PACKAGE –NON RESIDENTIAL BUILDINGS AT VARIOUS STATIONS OF NERTS TECHNICAL SPECIFICATIONS

SECTION – 3

INTERNAL ELECTRICATION WORKS

Section- 3. Specifications for Internal Electrical works

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SECTION 3 - ELECTRICAL

1. GENERAL TECHNICAL REQUIREMENTS FOR ELECTRICAL WORKS

1.0 SCOPE:-

1.1 The scope of the Electrical works is to provide complete electrical system for the distribution of electric power from LT switchgear to residential building. The detailed scope covers the following:

Design, engineering, manufacture, testing, supply on FOR destination site basis, including transportation & insurance, storage, erection, testing and commissioning of the following equipment/ items complete in all respects.

(i) 415 V LT switchboards/distribution boards

(ii) 1.1kV grade PVC / XLPE insulated cables as specified in the BOQ.

(iii) Internal Electrifications

1.2 The detailed bill of material item wise is brought out in bid proposal sheets. Further it will be Bidder's responsibility to work out the exact quantities during detailed engineering. Further, wherever quantity and unit are indicated, actual quantity erected shall be considered for payment purpose and wastage shall not be considered.

1.3 The Contractor shall also be responsible for the overall co-ordination with internal/external agencies, project management, training of Owner's manpower, loading, unloading, handling, moving to final destination for successful erection, testing and commissioning of the equipment/works.

1.4 Design of systems includes preparation of single line diagrams and electrical layouts, control and protection schematics, wiring and termination schedules, indoor and outdoor lighting/illumination and other relevant drawings & document required for engineering of all facilities under this contract, are covered under the scope of the Contractor.

1.5 Any other items not specifically mentioned in the specification but which are required for erection, testing and commissioning and satisfactory operation of the equipment are deemed to be included in the scope of the specification unless specifically excluded.

1.6 The reference drawing which form a part of the specifications, are enclosed.

2.0 GENERAL REQUIREMENT:-

2.1 The provisions under this section are intended to supplement general requirements for the materials, equipment and services covered under other sections of tender documents and are not exclusive. However, in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall prevail.

2.2 The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc., fully in conformity with the technical specification.

2.3 It is recognized that the Contractor may have standardized on the use of certain components, materials, processes or procedures different from those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to the Owner. Unless brought out clearly, the Bidder shall be deemed to conform to this specification scrupulously. All deviations from the specification shall be clearly brought out in the respective schedule of deviations. Any discrepancy between the specification and the catalogues or the bid, if not clearly brought out in the specific requisite schedule, will not be considered as valid deviation.

3.0 STANDARDS:-

SECTION 3 - ELECTRICAL

3.1 The works covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India.

3.2 The equipment to be furnished under this specification shall conform to latest issue with all amendments (as on the date of bid opening) of standards specified **in various equipments/systems specifications**.

3.3 The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to compliment each other.

3.4 The Contractor shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IS/IEC.

3.5 When the specific requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.

3.6 Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards specified under individual sections for various equipment shall also, be accepted, however the salient points of difference shall be clearly brought out in additional information schedule with English language version of such standard. The equipment conforming to standards other than specified under individual sections for various equipment shall be subject to Owner's approval.

3.7 The bidder shall clearly indicate in his bid the specific standards in accordance with which the works will be carried out.

4.0 Services To Be Performed By The Equipment Being Furnished:-

4.1 All equipment shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation.

4.2 All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc for the equipment.

5.0 Engineering Data And Drawings:-

5.1 The engineering data shall be furnished by the Contractor in accordance with the Schedule for each set of equipment as specified in the Technical Specifications.

5.2 The list of drawings/documents which are to be submitted to the Owner shall be discussed and finalized by the Owner at the time of award.

The Contractor shall necessarily submit all the drawings/documents unless anything is waived.

The Contractor shall submit 4 (four) sets hardcopy along with the soft copy of drawings/design documents / data/ test reports as may be required for the approval of the Owner.

5.3 **Drawings:-**

5.3.1 All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, dimensions, internal & the external connections, fixing arrangement required and any other information specifically requested in the specifications.

5.3.2 Each drawing submitted by the Contractor shall be clearly marked with the name of the Owner, Project Name, Project Title, material details with catalogue no. and the Make. If standard catalogue

pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

5.3.3 Further work by the Contractor shall be in strict accordance with these drawings and no deviation shall be permitted without the written approval of the Owner, if so required.

5.4 The review of these data by the Owner will cover only general conformance of the data to the specifications and documents interfaces with the equipment provided under the specifications. This review by the Owner may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the Owner shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

5.5 All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Owner. Approval of Contractor's drawing or work by the Owner shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

5.6 All engineering data submitted by the Contractor after final process including review and approval by the Owner shall form part of the Contract Document and the entire works performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Owner in Writing.

5.7 **Approval Procedure:-**

The scheduled dates for the submission of the drawings as well as for, any data/information to be furnished by the Owner would be discussed and finalized at the time of award. The following schedule shall be followed generally for approval and for providing final documentation.

i)	Shop drawings for Approval / comments / by Owner on initial submission	As per agreed schedule
ii)	Resubmission (whenever required)	Within 1 (one) week from date of comments.
iii)	Approval or comments of resubmission	Within 1 (one) weeks of receipt
iv)	Furnishing of distribution copies (4 Copies)	2 weeks from the date of final approval
v)	Furnishing of distribution copies of test reports (a) Test reports (4 Copies)	2 weeks from the date of final approval
vi)	Furnishing of instruction / operation manuals (2 copies per site)	As per agreed schedule
vii)	As built drawings (Two sets)	On completion of entire works

NOTE:

(1) The contractor may please note that all resubmissions must incorporate all comments given in the earlier submission by the Owner or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.

(2) The Softcopy of all Drawings/Documents along with hard copy to be submitted for all the time for review as well as Approval.

(3) The instruction Manuals shall contain full details of drawings of all equipment being supplied under this contract, their exploded diagrams with complete instructions for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures.

(4) The Contractor shall furnish to the Owner catalogues/Instruction Manual of Equipments/Switchgear/Spare parts.

6.0 MATERIAL/WORKMANSHIP:

6.1 **General Requirement:**

6.1.1 Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended.

6.1.2 In case where the equipment, materials or components are indicated in the specification as “similar” to any special standard, the Owner shall decide upon the question of similarity. When required by the specification or when required by the Owner the Contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Contractor.

6.1.3 The Execution of the Works shall be such that installation future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfil their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Owner.

6.1.4 Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

6.1.5 All materials and equipment shall be installed in strict accordance with the manufacturer’s recommendations(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be considered as being the erection of equipment as its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, leveling, aligning, coupling of or bolting down to previously installed equipment bases/foundations, performing the alignment check and final adjustment prior to initial operation, testing and commissioning in accordance with the manufacturer’s tolerances, instructions and the Specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacturer’s limits suitable guards shall be provided for the protection of personnel on all exposed rotating and / or moving machine parts and shall be designed for easy installation and removal for maintenance purposes. The spare equipment(s) shall be installed at designated locations and tested for healthiness.

6.1.6 The Contractor shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The Contractor shall apply all operational lubricants to the equipment installed by him.

6.1.7 All oil, grease and other consumables used in the Works/Equipment shall be purchased in India unless the Contractor has any special requirement for the specific application of a type of oil or grease not available in India. In such is the case he shall declare in the proposal, where such oil or

grease is available. He shall help Purchaser in establishing equivalent Indian make and Indian Contractor. The same shall be applicable to other consumables too.

6.1.8 The materials shall be supplied from approved vendors as per POWERGRID's Compendium of Vendors (COV) with prior approval.

6.2 **Degree of Protection:-**

a) The enclosures of the LT Panels to be installed shall provide degree of protection as detailed here under:

b) All indoor Panels to be supplied with minimum : IP-42 protection

6.3 **First Fill Of Consumables, Oil and Lubricants:-**

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

7.0 AS BUILT DRAWINGS BOTH HARD COPY AND SOFT COPY:-

At the completion of the works and before issue of the certificate of virtual completion, the contractor shall submit 4 sets of layout drawings (both hard copy and soft copy) drawn at approved scale indicating the complete wiring system as installed. These drawings must provide the following minimum information:

a. Run and size of conduits, inspections, junction and pull boxes.

b. Size of conductors in the conduits.

c. Location and rating of sockets and switches controlling the light and power outlets.

d. Location and details of distribution boards, mains, switches, switchgear, main panel and other particulars.

e. A complete wiring diagram, as installed and schematic drawings showing all connections in the complete electrical system.

f. Location of outlets, junction boxes, sizes of various conduits for telephones.

g. Location of all earthing stations, routes, sizes of all earthing conductors, manholes, layout of earth link strips, etc.

h. Layout and particulars of all cables.

Above indicates the general requirement. However, contractor must include all information desired by the client and Architects/Consultants in the final as built documents.

8.0 Pre-commissioning Tests:-

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

The testing equipment required for testing and commissioning shall be arranged by the contractor.

9.0 Statutory Clearances

The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning Facility. However necessary fee shall be reimbursed by POWERGRID on production of requisite documents.

10. PACKAGING & PROTECTION:-

10.1 All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Owner, the Contractor shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Owner to repack any equipment/material at a later date, in case the need arises. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Owner takes no responsibility of the availability of the wagons.

10.2 All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and pilings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

11.0 FINISHING OF METAL SURFACES:-

11.1 All metal surfaces shall be subjected to treatment for anti-corrosion protection. All steel conductors Including those used for earthing/grounding (above ground level) shall also be galvanized according to IS:2629.

11.2 After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting.

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

12.0 HANDLING, STORING AND INSTALLATION:-

12.1 In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Owner or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment / Panel shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented.

12.2 Contractor may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment / Panel being procured by them separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall full cooperation to them.

12.3 In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Owner. Contractor shall be held

responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.

12.4 Where assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of equipment / Panel. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

12.5 Contractor shall be responsible for examining all the shipment and notify the Owner immediately of any damage, shortage, discrepancy etc. for the purpose of Owner's information only. The Contractor shall submit to the Owner every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

12.6 The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Owner in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over the Owner, as well as protection of the same against theft, element of nature, corrosion, damages etc.

