switches and wired accordingly to trip the HT Breaker if the same is opened when the transformer is ON. The enclosure shall be provided with exhaust fans as an additional measure for cooling.

Drawings and Leaflets

Three copies of manual giving complete instructions for the installation, operation and maintenance with circuit diagram, foundation and trenching details shall be provided with the transformer.

Maximum Allowable Power Transformer Losses

Maximum allowable losses for Dry type distribution transformers with highest voltage for equipment upto 36 KV, at 50 % and 100 % of the load.

TRANSFORMER CAPACITY KVA	MAXIMUM ALLOWABLE LOSSES AT 50% KVA OR LOAD (% of rated KVA)	MAXIMUM ALLOWABLE LOSSES AT FULL LOAD / RATED KVA (% of rated KVA)
100	1.88	2.44
160	1.61	2.07
200	1.50	1.90
250	1.36	1.73
400	1.19	1.51
500	1.12	1.45
630	1.06	1.40
1000	0.90	1.20
1600	0.79	1.05
2000	0.75	1.00

Measurement and Reporting of Transformer Losses

Tests

- All routine tests as per IS2026-1977 / IS:11171-1985 which is applicable shall be carried out at the factory and copies of test reports shall be submitted for approval and records.
- Heat Run Test shall be carried out at an approved test lab as per IS:2026-1977 at no extra cost.
- Impulse test shall be carried out at an approved test lab as per IS:2026-1977
- Measurement of winding resistance.
- Ratio polarity and phase relationship.
- Impedance voltage.
- Load Losses.
- No-Load losses and no-load current.
- Insulation resistance.
- Induced over voltage with-stand.
- Temperature rise.

13.2 Dry Type Cast Resin Transformers with on Load Tap Changer

Scope

Design, manufacture, testing, supplying and commissioning of 6.6/ 11 / 22 / 33 KV/433 volts step down, transformer complete with all the accessories and fittings for efficient and trouble free operation.

Codes and Standard

Transformer shall Conform to Indian Standard IS:2026-1977 (Part I to IV),IS : 11171 - 1985 IEC 60726, ECBC-2007.

Rating

Transformer shall be suitable for continuous operation and maximum rating shall be as given in the schedule of quantities.

Connections and Vector Group

Delta on High Voltage side and star on low voltage side with neutral terminal brought out for solid earthing corresponding to the Vector Symbol Dyn - 11.

System of Supply

3 phase, 50 Cycles, 6.6 / 11 / 22 / 33 KV earthed system.

Tappings

On load tap changing on HV side. The tappings to be provided for variation on HV side from +5% to -15% in steps of 1.25% each.

Temperature Rise

Continuously rated for full load, temperature rise not exceeding 90° C corresponding to Class 'F'.

Type

Indoor type.

Terminals

The cable box with glands on H T side shall be suitable for 3 core XLPE cable of specified capacity. Flanges with cable box / bus duct on LT side shall be suitable for aluminium conductor armoured cables / LT bus duct of size mentioned in BOQ. All cable glands shall be earthed.

Cooling

A N Cooled

Insulation

Glass fibre reinforced epoxy cast resin type and class 'F'.

Earthing

Two earthing terminals shall be provided at the bottom on both sides.

Fittings and Accessories

- A.** The following fittings and accessories shall be provided for transformer:
- a. Transformer shall be provided with 4 Nos bi-directional rollers fitted on cross channels to facilitate the movement of the transformer in both direction.
 - b. Lifting lugs
 - c. Diagram and rating plate shall be provided indicating the details of transformer, connection diagram, Vector group, tap changing diagram etc.
 - d. 6 channels temperature scanner with alarm and trip contacts, and Thermistors
 - e. HV Cable terminating facility for XLPE cable.
 - f. LV Cable terminating facility /bus duct termination flange.
- B.** Following items shall be provided for OLTC :
- High Torque Electric motor suitable for 415 Volts, 3 phase, 50 Hz AC supply.
 - Motor drive and energy accumulator
 - Motor isolating device with over load protection
 - Contactors for forward and reverse operation of motor
 - 'Raise/Lower' control for local & remote operation.
 - 'Raise/Lower' Limit switch.
 - Interlock between manual & electrical operation.
 - Auxiliary transformer.
 - Retainer Switch
 - Tap Position Indicator
 - Tap operation counter
 - Stoppers to prevent over travelling of mechanism
 - Internal illuminating lamp with switch.
 - 'Local/Remote' control selector switch.
 - Auto/Manual selector switch.
 - Anti-condensation heater with switch and thermostat
 - Handle for manual operation.
 - Driving Mechanism chamber locking arrangement.
 - Terminal Strips
 - Lubricating Chart

- Undrilled gland plate for cable entry.
- C. The following shall be required for remote indicating. :
- Potentio meter for remote tap position indicator
 - Contacts for Tap change in progress indication.
 - Contacts for Upper and Lower limit reached indication.
 - Contacts for Tap change stuck / incomplete indication.

IRON CORE

The core shall consist of grain oriented laminations which shall be insulated on both sides for low losses.

WINDING

High Voltage and Low Voltage windings shall be made of copper and insulation shall be of class F. High voltage and low voltage windings, shall be completely impregnated and cast under vacuum into moulds. This process shall form the insulation system of uniform glass fibre epoxy laminate of highest electrical and mechanical quality, into which windings shall be voidlessly embedded.

Both the high voltage and low voltage windings of each phase shall be separately cast as one rigid tubular coil.

ENCLOSURE

The transformer shall be housed in 2 mm thick CRCA sheet steel enclosure mounted on bi-directional rollers. Enclosure shall be provided with metal screen at top and bottom for ventilation. Degree of protection of enclosure shall be IP-28. Transformer enclosure/doors shall be openable type and shall be provided with limit switches and wired accordingly to trip the HT Breaker if the same is opened when the transformer is ON. The enclosure shall be provided with exhaust fans as an additional measure for cooling.

DRAWINGS AND LEAFLETS

Three copies of manual giving complete instructions for the installation, operation and maintenance with circuit diagram , foundation and trenching details shall be provided with the transformer.

Maximum Allowable Power Transformer Losses

Maximum allowable losses for Dry type distribution transformers with highest voltage for equipment upto 36 KV, at 50 % and 100 % of the load.

TRANSFORMER CAPACITY KVA	MAXIMUM ALLOWABLE LOSSES (kW) AT 50% KVA OR LOAD (% of rated KVA)	MAXIMUM ALLOWABLE LOSSES (kW) AT FULL LOAD / RATED KVA (% of rated KVA)
100	1.88	2.44
160	1.61	2.07
200	1.50	1.90
250	1.36	1.73
400	1.19	1.51
500	1.12	1.45
630	1.06	1.40
1000	0.90	1.20
1600	0.79	1.05

2000	0.75	1.00
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Measurement and Reporting of Transformer Losses

TESTS

- All routine tests as per IS2026-1977 / IS:11171-1985 which is applicable shall be carried out at the factory and copies of test reports shall be submitted for approval and records.
- Heat Run Test shall be carried out at an approved test lab as per IS:2026-1977 at no extra cost.
- Impulse test shall be carried out at an approved test lab as per IS:2026-1977
- Measurement of winding resistance.
- Ratio polarity and phase relationship.
- Impedance voltage.
- Load Losses.
- No-Load losses and no-load current.
- Insulation resistance.
- Induced over voltage with-stand.
- Temperature rise.

REMOTE TAP CHANGER CONTROL PANEL (RTCC)

Construction Featres

RTCC panel shall be of sheet steel cabinet for indoor installation, floor mounting type. The RTCC panel shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket and padlocking arrangement. RTCC panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of RTCC panel shall be 14 SWG CRCA sheet steel and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-8623-1977 (part-I) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of RTCC panel. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panel.

The following components shall be provided in the RTCC panel :

- Digital Tap Position Indicating Meter
- Raise/Lower Push Buttons for Remote Control of OLTC
- Tap Change in Progress Signal Lamp.
- Supply on Signal Lamp
- Local / Remote Control Indicating Lamps
- Panel illuminating lamp with door switch.
- Space Heater with Switch and Thermostat.
- Automatic Voltage Relay with Time Delay Element.

- Selectors switch for Auto/Manual Operation.
- Undrilled Gland Plate for Cable entry.
- Earthing Terminal
- Lifting Eyes Bolts.

13.3 VPI Resin Dry Type Transformers With Off Load Tap Changing links

SCOPE

Design, manufacture, testing, supplying and commissioning of 6.6 / 11 KV / 433 volts step down transformer complete with all the accessories and fittings for efficient and trouble free operation.

CODES and STANDARD

Transformer shall conform to Indian Standard IS:2026-1977(Part I to IV). 11171-1985 and IEC 60726, ECBC-2007.

RATING

Transformer shall be suitable for continuous operation and maximum rating shall be as given in the schedule of quantities.

CONNECTIONS AND VECTOR GROUP

Delta on High Voltage side and star on low voltage side with neutral terminal brought out for solid earthing corresponding to the Vector Symbol Dyn-11.

SYSTEM OF SUPPLY

3 phase, 50 cycles, 6.6 / 11 KV earthed system.

TAPPINGS

Off load tap changing links on HV side. The tapplings to be provided for variation on HV side from +5%.to -7.5% in steps of 2.5% each.

TEMPERATURE RISE

Continuously rated for full load temperature rise not exceeding 115° C corresponding to Class "H"

TYPE

Indoor Type.

TERMINALS

The cable box with glands on HT side shall be suitable for 3 core XLPE cable of specified capacity. Flanges for bus duct on LT side shall be suitable for size mentioned in BOQ. All cable glands shall be earthed.

COOLING

A N Cooled.

EARTHING

Two earthing terminals shall be provided at the bottom on both sides.

FITTINGS AND ACCESSORIES

The following fittings and accessories shall be provided

- Transformers shall be provided with 4 Nos bi-directional rollers fitted on cross channels to facilitate the movement of the transformer in both direction.
- Lifting lugs
- Diagram and rating plate shall be provided indicating the details of transformer connection diagram. Vector group, tap changing diagram etc.
- 6 channels temperature scanner with alarm and trip contacts, and Thermistors
- HV Cable terminating facility for XLPE cable.
- Bus duct termination flange.
- .
- Disconnecting, chamber shall be provided for cable termination.

IRON CORE

The core shall consists of non-ageing cold rolled grain oriented sheet steel. Core shall be treated with high temperature resistant paint to prevent corrosion at edges of the core plates.

WINDING

Windings shall be of electrolytic copper conductors covered with Nomex polyimide paper fibre glass having high tensile and dielectric strength. Low voltage windings are two layer helical type employing number of strips in parallel. High voltage windings shall be of crossover coils or disc type coils separated from each other by keyed radical spacers.

IMPREGNATION

After winding, the coils shall be impregnated by a cycloaliphatic epoxy resin by vacuum pressure impregnation process. This process ensures void free impregnation i.e. the resins penetrate and seal the insulating materials forming a composite mass after polymerisation.

VPI process consists of

- Preheatings** : To remove moisture
- Vacuum Drying** : Moisture and volatiles are removed.
- Resin entry under vacuum**
- Vacuum submersion** : For impregnating and fill in the voids

ENCLOSURE

The transformer shall be housed in 2 mm thick CRCA sheet steel enclosure mounted on bi-directional rollers. Enclosure shall be provided with metal screen at top and bottom for ventilation. Degree of protection of enclosure shall be IP-23. Transformer enclosure/doors shall be openable type and shall be provided with limit switches and wired accordingly to trip the HT Breaker if the same is opened when the transformer is ON. The enclosure shall be provided with exhaust fans as an additional measure for cooling.

DRAWINGS AND LEAFLETS

Three copies of manual giving complete instructions for the installation, operation and maintenance with circuit diagram , foundation and trenching details shall be provided with the transformer.

Maximum Allowable Power Transformer Losses

Maximum allowable losses for Dry type distribution transformers with highest voltage for equipment upto 12 KV, at 50 % and 100 % of the load.