12.7 The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.

12.8 The words 'erection' and 'installation' used in the specification are synonymous.

12.9 Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

12.10 The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the minimum clearances as per the statutory requirement, the Contractor shall immediately proceed to correct the discrepancy at his risks and cost.

SECTION 3 - ELECTRICAL

ANNEXURE A

VARIOUS CODES FOR ELECTRICAL WORKS:-

A. Applicable IS Standards:-

The design engineering manufacturing and the installation shall be in accordance with established codes, sound engineering practices and specifications and shall confirm to the statutory regulations, applicable in the country. Contractor shall obtain all approvals from statutory authorities e.g Electrical Inspector, pollution control boards, BESCOMs as applicable before commissioning of electrical equipment. Relevant Indian standards are listed below.

1.	MEASURING METERS	IS:1248-
2.	INSTALLATION AND MAINTENANCE OF SWITCH GEARS	IS:3072-
3.	CODE OF PRACTICE FOR EARTHING	IS:3043
4	SWITCH GEARS AND FUSES FOR VOLTAGE NOT EXCEEDING 1000 VOLTS	IS:4064
5	GENERAL REQUIREMENTS FOR SWITCH GEAR AND GEAR FOR VOLTAGE NOT EXCEEDING 1000 VOLT	IS:13947
7.	DEGREE OF PROTECTION PROVIDED BY ENCLOSURES FOR LV S/GEARS	IS:13947
8.	ENCLOSED DISTRIBUTION FUSE BOARDS AND CUT-OUTS FOR VOLTAGE NOT EXCEEDING 1000 VOLTS	IS:2675
10.	MINIATURE CIRCUIT BREAKER	IS:882
11.	FUSE WIRE USED IN RE-WIRABLE TYPE ELECTRIC FUSES UP TO 650 VOLTS	IS:9926
12.	PVC INSULATED ELECTRIC CABLES HEAVY DUTY	IS:1554 (PART I)
13.	RECOMMENDED CURRENT RATING FOR CABLES	IS:3961(PART II)
14.	COPPER CONDUCTOR IN INSULATED CABLES AND CORES	IS:2982
15.	CONDUCTOR FOR INSULATED ELECTRIC CABLES AND FLEXIBLE CORDS	IS:8130
16.	MILD STEEL WIRES, STRIPS AND TAPES FOR ARMOURING CABLES	IS:3975
17.	PVC INSULATION AND SHEATH OF ELECTRIC CABLES	IS:5831
18.	ALUMINIUM CONDUCTOR FOR INSULATED CABLES	IS:8130
19.	PVC INSULATED AND PVC SHEATHED SOLID ALUMINIUM CONDUCTOR CABLES OF VOLTAGE RATING NOT EXCEEDING 1100 VOLTS	IS:4288
20.	RECOMMENDED CURRENT RATING FOR CABLE	IS: 3961
21.	CODE OF PRACTICE FOR ELECTRICAL WIRING INSTALLATION SYSTEM VOLTAGE NOT EXCEEDING 650 VOLTS	IS: 732
22.	CODE OF PRACTICE FOR FIRE SAFETY OF BUILDINGS GENERAL)ELECTRICAL INSTALLATION	IS: 1646
23.	PVC INSULATED CABLES (WIRES)	IS:694
24.	RIGID NON-METALLIC CONDUITS FOR ELECTRICAL WIRING	IS:9537
25.	FLEXIBLE (PLIABLE) NON-METALLIC CONDUITS FOR ELECTRICAL INSTALLATION	IS:6946
26.	THREE PIN PLUGS AND SOCKETS	IS:1293
26.	CONDUCTORS FOR INSULATED ELECTRICAL CABLES AND FLEXIBLE CODES	IS:8130
27.	SPECIFICATION FOR CONDUIT FOR ELECTRICAL INSTALLATION	IS:9537
28.	ACCESSORIES FOR NON-METALLIC CONDUITS FOR ELECTRICAL WIRING	IS:3419
29.	SWITCHES	IS:3854
30.	PLUGS	IS:6538
31.	SHUNT CAPACITORS FOR POWER SYSTEMS	IS:13925
32.	HRC CARTRIDGE FUSES AND LINKS UP TO 660 VOLTS	IS: 9224

33.	GENERAL AND SAFETY REQUIREMENT FOR LIGHTING FITTINGS	IS:1913
34.	CODE OF PRACTICE FOR LIGHTING PUBLIC THOROUGH FARES	IS:1944
35.	WATERPROOF ELECTRIC LIGHTING FITTINGS	IS:3528
36.	WATER TIGHT ELECTRIC LIGHTING FITTING	IS:3553
37.	MILD STEEL TUBULAR AND OTHER WROUGHT STEEL PIPE FITTING	IS:1239
38.	LUMINARIES FOR STREET LIGHT	IS:2149
39.	HRC FUSES HAVING RUPTURING CAPACITY OF 90 KA	IS:1370
40.	EXHAUST FAN	IS:2312
41.	CLASS I CEILING FAN	IS:374
42.	DANGER NOTICE BOARDS	IS: 2551

Note : -

All codes and standards means the latest edition where not specified, otherwise the installation shall generally follow the Indian Standard codes of practice or relevant British Standard Codes of Practice in the absence of corresponding Indian Standards.

Please Follow : -

a. **Indian Electricity Act of 2003** and rules issued there under revised up to date.

2. GENERAL TECHNICAL SPECIFICATIONS FOR ELECTRIC WORKS

2.1 LT Panels & Switchgears

1.1 TYPE OF PANEL:

All the FLOOR PANEL shall be metal clad, totally enclosed, rigid, floor mounted, air - insulated, cubical type suitable for operation on three phase / single phase, 415 / 230 volts, 50 Hz.

The FLOOR PANEL shall be designed to withstand the heaviest condition at site, with minimum expected ambient temperature of 45 degree Celsius, 80 percent humidity and dusty weather.

Should conform to Indian Electricity Act and rules (till last amendment) & approved as per FIA norms.

II. VARIOUS CODES FOR ELECTRICAL PANELS

A. APPLICABLE IS STANDARDS

1.	METERS (MEASURING) FOR ANALOG METERS	IS:1248
2.	INSTALLATION AND MAINTENANCE OF SWITCH GEARS	IS:3072
3.	H.D. AIR BREAKER, SWITCH GEARS AND FUSES FOR VOLTAGE NOT EXCEEDING 1000 VOLTS	IS:4064
4.	GENERAL REQUIREMENTS FOR SWITCH GEAR AND GEAR FOR VOLTAGE NOT EXCEEDING 1000 VOLTS	IS:13947
5.	DEGREE OF PROTECTION PROVIDED BY ENCLOSURES FOR LV S/GEARS	IS:13947
7.	ENCLOSED DISTRIBUTION FUSE BOARDS AND CUT-OUTS FOR VOLTAGE NOT EXCEEDING 1000 VOLTS	IS:2675
9.	FUSE WIRE USED IN RE-WIRABLE TYPE ELECTRIC FUSES UP TO 650 VOLTS	IS:9926
10.	CONDUCTOR FOR INSULATED ELECTRIC CABLES AND FLEXIBLE CORDS	IS:8130
11.	SHUNT CAPACITORS FOR POWER SYSTEMS	IS:13925
12.	HRC CARTRIDGE FUSES AND LINKS UP TO 660 VOLTS	IS:9224
13.	HRC FUSES HAVING RUPTURING CAPACITY OF 50 KA	IS:13703
14.	AC ELECTRICITY METERS: PART – 1 GENERAL REQUIREMENETS AND TESTS	IS:722 PART 1
15.	DIRECT ACTING ELECTRICAL INDICATING INSTRUMENTS	IS:1248
16.	CURRENT TRANSFORMERS	IS:2705
17.	ELECTRICAL RELAYS FOR POWER SYSTEMS PROTECTION	IS:3231
18.	PHOSPHATE TREATMENT OF IRON AND STEEL FOR PROTECTION AGAINST CORR0SION	IS:3618
19.	GUIDE FOR MARKING OF INSULATED CONDUCTOR	IS:5578
20.	CODE OF PRACTICE OF PHOSPHATING OF IRON AND STEEL	IS:6005
21.	FACTORY BUILT AASEMBLIES OF SWITCHGEAR AND CONTROL-GEAR FOR VOLTAGES UPTO AND INCLUDING 1000V AC AND 1200V DC.	IS:8623
22.	GUIDE FOR UNIFORM SYSTEM MARKING AND IDENTIFICATION OF CONDUCTORS AND APPARATUS TERMINALS	IS:11353
23.	LOW VOLTAGE FUSES	IS:13703
24.	LV SWITCHGEAR AND CONTROL GEAR (PART 1 TO PART 5)	IS:13947
25.	STRUCTURE CONSTRUCTION (IP-54)	IS:13947
26.	MINIATURE CIRCUIT BREAKER (MCB)	BS:3871 (PART-1)
27.	FUSE	IS:9926
28.	AIR CIRCUIT BREAKER	IS:13947
29.	CONTACTORS	IS:2959
30.	DIGITAL METER	IS:13779
31.	ELECTRICAL POWER & CONTROL WIRING CONNECTION	

	WIRING INSIDE THE MODULE FOR POWER, CONTROL PROTECTION	IS:694 & IS:8130
32.	DANGER NOTICE PLATE	IS:2551-1982 & S:5-1978
33.	MCCB	IEC 60947 IS: 13947
34.	ELCB/ELMCB	IS - 12640 – 1988/ IEC 61008

Note : -

All codes and standards means the latest edition where not specified, otherwise the installation shall generally follow the Indian Standard codes of practice or relevant British Standard Codes of Practice in the absence of corresponding Indian Standards.

1.2 STRUCTURE :

The FLOOR PANEL shall be metal clad enclosed and be fabricated out of high quality CRCA sheet, suitable for indoor installation, front operated, free standing and floor mounting type.

CRCA sheet steel used in the construction of FLOOR PANEL shall be 2 mm thick for structure, main frame & Doors, 1.6 mm thick for shrouds/Internal partition and 3 mm thick for gland plate and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet shall be seam welded, all welding slag grounded off and welding pits wiped smooth with plumber metal.

The FLOOR PANEL shall be totally enclosed, completely dust and vermin proof and degree of protection being no less than IP-42. Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust proof. All doors and covers shall be fully gasketted with neoprene gaskets and shall be lockable.

All panels and covers shall be properly fitted and secured with the frame, and holes in the panel correctly positioned. Fixing screw shall enter into holes taped into an adequate thickness of metal or provided with bolts and nuts.

A base channel of 75 mm x 75 mm x 5 mm or as per the weight of the panel shall be provided at the bottom.

FLOOR PANEL shall be arranged in multi-tier formation. The FLOOR PANEL shall be of adequate size to facilitate enough space for maintenance and cooling. The size of the FLOOR PANEL shall be designed in such a way that the internal space is sufficient for hot air movement, and the electrical component does not attain temperature more than 40^0C over an ambient temperature of 50^0C while carrying rated current. Openings shall provide for natural ventilation, but the said openings shall be screened with fine wire mesh.

Knockout holes of appropriate size and number shall be provided in the FLOOR PANEL in conformity with number, and size of incoming and outgoing conduits / cables.

Alternatively the FLOOR PANEL shall be provided with removable sheet plates at top and bottom to drill holes for cable / conduit entry at site.

The FLOOR PANEL shall be designed to facilitate easy inspection, maintenance and repair.

The FLOOR PANEL shall be sufficiently rugged in design and shall support the equipment without distortion under normal and short circuit condition they shall be suitable braced for short circuit duty.

The panel shall have sufficient space at least 20% of outgoing feeders with wiring provision for future use.

The front of each compartment shall be provided with hinged single leaf door with locking facilities. Panel shall be provided with suitable lifting facilities. MCCB/ACBs and accessories shall be of fixed/draw out type as per Legend provided in the SLD.

1.3 PROTECTION CLASS:

All the indoor FLOOR PANEL shall have protection class of minimum IP - 42.

1.4 POWDER COATING:

All sheet steel material shall undergo seven-tank process after all the necessary shearing and other mechanical works are completed. After the seven-tank process powder coating treatment shall be adopted using powder of reputed make. After the powder coating is complete welding in the panel or any sort of shearing, bending or cutting activity shall not be done. The colour shall be Siemens Grey RAL 7032./Smoke Gray.

1.5 CIRCUIT COMPARTMENT:

Each circuit breaker and switch fuse units shall be housed in separate compartments and shall be enclosed on all sides. Sheet steel hinged lockable door shall be duly inter-locked with the breaker / switch fuse units in ON and OFF position. Safety interlocks shall be provided for non-opening of the door when the breaker is in ON position. Safety interlock with operating handle shall be provided. All MCCB shall be Rotary Handeled ,Operating Mechanically..

The door shall not form integral part of the draw out position of the circuit breaker. All instruments and indicating lamp shall be mounted on the compartment door. Sheet steel barriers shall be provided between the tiers in a vertical section.

1.6 INSTRUMENT COMPARTMENT :

Separate and adequate compartment shall be provided for accommodating instruments, indicating lamp, control contactors, relays and control fuses etc. These components shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, switch fuse units, bus bars and connections.

1.7 BUSBARS :

The bus bar shall be air insulated and made of high quality, high conductivity, high strength copper and as per relevant IS code. The bus bar shall be for three phases and neutral system with separate neutral and earth bar. The busbar and interconnection between busbar and various components shall be of high conductivity, hard drawn, electrolytic copper. The busbar shall be of rectangular cross section designed to withstand full load current for phase busbar and full rated current for neutral busbar and shall be extendable type on either side. The busbar shall be rated for the frame size of the main incoming breaker. The busbar shall have uniform cross section through out the length. Ratio of 1 Sqmm = 1.2 A shall be adopted for tinned copper bus bars. The busbars to be sized based this ratio.

The busbar and interconnection shall be insulated with heat shrinkable PVC sleeves and be colour coded as per relevant IS. The busbar shall be supported on unbreakable, non hygroscopic DMC/SMC/FRP insulated supports at sufficiently close interval to prevent busbar sag and shall effectively withstand electromagnetic stresses in the event of short circuit capacity of 35 / 50 KA, as mentioned in the SLD.

The busbar shall be housed in a separate compartment. The busbar shall be isolated with 3 mm thick FRC sheet to avoid any accidental contact. The busbar shall be arranged such that minimum clearances between the bus bar are maintained as per relevant IS/BIS.

All busbar connection shall be done by drilling holes in busbars and connecting by chromium plated bolt and nuts. Additional cross section of busbar shall be provided in all LPDs / PDBs to cover-up the holes drilled in the busbars. Spring and flat washers shall be used for tightening the bolts.

All connection between busbar and circuit breaker / switches and between circuit breaker/ switches and cable terminals shall be through solid copper strips of proper size to carry full rated current. These strips shall be insulated with insulating strips.

Copper earth bus of suitable size shall be provided at the bottom of the panel throughout the length. Similarly suitable size of Copper strip in each vertical section for earthing the individual equipment/accessories shall be provided and connected to main horizontal bus.

1.8 ELECTRICAL POWER & CONTROL WIRING CONNECTION :

Terminal for both incoming and outgoing cable shall be suitable for 1100 volts grade, aluminium/copper conductor PVC / XLPE insulated and sheathed, armoured cable and shall be suitable for connections of solder less sockets for the cable size as indicated on the appended drawing for the LDBs, PDBs.

Both control and power wiring shall be brought out in cable alley for ease of external connections, operation and maintenance. Control and power wiring shall not be mingled.

Both control and power terminals shall be properly shrouded.

10% spare terminal shall be provided on each terminal block. Sufficient terminals shall be provided on each terminal block so that not more than one outgoing wire connected per terminal.

Terminal strip for power and control shall preferably be separated from each other by suitable barriers of enclosures.

Wiring inside the module for power, control protection and instrument etc. shall be done with use of 1100 V confirming to IS 694 and IS 8130. For current transformer circuits and other control wiring shall be done with 2.5 sq mm copper conductor wires. All door frames of L.T switch boards shall be earthed with bare braided copper wire. All conductors shall be crimped with solder less sockets at the ends before connections are made to the terminals.

Particular care shall be taken to ensure neat and orderly laying of the wiring. Identification ferrules shall be tagged to all the wire termination for ease of identification and to facilitate and testing. The colour coding shall be as per latest edition of IS:375.

Final wiring diagram of the LPD, PDB power and control circuit with ferrules number shall be submitted along with the LPD/PDB as one of the documents.

1.9 TERMINALS :

The outgoing terminals and neural link shall be brought out to a cable alley suitably located and accessible from the panel front. The current transformer for instrument metering shall be mounted on the disconnecting type terminal blocks. No direct connection of incoming and outgoing cables to internal components connection of the distribution board is permitted. Only one conductor may be connected in one terminal.

1.10 WIREWAYS :

A horizontal PVC wire way with screwed covers shall be provided at the top/bottom to take interconnecting control wiring between different vertical sections.

1.11 CABLE COMPARTMENT:

Cable compartment of adequate size shall be provided in the LPDs, and PDBs for easy termination of all incoming and outgoing cables entering from top. Adequate support shall be provided in the cable compartment.

1.12 EARTHING :

Copper earth bus bar of minimum 25 mm x 5 mm size shall be provided in the LPDs, PDBS for the entire length of panel. As per the rating of the main bus bars the size of earthing bus bar shall be decided. The framework of the LPDs, PDBs shall be connected to this earth busbar. Provisions shall be made for connection from earth busbar to the main earthing bar coming from the earth pit on both sides of the LPDs, PDBs.

The earth continuity conductor of each incoming and outgoing feeder shall be connected to this earth bar. The armour shall be properly connected with earthing clamp and the clamp shall be ultimately bonded with the earth bar.

1.13 LABELS:

Engraved Aluminum sheet labels shall be provided on all incoming and outgoing feeders. Single line circuit diagram showing the arrangements of circuit inside the distribution board shall be pasted on inside of the panel door and covered with transparent laminated plastic sheet.

1.14 NAME PLATE :

A prominent engraved name plate with panel designation in bold letter shall be fixed at top of the central in panel. A separate name plate giving feeder details shall be provided for each feeder module door.

Inside the feeder compartment, the electrical component, equipment, accessories like switchgear, contactor, lamp, relays etc. shall suitably be identified by prominent engraved identification plates.

Engraved nameplates shall be of Aluminum strip of black colour and WHITE letters format. Inscription and lettering sizes shall be subject to Owners approval.

Nameplate shall be fastened by counter sunk screws / riveted and not by adhesives.

Suitable stenciled paint marks shall be provided inside the panel/module identification of all equipment in addition to the plastic sticker labels. These labels shall be partitioned so as to be clearly visible and shall have the device number, as mentioned in the module wiring design.

1.15 DANGER NOTICE PLATE :

The danger plate shall be affixed in a permanent manner on operating side of the panel.

The danger notice plate shall indicate danger notice both in Hindi, English & local language and with a sign of skull and bones.

The danger notice plate in general shall meet to requirements of local inspecting authorities.

Overall dimension of the danger notice plate shall be 200 mm wide and 150 mm high. The danger notice plate shall be made from minimum 1.6 mm thick mild steel sheet and after due pre-treatment to the plate, the same shall be painted white with vitreous enamel paint on both front and rear surface of the plate.

The letter, the figure, the conventional skull and bones shall etc. shall be positioned on the plate as per recommendations of IS: 2551.

The said letter, the figure and the sign of skull and bones shall be painted in single red colour as per IS: 5-2007.

1.16 INTERNAL COMPONENTS:

The LPDs / PDB shall be equipped complete with all type of required number of air circuit breakers, MCCB, switch fuse unit, contactor, relays, fuses, meters, instruments, indicating lamps, push buttons, equipment, fittings, bus bar, cable boxes, cable glands etc. and all the necessary internal connections /wiring as required and as indicated on relevant drawings (SLD). Components necessary for proper complete functioning of the LPDs /PDBs but not indicated on the drawing shall be supplied and installed on the LPDs/PDBs.