TRANSFORMER CAPACITY KVA	MAXIMUM ALLOWABLE LOSSES (kW) AT 50% KVA OR LOAD (%)	MAXIMUM ALLOWABLE LOSSES (kW) AT FULL LOAD / RATED KVA (%)
100	1.88	2.44
160	1.61	2.07
200	1.50	1.90
250	1.36	1.73
400	1.19	1.51
500	1.12	1.45
630	1.06	1.40
1000	0.90	1.20
1600	0.79	1.05
2000	0.75	1.00

Measurement and Reporting of Transformer Losses

TESTS

- All routine tests as per IS2026-1977 / IS:11171-1985 which is applicable shall be carried out at the factory and copies of test reports shall be submitted for approval and records.
- Heat Run Test shall be carried out at an approved test lab as per IS:2026-1977 at no extra cost.
- Impulse test shall be carried out at an approved test lab as per IS:2026-1977
- Measurement of winding resistance.
- Ratio polarity and phase relationship.
- Impedance voltage.
- Load Losses.
- No-Load losses and no-load current.
- Insulation resistance.
- Induced over voltage with-stand.
- Temperature rise.

13.4 VPI Resin Dry Type Transformers with OLTC on HV Side

SCOPE

Design, manufacture, testing, supplying and commissioning of 6.6 / 11 KV / 433 volts step down transformer complete with all the accessories and fittings for efficient and trouble free operation.

This specification covers only the general requirements of the transformer. The specific requirements shall be given in detail on the attached Transformer Data Sheet.

CODES AND STANDARDS

Transformer shall conform to Indian Standard IS 2026-1977 (part I to IV), IS 11171-1985, IEC 60726, ECBC-2007.

RATING

Transformer shall be suitable for continuous operation and maximum rating shall be as given in the schedule of quantities.

CONNECTIONS AND VECTOR GROUP

Delta on High Voltage side and star on low voltage side with neutral terminal brought out for solid earthing corresponding to the Vector Symbol Dyn-11.

SYSTEM OF SUPPLY

3 phase, 50 cycles, 6.6/11 KV earthed system.

TAPPINGS

ON load tap changing (oltc) on HV side. The tappings to be provided for variation on HV side from + 5% to – 15% in steps of 1.25% each.

TEMPERATURE RISE

Continuously rated for full load temperature rise not exceeding 115° C corresponding to Class “H”.

TYPE

Indoor Type.

TERMINALS

The cable box with glands on HT side shall be suitable for 3 core XLPE cable of specified capacity. Flanges for bus duct on LT side shall be suitable for size mentioned in BOQ. All cable glands shall be earthed.

PHASE SEQUENCE

RYB

COOLING

A N Cooled.

EARTHING

Two earthing terminals shall be provided at the bottom on both sides.

FITTINGS AND ACCESSORIES

- A.** The following fittings and accessories shall be provided for transformer:
- Transformers shall be provided with 4 Nos bi-directional rollers fitted on cross channels to facilitate the movement of the transformer in both direction.
 - Lifting lugs
 - Diagram and rating plate shall be provided indicating the details of transformer connection diagram. Vector group, tap changing diagram etc.
 - 6 channels temperature scanner with alarm and trip contacts, and Thermistors
 - HV Cable terminating facility for XLPE cable.
 - Bus duct termination flange.
- B.** Following items shall be provided for OLTC :
- High Torque Electric motor suitable for 415 Volts, 3 phase, 50 Hz AC supply.
 - Motor drive and energy accumulator
 - Motor isolating device with over load protection
 - Contactors for forward and reverse operation of motor
 - 'Raise/Lower' control for local & remote operation.
 - 'Raise/Lower' Limit switch.
 - Interlock between manual & electrical operation.
 - Auxiliary transformer.
 - Retainer Switch
 - Tap Position Indicator
 - Tap operation counter
 - Stoppers to prevent over travelling of mechanism
 - Internal illuminating lamp with switch.
 - 'Local/Remote' control selector switch.
 - Auto/Manual selector switch.
 - Anti-condensation heater with switch and thermostat
 - Handle for manual operation.
 - Driving Mechanism chamber locking arrangement.
 - Terminal Strips
 - Lubricating Chart

- Undrilled gland plate for cable entry.

C. The following shall be required for remote indicating. :

- Potentio meter for remote tap position indicator
- Contacts for Tap change in progress indication.
- Contacts for Upper and Lower limit reached indication.
- Contacts for Tap change stuck / incomplete indication.

IRON CORE

The core shall consist of non-ageing cold rolled grain oriented sheet steel. Core shall be treated with high temperature resistant paint to prevent corrosion at edges of the core plates.

WINDING

Windings shall be of electrolytic copper conductors covered with Nomex polyimide paper fibre glass having high tensile and dielectric strength. Low voltage windings are two layer helical type employing number of strips in parallel. High voltage windings shall be of crossover coils or disc type coils separated from each other by keyed radical spacers.

IMPREGNATION

After winding, the coils shall be impregnated by a cycloaliphatic epoxy resin by vacuum pressure impregnation process. This process ensures void free impregnation i.e. the resins penetrate and seal the insulating materials forming a composite mass after polymerisation.

VPI process consists of

Preheatings : To remove moisture

Vacuum Drying : Moisture and volatiles are removed.

**Resin entry under vacuum
Vacuum submersion** : For impregnating and fill in the voids

ENCLOSURE

The transformer shall be housed in 2 mm thick CRCA sheet steel enclosure mounted on bi-directional rollers. Enclosure shall be provided with metal screen at top and bottom for ventilation. Degree of protection of enclosure shall be IP-23. Transformer enclosure/doors shall be openable type and shall be provided with limit switches and wired accordingly to trip the HT Breaker if the same is opened when the transformer is ON. The enclosure shall be provided with exhaust fans as an additional measure for cooling.

DRAWINGS AND LEAFLETS

Three copies of manual giving complete instructions for the installation, operation and maintenance with circuit diagram, foundation and trenching details shall be provided with the transformer.

Maximum Allowable Power Transformer Losses

Maximum allowable losses for Dry type distribution transformers with highest voltage for equipment upto 12 KV, at 50 % and 100 % of the load.

TRANSFORMER CAPACITY KVA	MAXIMUM ALLOWABLE LOSSES (kW) AT 50% KVA OR LOAD (%)	MAXIMUM ALLOWABLE LOSSES (kW) AT FULL LOAD / RATED KVA (%)
100	1.88	2.44
160	1.61	2.07
200	1.50	1.90
250	1.36	1.73
400	1.19	1.51
500	1.12	1.45
630	1.06	1.40
1000	0.90	1.20
1600	0.79	1.05
2000	0.75	1.00

Measurement and Reporting of Transformer Losses

TESTS

- All routine tests as per IS2026-1977 / IS:11171-1985 which is applicable shall be carried out at the factory and copies of test reports shall be submitted for approval and records.
- Heat Run Test shall be carried out at an approved test lab as per IS:2026-1977 at no extra cost.
- Impulse test shall be carried out at an approved test lab as per IS:2026-1977
- Measurement of winding resistance.
- Ratio polarity and phase relationship.
- Impedance voltage.
- Load Losses.
- No-Load losses and no-load current.
- Insulation resistance.
- Induced over voltage with-stand.
- Temperature rise.

REMOTE TAP CHANGER CONTROL PANEL (RTCC)

Construction Features

RTCC panel shall be of sheet steel cabinet for indoor installation, floor mounting type. The RTCC panel shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket and padlocking arrangement. RTCC panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of RTCC panel shall be 14 SWG CRCA sheet steel and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall conform to IS-8623-1977 (part-I) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of RTCC panel. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panel.

The following components shall be provided in the RTCC panel :

- Digital Tap Position Indicating Meter
- Raise/Lower Push Buttons for Remote Control of OLTC
- Tap Change in Progress Signal Lamp.
- Supply on Signal Lamp
- Local / Remote Control Indicating Lamps
- Panel illuminating lamp with door switch.
- Space Heater with Switch and Thermostat.
- Automatic Voltage Relay with Time Delay Element.
- Selectors switch for Auto/Manual Operation.
- Undrilled Gland Plate for Cable entry.
- Earthing Terminal
- Lifting Eyes Bolts.

13.5 Oil Filled Transformers with OFF Load Tap Changing Links on HV Side

SCOPE

Design, manufacture, testing, supplying and commissioning of 6.6 / 11 / 22 / 33 KV / 433 volts step down transformer complete with all the accessories and fittings for efficient and trouble free operation.

CODES and STANDARD

Transformer shall conform to Indian Standard IS: 2026-Part I to Part IV, ECBC-2007.

RATING

Selected transformer shall be of specified rating suitable for continuous operation.

CONNECTIONS AND VECTOR GROUP

Delta on High Voltage side and star on low voltage side with neutral terminal brought out for solid earthing corresponding to the Vector Symbol Dyn - 11.

SYSTEM OF SUPPLY

3 phase, 50 Hz 6.6 / 11 / 22 / 33 KV earthed system.

TAPPINGS

'OFF' load tap changing links on HV side. The tappings to be provided for variation on HV side from + 2.5% to - 7.5% in steps of 2.5%. each.

TEMPERATURE RISE

Continuously rated for full load, temperature rise not exceeding 45° C by thermometer in oil or 55 Deg C by resistance.

TYPE

Outdoor/Indoor type.

TERMINALS

The cable box with glands on H T side shall be suitable for 3 core XLPE cable of specified capacity. Flanges with cable box / bus duct on LT side shall be suitable for aluminium conductor armoured cables / LT bus duct of size mentioned in BOQ. All cable glands shall be earthed.

COOLING

Natural cooling by means of pressed/round tubes around transformer tank.

INSULATION

The transformer shall be oil insulated type.

EARTHING

Two separate earthing terminals to be provided at the bottom on both sides.

FITTINGS AND ACCESSORIES

The following accessories and fittings shall be provided.

- a) Lifting Lugs : The arrangement for lifting the active part out of the transformer tank alongwith the cover by means of lifting lugs without disturbing the connections.
- b) Swivel Type Rollers: the transformer to be provided with 4 Nos Bi-Directional rollers fitted on cross channels to facilitate the movement of the transformer in both directions.
- c) Oil Conservator : The transformer to be provided with an oil conservator with welded end plates. It is to be bolted to the cover and can be dismantled for purpose of transport. It has to be provided with magnetic oil level gauge and an oil filling hole 1 1/4" BSF size with a cap, which can be used for filtering oil. For draining purpose a plug shall be provided.. A connection pipe between the conservator and the main tank is to be provided which projects inside the conservator and the main tank
- d) Air release Valve : An air release valve is to be provided on the top of the tank cover facilitate the release of the entrapped air and filling of oil.
- e) Breather : The transformer to be provided with an indicating dehydrating silicagel breather of sufficient capacity.

- f.) Drain-cum-oil Filter Valves : The transformer to be provided with a drain-cum-oil filter valve of 1 1/4" BSF size at the bottom of the tank.
- g.) Diagram and rating plate : Diagram and rating plate shall be provided indicating the details of transformer, connection diagram, vector group, tap changing diagram etc.
- h.) Dial type thermometer for Oil (150 mm dia) with maximum set pointer at 75 deg C and electrical contacts for electrical alarm at high temperature.
- i.) Winding temperature indication and electrical contacts for trip / alarm.
- j.) Buchholz relay of double float type with high gas pressure alarm & trip suitable for 24 volts DC supply.
- k.) Filter valve of 1 1/4" BSF at top.
- l.) Explosion vent.
- m.) Disconnecting chamber shall be provided for cable termination.
- n.) Outdoor type Marshalling box with interconnecting cables
- o.) HT Cable box suitable for 3 C x 300 sq.mm HT XLPE (E) cable
- p.) LV Cable box suitable for 3 C x 300 sq.mm 1.1 kV XLPE (E) cable or L.V bus duct flange arrangement as per BOQ

WINDING

The transformer shall be copper conductor wound.

CORE

The magnetic core shall be made up of cold rolled grain oriented low loss steel stampings.

DRAWINGS AND LEAFLETS

Three copies of operation and maintenance manual with complete instructions for the installation, operations, maintenance and repairs, circuit diagram, foundation and trenching details shall be provided with the transformer.

Maximum Allowable Power Transformer Losses

Maximum allowable losses for oil filled distribution transformers with highest voltage for equipment 36 KV, at 50% and 100% of the load.

TRANSFORMER CAPACITY KVA	MAXIMUM ALLOWABLE LOSSES (kW) AT 50% KVA OR LOAD (%)	MAXIMUM ALLOWABLE LOSSES (kW) AT FULL LOAD / RATED KVA (%)
100	1.04	1.8
160	0.96	1.38
200	0.93	1.35
250	0.89	1.27
400	0.79	1.12
500	0.75	1.05
630	0.70	0.99

1000	0.70	0.98
1600	0.65	0.98
2000	0.64	0.98

Measurement and Reporting of Transformer Losses

TESTING

The transformer shall be subject to the following tests at the factory before despatching the same and test certificates shall be furnished.