All part of the LPD/ PDB carrying current including the components, connections, joints and instruments shall be capable of carrying their specified rated current continuously, without temperature rise exceeding the acceptable values of the relevant specifications at any part of the LPD/ PDB.

1.17 INSPECTIONS / TESTING:

Owner, his consultant and their authorized representative shall have the right to inspect and test or get inspected and tested the goods at the works of the Seller any time during manufacture and prior to dispatch .

The LPD / PDB shall be inspected and checked as per inspection manual of the LPD / PDB manufacturer.

Various electrical components and accessories of the LPD / PDB shall be checked for their functionality & as per drawing for the respective LPD / PDB.

The LPD / PDB shall be checked for rigid mounting, earthing connections, proper rating and size of components, internal wiring, etc.

All mechanical fasteners and electrical connections shall be checked and tightened before installation.

Type Test

Type test certificate of LT panels shall be provided

Routine Test:

Prior to dispatch of the LPD / PDB following tests shall be carried out.

a) All routine tests specified in relevant India/British standards/NBC shall be carried out on all circuit breakers.

b) Mechanical endurance test shall be carried out by closing and opening of all the ACB's, MCB's switches etc.

c) Over voltage and Insulation resistance test shall be carried out between phases and between phase to earth bus.

d) All the interlocks, controls and tripping mechanism of the switchgears shall be tested for their proper functioning.

e) Continuity test, Control circuit test shall be carried out. Also, HV test on secondary wiring and components on which such test is permissible (2 kV for one minute).

f) Simulating external circuits for remote operation of breaker, remote indicating lights and other remote operations, if any.

g) Pick up and dropout voltages for shunt trip and closing coils.

h) Measurement of power required for closing/trip coil of the breaker.

i) Protective relay operation shall be tested by primary or secondary injection method (wherever applicable).

j) Operation of all meters CT polarity & ratio test.

Vendor shall provide all facilities such as power supply, testing instruments and apparatus required for carrying out the tests. Required copies of test certificates for all the tests carried out along with copies of test certificates and certificates from sub-vendor for the major components (and or for the items which are deemed reasonable by the owner) procured from them are to be submitted before dispatch of switchboards/Panels.

DRAWINGS AND INFORMATION

The vendor shall furnish following drawings/documents.

i. General arrangement drawing of the switchboard, showing front view, plan, foundation plan, floor cut-outs/trenches for external cables, elevations and sections with weights.

ii. Sectional drawings of the circuit breaker panels, showing general constructional features, mounting details of various devices, bus bars, current transformers, cable boxes, terminal boxes for control cables etc.

iii. Schematic and control wiring diagram for circuit breaker and protection including indicating devices, metering instruments, alarms, space heaters etc.

iv. Terminal plans showing terminal numbers, ferrules marking, device terminal numbers, function etc.

v. Relay wiring diagrams.

vi. Equipment list.

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

The information furnished shall include the following.

i. Technical literature giving complete information of the equipment.

ii. Erection, Operation and Maintenance manual complete with all relevant information, drawings and literature for auxiliary equipment and accessories, characteristics curves for relays etc.

iii. A comprehensive spare parts catalogue.

1.18 L. T. SWITCHGEARS:

1.18.1 GENERAL:

The type, size, and rating of the components shall be as indicated on the relevant single line diagrams.

1.18.2 MOULDED CASE CIRCUIT BREAKER: (CLASS P-2 DUTY)

MCCB shall confirm to the latest IS: 13947/IEC: 947

The MCCB shall be air break type and having quick make quick break with trip free operating mechanism.

Housing of the MCCB shall be of heat resistant and flame retardant insulating material.

Rotating Handle Operating handle (RHOM) of the MCCB shall be in front and clearly indicate ON / OFF (or) TRIP positions. In case of 4 pole MCCB the neutral shall be defined and capable of offering protection.

The MCCB shall be provided with microprocessor based trip units as provided in the SLD.. All the releases shall operate on common trip bus bar so that in case of operation of any one of the releases in any of the three phases, it will cut off all the three phases and thereby single phasing of the system is avoided.

The MCCB whenever called for in the drawings shall be provided with Over Load, Short Circiut and Earth fault protection

The MCCB shall provide two sets of extra auxiliary contacts with connections for additional controls at future date.

1.18.3 CONTACTORS:

The contactor shall meet with the requirements of IS: 2959 /BS: 775.

The contactors shall have minimum making and breaking capacity in accordance with utilization category.

If the contactor forms part of a distribution board then a separate enclosure is not required, but the installation of the contactor shall be such that it is not possible to make an accidental contact with live parts.

1.18.4 MULTI DATA METER

Flush mount 96 x 96 x 80 mm Load manager type Enercon EM 6400 or equivalent meter of accuracy class 1 as per IS 13779/IEC 62052-11 & 62053-21 shall be provided. The meter shall be capable of simultaneous sampling of voltage and amperes. It shall have low burden on PT and CT shall have bright display, shall view 3 parameters together and shall have auto scaling from kilo to mega to giga units, shall have programmable CT, PT ratios. Communication with PC; PLC DCS shall be possible through RS 485 serial port. It shall be dust proof, tamper proof with data import export option.

Parameters to be monitored shall be Frequency, Line to line and average and line to neutral and average voltage, phase wise and average current, phase wise and total KVA, KW and P.F. reading and KWH monitoring.

User programmable facility for delta 2e and star 3e measurement, C.T. and P.T. ratios, Sensing shall be 3 phase, 4 wire measuring True RMS with voltage input range of 110 to 415 V nominal and current input of 5 amps or 1 amps as per field configuration. Current range shall be from 50 mA to 6A and burden on PT or CT shall be Max 5 VA.

Accuracy for kW / kWh shall be as per IS 13779 / CBIP88/62052-11 & 62053-21 , for Kvar/Kvarh 2% and for all other parameters 1% for class 1. Digital readout shall be of 3 rows of 4 digits each with 7 segments bright red LED. Input frequency shall be 50Hz / +/- 5%.

Resolution for power parameters shall be for 4 digits and energy parameters shall be 8 digits. Display update shall be at every 15 seconds for demand parameters and 1 sec for other parameters. Temperature range shall be 0-50°C and humidity <95% non-condensing.

Display parameters shall be as follows:

Instantaneous – VLL, VLn, A, F,KVA, kW, PF
Individual phases of above parameters.

Integrated – kVAh, KWh, Run hours, On hours & Interruption.

1.18.5 PUSH BUTTON:

The push button unit shall comprise of the contact element, a fixing holder, and push button actuator. The push button shall be momentary contact type. The contacts shall be of silver or silver alloy and rated at 10 Amps. Continuous current rating. The actuator shall be of stranded type and colour as per its usage for ON, OFF and Trip.

1.18.6 INDICATING LAMP:

Indicating Lamp shall be LED type and shall supplied complete with translucent covers to diffuse the lamp light. Indicating lamps shall be part of push buttons.

Colour shade for the indicating lamps shall be as below:

ON indicating lamp	:	RED
OFF indicating lamp	:	GREEN
TRIP indicating lamp	:	Amber
PHASE indicating lamp	:	Red, Yellow, and Blue.

1.19.0 Workmanship:-

The contractor shall erect the panel at site in co-ordination with the supplier if required. He should check for loose ends on the part of the supplier and shall inform client and consultant for the same. Physical and continuity tests shall be carried out by contractor. Also the field tests carried out by the supplier shall be recorded by the contractor.

1.19.1 TOOLS:-

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

1.19.2 SPARES

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

1.19.3 DEVIATIONS

Deviation from specification must be stated in writing at the quotation stage.
In absence of such a statement, it will be assumed that the requirements of the specifications are met without exception.

2.0. DRAWINGS AND DOCUMENTS TO BE FURNISHED BY TENDERER:-

2.1. After award of the contract for approval (4 copies) & distribution (as per General Requirements) along with softcopy.

a) General arrangement drawings of capacitor Banks and Capacitor Control Panels Indicating overall and other dimensions and weight.

b) Control schematic with co-ordinated terminal mounting and wiring diagram for all the equipment.

c) A complete bill of materials of all equipment and accessories of Capacitors and Control Panels covering technical particulars, quantity, make of bought out Items etc.

d) Manufacturers catalogues of major bought out items.

e) Erection, maintenance and operation manual.

f) Any other drawings/information pertinent to this equipment, if required by Owner.

INSPECTION AND TESTS

At Manufacturer's Works

a) Routine tests of each capacitor and capacitor control panel shall be carried out in compliance with relevant Indian Standards.

b) Routine test certificates as per IS for bought out items shall be furnished for Owner's approval.

At site Complete assembled and installed equipment will be inspected and necessary tests shall be carried out as per manufacturer's recommendations and relevant National Building codes and standards.

2.2 CABLE LAYING IN TRENCHES AND TRAYS

A. SPECIFICATIONS:-

Cable Trench:-

Cable trench shall be dug to the minimum depth of minimum 0.75 mtr as per site condition in co-ordination with other services such as, PHE, Networking etc. and the width shall dependent on the no of cables to be kept with the layer of brick in between two cables.

Bricks:-

The bricks shall be hand or machine moulded and made from suitable soils and kiln burnt. They shall be free from cracks, flaws and modules of free lime. They shall have smooth rectangular faces with sharp corners and shall be uniform in colour. The bricks shall be moulded with a frog of size 100 mm. x 40 mm., and 10 mm. to 20 mm. deep on one of its flat sides. The bricks shall not break when thrown on the ground from a height of 6 m. Class 35 designated bricks shall be used.

Sand:-

Sand shall be natural sand, clean, well graded, hard, strong, durable and gritty. Sand particles should be free from injurious amounts of dust, clay, soft or flaky particles of shale, alkali, salts, organic matter loam, mica or other deleterious substances and shall be got approved from the CLIENT AND/OR ITS ARCHITECT. The sand used by civil agency shall be used.

Cable Trays and Raceways:-

Cable trays shall be fabricated from Hot Dip GI and channels of minimum 16 gauge and shall be powder coated with 7 tank process if specified. The design shall be ladder type with optional cover.