- a. Measurement of winding resistance.
- b. Ratio polarity and phase relationship.
- c. Impedance voltage.
- d. Load losses.
- e. No-load losses and no-load current.
- f. Insulation resistance.
- g. Induced over voltage withstand.
- h. Separate - source voltage withstand.
- j. Temperature rise.
- k. Di-electric strength of oil.

13.6 Oil Filled Transformers with on Load Tap Changing on HV Side

SCOPE

Design, manufacture, testing, supplying and commissioning of 6.6 / 11 / 22 / 33 KV / 433 volts step down transformer complete with all the accessories and fittings for efficient and trouble free operation.

CODES and STANDARD

Transformer shall Conform to Indian Standard IS:2026-Part I to Part IV, ECBC-2007.

RATING

Selected Transformer shall be of specified rating suitable for continuous operation.

CONNECTIONS AND VECTOR GROUP

Delta on High Voltage side and star on low voltage side with neutral terminal brought out for solid earthing corresponding to the Vector Symbol Dyn - 11.

SYSTEM OF SUPPLY

3 phase, 50 Hz 6.6 , 11 , 22 , 33 KV earthed system.

TAPPINGS

'ON' load tap changing on HV side. The tappings to be provided for variation on HV side from + 5% to -15.% in steps of 1.25.% each.

TEMPERATURE RISE

Continuously rated for full load, temperature rise not exceeding 45° C by thermometer in oil or 55 Deg C by resistance.

TYPE

Indoor/ Outdoor type.

TERMINALS

The cable box with glands on H T side shall be suitable for 3 core XLPE cable of specified capacity. Flanges with cable box / bus duct on LT side shall be suitable for aluminium conductor armoured cables/LT bus duct of size mentioned in BOQ. All cable glands shall be earthed.

COOLING

Natural cooling by means of pressed/round tubes around transformer tank.

INSULATION

The transformer shall be oil insulated type.

EARTHING

Two separate earthing terminals to be provided at the bottom on both sides.

FITTINGS AND ACCESSORIES

A. The following accessories and fittings shall be provided for Transformer :

- Lifting Lugs : The arrangement for lifting the active part out of the transformer tank alongwith the cover by means of lifting lugs without disturbing the connections.
- Swivel Type Rollers: the transformer to be provided with 4 Nos Bi-Directional rollers fitted on cross channels to facilitate the movement of the transformer in both directions.
- Oil Conservator : The transformer to be provided with an oil conservator with welded end plates. It is to be bolted to the cover and can be dismantled for purpose of transport. It has to be provided with magnetic oil level gauge and an oil filling hole 1 1/4" BSF size with a cap, which can be used for filtering oil. For draining purpose a plug shall provided.. A connection pipe between the conservator and the main tank is to be provided which projects inside the conservator and the main tank
- Air release Valve : An air release valve is to be provided on the top of the tank cover facilitate the release of the entrapped air and filling of oil.
- Breather : The transformer to be provided with an indicating dehydrating silicagel breather of sufficient capacity.
- Drain-cum-oil Filter Valves : The transformer to be provided with a drain-cum-oil filter valve of 1 1/4" BSF size at the bottom of the tank.

- Diagram and rating plate : Diagram and rating plate shall be provided indicating the details of transformer, connection diagram, vector group, tap changing diagram etc.
- Dial type thermometer (150 mm dia) with maximum set pointer at 75 deg C and electrical contacts for electrical alarm at high temperature.
- Winding temperature indication and electrical contacts for trip / alm.
- Buchholz relay of double float type with electrical contacts for low oil level alarm and high gas pressure trip suitable for 24 volts DC supply.
- Filter valve of 1 1/4" BSF at top.
- Explosion vent.
- Disconnecting chamber shall be provided for cable termination.
- Outdoor type Marshalling box with interconnecting cables
- HT Cable box suitable for 3 C x 300 sq.mm HT XLPE (E) cable
- LV Cable box suitable for 3.5 C x 300 sq.mm 1.1 kV XLPE (E) cable or L.V bus duct flange arrangement as per BOQ

B. Following items shall be provided for OLTC :

- High Torque Electric motor suitable for 415 Voltas, 3 phase, 50 Hz AC supply.
- Motor drive and energy accumulator
- Motor isolating device with over load protection
- Contactors for forward and reverse operation of motor
- 'Raise/Lower' control for local & remote operation.
- 'Raise/Lower' Limit switch.
- Interlock between manual & electrical operation.
- Auxiliary transformer.
- Retainer Switch
- Tap Position Indicator
- Tap operation counter
- Stoppers to prevent over travelling of mechanism
- Internal illuminating lamp with switch.
- 'Local/Remote' control selector switch.
- Auto/Manual selector switch.
- Anti-condensation heater with switch and thermostat
- Handle for manual operation.

- Driving Mechanism chamber locking arrangement.
- Terminal Strips
- Lubricating Chart
- Undrilled gland plate for cable entry.

C. The following shall be required for remote indicating. :

- Potentio meter for remote tap position indicator
- Contacts for Tap change in progress indication.
- Contacts for Upper and Lower limit reached indication.
- Contacts for Tap change stuck / incomplete indication.

WINDING

The transformer shall be copper conductor wound.

CORE

The magnetic core shall be made up of cold rolled grain oriented low loss steel stampings.

DRAWINGS AND LEAFLETS

Three copies of operation and maintenance manual with complete instructions for the installation, operations, maintenance and repairs, circuit diagram, foundation and trenching details shall be provided with the transformer.

Maximum Allowable Power Transformer Losses

Maximum allowable losses for oil filled distribution transformers with highest voltage for equipment 36 KV, at 50% and 100% of the load.

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630	0.70	0.99
1000	0.70	0.98
1600	0.65	0.98
2000	0.64	0.98

Measurement and Reporting of Transformer Losses

TESTING

The transformer shall be subject to the following tests at the factory before despatching the same and test certificates shall be furnished.

- a. Measurement of winding resistance.
- b. Ratio polarity and phase relationship.
- c. Impedance voltage.
- d. Load losses.
- e. No-load losses and no-load current.
- f. Insulation resistance.
- g. Induced over voltage withstand.
- h. Separate - source voltage withstand.
- j. Temperature rise.
- k. Di-electric strength of oil.

REMOTE TAP CHANGER CONTROL PANEL (RTCC)

Construction Features

RTCC panel shall be of sheet steel cabinet for indoor installation, floor mounting type. The RTCC panel shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket and padlocking arrangement. RTCC panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of RTCC panel shall be 14 SWG CRCA sheet steel and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall conform to IS-8623-1977 (part-I) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of RTCC panel. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panel.

The following components shall be provided in the RTCC panel :

- Digital Tap Position Indicating Meter
- Raise/Lower Push Buttons for Remote Control of OLTC
- Tap Change in Progress Signal Lamp.
- Supply on Signal Lamp
- Local / Remote Control Indicating Lamps
- Panel illuminating lamp with door switch.
- Space Heater with Switch and Thermostat.
- Automatic Voltage Relay with Time Delay Element.
- Selectors switch for Auto/Manual Operation.
- Undrilled Gland Plate for Cable entry.
- Earthing Terminal
- Lifting Eyes Bolts.

14. TECHNICAL DATA FOR TRANSFORMER
TENDERER MUST FILL IN THE FOLLOWING TECHNICAL DATA

S. No.	Technical Parameters	CAST RESIN DRY TYPE	VPI Dry TYPE	Oil Filled TYPE
1.	Type and class of insulation			
2.	Output in KVA (Continuously rated)			
3.	Rated Voltage			
	a. HV (Volts)			
	b. LV (Volts)			
4.	Rated Current			
	a. HV (amps)			
	b. LV (amps)			
5.	No. of phase			
6.	Type of cooling			
7.	Frequency			
8.	Winding Connection			
9.	Tapings			
10.	Vector Group			
11.	Ref. Ambient temperature			
	Temperature rise winding			
	Class of insulation			
12.	Physical Dimensions			
	a. Length (in mm)			
	b. Width (in mm)			
	c. Height (in mm)			
13.	% Impedance			
14.	X/R ratio			
15.	Iron losses at normal voltage ratio			
16.	Copper loses at normal voltage ratio at full load			

S. No.	Technical Parameters	CAST RESIN DRY TYPE	VPI Dry TYPE	Oil Filled TYPE
17.	Efficiency at unity power factor			
	a. Full load			
	b. 75% load			
	c. 50% load			
18.	Regulation at unit power factor			
19.	Regulation at 0.8 power factor			
20.	Approximate weight			
	a. Core & winding (Kgs.)			
	b. Total Weight (Kgs.)			
21	Oil (Ltrs)	Not Applicable	Not Applicable	

15. COMPACT PACKAGE SUBSTATION

CODE & STANDARDS:

All equipment and material shall be designed manufactured and tested in accordance with the latest applicable Indian Standard / IEC standard, shall be type tested and shall have necessary statutory approval **from local authority**.

Equipment and material conforming to any other standard which ensures equal or better quality may be accepted. In such case copies of English version of the standard adopted shall be submitted.

The electrical installation shall meet the requirement of Indian Electricity Rules as amended upto date relevant IS code of practice and Indian electricity act.

The Compact Secondary Sub-station offered shall in general comply with the latest issues including amendments of the following standards but not restricted to it.

Title	Indian Standards
High Voltage Low Voltage Pre-Fabricated Substation	IEC:1330
6.6 / 11 kV Switchgear cubicles	IS:13118, IS:3427, IEC:694. IEC:298
Ring main unit 6.6 / 11 kV grade	IS:9920, IEC:265
Code of practice for selection, installation and maintenance of Switchgear	IS:10118
Distribution Transformer	IS: 2026
Dry Type Power Transformer	IS:11171
Colour for ready mix paints	IS:5
Enamel synthetic, exterior a)Undercoating b) finishing	IS:2932
Indian Electricity Rules	1956
Indian Electricity Act	1910

DESIGN CRITERIA

Compact Secondary Sub-station consisting of **6.6 / 11kV Non-Ext Compact SF6 RMU(2no. cable isolating switches & one Tap off Vacuum circuit Breaker) + Transformer + L.T. Switchgear** with all connection accessories, fitting & auxiliary equipment in an Enclosure to supply Low-voltage energy from high-voltage system as detailed in this specification. The complete unit shall be installed on a substation plinth (base) as **Outdoor substation** located at very congested places. The HT Circuit Breaker shall be used to control and isolate the 6.6 / 11kV/433V Distribution transformer. The transformer L.T. side shall be connected to L.T. switchgear. The connection cables to Feeder Pillars shall be taken out from the L.T. switchgear.

The prefabricated-Compact Secondary substation shall be designed for a) Compactness, b) fast installation, c) maintenance free operation, d) safety for worker/operator & public.

The Switchgear and component thereof shall be capable of withstanding the mechanical and thermal stresses of short circuit listed in ratings and requirements clause without any damage or deterioration of the materials.

For continues operation at specified ratings temperature rise of the various switchgear components shall be limited to permissible values stipulated in the relevant standard and / or this specification.

Service Conditions:

The equipment offered shall be suitable for continuous satisfactory operation in tropical area of Installation.

Enclosure: The Enclosure, High Voltage switchgear-control gear, Low Voltage switchgear-control gear & Transformer of the Compact Secondary substation shall be designed to be used under **normal outdoor service condition** as mentioned. The enclosure should take minimum space for the installation including the space required for approaching various doors & equipment inside. The enclosure construction shall be such that it fully protects ingress of rain water & rusting .For this purpose, construction without welded joint is preferred.

SPECIFIC REQUIREMENT

The main components of a prefabricated-Compact Secondary substation are Transformer, High-voltage switchgear-control gear, Low-voltage switchgear-control gear, corresponding interconnections (cable, flexible, bus bars) & auxiliary equipment. The components shall be enclosed, by either common enclosure or by an assembly of enclosure. All the components shall comply with their relevant IS/IEC standards.