The perforated tray should be minimum 1.6 mm thick hot dip galvanized iron with powder coated paint.

Trays shall be fixed or suspended from the ceiling with the help of suspenders which shall have adequate diameter to sustain the weight of the cables and channels. Also if necessary anchor fasteners shall be used for grouting purpose.

Floor / Ceiling raceway with cover of hot dip galvanized sheet of minimum 16G mm shall be used and the dimensions for the same shall be as per the BOQ. The raceways shall be free of any sort of welding edges or other sharp edges to protect cutting of wires during pulling. The raceways shall be laid with use of junction boxes fabricated from minimum 16 g hot dip GI as per drawing.

Raceways shall be supported from the ceiling using minimum 12mm threaded rods for carrying the Electrical and Networking cables.

Minimum 300mm distance to be maintained between Electrical and Networking Raceways during the execution.

B CABLE LAYING

a) Cable network shall include power, control, lighting and communication cables, which shall be laid in trenches, cable trays or conduits as detailed in the relevant drawings. Erection of cable trays as required shall be the responsibility of contractor. Cable routing given on the layout drawings shall be checked in the field to avoid interference with structures, piping or air-conditioning ducts, and minor adjustments shall be done to suit the field conditions, wherever deemed necessary, without any extra cost.

b) High voltage, medium voltage and other control cables shall be separated from each other by adequate spacing or running through independent pipes, trenches or cable trays, as applicable.

c) All cable routes shall be carefully measured and cables cut to the required lengths, leaving sufficient length for the final connection of the cable to the terminal of the equipment. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. The quantity indicated in the cable schedule is only approximate. The contractor shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structures, foundation, pipe work or any other works.

d) Cables as far as possible shall be laid in complete uncut lengths from one termination to the other.

e) Straight through joints if required shall be made by using epoxy resin type jointing kit.

f) Cables shall be neatly arranged in the trenches / trays in such a manner so that criss-crossing is avoided and final take off to the switchgear is facilitated. Arrangements of cables within the trenches / trays shall be the responsibility of the contractor.

g) All cables will be identified close to their termination point by cable numbers as per cable schedule. Cable numbers will be punched on aluminum straps (2mm thick), securely fastened to the cable and wrapped around it. Alternatively cable tags shall be circular in construction to which cable numbers can be conveniently punched.

h) Each underground cable shall be provided with identity tags of lead securely fastened every 30 Mtrs of underground length with at least one tag at each end before the cable enters the ground.

i) All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all PVC insulated cables shall be tapped with an approved PVC or rubber insulating tape. Use of friction tape or other type of tape is not permitted. Lead sheathed cables shall be plumbed with lead alloy.

j) RCC cable trenches with removable covers as shown on the drawings will be provided by the contractor. Concrete cable trenches shall be filled with sand where specified to avoid accumulation of hazardous gases. RCC covers of trenches, in process areas shall be effectively sealed to avoid ingress of chemicals etc. Removal of concrete covers for purposes of cable laying and reinstating them in their proper positions after the cables are laid shall be done by the electrical contractor at no extra cost.

k) Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cables leaving the trenches shall be provided with a protective pipe or cover, until such times the final termination to the equipment is completed.

l) Directly buried cables shall be laid underground in excavated cable trenches where specified on layout drawings. Trenches shall be of sufficient depth and width for accommodation of all cables correctly spaced and arranged with a view of heat dissipation and economy of design.
Depth of burying shall allow minimum 750 mm soil cover for LT cables as per standard.. Cables shall be laid in trenches at depth as shown in the drawing. Before cables are placed, the trench bottom shall be filled with a layer of sand not less than 50mm for LT cables. The sand shall be leveled and the cables laid over it. The cables shall be covered with 150 mm of sand on top of the largest diameter cable, and sand shall be handy pressed. A protective covering of 75 mm thick second class red bricks shall be then laid flat. The remainder of the trench shall then be backfilled with soil, rammed and leveled.

As each row of cables is laid in place, and before covering with sand, every cable shall be given an insulation test in the presence of the engineer. Any cable, which proves defective, shall be replaced before the next group of cables are laid.

All wall openings shall be effectively sealed after installation of cables to avoid leakage of water.

m) Where cables rise from trenches to control station, lighting panels etc., they shall be taken in vertical trays for mechanical protection.

Cable ends shall be carefully pulled through the conduits to prevent damage to the cable. Where required, approved cable lubricant shall be used for this purpose. Where cable enters conduit the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.

n) After the cables are installed and all testing is complete conduit ends above ground shall be plugged with a suitable weatherproof plastic compound / PUTTI for sealing purpose. Alternatively G.I. lids or PVC bushes shall be employed for sealing purposes. The cost for the same shall be deemed to be included in the installation of PVC pipe and no separate payment shall be done.

o) Where cables pass through foundation walls or other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures the electrical contractor shall determine the location, and obtain approval of the engineer in charge before cutting is done.

p) At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends after back filling.

q) Drum number of each cable from which it is taken shall be recorded along with the cable number in the cable schedule.

r) Cables installed above ground shall be run in trays exposed on walls, ceiling, structures and shall be run parallel or at right angles to beams, walls or columns. Cables shall be so routed that they will not be subjected to heat from adjacent hot piping or vessels.

s) Individual cables or small groups which run along structures / walls etc. will be by means of 16 SWG G.I. saddles on 25 x 6 mm saddle bars. The cost of saddle and saddle bars shall be deemed to have been included in the installation of cables and no separate payment shall be made on this account. They shall be rigidly supported on structural steel and masonry, individually or in groups, as required. If drilling of steel must be resorted to, approval must be secured and steel must be drilled where the minimum weakening of the structure will result. Cables shall be supported so as to prevent unsightly sagging. In general distance between supports shall be approximately 300 mm for cables upto 25 mm diameter and maximum 450 mm for cables larger than 25 mm diameter.

t) All PVC Pipes shall be laid as per requirements. Before fabrication of various profiles of pipe by hydraulically operated bending machine (which is to be arranged by the Contractor), all the burs from the pipes shall be removed. PVC pipes buried in soil, bitumen coating shall be applied on the buried lengths. Installation of PVC Pipes shall be undertaken well before paving is completed and necessary coordination with paving agency shall be the responsibility of the Electrical Contractor. The open ends of pipes shall be suitably plugged with G.I. plugs/PVC Glands after they are laid in final position. G.I. Plugs/PVC Glands shall be supplied by the contractor at no extra cost.

u) Cable laid on supporting angle in cable trenches, structures, columns and vertical run of cable tray shall be suitably clamped by means of G.I. saddles / clamps, whereas cable in horizontal run of cable trays shall be tied by means of nylon cords.

v) Supporting steel shall be painted before laying of cables. The painting shall be done with one coat of red lead paint and two coats of approved bituminous aluminum paint.

B. WORKMANSHIP:-

The cable shall be laid as mentioned above, the trench shall be terminated in Manholes with specified size of R.C.C. hume pipes as shown in drawing. Cable markers shall be provided through out the route of cable at 10 mtrs distance. The trenches shall be refilled after the cable is laid and the Ground level shall be done as per original after pressing the same. The cables shall be checked for insulation resistance and continuity tests shall be carried out.

C. MODE OF MEASUREMENT:-

The cable laying shall be measured in Rmt. The trenches dug and refilled shall be measured in cu. Mtr. The bricks and sand bedding shall be measured in Rmt. The cable trays shall be measured in Rmt

2.3 1.1 KV GRADE L.T. CABLES AND CABLE TERMINATION

A. SPECIFICATIONS

L. T. XLPE CABLE *:*

General :

The medium voltage cables shall be supplied, laid, connected, tested and commissioned in accordance with the drawings, specifications, relevant Indian Standards specifications, manufacturer's instructions. The cables shall be delivered at site in the original drums with manufacturer's name, size and type clearly written on the drums.

All cables shall be adequately protected against any risk of mechanical damage to which they may be liable in normal conditions of handling during transportation, loading, unloading etc.

The cable shall be supplied in single length i.e. without any intermediate joint or cut unless specifically approved by the client.

The cable ends shall be suitably sealed against entry of moisture, dust, water etc. with cable compound as per standard practise.

Conductor :

Uncoated, annealed copper / aluminum, of high conductivity, upto 4 mm^2 size the conductor shall be solid Circular and above 4 mm^2 the conductors shall be stranded compacted shaped.

Insulation :

Cross link polyethylene (XLPE) extruded insulation rated at 70^oc.

Core Identification :

Two core	:	Red and Black
Three core	:	Red, Yellow and Blue
Four core	:	Red, Yellow, Blue and Black
Single core	:	Green for earthing.

Black shall always be used for neutral and green shall be used for earthing.

Assembly :

Two, three or four insulated conductors shall be laid up, filled with non-hygroscopic material and covered with an additional layer of thermoplastic material.

Armour :

Galvanized steel flat strip / round strips applied helically in single layers complete with covering the assembly of cores.

Sheath :

The inner sheath shall be of PVC type. Outer sheath shall be of an extruded type layer of suitable PVC TYPE-ST-2 material compatible with the specified ambient temp. of 50^oc and operating temperature of cables. The sheath shall be resistant to water, ultra violet radiation, fungus, termite and rodent attacks. The colour of outer sheath shall be black.

Sequential length marking along with size and other standard parameters shall be required at every 1.0 mtr on the outer sheath.

Testing :

Finished cable tests at manufacturers works : The finished cables shall be tested at manufacturer's works for all the routine tests for all the length and size of cables to be delivered at site and the certificate for the same shall be furnished to client. If required the cables shall be tested in presence of the client's representative.

1) Voltage test : Each core of cable shall be tested at room temperature at 3 KV A.C. R.M.S. for duration of 5 minutes.

2) Conductor resistance test : The D.C. resistance of each conductor shall be measured at room temperature and the results shall be corrected to 20°c to check the compliance with the values specified in the IS 8130 .

Cable tests before and after laying cables at site :

1. Insulation resistance test between phases, phase to neutral and phase to earth.
2. Continuity test of all the phases, neutral and earth continuity conductor.
3. Earth resistance test of all the phases and neutral.