Ratings:

Description	Value
Rated Voltage/ Operating Voltage	6.6 / 11 kV rms
Rated frequency & Number of phases	50Hz & 3nos.
Rated maximum power of sub-station	As given in B.O.Q.
Rated Ingress protection class of Enclou:	IP-23D for substation enclosure and IP:54 for LT Switchgear & HT Switchgear enclosure
HV Insulation Level	
Rated withstand voltage at power frequency of 50 Hz	28 kV rms
Rated Impulse withstand Voltage	75 kV peak
HV Network & Busbar	
Rated current	630 Amp
Bus Bar current density (Cu)	1 Amps/sq.mm
Rated short time withstand current	21 kA rms/1sec
Making capacity for switch-disconnector & earthing switches	52.5 kA peak
Breaking capacity of Isolators (rated full load)	630 A
Tap off Breaker	630 A
LT Network	
	1 No. ---A (Max.), 3P, ---kA ACB with micro-processor based release as incomer
	---Nos. ---A (Max), 3P, ---kA ACB/ MCCB with micro-processor based release as outgoing.

Outdoor enclosure:

The enclosure shall be made of Galvanized Iron tropicalised to Indian weather conditions.

The metal base shall ensure rigidity for easy transport & installation.

The structure of the substation shall be capable of supporting the gross weight of all the equipment & the roof of the substation compartment shall be designed to support adequate loads.

The protection degree of the Enclosure shall be **IP54 for LT & HT switchgear compartment & IP23D for Transformer compartment**. Proper / adequate ventilation aperture shall be provided with Louvers for natural ventilation etc.

The doors shall be provided with proper interlocking arrangement for safety of operator.

The H.V. & L.V. outgoing of the transformer are to be connected to HT Breaker & incomer of the L.V.

Internal Fault : Failure within the Compact Secondary substation due to either a defect, an exceptional service condition or mal-operation may initiate an internal arc. Such an event may lead to the risk of injury, if persons are present. It is desirable that the highest practicable degree of protection to persons shall be provided.

Covers & Doors : Covers & doors shall be part of the enclosure. When they are closed, they shall provide the degree of protection specified for the enclosure. Ventilation openings shall be so arranged or shielded that same degree of protection as specified for enclosure is obtained. Additional wire mesh may be used with proper Danger board for safety of the operator. All covers, doors or roof shall be provided with locking facility or it shall not be possible to open or remove them before doors used for normal operation have been opened. The doors shall open outward at an angle of at least 90° & be equipped with a device able to maintain them in an open position.

Earthing : All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequate terminal intended for connection to the earth system of the installation, by way of flexible jumpers/strips & Lug arrangement. The continuity of the earth system shall be ensured taking into account the thermal & mechanical stresses caused by the current it may have to carry. The components to be connected to the earth system shall include:

- a) The enclosure of Compact Secondary / prefabricated substation,
- b) The enclosure of High voltage switchgear & control gear from the terminal provided for the purpose,
- c) The metal screen & the high voltage cable earth conductor,
- d) The transformer tank or metal frame of transformer,
- e) The frame &/or enclosure of low voltage switchgear,

There shall be arrangement for internal lighting activated by associated switch for HV, Transformer & LT compartments separately.

Labels : Labels for warning , manufacturer's operating instructions etc. & those according to local standards & regulations shall be durable & clearly legible.

Cleaning & Painting :

- a) The paints shall be carefully selected to withstand tropical heat rain. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.
- b) Special care shall be taken by the manufacturer to ensure against rusting of nuts, bolts and fittings during operation. All bushings and current carrying parts shall be cleaned properly after final painting.

6.6 / 11kV Non-Ext RMU:

The requirement of 11kV Switchgear is as under.

SF6 Gas filled Non-extensible Ring Main Units with HT Circuit Breaker comprising of 3 panels as indicated below:

Panel No.1 & 2 : Isolator panel with one number SF6 insulated load breaking fault making isolator switch with one cable box accessible from the front.

Panel No.3- VCB Breaker (Feeding to transformer) complete with operating mechanism, protection system and One Number of cable box accessible from the front suitable for terminating of suitable size XLPE cables (Details to be frozen while detailed engineering)

The above Breaker , Busbars should be mounted inside a robotically welded sealed for life , stainless steel tank of 3 mm thick sheet metal. The tank should be filled with SF6 gas at adequate pressure. The degree of protection for gas tank should be IP67.

The VCB is required to control 6.6 / 11 kV/433 volts distribution Transformer of suitable rating and relay settings shall be selected accordingly.

General Finish: Totally enclosed, metal clad, vermin and dust proof suitable for tropical climate use as detailed in the specification.

Ratings: The busbars shall have continuous rating of 630 Amps. The isolator shall have a continuous rating of 630 Amps VCB Breaker shall have a continuous rating of 200 Amps. in accordance with relevant IS / IEC standard

Breaking & Making Capacity : The VCB, Breaker shall be capable of having rupturing capacity of 21kA symmetrical at 11000 volts three phase.

Busbar: Switchgear shall be complete with all connection, bus-bars etc. Copper busbars continuous rating shall be 630 Amps. The busbars should be fully encapsulated by SF6 gas inside the steel tank.

Remote Operation: Provision of remote operation of the RMU's Isolators & Breaker CB shall be possible using Motors fitted to the operating mechanism. It shall be possible to fit the motors either directly in manufacturing plant or on site as & when required. Installation on site shall be possible (optional – all required provisions to be made)

Switchgear :

The SF6 RMU shall be Sealed for life, the enclosure shall meet the “sealed pressure system” criteria in accordance with IEC:298 (a system for which no handling of gas is required through out service life of approximate 25 years.) There shall be no requirement to ‘top up’ the SF6 gas. In addition, manufacturer shall confirm that maximum leakage rate is lower than 0.1% per year. It shall provide full insulation, making the switchgear insensitive to the environment. Thus assembled, the active parts of the switchgear unit shall be maintenance free.

The switchgear & switchboard shall be designed so that the position of different devices is visible to the operator on the front of the switchboard & operation are visible as well. The switchboard shall be designed so as to prevent access to all live parts during operation without the use of tools.

RMU should be tested for internal arc fault test.

Isolator :

The Isolators offered shall conform to IEC60129. The isolator shall be triple pole, spring assisted, hand operated, non-automatic type with quick break contacts. The operating handle shall have three positions 'ON', 'OFF' and 'EARTH' which shall be clearly marked with suitable arrangement to padlock in any position. A safety arrangement for locking shall be provided by which the isolator operation shall be prevented from 'ON' position to 'EARTH' position or vice versa in a single operation.

VCB:

The Unit shall consist 630 A Tee-off spring assisted, three pole VCB circuit Breaker, with integral fault making / dead breaking earth switch. The function shall be naturally interlocked to prevent the main & earth switch from being switched 'ON' at the same time & the CB not allowed to trip in 'Earth On' position. The selection of the main/earth switch lever on the panel, which is allowed to move only if the main or earth switches in the off position. The lever shall be able to pad locked in either the main or earth position.

The manual operation of the circuit breaker shall not have an effect on the trip spring. This should only be discharged under a fault (electrical) trip condition, the following manual reset operation should recharge the trip spring & reset the CB mechanism in 'main off' position.

Protection :

a) **Protection Relays:** The CB shall be fitted with microprocessor based self powered relay inside the front cover to avoid any tampering.

Cable Box :

Every isolator shall be provided with suitable and identical cable boxes for connecting 3 core, 11kV cable from vertically below. The cable boxes shall be so located at convenient height to facilitate easy cable jointing work. **The Cable termination shall be done by Heat shrinkable Termination method** so adequate clearances shall be maintained between phases for Termination. Access to all the cables should be possible from the front of RMU.

Locking Arrangement : Suitable padlocking arrangements shall be provided as stated below...

- a) CB manual operating handle in the "OFF" position.
- b) Each feeder Panel operating handle in 'Closed' 'Open' or 'Earth' position.
- c) Each isolator operating handle in 'Closed', 'Open', or 'Earth' position.

Ratings :

Non-Extensible switchgear with VCB

Switchgear Data

- | | |
|-------------------------------------|------------------------------|
| a) Service | Outdoor but inside Enclosure |
| b) Type | Metal clad |
| c) Number of phases | 3 |
| d) Voltage | 6.6 / 11 KV |
| e) Rated Frequency | 50 Hz |
| f) Rated Current | 630 Amp |
| g) Short Circuit rating | |
| i) Breaking | 21 kA rms for Breaker |
| ii) Short time withstand for 3 Sec. | 21 kA rms |
| iii) Rated S/c making | 52.5 kA peak for Breaker |
| h) Short duration power frequency | 28 kV |

- i) Insulation Level 75 kV peak
- j) System earthing Solidly earthed at substation

Breaker

- a) Type VCB in SF6 tank
- b) Rated voltage 6.6 / 11 KV
- c) Breaking current
 - i) Load breaking 21 kA rms.
- d) Making current 52.5 kA peak
- e) Rated current 630 Amps.
- f) No. of poles 3
- g) Operating mechanism. Trip free & free handle type with mechanically operated indication & pad locking.

Busbars (If any)

- a) Material Copper
- b) Type SF6 insulated
- c) Rated Current 630 Amps

Tests For RMU: Each type of 6.6 / 11kV Switchgear shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards i.e. IS : 9920, IS : 3427, IS : 13118, IEC : 265, IEC : 298 and during manufacturing and on completion

Routine Tests : The tests shall include but not necessarily limited to the following -

- a) Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme and proper functioning of the equipment.
- b) All wiring and current carrying part shall be given appropriate High Voltage test.

DISTRIBUTION TRANSFORMER

Cast Resin/ VPI Resin Dry Type Transformer :

Requirement: 6.6 /11 / 0.433 KV Cast resin/ VPI Resin Dry Type , (KVA as per B.O.Q.) KVA, AN cooled suitable for installation at outdoor in Enclosure for ground mounting.

Voltage Ratio : No load voltage 6600 / 11000/433 volt within tolerance as stipulated in IS.

Rating : The transformer shall have a continuous rating as specified at any of the specified tapping position and with the maximum temperature rise specified.

Magnetic Core : The Core will be made from Laminations of grain oriented silicon steel, insulated with mineral oxide and will be protected against corrosion with coat of varnish.

The choice and grade of steel and the cutting pattern and method of assembly minimizes the loss level and the no load current with the effect of a very low noise level.

Fittings / Accessories

- 1) 2 nos. earthing terminals
- 2) Rating and diagram plate
- 3) 1 no. Winding temperature indicator
- 4) Off circuit tapping links
- 5) 4 nos. flat bi-directional rollers
- 6) Lifting lugs
- 7) Cooling fans
- 8) Marshalling box

Technical Particulars of Transformer

	<u>Description</u>	<u>Unit</u>	<u>Value</u>
1	Service		Outdoor
2	Type		Dry Type
3	Rating	kVA	As per B.O.Q
4	Rated frequency	Hz	50
5	Number of Phase		
	HV Side		3 phase 3 wire
	LT Side		3 phase 4 wire
6	Rated Voltage		
	HV Side	kV	6.6/11
	LT Side	kV	0.433
	Vector Group		DYN-11
8	Type of Cooling		AN
9	Class of Insulations		CLASS F/H
10	Insulation Level		
	a) Power Frequency withstand	kV rms	20 KV/ 28KV
	Impulse Withstand	kV Peak	60 KV/ 75KV
11	Method of earthing-LT		TNS as per IS3043
12	Duty		Continuous
13	Taps		
	a) range	%	+5% to -7.5%
	b) No. of Steps		6
	c) In steps of	%	2.5% each
	d) Tapping provided on HV Side		Yes
14	Tap Changer Type		OFF Load
15	Impedance Voltage at 75°C		
	a) At Principal tapping	%	As per IS Code ±10%
16	Temperature Rise above 50°C ambient		
	a) Winding by Resistance	°C	40°C for Class F/ 65°C for Class H
17	Terminals		
	a) HV Side		Cable Box
	b) LT Side		Flexible Copper connection
18	Losses (at 75°C and principle Tapping) (IS Tol.)		
	a) No Load at rated Voltage and Frequency	KW	Should be less than allowed in ECBC-2007.
	b) Load loss at Rated Current	KW	Should be less than allowed in ECBC-2007.
	c) Total Loss at maximum Rated Power	KW	Should be less than allowed in ECBC-2007.
19	Efficiency at 75°C and unity P.F.		
	a) At Full Load	%	Should be better than allowed in ECBC.
	b) At 75% Load	%	Should be better than allowed in ECBC.
	c) At 50% of Load	%	Should be better than allowed in ECBC.
	Hot spot temperature of winding limited to	°C	90°C for Class F/ 115°C for Class H
20			
21	Reference Standards		IS-2026, IS-11171, IEC 60726, ECBC-2007

ISOLATOR PANEL :

System:-

- a) **Declared voltage** :- 3 Phase, 415V ($\pm 10\%$) 50 Hz,
- b) **Neutral** :- Solidly earthed at substation.