TESTING INSTRUMENTS SHALL BE OF REPUTED MAKE AND SHALL HAVE VALID CALIBRATION.

All the tests shall be carried out in accordance with the relevant IS code of practise and Indian Electricity Rules. The vendor shall provide necessary instruments, equipments and labour for conducting the above tests and shall bear all the expenses in connection with such tests. All tests shall be carried out in the presence of client and the results shall be prescribed in forms and submitted.

Cable Marking :

The outer sheath shall be legibly embossed at every meter with following legend :

ELECTRIC CABLE : 1100 V, SIZE :__C X ___ MM^2 with Manufacturers name, year of manufacturing and ISI symbol.

Sealing Drumming And Packing :

After tests at manufacturer's woks, both ends of the cables shall be sealed to prevent the ingress of moisture during transportation and storage.

Cable shall be supplied in length of 500 mtrs or as required in non-returnable drums of sufficiently sturdy construction.

Cables of more than 250 meters shall also be supplied in non-returnable drums.

The spindle hole shall be minimum 110 mm in diameter.

Each drum shall bear on the outside flange, legibly and indelibly in the English literature, a distinguishing number, the manufacturer's name and particulars of the cable i.e. voltage grade, length, conductor size, cable type, insulation type, and gross weight shall also be clearly visible. The direction for rolling shall be indicated by an arrow. The drum flange shall also be marked with manufacturer's name and year of manufacturing etc.

4 Cable Termination:

4.1 All LT cables upto 1100 V grade shall be terminated at the equipment by means of double compression type cable glands of aluminum / copper conductor. Cable glands to be supplied by the contractor should be preferably of leading and approved brands only. They shall have a screwed nipple with conduit, electrical thread and check nut.

4.2 Power cables shall be identified with Red, Yellow and Blue PVC tapes. Where copper to aluminum connections are made necessary, bimetallic washers shall be used. For trip circuit identification, additional red ferrules shall be used only in the particular cores of control cables at the termination points in the switchgear / control panels and control switches.

4.3 In case of control cables all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules, or self sticking cable markers. Wire numbers shall be as per the schematic / wiring / interconnection diagrams. The contractor shall have the samples of PVC ferrules / cable markers approved before starting of the work.

4.4 Where threaded cable gland is screwed into threaded opening of different size, suitable galvanized threaded reducing bushing of approved type shall be used, at no extra cost. Contractor shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic materials / aluminum sheet in case of single core cables.

4.5 The cable shall be taken through glands inside the panels or any other equipment such as motors. The individual cores shall then be dressed and taken along the cableways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals.

In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom, close fit hole should be drilled in the bottom plate for all the cable in on line: then the bottom plate should be split in to parts along the centre line of holes. After installation of bottom plate and cables, it should be sealed with cold setting compound. Cables shall be clamped over the open armouring to connect it to the earth bus.

4.7 Cable leads shall be terminated at the equipment terminals by means of crimped type solder less connectors as manufactured by leading and approved companies / brands. Crimping shall be done by hand crimping / hydraulically operated tool, and conducting jelly shall be applied on the conductor. Insulation of the leads should be removed immediately before the crimping. Conductor surface shall be cleaned and shall not be left open.

B. WORKMANSHIP

Cables shall be laid in the routes marked in the drawings. Where the route is not marked, the Contractor shall mark it out on the drawings and also on the site and obtain the approval of the CLIENT AND/OR ITS ARCHITECT before laying the cable. **Procurement of cables shall be on the basis of actual site measurements and the quantities shown in the schedule of work shall be regarded as a guide only.**

Cables shall be laid on walls, cable trays, inside shafts or trenches. Saddling or support for the cable shall not be more than 500 mm apart. Plastic identification tags shall be provided at every 30 m.

Cables shall be bent to a radius not less than 12 (twelve) times the overall diameter of the cable or in accordance with the manufacturer's recommendations whichever is higher.

In the case of cables buried directly in ground, the cable route shall be parallel or perpendicular to roadways, walls etc unless marked on drawing by architect / consultant. Cables shall be laid on an excavated, graded trench, over a sand or soft earth cushion to provide protection against abrasion. Cables shall be protected with brick or cement tiles on all the three sides as shown on drawings. Width of excavated trenches shall be as per drawings. Back fill over buried cables shall be with a minimum earth cover of 750 mm to 1000 mm. The cables shall be provided with cables markers at every 10 meters and at all loop points.

All cables shall be full runs from panel to panel without any joints or splices. Cables shall be identified at end termination indicating the feeder number and the Panel/Distribution board from where it is being laid. Cable termination for conductors up to 4 sq.mm. may be insertion type and all higher sizes shall have compression type lugs. Cable termination shall have necessary brass glands. The end termination shall be insulated with a minimum of six half-lapped layers of PVC tape. Cable armouring shall be earthed at both ends.

In case of cables entering the buildings. It would be done duly only through pipes. The pipes shall be laid in slant position, so that no rainwater may enter the building. After the cables are tested the pipes shall be sealed with M. seal & then tarpaulin, shall be wrapped around the cable for making the entry watertight.

Testing :

MV cables shall be tested upon installation with a 500 V Meggar and the following readings established:

1. Continuity on all phases.
2.
3. Insulation Resistance: Between conductors and All conductors & ground.

All test readings shall be recorded and shall form part of the completion documentation.

Cable joints shall be done as per regular practice and check shall be carried out for loose connections and leakages. Insulation cutting shall be done properly taking care that no area of the conductor remains exposed. Crimping shall be done with the help of hydraulic tool. Proper insulation tape shall be applied at the cable and lug joint.

Format for cable testing certificate :

a. Drum no. from which cable is taken :

b. Cable from _____to _____

c. Length of run of this cable _____mtr

d. Insulation resistance test

Between core 1 to earth _____mega-ohm

Between core 2 to earth _____mega-ohm

Between core 3 to earth _____mega-ohm

Between core 1 to core 2 _____mega-ohm

Between core 2 to core 3 _____mega-ohm

Between core 1 to core 3 _____mega-ohm

Duration used :

e. C. MODE OF MEASUREMENT:-

The cables shall be measured in Rmt and terminations on unit basis.

2.4. DISTRIBUTION BOARDS

A. SPECIFICATIONS

Distribution boards shall be readymade as specified in the make of material list. It shall be of double door type with hinged (lockable if required) door suitable for recessed mounting in wall.

The distribution boards shall be provided with phase barriers, wiring channels to accommodate wires and individual per phase neutral links. There shall be separate or individual earth link as per requirement. Proper arrangement shall be made for mounting of MCB's and other accessories.

Distribution boards shall meet with the IS requirements and marking arrangement of bus bars shall be in accordance with I.S. standards.

Bus bars shall be suitable for the incoming switch rating and sized for a temperature rise of 35° C over the ambient. Each board shall have two separate earthing terminals. Circuit diagram indicating the load distribution shall be pasted on the inside of the DB as instructed. One earthing terminal for single phase and two terminals for 3 phase DB's shall be provided with an earth strip connecting the studs and the outgoing copper earth bar.

The top and the bottom faces of the D.B. shall be provided for conduit entry of minimum 1" dia. The faces if asked shall be kept detachable.

Miniature Circuit Breakers (MCB):

MCB's shall have quick make and break for 10 KA short circuit both on the manual and automatic operation. Each pole of the breaker shall be provided with inverse time thermal over load and instantaneous over current tripping elements, with trip-free mechanism. In case of multi-pole breakers, the tripping must be on all the poles and operating handle shall be common. Breakers must confirm to **IS:8828** with facility for locking in OFF position.

Tripping characteristics of the MCBs (B/C/D curve) should be based on the load connected to the MCB

RCBB / ELCB

The RCCB should suffices all the requirements of IS as per code IS - 12640 – 1988/IEC 61008. The RCCB should be current operated and not on line voltage.

The RCCB should ensure mainly the following functions:

i) Comparison of the fault current with a reference value.

ii) The RCCB should have a toroidal transformer which has the main conductors of primary (P - N) which check the sum of the current close to zero.

iii) All metal parts should be inherently resistant to corrosion and treated to make them corrosion resistant.

iv) It should be truly current operated.

v) It should operate even in case of neutral failure.

vi) It should trip at a present leakage current within 100mA for Lighting circuit and 300mA for Raw power and AC circuits.

vii) Its enclosure should be minimum protection of IP 30.

viii) Its mechanical operation life should be more than 20,000 operations.

ix) It should conform to all national and international standards like IS: 12640-1988, IEC 61008

B. WORKMANSHIP

The D.B. shall be properly grouted in the wall in concealed manner taking care that the powder coating is not scratched and dents are not formed on the D.B. The MCBs and ELMCBs. In the distribution boards shall be fixed as per the circuit details provided. All the wires terminating in the MCBs and the ELMCBs shall be lugged for proper contact and ferrules depicting the circuit nos. shall be provided. D.B.s mounted in concealed manner shall have a groove around it so as to save the finish of the plaster and colour during future opening of the door. The distribution boards shall have circuit chart tagged on the door for future maintenance. Danger notice plates shall be fitted to the distribution boards with screws and not stuck so as to assure its presence for a longer duration.

C. MODE OF MEASUREMENT

The distribution boards shall be measured in nos. and the MCBs and ELMCBs shall be measured in nos. separately.

2.5. INTERNAL WIRING

A. SPECIFICATIONS

Rigid PVC And Flexible PVC Conduits:

All conduits shall be rigid PVC alloy low in halogens pipe having minimum wall thickness of medium gauge 1.6 to 2.0 approved by F.I.A. & I.S.I. and shall confirm to IS 9537 part 3 and complying with fire safety standards.

Up to 38 mm diameter in slab - minimum 1.8 mm. wall thickness.
Up to 38 mm diameter in floor - minimum 2.0 mm. wall thickness.
Above 40 mm. diameter - minimum 2.2 mm. wall thickness.

Flexible conduits shall be formed from a continuous length of spirally wound interlocked steel strip with a fused zinc coating on both sides. The conduit shall be terminated in brass adapters.

Accessories:

PVC conduit fittings such as bends, elbows, reducers, chase nipples, split couplings, plugs etc. shall be specifically designed and manufactured for their particular application. All conduit fittings shall conform to IS: 2667-1964 and IS: 3857-1966. All fitting associated with galvanized conduit shall also be galvanized.

Wires:

All wires shall be single core /multi-strand flexible copper or single strand Copper (as specified in BOQ), PVC insulated FRLS grade as per IS: 694 and shall be 660 V\1100 V.

All wires shall be colour coded as follows:

Phase	Colour of wire
R	Red
Y	Yellow
B	Blue
N	Black
Earth	Green (insulated)
Control (If any)	Grey

Switches & Sockets:

Switches and sockets shall be modular type approved brands. Sockets shall be 3 OR 6 pins with switch and Modular plate type cover. Combination of multiple switch units and sockets should be used to minimize the switch boxes.

For heavy duty, metal clad sockets with M.C.B / Isolator mounted in a galvanized steel box shall be provided.

Switch Plate And Box:

Plates of the same make, as that of switches shall be used with the modular range. Also M.S. boxes shall be taken as switch boxes.

B. WORKMANSHIP:-

The size of conduit shall be selected in accordance with the number of wires permitted under table given below. The minimum size of the conduit shall be 19/20 mm diameter unless otherwise indicated or approved. Size of wires shall not be less than 1.5 sq.mm. Copper or 2.5 sq.mm. Aluminum.

Nominal Cross sec. Area	20 mm		25 mm		32 mm		38 mm	
(mm^2)	S	B	S	B	S	B	S	B
1.50	4	3	8	6	15	9	--	--
2.50	4	2	6	4	10	8	--	--
4.00	2	2	4	3	8	6	--	--
6.00	1	--	4	3	6	6	--	--
10.00	1	--	3	2	5	4	6	5
16.00	--	--	1	1	2	2	5	4

S - runs of conduits which have distance not exceeding 4.25 m. between draw boxes & which do not deflect from the straight by an angle more than 15 degree.

B - runs of conduits, which deflect, from the straight by more than 15°.

Conduits shall be kept at a minimum distance of 100 mm. from the pipes of other non-electrical services. And maintain minimum 300 mm distance between telephones, TV & Computer piping.

Wiring for short extensions to outlets in hung ceiling or to vibrating equipment, motors etc., shall be installed in flexible conduits. Otherwise rigid conduits shall be used. No flexible extension shall exceed 1.25 m.

Conduits run on surfaces shall be supported on metal 1.2 mm. thick G.I. pressure saddles which in turn are properly screwed to the wall or ceiling. Saddles shall be at intervals of not more than 500 mm. Fixing screws shall be with round or cheese head and of rust-proof materials. Exposed conduits shall be neatly run parallel or at right angles to the walls of the building and shall be painted in colour matching the adjoining area. Unseemly conduit bends and offsets shall be avoided by using fabricated mild steel junction/pull through boxes for better appearances. No cross-over of conduits shall be allowed unless it is necessary and entire conduit installation shall be clean and neat in appearance.

Conduits embedded into the walls shall be fixed by means of staples at not more than 500 mm. intervals. Chases in the walls shall be neatly made and refilled after laying the conduit and brought to the finish of the wall but the building Contractor will do final finish.

Conduits buried in concrete structure shall be put in position and securely fastened to the reinforcement and got approved by the CLIENT AND/OR ITS ARCHITECT, before the concrete is poured. Proper care shall be taken to ensure that the conduits are neither dislocated nor choked at the time of pouring the concrete suitable fish wires shall be drawn in all conduits before they are embedded.

Where conduit passes through expansion joints in the building, adequate expansion fittings shall be used to take care of any relative movement.

Inspection boxes shall be provided for periodical inspection to facilitate withdrawal and removal of wires. Such inspection boxes shall be flush with the wall or ceiling in the case of concealed conduits. Inspection boxes shall be spaced at not more than 12 meters apart or two 90° solid bends or equal. All junction and switch boxes shall be covered by 6 mm clear plate. These junction boxes shall form part of point wiring or conduit wiring as the case may be including the cost of removing the cover for painting and re-fixing. No separate charges shall be allowed except where specially mentioned.

Conduits shall be free from sharp edges and burrs and the threading free from grease or oil. The entire system of conduits must be completely installed and rendered electrically continuous before the conductors are pulled in. Conduits should terminate in junction boxes of not less than 32 mm. deep.

Lighting & Power Wiring:

All final branch circuits for lighting and appliances shall be single conductor/ stranded/ flexible wires run inside conduits. The conduit shall be properly connected or jointed into sockets, bends, and junction boxes.

Branch circuit conductor sizes shall be as shown in the schedule of quantities and or drawings.

All circuits shall preferably be kept in a separate conduit up to the Distribution Board. No other wiring shall be bunched in the same conduit except those belonging to the same phase. Each lighting branch circuit shall not have more than ten outlets or 800 watts whichever is lower. Each conduit shall not hold more than three branch circuits.

Flexible cords for connection to appliances, fans and pendants shall be 650/1100 V grade (three or four cores i.e. with insulated neutral wire of same size) with tinned stranded copper wires, insulated, twisted and sheathed with strengthening cord. Colour of sheath shall be subject to the CLIENT AND/OR ITS ARCHITECT'S approval.

Looping system of wiring shall be used. Wires shall not be jointed. Where joints are unavoidable, they shall be made through approved mechanical connectors. No such joints shall be made unless the length of the sub-circuit, sub-main or main is more than the length of the standard coil. No reduction of strands are permitted at the terminations.

Control switches shall be connected in the phase conductors only and shall be `ON' when knob is down. Switches shall be fixed in 3 mm. thick painted or galvanized steel/MS boxes with cover plates as specified. Cadmium plated brass screws shall be used.

Power wiring shall be distinctly separate from lighting wiring. Conduits not less than 20mm. and wires not less than 1.5 sq.mm. copper shall be used.

Every conductor shall be provided with identification ferrules at both ends matching the drawings.

Testing: the entire installation shall be tested for :

Insulation resistance.

Earth continuity.

Polarity of single pole switches.

General: All the wiring switch board, outlet points shall be done in a concealed manner in wall & slab in PVC conduit of minimum 20 mm dia. (medium gauge) & with 650v / 1100v grade PVC insulated flexible copper conductor wire. The switches should be modular with moulded cover plates, blank plates for outlet boxes. The accessories, connectors, sockets, should be fixed with brass chrome / cadmium plated machine screw. For fan points the regulator should be 300W with hum -free type as required to complete the point wiring. The wiring shall be as per IS: 732 and IS: 4648. The wiring shall be done in a looping manner so as to avoid junction boxes at any place. All the looping shall be done only in the switchboard and outlet points. The size of the wire shall be as per the specification. Colour code shall be strictly followed.

The size of wires shall be followed as per given Electrical Distribution Diagram.

Separate pipes shall be laid for point wiring and circuit mains.

Circuit mains of same phase shall be drawn in one pipe with prior permission/discussion with the consultant.

Separate phase, neutral and earthing wire of sizes recommended by consultant shall be drawn for each and every circuit mains.

Mains for lighting and on board plug points shall be of one-size higher wires than those used in off.

The point definition shall be conduiting and wiring from D.B. to S.B. and there from to final outlet point including switches and accessories, junction boxes, fan boxes, etc of approved make.

C. MODE OF MEASUREMENT

The items shall be measured on unit basis or on mtr basis as per BOQ.

Separate conduits/Raceways shall be used for :

Separate **PVC conduits to be used for following services cable/wires**

a) Normal lights and 5 A 3 pin sockets on lighting circuit.

b) Power outlets - 15 A/20A 3/6 pin

c) D.B. to switch board.

d) Emergency lighting.

e) Fire alarm system.

f) Public address system & Music system.

g) T.V. Cable

h) CCTV Cable

i) BMS Cable

j) LMS (Lighting Management System)

k) Access Control System

Separate Cable Tray and Raceways to be used for following services cable/wires

a) Data and Telephone Cables.

b) UPS and Raw Power Wires.

Separate Raceways shall be provided for UPS and Raw Power wiring, wires shall be taken through the Raceways supported to ceiling from the Distribution Board and drop to the nearest Brick wall / Partition wall and connected to UPS / Raw power sockets through the PVC conduit laid inside the wall or below floor.

2.6. LIGHT FIXTURES

A. SPECIFICATIONS

Light fixtures as mentioned in the BOQ with the catalogue nos. and makes or equivalent models of other approved brands shall be installed. The fixtures shall be complete with ballast and shall be prewired by the manufacturer.

Lumen output of lamps to be provided as follows,

18W, LED	= 1200 Lumens
14W, LED T5 Lamp	= 1200 Lumens
28W, LED T5 Lamp	= 2750 Lumens
55W, LED	= 5400 Lumens

All Out door fixtures should have high efficiency Lamp and same shall be confirmed by manufacturer.

Fans of the approved makes and size shown in the drawing shall be used and install in the hook type M.S. box used by the CLIENT.

B. WORKMANSHIP

The fixture shall be installed on wall / ceiling as directed and as per manufacturer's instruction, with necessary accessories for surface, concealed, suspended from ceiling, bracket mounting etc. The job also includes connection of fixture with respective outlet point with heat resistant wires through heat resistance sleeve and PVC connector. The exhaust fan shall be installed complete with M.S. angle iron mounting frame/ ring, G.I. louvers, wire mesh and plug at the end of the cord including wiring & earthing etc. Proper earthing shall be provided to the fixtures

C. MODE OF MEASUREMENT

The unit rate shall be considered for fitting one fixture. The rate shall include following

- All fixing accessories, mounting bracket, ballast condensers and control gear wherever applicable.
- Supplying and fixing Ball and socket joints wherever required.
- Earthing of fittings.
- Electrical connections to fittings/fans from the junction box/ceiling rose.
- Installation and interconnection of Electronic regulators for ceiling fans.
- Supplying and fixing 300 mm. GI down rod for ceiling fans.