General finish :- Tropical, totally enclosed, metal-clad, weather-proof, vermin and dust proof.

Enclosure :- Type of enclosure shall be able to provide the degree of protection IP : 4X .

Circuit Ways for kVA (as per B.O.Q.) CSS :

Incoming of 1no ---A, 3P, ---kA Fixed Manual ACB with microprocessor based release .
Outgoing of --- nos. ---A, 3P, --kA Fixed Manual ACB/ MCCB with microprocessor based release

Construction :

The terminals shall be of sufficient mechanical strength and shall provide adequate electrical contact for the appropriate size of cable used. They shall be capable of receiving appropriate size of Aluminum conductors. They shall be provided with stainless steel nut bolts, plane washers and spring washers for cable connection.

The enclosure of LT Shall be constructed using 2mm CRCA sheet steel.

No contact pressure shall be transmitted through insulating material & the gripping of the conductor shall take place between metal faces.

Earthing :

Earthing arrangement shall be provided for earthing each cable, PVC cable gland, neutral busbar, chassis and frame work of the cubicle with separate earthing terminals at two ends. The main earthing terminals shall be suitably marked .The earthing terminals shall be of adequate size, protected against corrosion, and readily accessible. These shall be identified by means of sign marked in a legible manner on or adjacent to terminals.
Neutral bus bar strip shall be connected to Earthing terminal with help of copper strip of suitable capacity & nut-bolt arrangement.

Accessories: The following accessories shall be supplied duly mounted.

One incandescent lamp (with necessary fuse) to illuminate the fuse board internally.

TYPE / ROUTINE TEST ON COMPACT SECONDARY SUBSTATION :

Type Tests:

The offered Compact Secondary substation should be fully type tested as per the IEC-1330

Routine Tests :

The routine tests shall be made on each complete prefabricated substation.

- a) Voltage tests on auxiliary circuit.
- b) Functional test.
- c) Verification of complete wiring.

Test Witness: Routine test shall be performed in presence of Owner's representative if so desired by the Owner. The Contractor shall give at least fifteen (15) days advance notice of the date when the tests are to be carried out.

Test Certificates:

Test report for the test mentioned under Type tests clause shall be submitted along with offer.

Certified reports of all the tests carried out at the works shall be furnished in three (3) copies for approval of the Owner.

16. HT CABLE

6.6 / 11 / 22 / 33 KV GRADE XLPE

16.1 General

Cables shall be aluminium conductor, cross linked polyurethene construction and shall be supplied, inspected, laid, tested and commissioned in accordance with drawings, specifications, relevant Standard Specifications and cable manufacturers instructions.

16.2 Material

a. Conductor

The Conductor shall be made from electrical purity aluminum stranded wires compacted together.

b. Insulation

High quality TROPOTHEN - X (XLPE) unfilled insulating compound of natural colour shall be used for insulation. Insulation shall be applied by extrusion process and shall be chemically cross linked in continuous vulcanization process.

c. Shielding

Cables shall be provided with conductor shielding as well as insulation shielding and shall consist of extruded semi-conducting compound, additionally insulation shield shall be provided with semi-conducting and metallic tape shield over the extruded insulation shield. XLPE insulation and outer core shielding shall be extruded in one operation.

d. Armouring

Armouring shall be applied over the inner sheath and shall comprise of flat steel wires (strips).

e. Outer Sheath

Tough outer sheath of heat resisting PVC compound shall be extruded over the armouring in case of armoured cables or over extruded over the armouring in case of armoured cables or over inner sheath in the case of unarmoured cables.

16.3 Tests

Cables shall be type tested and routine tested in accordance with IS:7098 (Part II).

a. Conductor resistance test.

b. Partial discharge test.

c. High Voltage test.

The following tests shall be carried out at site for insulation between phases and between phase and earth before and after cable laying.

- a. Insulation Resistance Test.
- b. Continuity resistance test.
- c. Sheathing continuity test.
- d. Earth test.
- e. High Voltage test.

Cables shall be laid with a clearance of at least 75 mm between two cables.

16.4 End Termination of HT Cable

Pre-moulded cable terminations for XLPE cable shall be used as per manufacturer's instructions. The steel cone of M-seal Push-On shall consist of highly track resistant insulating section vulcanised to a semi-conducting section. The pad material shall have cold-flow properties and shall be flame retardant.

Each end terminal shall undergo Hi Pot Test.

16.5 Laying of HT Cables

Direct in Ground

The work shall involve excavation of trench and laying of cable(s) as indicated in drawing and Schedule of Quantities.

The depth of the excavation shall not be less than 900 mm for 6.6 / 11 KV and 1050 mm for 22 / 33 KV plus radius of cable, from the upper surface of ground. Where more than one multicore cable is laid in the same trench, a horizontal inter spacing of 250 mm shall be left in order to reduce mutual heating and also to ensure that fault occurring on one cable will not damage the adjacent cable.

Cable shall be laid in cement pipes encased in concrete or hume pipes at all road crossing. Cables shall be laid in trenches over rollers placed inside the trenches. After the cable has been properly laid and straightened, it shall be covered with 80 mm thick layer of sand. Cable shall then be lifted and placed over this sand cushion. Again, the cable shall be covered with a 80 mm layer of sand. Over the sand a layer of cable protection tiles shall be placed by overlapping 50 mm on either side. Trenches shall then be back-filled with earth and shall be consolidated. Suitable cable markers made of cast iron with aluminium paint indicating the voltage grade and direction of run of the cables shall be installed at regular intervals.

16.6 RCC/Masonry Trench

For laying of HT cable in RCC/Masonry trench refer detail on sub-station layout drawing and IS-1255-1983.

17. H.T. SERVO VOLTAGE STABILISER

17.1 Specifications

a.	KVA Rating	:	As specified in Schedule of Quantity
b.	Rated Voltage	:	6.6/11/22/33 KV AC
c.	Input Volts	:	4.5 KV to 7.5KV for 6.6 KV System 9 KV to 12KV for 11 KV System 18 KV to 24KV for 22 KV System 28 KV to 36 KV for 33 KV System
d.	Output Volts	:	6.6/ 11/ 22/ 33 KV \pm 1%
e.	Rated Frequency	:	50 Hz
f.	No. of Phases	:	3 Phase
g.	Load	:	Unbalanced
h.	Basic Impulse insulation level	:	60/75/125/170 KV peak
j.	Type of cooling	:	ONAN
k.	Maximum temperature rise		
	i. of oil by thermometer	:	44 deg C
	ii. of winding by resistance	:	55 deg C
	iii. of hot spot temperature indicator	:	65 deg C
l.	Limit of hot spot temperature for which the transformer is to be designed	:	110 deg C
m.	Service	:	Indoor/Outdoor

17.2 Schedule Of Equipment

..... KV automatic voltage stabilizer as per technical requirements shall comprise of :

- Step down transformer double wound star / delta connected.
- On load stepless rolling contact type voltage regulators, Auto wound, delta connected.
- Booster transformer, double wound open / open.
- Automatic control gear : Consisting of one electronic relay, one reversing geared motor unit, two limit switches in order to avoid over - running highest and lowest positions, chain drive, coupling devices and all electrical connections.

Tanks and Fittings:

Item (a) & (c) above, shall be housed in a sheet steel tank fitted with radiators and mounted on unidirectional rollers. Item b & d above shall be housed in a separate sheet steel tank. The following fitting shall be provided with the equipment :

- a. Lifting lugs.
- b. Earthing terminals
- c. Rating plate
- d. Filter valve top and bottom.
- e. Oil filling hole
- f. Thermometer pocket.
- g. Oil level gauge.
- h. Silicagel dehydrating breather (with alarm contacts)
- j. Conservator.
- k. Dial type oil temperature indicator with alarm and contacts.
- l. Buchholz relay with alarm and trip contacts.
- m. Explosion vent.
- n. The tank shall be supplied with first filling of transformer oil conforming to IS-335 (Latest addition) and all other fittings as mentioned in your offer.
- o. Jacking Pad.
- p. Air release device.
- q. Winding temperature indicator with one set of contacts for alarm and trip. (These should be housed in W.P. box with flexible leads and with requisite connectors)
- r. Axles and wheels

The booster shall be provided with bidirectional flanged wheels suitable for use on rail track. These wheel shall be suitable for being turned through an angle of 90 deg. and locked in that position when the tank is jacked up.
- s. Detachable radiators with top and bottom shut off valves and air release plug on each radiator top.
- t. Inspection cover with air release plug.
- u. Terminal box alarm and trip contacts with requisite connectors.

Terminals:

- i. Input/outputs dust and vermin proof indoor type.
- ii. Aux, connection - suitable for 1.1 KV grade PVC cable.
(All necessary cables shall be supplied by the supplier).

Central Constructional Features:

The unit shall have three distant features as under :

- i. Hand control,
- ii. Motor control
- iii. Automatic control.

- a. Hand Control

A hand control shall be located on the front of the regulator tank at convenient operative height.

- b. Motor Control

Raise / Lower push button control by means of small single phase reversible geared motor of the permanent capacitor type shall be provided. The limit switches shall be provided to restrict the travel at extreme positions. It shall be possible to provide remote control to the regulating unit.

- c. Automatic Control

An electronic relay shall be provided to correct the fluctuations in supply voltage automatically. It shall sense the output voltage and provide signal to the driving motor for necessary correction.

Necessary interconnection including termination arrangement between stepdown transformer, regulator, boost transformer and automatic control gear shall be provided by the supplier.

Each unit shall be supplied complete in its own self with all necessary accessories and no item / accessories shall be provided by the purchaser.

18. L.T. SERVO VOLTAGE STABILISER

- 18.1 Voltage stabiliser shall correct the voltage automatically as per required specification and variation limit without any distortion in the output voltage waveform.
- 18.2 Voltage stabiliser up to 100 kVA shall be air cooled where as stabiliser above 100 kVA shall be oil cooled.
- 18.3 Stabiliser shall consist of following units:
- Regulator unit
 - Buck boost unit
 - Automatic control unit
 - Enclosure
- 18.4 Automatic regulator unit shall be oil cooled above 100 kVA, naturally cooled on load, stepless rolling contact type.
- Fittings and accessories for regulator shall be as follows:
- Radiator cooling system when oil cooled
 - Lifting lugs
 - Earthing terminals
 - Diagram and rating plate.
 - Drain valve and oil filling hole when oil cooled
 - Silica gel breather when oil cooled
 - Thermometer pockets
- 18.5 Core :

The magnetic circuit shall be built of transformer grade cold rolled grain oriented low loss steel stampings having high permeability and conforming to adopted standards. Stamping shall be insulated from each other with material having high inter-lamination insulation resistance and rust inhibiting property and also capable of withstanding pressure, mechanical vibration and action of heat and oil, thus reducing the possibility of sludge formation to a minimum.

The framework clamping arrangement and general structure of the cores shall be of robust construction and shall be capable of with sustained any shock to which they may be subject during transport, installation and service. The assembled core shall be securely clamped on the limbs and the yoke, to build up a rigid structure. The clamping pressure shall be uniform the whole of the core and so adjusted as to minimize noise and vibration in the core when the transformer is in service. The framework and the core bolts shall be efficiently insulated from the core so as to reduce the circulating currents to a minimum.

The core clamping frame shall be provided with lifting eyes for the purpose of tanking and untanking the core with winding mounted thereon and shall have ample strength to take the full weight of th core and winding assembly.

- 18.6 Winding

The coils used for winding shall be circular in shape made of paper insulated continuous and smooth tinned or enameled electrolytic copper conductors of high conductivity.