2.7. EARTHING

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

Following equipment shall be earthed.

a. Non-current carrying metallic parts of electrical equipment such as switchgear, bus ducts, rising mains, panel boards, motor control centres, power panels, distribution boards, cable trays, metal conduits etc.

The shop drawing for earthing system shall be prepared by the contractor based on the GFC drawing issued by consultants and be got approved by owner/Architect. The work shall be done in accordance with approved drawings.

A. SPECIFICATION

i) Plate Electrode Earth Station:-

The earth electrode shall be plate of COPPER PLATE with Copper Strip of required size as per BOQ coming out to ground level.

The earth resistance shall be maintained with a suitable soil treatment. The resistance of each earth station should not exceed 5 ohms.

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

The earth lead shall be fixed to the pipe with a nut and safety set screws. The clamp shall be permanently accessible.

G.I. pipe with funnel of approved quality shall be used for watering the earth electrode \ station.

The block masonry chamber with Cast Iron hinged cover shall be provided for housing the above referred funnel and pipe.

The hardware and other consumable for earthing installation shall be brass or hot dip galvanized iron material as shown on the drawing.

ii) Earth Leads and Connections:

Copper lead shall have a phosphor content of not over 0.15%. At road crossing necessary Hume pipes shall be laid. Earth lead run on surface of wall or ceiling shall be fixed on saddles so that strip is at least 8 mm away from the wall surface.

The complete earthing system shall be mechanically and electrically bonded to provide an independent return path to the earth source.

B. WORKMANSHIP:-

Following activities shall be carried out for the earthing station

- Excavation in hard murrum.
- Laying Watering pipe.
- Brick masonry with hinged covers.
- Charcoal and Salt fill.

- Earth station should be **2** mt. away from wall of foundation
- Keep minimum **3.5** mt. distance between two earth pits.
- The pit should be minimum 10ft deep. (3.5 Mtr.)
- The earth resistance should not exceed 5 ohm.
- All earth pits of same category shall be interlinked with strip.

Following points shall be followed strictly.

The plate electrode, as far as practicable, shall be buried below permanent moisture level but in no case not less than 3.5 M below finished ground level.

The plate electrode shall be kept clear of the building foundation and in no case, it shall be nearer by less than 2 M from outer face of the respective building wall \ column.

The plate electrode shall be installed vertically and shall be surrounded with 150 mm. thick layers of Charcoal dust and Salt mixture.

20-40 mm. dia. G.I. pipe for watering, shall run from top edge of the pipe electrode to the mid level of block masonry chamber.

Top of the pipe shall be provided with G.I. funnel and screen for watering the earth \ ground through the pipe.

The funnel with screen over the G.I. pipe for watering to the earth shall be housed in a block masonry chamber as shown in the drawing.

The masonry chamber shall be provided with a Cast Iron hinged cover resting over the Cast Iron frame, which shall be embedded in the block masonry.

Construction of the earthing station shall in general be as shown in the drawing and shall conform to the requirement on earth electrodes mentioned in the latest edition of Indian Standard IS: 3043, Code of Practice for Earthing Installation.

The earth conductors inside the building shall properly be clamped / supported on the wall with Galvanized Iron clamps and Mild Steel Zinc Passivated screws / bolts. The conductors outside the building shall be laid at least 600 mm. below the finished ground level.

The earth conductors shall either terminate on earthing socket provided on the equipment or shall be fastened to the foundation bolt and / or on frames of the equipment. The earthing connection to equipment body shall be done after removing paint and other oily substances from the body and then properly be finished.

Over lapping of earth conductors during straight through in joints, where required, shall be of minimum 75mm. long.

The earth conductors shall be in one length between the earthing grid and the equipment to be earthed.

Additional equipment earthing shall be done with Cu strip / Bare Cu Wire as per size indicated in drawing.

Lightening arrestors shall be installed at topmost point of the building. The quantity for the same shall be designed & specification in BOQ to cover total building area. Early streamer emission type arrestor shall be connected to separate earth pit with Cu Strip.

Following tests shall be carried out:

The entire earthing installation shall be tested as per requirements of Indian Standard Specification IS: 3043.

The following earth resistance values shall be measured with an approved earth megger and recorded.

- Each earthing station
- Earthing system as a whole
- Earth continuity conductor

Earth conductor resistance for each earthed equipment shall be measured which shall not exceed 5 Ohm in each case.

Measurements of earth resistance shall be carried out before earth connections are made between the earth and the object to be earthed.

C. MARKING

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

ii. Main earthing terminals shall be marked “SAFETY EARTH-DO NOT DISCONNECT”

3. TESTING OF INSTALLATION

1.0 SCOPE

This chapter describes the details of tests to be conducted in the completed internal electrical installations, before commissioning.

1.1 GENERAL

1.1.1 Tests

On completion of installation, the following tests shall be carried out:-

1) Insulation resistance test.
2) Polarity test of switch.
3) Earth continuity test.
4) Earth electrode resistance test.

1.1.2 Witnessing of tests

Testing shall be carried out for the completed installations, in the presence of and to the satisfaction of the Engineer-in-charge by the contractor. All test results shall be recorded and submitted to the Department.

1.1.3 Test instruments

All necessary test instruments for the tests shall be arranged by the contractor if so required by the Engineer-in-charge.

1.2 INSULATION RESISTANCE

1.2.1 The insulation resistance shall be measured by applying between earth and the whole system of conductors, or any section thereof with all fuses in place, and all switches closed, and except in earthed concentric wiring, all lamps in position, or both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure, provided it need not exceed 500 volts for medium voltage circuits. Where the supply is derived from a three wire D.C, or a polyphase A.C. system, the neutral pole of which is connected to earth either directly or through added resistance, the working pressure shall be deemed to be that which is maintained between the phase conductor and the neutral.

1.2.2 The insulation resistance shall also be measured between all the conductors connected to one pole, or phase conductor of the supply, and all the conductors connected to the neutral, or to the other pole, or phase conductors of the supply with all the lamps in position and switches in "off' position, and its value shall be not less than that specified in sub-clause 1.2.3.

1.2.3 The insulation resistance in mega ohms measured as above shall not be less than 12.5 mega ohms for the wiring with PVC insulated cables, subject to a minimum of 1 mega ohm.

1.2.4 Where a whole installation is being tested, a lower value than that given by the formula, subject to a minimum of 1 mega ohm, is acceptable.

1.2.5 A preliminary and similar test may be made before the lamps etc. are installed, and in this event the insulation resistance to earth should not be less than 25 mega ohms for the wiring with PVC insulated cables, subject to a minimum of 2 mega ohms.

1.2.6 The term "outlet" includes every point along with every switch, except that a switch combined with a socket outlet, appliance or lighting fitting is regarded as one outlet.

1.2.7 Control rheostats, heating and power appliances and electric signs may, if required, be

disconnected from the circuit during the test, but in that event the insulation resistance between the case or frame work, and all live parts of each rheostat, appliance and sign, shall be not less than that specified in the relevant Indian Standard Specifications, or where there is no such Specification, shall be not less than one mega ohm.

1.3 POLARITY TEST OF SWITCH

1.3.1 In a two wire installation, a test shall be made to verify that all the switches in every circuit have been fitted in the same conductor throughout, and such conductor shall be labeled or marked for connection to the phase conductor, or to the non-earthed conductors of the supply.

1.3.2 In a three wire or a four wire installation, a test shall be made to verify that every non-linked single pole switch is fitted in a conductor which is labeled, or marked for connection to one of the phase conductors of the supply.

1.3.3 The installation shall be connected to the supply for testing. The terminals of all switches shall be tested by a test lamp, one lead of which is connected to the earth. Glowing of test lamp to its full brilliance, when the switch is in "on" position irrespective of appliance in position or not, shall indicate that the switch is connected to the right polarity.

1.4 TESTING OF EARTH CONTINUITY PATH

The earth continuity conductor, including metal conduits and metallic envelopes of cables in all cases, shall be tested for electric continuity. The electrical resistance of the same along with the earthing lead, but excluding any added resistance, or earth leakage circuit breaker, measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed one ohm.

1.5 MEASUREMENT OF EARTH ELECTRODE RESISTANCE

1.5.1 Two auxiliary earth electrode, besides the ‘test’ electrode, are placed at suitable distance from the test electrode. A measure current is passed between the ‘test’ electrode to be tested and an ‘auxiliary’ current electrode and the potential difference between the ‘test’ electrode and ‘auxiliary’ electrode potential is measured. The resistance of the test electrode is then given by:

$R=V/I$

Where,

R - Resistance of the test electrode in ohms,

V - Reading of the voltmeter in volts.

I - Reading of the ammeter in amps.

1.5.2 (i) Stray currents flowing in the soil may produce serious errors in the measurement of earth resistance. To eliminate this, hand driven generator is used.

(ii) If the frequency of the supply of hand driven generator coincides with the frequency of stray current, there will be wandering of instrument pointer. An increase or decrease of generator speed will cause this to disappear.

1.5.3. At the time of test, the test electrode shall be separated from the earthing system.

1.5.4 The auxiliary electrodes shall be of13 mm diameter mild steel rod driven upto 1 m into the ground.

1.5.5 All the three electrodes shall be so placed that they are independent of the resistance area of each other. If the test electrode is in the form of a rod, pipe or plate, the auxiliary current electrode 'c' shall be placed at least 30 m away from it, and the auxiliary potential electrode' B' shall be placed mid-way between them.

1.5.6 Unless three consecutive readings of test electrode resistance agree, the test shall be repeated by

increasing the distance between electrodes A and C upto 50 m, and each time placing the electrode B midway between them.

1.5.7 On these principles, "Megger Earth Tester", containing a direct reading ohm-meter, a hand driven generator and auxiliary electrodes are manufactured for direct reading of earth resistance of electrodes.

1.5 TEST CERTIFICATE

On completion of an electrical installation (or an extension to an installation), a certificate shall be furnished by the contractor, countersigned by the certified supervisor under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as provided in the National Building Code of India, PART 8 BUILDING SERVICES – SECTION 2 ELECTRICAL AND ALLIED INSTALLATIONS, ANNEX E, (Clause 9.3.2.6), FORM OF COMPLETION CERTIFICATE (REFER NBC 2005).