Liberal ducts shall be provided to prevent any hot spot temperature in the winging that may adversely affect the life of the equipment. Adequate supports wedges and spacers of hard insulating material shall be so fitted that they will neither move nor permit relative movement of any part of winding during transit of normal service or under terminal short-circuit, nor damage the winding insulation in any way. All leads

and connections shall be robust, adequately insulated, protected and clamped. The winding assembly shall be dried in vacuum with tested insulating oil of approved standard. The windings shall be subjected to a through shrinking and seasoning process so that no further shrinking of windings occurs during service at site. However, adjustable devices shall be provided for taking up any possible shrinkage of coils in service. The assembly shall be held in position under adequate axial compression to withstand the axial thrust likely to occur under terminal short-circuit.

18.7 Auto Control Unit

Auto control unit shall be mounted along with the regulator tank and shall consists of

- PCB relay / electronic relay
- Step syn. Geared motor
- Auto / manual switch
- Set of push buttons
- Lower raise switch /push buttons
- Indicating lights
- Input & output voltmeters
- Ammeter with selector switch

a.	KVA Rating	:	As per schedule of quantities.
b.	Rated Voltage	:	415 VAC
c.	Input Volts	:	330 V to 460 V AC
d.	Output Volts	:	415 V \pm 1%
e.	Rated Frequency	:	50 Hz.
f.	No. of phases for bypass system	:	3 Phase 4 wires system
g.	Load	:	Unbalanced
h.	Type of cooling	:	Air cooled upto 100 kVA and ONAN above 100 kVA
i.	Maximum temperature rise		
	- of oil by thermometer	:	44 Deg C
	- of winding by resistance	:	55 Deg C
	- of hot spot temperature indicator	:	65 Deg C
j.	Limit of hot spot temperature for which the transformer is to be designed.	:	110 Deg C
k.	Service	:	Indoor / Outdoor
l.	Automatic control gear : Consisting of one electronic relay, reversing geared motor under limit switches in order to avoid over - running highest and lowest positions, chain drive, control devices and all electrical connections. Alternatively variac consisting of carbon brushes can be provided for Automatic regulation.		
m.	Efficiency	:	Better than 94%

- n. Distortion at output : Not exceed 5%
- o. Rate of correction : Not more than 8 volts per second.
- p. Schedule of Equipment
415 V Automatic voltage stabiliser as per technical requirements shall comprise of :
 - i. Rolling contact type on load voltage regulator /variac carbon brush type.
 - ii. Buck-Boost transformer.
 - iii. Automatic control gear.

q. Tanks and Fittings :

The equipment shall be housed in a sheet steel tank fitted with radiators and mounted on bidirectional / Unidirectional rollers. The following shall be with the equipment.

- i. Lifting lugs.
- ii. Earthing terminals.
- iii. Rating plate.
- iv. Drain valves.
- v. Oil filling hole.
- vi. Thermometer pocket.
- vii. Oil Level Guage.
- viii. Silicagel breather
- ix. Filter Valve.

Note :

- i) 0-500 digital voltmeter with selector switch shall be provided for incoming and outgoing side of stabilizer

19. EXTERNAL / STREET LIGHTING POLES

19.1. M.S. Tubular Poles

19.1.1 7 Meter High Pole with Ladder Bars

7 meter high (5.75 meters above and 1.25 meters below ground) shall be M.S. step tubular pole in 3 steps (bottom part shall be 4 meters high, 114.3 mm outer dia and 3.65 mm wall thickness, middle part shall be 1.5 meter high, 88.9 mm outer dia and 3.25 mm wall thickness, top part shall be 1.5 meters high, 76.1 mm outer dia and 3.25 mm wall thickness) with 300 mm x 300 mm x 6 mm thick base plate. Foundation for the pole shall be of cement concrete in 1:2:4 ratio. (1 part cement, 2 parts, coarse sand and 4 parts stone aggregate) IP-55 weather proof junction box shall also be provided to accommodate 1 No. 3 phase and neutral terminal block and 1 No. 6 amps SP MCB including 2.5 sq.mm PVC insulated copper conductor wire from the terminal block to the fixture and 2 Nos. 32 mm dia GI sleeves of suitable length shall be provided to the junction box.

19.1.2 4.5 Meter High Pole

4.5 meter high (3.6 meter above and 0.9 meter below ground) shall be 75 mm dia, 3.25 mm wall thickness MS tubular straight pole with a cast aluminium adaptor for post top mounting. Pole shall be provided with 300 mm x 300 mm x 6 mm thick MS base plate. Foundation for the pole shall be of cement concrete in 1:2:4 ratio (1 part cement, 2 parts coarse sand and 4 parts stone aggregate) IP-55 weather proof junction box shall also be provided to accommodate 1 No. 3 phase and neutral terminal block and 1 No. 6 amps SP MCB including 2.5 sq.mm PVC insulated copper conductor wires from the terminal block to the fixture and 2 Nos. 32 mm dia GI sleeves of suitable length shall be provided to the junction box.

19.2 Cast Aluminium Poles

Design & Construction

Ornamental cast aluminum pole shall be made out of cast aluminum as per requirements of IS:202 (1993). Casting of all pole Sections shall be accurately done from permanent moulds and cores of the design submitted to Achieve uniformity in all design aspects in internal and external shape of the unit. All sections shall be free from defects like blow holes, porosity, hard spots, cracks, Hot tears, cold shuts, distortion, sand and slag inclusion and other harmful defects. All the casted sections used in the pole shall be free from welding of any kind used to repair it. The casted sections shall be machined from all the locations used to insert the pieces into one another using either threading or socket method. Accuracy of all machined parts shall be maintained through out a lot for random replacements of sections if and when required. All the threaded joints shall be mechanically tightened and sealed using industrial tools to make the entire unit vandal resistant.

Aesthetic appearance

All the grooves and carvings of the pole unit shall be free from any kind of distortion for a pleasing aesthetic appearance.

Material

Cast aluminum material used for casting pole unit shall be Grade FG-220 type, as described in IS:202 and shall have minimum tensile strength of the order of 200 N/mmsq.

Pre-treatment

Each and every casted piece shall be subject to Sand blasting at a pressure of 10-15 kgf to remove all its external dirt and sand remains etc..

Painting and Finishing

Entire unit shall be given an extensive three stage treatment with PU based two pack Zn-Ph primer and paint prescribed for CI surfaces to make it absolutely rust and corrosion proof, as well as giving it a pleasing appearance. PU based paint shall be MRF make or equivalent.

Thickness of the coating

A minimum of 80 microns of coating thickness shall be achieved on the final piece.

Mounting arrangement

Pole unit shall be grouted using 4 nos. anchor bolts of size M-16x450 mm conforming to 6.8 Gr. as per IS 2062. Pole unit shall be grouted on a foundation made out of 1:3:6 concrete cement after excavating the earth with proper cable sleeves etc.. laid in the foundation itself.

Dimensions of the unit

Total height = 3000 mm

Dia of base plate = 380 mm

Pitch Circle Dia = 335 mm

Description of top bracket / arms

Single double decorative arm shall be provided on the pole (as asked for in B.O.Q.), secured with the help of two nos. bolts outreach not less than 400 mm.

Service window

A service window of the size 150 mm x 100 mm shall be provided in the base of the pole to allow access to electrical connections and terminations. It shall be covered with MS plate and proper rubber gaskets shall be provided to prevent any ingress of water etc..

Electrical connections

Four way connectors shall be provided along with Slide lock and 1 no. 6 amps Sp MCB including 2.5 sqmm PVC insulated copper conductor wires from the terminal block to the fixture and 2 nos. 32 mm dia GI sleeves of suitable length shall be provided upto the service window. An earth boss is provided on the control plate along with connectors and interrupters.

19.3 Galvanized Octagonal Poles

Design

The Octagonal poles shall be designed to withstand the maximum wind speed of 169 KM / Hr. as per IS 875. The top loading i.e. area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS : 5649 Part VI 1982.

Pole Shaft

The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinal welding. There shall not be any circumferential welding. The welding of pole shaft shall be done by submerged Arc Welding (SAW) process.

All octagonal pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing 4 foundation bolts. This base plate shall be fillet welded to the pole shaft at two locations i.e. from inside and outside. The welding shall be done as per qualified MMAW process approved by Third Party Inspection agency.

Door opening

The octagonal poles shall have door of approximate 500 mm length at the elevation of 500 mm from the Base plate. The door shall be vandal resistance and shall be weather proof to ensure safety of inside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing.

The pole shall be adequately strengthened at the location of the door to compensate for the loss in section.

Material

Octagonal Poles HT Steel Conforming to grade S355JO

Base Plate Fe 410 conforming to IS 226 / IS 2062

Foundation Bolts EN.8 grade

Welding

The welding shall be carried out conforming to approved procedures duly qualified by third party inspection agency. The welders shall also be qualified for welding the octagonal shafts.

Pole sections

The Octagonal Poles shall be in single section (upto 11 mtr). There shall not be any circumferential weld joint.

Galvanization

The poles shall be hot dip galvanized as per IS 2629 / IS 2633 / IS 4759 standards with average coating thickness of 70 micron. The galvanizing shall be done in single dipping.

Xing type

The Octagonal Poles shall be bolted on a pre-cast foundation with a set of four foundation bolts for greater rigidity.

Top Mountings

The galvanized mounting bracket shall be supplied along with the Octagonal Poles for Installation of the luminaries.

Manufacturing

The pole manufacturing & galvanizing unit shall be ISO 9001 : 2000 & ISO 14001 certified to ensure consistent quality & environmental protection.

Service window

A service window of the size 150 mm x 100 mm shall be provided in the base of the pole to allow access to electrical connections and terminations. It shall be covered with MS plate and proper rubber gaskets shall be provided to prevent any ingress of water etc..

Electrical connections

Four way connectors shall be provided along with Slide lock and 1 no. 6 amps Sp MCB including 2.5 sqmm PVC insulated copper conductor wires from the terminal block to the fixture and 2 nos. 32 mm dia GI sleeves of suitable length shall be provided upto the service window. An earth boss is provided on the control plate along with connectors and interrupters.

Galvanized Octagonal Poles Dimensions

HEIGHT	TOP DIA (A/F)	BOTTOM DIA (A/F)	SHEET THICKNESS	BASE PLATE DIMENSIONS (LxBxT)	FOUNDATION BOLT			
					BOLT SIZE (NO. x DIA)	PITCH CIRCLE DIA (PCD)	BOLT LENGTH (MM)	PROJECTED BOLT LENGTH
(mtr)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
3	70	130	3	200 x 200 x 12	4 x 16 Dia	200	450	80
4	70	130	3	200 x 200 x 12	4 x 16 Dia	200	450	80
5	70	130	3	200 x 200 x 12	4 x 16 Dia	200	600	80
6	70	130	3	220 x 220 x 12	4 x 20 Dia	205	600	100
7	70	130	3	220 x 220 x 12	4 x 20 Dia	205	700	100
8	70	135	3	225 x 225 x 16	4 x 20 Dia	210	750	100
9	70	155	3	260 x 260 x 16	4 x 24 Dia	250	750	125
10	70	175	3	275 x 275 x 16	4 x 24 Dia	270	750	125
11	90	210	3	300 x 300 x 20	4 x 24 Dia	300	750	125
12	90	240	3	320 x 320 x 20	4 x 24 Dia	325	850	125

20. AUTOMATIC TRANSFER SWITCHES

20.1 Scope

Supply and installation of automatic transfer switches (ATS) with number of poles, amperage, voltage, withstand and close-on ratings as shown on the plans. Each automatic transfer shall consist of an inherently double throw power transfer switch mechanism and a microprocessor controller to provide automatic operation. All transfer switches and controllers shall be the products of the same manufacturer.

20.2 Codes and Standards

The automatic transfer switches and controls shall conform to the requirements of:

UL 1008 - Standard for Transfer Switch Equipment
IEC 947-6-1 Low-voltage Switchgear and Control gear; Multifunction equipment; Automatic Transfer Switching Equipment
NFPA 70 - National Electrical Code
NFPA 99 - Essential Electrical Systems for Health Care Facilities
NFPA 110 - Emergency and Standby Power Systems
IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches
UL 508 Industrial Control Equipment

20.3 Mechanically Held Transfer Switch

The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single-solenoid mechanism. Main operators which include over current disconnect devices, linear motors or gears shall not be acceptable. The switch shall be mechanically interlocked to ensure only two possible positions and only one position at a time, normal or emergency.

All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.

The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.

All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.

Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 600 amps and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.

Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.

Where neutral conductors must be switched as shown on the plans, the ATS shall be provided with fully rated overlapping neutral transfer contacts. The neutrals of the normal and emergency power sources shall be connected together only during the transfer and retransfer operation and remain connected together until power source contacts close on the source to

which the transfer is being made. The overlapping neutral contacts shall not overlap for a period greater than 100 milliseconds. Neutral switching contacts which do not overlap are not acceptable.

Where neutral conductors are to be solidly connected as shown on the plans, a neutral conductor plate with fully rated AL-CU pressure connectors shall be provided.

20.4 Microprocessor Controller

The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module.

A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to $\pm 1\%$ of nominal voltage. Frequency sensing shall be accurate to $\pm 0.2\%$. The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.

The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.

All customer connections shall be wired to a common terminal block to simplify field-wiring connections.

The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:

1. EN 55011:1991 Emission standard - Group 1, Class A
2. EN 50082-2:1995 Generic immunity standard, from which:
EN 61000-4-2:1995 Electrostatic discharge (ESD) immunity
ENV 50140:1993 Radiated Electro-Magnetic field immunity
EN 61000-4-4:1995 Electrical fast transient (EFT) immunity
EN 61000-4-5:1995 Surge transient immunity
EN 61000-4-6:1996 Conducted Radio-Frequency field immunity
3. IEEE472 (ANSI C37.90A) Ring Wave Test.

20.5 Controller Display and Keypad

A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port. The following parameters shall only be adjustable via DIP switches on the controller:

1. Nominal line voltage and frequency
2. Single or three phase sensing
3. Operating parameter protection
4. Transfer operating mode configuration
(Open transition, Closed transition, or Delayed transition)

All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

20.6 Voltage, Frequency and Phase Rotation Sensing

Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities (values shown as % of nominal unless otherwise specified):

<u>Parameter</u>	<u>Sources</u>	<u>Dropout / Trip</u>	<u>Pickup / Reset</u>
Undervoltage	N&E,3 ϕ	70 to 98%	85 to 100%
Overvoltage	N&E,3 ϕ	102 to 115%	2% below trip
Underfrequency	N&E	85 to 98%	90 to 100%
Overfrequency	N&E	102 to 110%	2% below trip
Voltage unbalance	N&E	5 to 20%	1% below dropout

Repetitive accuracy of all settings shall be within $\pm 0.5\%$ over an operating temperature range of -20°C to 60°C .

Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.

The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).

Source status screens shall be provided for both normal & emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation.

20.7 Time Delays

An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.

A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.

Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.

A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.

A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:

1. Prior to transfer only.
2. Prior to and after transfer.
3. Normal to emergency only.
4. Emergency to normal only.
5. Normal to emergency and emergency to normal.
6. All transfer conditions or only when both sources are available.

The controller shall also include the following built-in time delays for optional Closed Transition and Delayed Transition operation:

1. 1 to 5 minute time delay on failure to synchronize normal and emergency sources prior to closed transition transfer.
2. 0.1 to 9.99 second time delay on an extended parallel condition of both power sources during closed transition operation.
3. 0 to 5 minute time delay for the load disconnect position for delayed transition operation.

All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.

All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port.

20.8 Additional Features

A three position momentary-type test switch shall be provided for the test / automatic / reset modes. The test position will simulate a normal source failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal.

A SPDT contact, rated 5 amps at 30 VDC, shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.

Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the emergency source.

LED indicating lights (16 mm industrial grade, type 12) shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).

LED indicating lights (16 mm industrial grade, type 12) shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.

The following features shall be built-in to the controller, but capable of being activated through keypad programming or the serial port only when required by the user:

Provide the ability to select "commit/no commit to transfer" to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.

Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.

An Inphase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The inphase monitor shall be specifically designed for and be the product of the ATS manufacturer.

The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode using an external control device.

20.9 Engine Exerciser

The controller shall provide an internal engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. For each routine, the user shall be able to:

1. Enable or disable the routine.
2. Enable or disable transfer of the load during routine.
3. Set the start time, .
 - time of day
 - day of week
 - week of month (1st, 2nd, 3rd, 4th, alternate or every)
4. Set the duration of the run.

At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10-year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.

20.10 System Status

The controller LCD display shall include a “System Status” screen which shall be readily accessible from any point in the menu by depressing the “ESC” key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. For example,

Normal Failed
Load on Normal
TD Normal to Emerg
2min15s

Controllers that require multiple screens to determine system status or display “coded” system status messages, which must be explained by references in the operator’s manual, are not permissible.

20.11 Self Diagnostics

The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.

20.12 Communications Interface

The controller shall be capable of interfacing, through an optional serial communication module, with a network of transfer switches, locally (up to 4000 ft.) or remotely through modem serial communications. Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control and setup of parameters.

20.13 Data Logging

The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:

- i). Event Logging
 1. Data and time and reason for transfer normal to emergency.
 2. Data and time and reason for transfer emergency to normal.
 3. Data and time and reason for engine start.
 4. Data and time engine stopped.

5. Data and time emergency source available.
6. Data and time emergency source not available.

ii). Statistical Data

1. Total number of transfers.
2. Total number of transfers due to source failure.
3. Total number of days controller is energized.
4. Total number of hours both normal and emergency sources are available.

20.14 Communications Module

A full duplex RS485 interface shall be installed in the ATS controller to enable serial communications. The serial communications shall be capable of a direct connect or multi-drop configured network. This module shall allow for the seamless integration of existing or new communication transfer devices. The serial communication interface shall be equal to appropriate make.

20.15 External DC Power Supply

An optional provision shall be available to connect an external 24 VDC power supply to allow the LCD and the door mounted control indicators to remain functional when both power sources are dead.

20.16 Withstand and Closing Ratings

The ATS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS terminals with the type of over current protection shown on the plans.

The ATS shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard's 1½ and 3 cycle, long-time ratings. ATSs which are not tested and labeled with 1½ and 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable.

20.17 Tests and Certification

The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.

The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001.

20.18 Service Representation

The ATS manufacturer shall maintain a national service organization of company-employed personnel located throughout the contiguous United States. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.

The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.

21. CABLING FOR VOICE SYSTEM

21.1 Scope

This document defines the cabling system and subsystem components to include cable, termination hardware, supporting hardware, and miscellany required to supply, and to install a complete cabling infrastructure supporting voice and video. The intent of this section is to provide pertinent information to allow the vendor to bid the labor, supervision, tooling, materials, and miscellaneous installation hardware and consumables to install a complete system. However, it is the responsibility of the vendor to propose any, and, all items required for a complete system whether or not it is identified in the specification, drawings and bill of materials attached to this specification.

21.2 Applicable Documents:

The cabling system described in this specification is derived in part from the recommendations made in industry standard documents. The list of documents below (or the latest revisions) has bearing on the desired cabling infrastructure are incorporated into this specification by reference:

- 1) This Technical Specification and Associated Drawings
- 2) ANSI/TIA/EIA 568-B Commercial Building Telecommunications Cabling Standard – March 2001
- 4) ANSI/EIA/TIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces - February, 1998
- 5) ANSI/EIA/TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings - February, 1993
- 6) ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications - August, 1994

21.3 Backbone Wiring

General

The function of the backbone wiring shall be to provide interconnections between telecommunications closets, equipment rooms and entrance facilities in the telecommunications wiring system. The backbone wiring shall consist of the transmission media, intermediate and main cross connects, and mechanical terminations for interconnection of telecommunications closets, equipment rooms and entrance facilities. The backbone wiring shall include transmission media in the building.

The backbone wiring shall use the star topology wherein each telecommunications closet shall be wired to a main cross connect / patch panel or an intermediate cross connect then to a main cross-connects / patch panel. There shall be no more than two hierarchical levels of cross connects / patch panel in the backbone wiring. Interconnections between any two telecommunications closet shall pass through three or fewer cross-connects / patch panel.

Bridged taps shall not be permitted as part of the backbone wiring.

One of the following types of cables shall be used for backbone wiring as defined in schedule of quantities.

1. 100-ohm UTP multiplier backbone cable.
2. 62.5 / 12.5 um optical fiber cable.

The contractor has to assure that cross talk coupling between individual, unshielded twisted-pairs shall not affect the transmission performance of multi-pair cables.

21.4 Horizontal Wiring

General

The horizontal wiring shall be the portion of the tele communications wiring system that will extend from the work area telecommunications outlet to the telecommunications closet. The horizontal wiring shall include the telecommunications outlet in the work area, mechanical termination for the horizontal cables, and cross-connections located in the telecommunications closet.

The horizontal wiring shall be capable of handling the following minimum services.

1. Voice telecommunications.
2. Premises switching equipment.

The horizontal wiring shall be a star topology with each work area telecommunications outlet connected to a telecommunications closet. Horizontal wiring shall preferably contain no more than one transition point between different forms of the same cable type.

Bridged taps shall not be permitted as part of the horizontal wiring.

The maximum horizontal distance shall be limited to 90 meters (295 ft) independent of media type i.e. the cable length from the mechanical terminating of the media in the telecommunications closet to the telecommunications outlet in the work area shall be limited to this distance. This horizontal distance includes cabling required from the telecommunications outlet to the work station. Horizontal cable shall be limited to one of the following types as listed out in the schedule of quantities.

1. Four-pair 100-ohm unshielded twisted pair (UTP) cables.
2. 62.5/125 um optical fiber cable.

Grounding Considerations

Grounding system shall be an integral part of the telecommunications wiring system. In addition to helping protect personnel and equipment from hazardous voltages, the grounding system shall reduce the effect of electromagnetic interference ((EMI) to and from the telecommunications wiring system.

Grounding shall meet the NEC requirements and practices or local authorities or codes whichever impose a more stringent requirement.

The following shall be considered for the grounding system.

Installation conforms with proper practices and requirements.

Each telecommunications closet shall have an appropriate grounding access.

Grounding shall be available for cross-connect frames, patch panel racks, telephone and data equipment and equipment required for maintenance and testing.

21.5 Backbone Wiring Distances

Telecommunications Closet to Main Cross-Connect

The maximum backbone distance between the main cross-connect patch panel and the mechanical termination in the telecommunications closet shall be as follows:

For 62.5 / 125 ohms optical Fiber cable the distance between Telecommunication closet and main cross connect / patch panel shall not exceed 2000 mts.

For 100 ohm UTP cable, maximum distance between telecommunication closet and main cross connect / panel shall be 800 mts.

Telecommunications equipment which connect directly to main or intermediate cross-connects / patch panel shall done via cables of 30 m or less.

21.6 Telecommunications Closet

A telecommunications closet shall be defined as an area within the building set aside for the exclusive purpose of housing equipment associated with the telecommunications wiring system. There shall be no upper limit on the number of telecommunications closets which may be provided within the building. The telecommunication closet shall have following three possible configurations.

Horizontal Backbone Connection

The telecommunications closet shall contain the mechanical terminations for a portion of the horizontal wiring system and a portion for the backbone wiring system. In such a case the telecom closet shall provide facilities (space, power, grounding etc.) for the passive (cross-connect) / patch panel or active devices or both used to interconnect the two system.

Backbone Wiring System Interconnection

The telecommunications closet may contain the intermediate cross-connect / patch panel or main cross connect / patch panel for different portions of the backbone wiring system. In this usage, the telecommunications closet shall provide facilities for the passive or active devices or both used to interconnect two or more portions or the backbone wiring system.

Entrance Facilities

A telecommunications closet may be used to contain the demarcation point or an interbuilding entrance facility. In this usage, the telecommunications closet shall provide facilities for the active and / or passive devised required to interconnect the demarcation point or interbuilding entrance facility or both to the telecommunication wiring system.

The design of the telecommunications closet shall be as per the requirements of EIA/TIA-569.

21.7 Equipment Room

The equipment room shall be defined as an area within the building where telecommunications systems shall be housed along with the mechanical termination of one or more portions of the telecommunications wiring system. Equipment room shall be considered to be distinct from telecommunications closets because of the nature or complexity of the equipment they contain. Any or all of the functions of a telecommunications closet shall be alternatively provided by an equipment room.

21.8 Cable Specifications

21.8.1 UTP Cabling System

21.8.1.1 Unshielded twisted pair cabling system, TIA / EIA 568-B.1 addendum Category 6 Cabling system

- | | |
|-----------------------|---|
| a. Networks Supported | 10 / 100 Ethernet, 155 Mbps ATM, 1000 Mbps IEEE 802.3ab Ethernet, and proposed Cat 6 Gigabit Ethernet |
| b. Warranty | 25-year systems warranty; Warranty to cover Bandwidth of the specified and installed cabling system, and the installation costs |

- c. Performance characteristics to be provided along with bid Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR for 4-connector channel

21.8.1.2 Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2

- a. Material:
- b. Conductors 23 AWG solid bare copper or better
- c. Insulation Polyethylene
- d. Jacket Flame Retardant PVC
- e. Pair Separator Cross-member fluted Spline.
- f. Approvals UL Listed
ETL verified to TIA / EIA Cat 6
- g. Operating temperature -20 Deg. C to +60 Deg. C
- h. Frequency tested up to Minimum 600 MHz
- i. Packing Box of 305 meters
- j. Delay Skew 45ns MAX.
- k. Impedance 100 Ohms + / - 15 ohms, 1 to 600 MHz.
- l. Performance characteristics to be provided along with bid Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR

21.9 Category 5 Riser Cable

This cable shall consist of solid copper conductors insulated with expanded polyethylene covered by a PVC sheet. The core shall be covered with a layer of plastic tape and overlaid with a corrugated PVC plastic. It shall be suitable to be used without conduit. The cable shall meet EIA/TIA -568, C S A T -529, IEEE 802.3 & 10 B A S E -T. The pair sizes shall be as per the schedule of quantities. The cable shall meet the following specifications.

- a. Maximum DC Resistance 26.5 ohm per 100 ft.
- b. Maximum D C Unbalanced Resistance 17%
- c. Mutual Capacitance at 1 kHz 16 nF per 1000 ft.

21.10 Warranty

Owner seeks warranty for the installed cable plant from the OEM equipment supplier. Bidder shall ensure that the OEM norms for supply, installation, testing and documentation as specified by the OEM supplier shall be adhered to, provided those are in line with TIA / EIA standards and Owner requirement specifications. The warranty shall be provided by the OEM vendor to Owner and shall be administered in India. The duration of the warranty shall be for a minimum of 25 years and shall cover the system performance, application assurance and the costs of the supply of components and installation.

22. CABLING FOR DATA SYSTEM

22.1 Scope

This document defines the cabling system and subsystem components to include cable, termination hardware, supporting hardware, and miscellany required to supply, and to install a complete cabling infrastructure supporting data and video. The intent of this section is to provide pertinent information to allow the vendor to bid the labor, supervision, tooling, materials, and miscellaneous mounting hardware and consumables to install a complete system. However, it is the responsibility of the vendor to propose any, and, all items required for a complete system whether or not it is identified in the specification, drawings and bill of materials attached to this specification.

22.2 Applicable Documents

The cabling system described in this specification is derived in part from the recommendations made in industry standard documents. The list of documents below (or the latest revisions) has bearing on the desired cabling infrastructure are incorporated into this specification by reference:

- 1) This Technical Specification and Associated Drawings
- 3) ANSI/TIA/EIA 568-B Commercial Building Telecommunications Cabling Standard – March 2001
- 4) ANSI/EIA/TIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces - February, 1998
- 5) ANSI/EIA/TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings - February, 1993
- 6) ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications - August, 1994

22.3 Cabling System and Component Specifications

22.3.1 UTP Cabling System

22.3.1.1	<u>Unshielded twisted pair cabling system, TIA / EIA 568-B.1 addendum Category 6 Cabling system</u>
Networks Supported	10 / 100 Ethernet, 155 Mbps ATM, 1000 Mbps IEEE 802.3ab Ethernet, and proposed Cat 6 Gigabit Ethernet
Warranty	25-year systems warranty; Warranty to cover Bandwidth of the specified and installed cabling system, and the installation costs
Performance characteristics to be provided along with bid	Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR for 4-connector channel
22.3.1.2	<u>Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2</u>
Material:	
Conductors	23 AWG solid bare copper or better
Insulation	Polyethylene
Jacket	Flame Retardant PVC
Pair Separator	Cross-member fluted Spline.
Approvals	UL Listed ETL verified to TIA / EIA Cat 6
Operating temperature	-20 Deg. C to +60 Deg. C
Frequency tested up to	Minimum 600 MHz
Packing	Box of 305 meters
Delay Skew	45ns MAX.
Impedance	100 Ohms + / - 15 ohms, 1 to 600 MHz.
Performance	Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT,

characteristics to be provided along with bid Return Loss, ACR and PS ACR

22.3.2 UTP Jacks

<u>Type</u>	<u>PCB based, Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2</u>
Durability	
Modular Jack	750 mating cycles
Wire terminal	200 termination cycles
Accessories	Strain relief and bend-limiting boot for cable Integrated hinged dust cover
Materials	
Housing	Polyphenylene oxide, 94V-0 rated
Wiring blocks	Polycarbonate, 94V-0 rated
Jack contacts	Phosphorous bronze, plated with 1.27micro-meter thick gold
Approvals	UL listed
Performance	Attenuation, NEXT, PS NEXT, FEXT and Return Loss
Characteristics to be provided with bid	

22.3.3 UTP Jack Panels

<u>Type</u>	<u>24-port, PCB based, Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2</u>
Ports	24
Port arrangement	Modules of 6-ports each, arranged 1port x 6.
Category	Category 6
Circuit Identification Scheme	Icons on each of 24-ports
Port Identification	9mm or 12mm Labels on each of 24-ports (to be included in supply)
Height	1 U (1.75 inches)
Durability	
Modular Jack	750 mating cycles
Wire terminal (110 block)	200 termination cycles
Accessories	Strain relief and bend limiting boot for cable
Materials	
Housing	Polyphenylene oxide, 94V-0 rated
Wiring blocks	Polycarbonate, 94V-0 rated
Jack contacts	Phosphorous bronze, plated with 1.27micro-meter thick gold
Panel	Black, powder coated steel
Approvals	UL listed
Termination Pattern	TIA / EIA 568 A and B;
Performance	Attenuation, NEXT, PS NEXT, FEXT and Return Loss
Characteristics to be provided along with bid	

22.3.4 Faceplates

<u>Type</u>	<u>1-port, White surface box</u>
Material	ABS / UL 94 V-0
No. of ports	One

22.3.5 Workstation / Equipment Cords

Type	<u>Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2</u>
Conductor	24 AWG 7 / 32, stranded copper
Length	7-feet
Plug Protection	Matching colored snag-less, elastomer polyolefin boot
Warranty	25-year component warranty
Category	Category 5
Plug	
Housing	Clear polycarbonate
Terminals	Phosphor Bronze, 50 micron gold plating over selected area and gold flash over remainder, over 100 micron nickel underplate
Load bar	PBT polyester
Jacket	PVC
Insulation	Flame Retardant Polyethylene

22.3.6 Fiber optic Cable

Cable Type	6-core, Multimode, 10G Ethernet OM3, Armored, loose-tube, Gel Filled
Fiber type	50 / 125, Laser Grade, 250 micron primary coated buffers
No. of cores	6
Cable Construction	BELLCORE GR 20 / IEC 794-1
Attenuation	
@850nm	3.5 dB / KM
@1300nm	1.5 dB / KM
Bandwidth	
@850nm	1500 MHz-KM
@1300nm	500 MHz-KM
Network Support	
10 / 100 Ethernet	2000m
155 Mbps ATM	2000m
1000 Base SX	900m
1000 Base Lx	550m without Mode Conditioning launch patch cord.
Tensile rating	1200N
Maximum Crush	3000N
resistance	
Operating	-40 Degree C to +60 Degree C
Temperature	
Armor	Corrugated Steel tape Armor

Note: For Composite fiber optic cables, the above specifications for SM and MM fibers apply.

22.3.7 Fiber Optic Connectors

<u>Connector Type</u>	<u>SC-Style, Simplex</u>
Operating temperature	-40 Degree C to +85 Degree C
Durability & color	
MM connectors	500 cycles, Beige
SM connectors	220 cycles, Blue
Ferrules	Pre-radiused Ceramic Ferrules
Attenuation	Not more than 0.75 dB per mated pair

22.3.8 Fiber Optic Patch panels

Fiber optic patch panel **19-inch, Rack mounted Fiber optic patch panel**

Height	3 U, 5.25 inches
# of fibers	48,96,192
# of OSP Cables for termination	Minimum 2
Grounding	2 Nos. of earthing lugs, pre-loaded
Cable Management rings	Front and rear cable management rings, pre-loaded
# of 6-port / 12-port adapter plates	8 / 8 Max.

Fiber optic patch panel **19-inch, Rack mounted Fiber optic patch panel**

Height	1 U, 1.75 inches
# of fibers	18,36,72
# of OSP Cables for termination	Minimum 2
Grounding	2 Nos. of earthing lugs, pre-loaded
Cable Management rings	Front and rear cable management rings, pre-loaded
# of 6-port / 12-port adapter plates	3 / 3 Max.

22.3.9 Fiber Optic Adapter plates

Fiber Optic adapter plate **6-port, SC-Style, MM**

Attenuation	Max of 0.75 dB per mated pair
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22.3.10 Fiber Optic Patch Cord.

Fiber Optic Patch Cords **50/ 125 Ethernet Patch Cord**

Bandwidth	
@850nm	500 MHz-KM
@1300nm	500 MHz-KM
Insertion Loss	Less than 0.5 dB

22.4 Warranty

Owner seeks warranty for the installed cable plant from the OEM equipment supplier. Bidder shall ensure that the OEM norms for supply, installation, testing and documentation as specified by the OEM supplier shall be adhered to, provided those are in line with TIA / EIA standards and Owner requirement specifications. The warranty shall be provided by the OEM vendor to Owner and shall be administered in India. The duration of the warranty shall be for a minimum of 25 years and shall cover the system performance, application assurance and the costs of the supply of components and installation.

23. CABLING FOR TV SYSTEM

- 23.1 The Co-axial cable shall be of wide band type with operation capability upto 500 MHz.
- 23.2 The ageing resistance of the co-axial cable shall comply 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)
- 23.3 Cables shall meet or exceed the following specifications.

Construction	RG-6 MATV Type	RG-11 MATV Type
a. Center Conductor	18 AWG tinned copper	14 AWG tinned copper
b. Dielectric	Foam Polyethylene Nom. dia 0.180	Foam Polyethylene Nom. dia 0.280
c. Shield	Foil - 0.003 Al. Tape Braid - 34 AWG 4 end AL. 60% coverage dia 0.212	Foil - 0.003 Al. Tape Braid - 34 AWG 6 end AL 60% coverage dia 0.314.
d. Jacket	Black PVC flame retardant dia over jacket 0.272 ± 0.008 Min. spot 0.023	PVC flame retardant dia over jacket 0.405 ± 0.010 Min. spot 0.032.

Electrical Properties

a. Dielectric Strength	Conductor to shield 2000 VDC	Conductor to shield 1500 VDC
b. Capacitance	16.2 PF / FT, Nom	16.2 PF / FT. Nom
c. Impedance	75.0 ± 3.0 ohms	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	DB/100 ft. 0.35 DB @ 5 MHZ 0.94 DB @ 50 MHZ 1.28 DB @ 100 MHZ 1.78 DB @ 200 MHZ 2.20 DB @ 300 MHZ 2.75 DB @ 450 MHZ 4.30 DB @ 1000 MHZ
e. Velocity of propagation	82.0% Nom	82.0% Nom
f. DCR	35.47 ohms / 1000 ft.	14.29 ohms / 10000 ft.
g. SRL	30 DB (10 MHZ to 300 MHZ) 20 DB (5 to 450 Mhz)	

23.4. DIRECTIONAL COUPLERS

These shall be of Ultra Wideband type and of hybrid circuit design.

These shall have a near flat frequency response over the entire operating range.

These shall have an aluminium cast housing for high frequency radiation resistance.

These shall have 'F' sockets for all input, output and branch ports.

The Tapoffs shall be available in one way, two way and four way configurations.

The splitters shall be available in two way, three way and four way configurations.

The Tapoffs shall be available in different tap values ranging from 11 dB, 15 dB, 20 dB, 25 dB and 30 dB.

These shall meet or exceed the following specifications:

		Tap off	Splitters
a.	Tap Loss	11-30 dB	--
b.	Through Loss	0.5-4 dB	4..0 - 8.0 dB
c.	Isolation	> 22 dB	> 22 dB
d.	Screening factor	> 50 dB	> 50 db

