

TECHNICAL SPECIFICATIONS FOR ELECTRICAL SYSTEM WORKS

PREAMBLE

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- The technical specifications, preamble, scope of work, BOM/Q and SLD forms part of BID document.
- Vendor shall go through all the drawings, Bill of Material and quantities and in case of doubt discuss with consultant / Client for better understanding of the work and submit offer accordingly.
- All drawings shall be read in conjunction with relevant Architectural, structural, HVAC, PHE, fire alarm, fire protection, IT Layouts, AV Layouts, Security systems and relevant drawings.
- The bill of quantities shall be read in conjunction with Preamble, Invitation for Bid, Technical Specifications and Drawings.
- The entire installation shall be carried out in accordance with Indian Electricity code and relevant IS standards up to date. The work shall also comply with all statutory regulations of supply agencies, state inspection authorities and fire regulations.
- All material, equipment, fittings used in the supply & installation shall be from recommended makes listed elsewhere in this document, confirming of relevant IS specifications.
- Any deviation without approval is liable for rejection by client / consultant / Project Manager.
- All the relevant items for making the system envisaged 100% functional, however bidders may consider items which is either found as shortfall or for higher performance and can highlight such items separately in addition to the bid submitted.
- Liaison with Electricity board, inspectorate to obtain power sanction by preparation and submission of drawings. This will be part of electrical contractor / vendor's scope of work. Refer to BOM / Q under miscellaneous items.
- The client reserves the right supply any material.
- The successful Vendor / contractor shall prepare shop / general arrangement drawings for proposed electrical works and switchboards and obtain approval before taking up execution. Contractor/vendor shall immediately bring out the difficulties faces in execution of works to the notices of Client/Consultant
- All the materials and equipments supplied & Installed by the contractor/vendor shall be offered for inspection before lifted from manufacturer's site.
- All outdoor Panels shall have Protection of IP 55 & Indoor Panels shall have Protection of IP42 for indoor panels with Louvers & IP52 for indoor panels without Louvers or Better whether specified or not.
- For those Equipments / systems which are either Controlled & Monitored by BMS or monitored by BMS, Adequate No. of Potential Free NO/NC Contacts shall be provided whether specified or not. All such equipments / systems shall be BMS Compatible.
- All multi strand copper & control cables shall be of FRLS and wires shall be FRLS Type whether specified or not.
- Unless otherwise specified all ACB's, MCCB's (microprocessor based), Maximum demand controllers, Energy meters, Digital load monitors, Power monitors, Multi function relays, ATS, Branch circuit power monitors, annunciators shall have RS 485 communication port.
- Switchgear shall be provided with door interlock and interlock defeat arrangement.

- Selection of CT & PT shall be as per the calculations for burden, accuracy and type.
- The switchboard fabrication shall confirm to Form-3b&4b.
- Refer Single line diagram and BOM&Q for switch board details.
- All switch boards and bus ducts neutral shall be rated for 100% of phase current.
- Fault levels indicated in calculations or single line diagram are applicable for both switchboards and switchgears.
- All LT switchgear, cables shall be tested for insulation resistance using 1000 V megger and results shall be noted. The tests shall be conducted in the presence of Client / Consultants
- Capacitor banks shall not work under DG power supply, necessary control wiring shall be considered.
- All steel supports shall be provided with 2 coats of primer and enamel paint before installation.
- Selection of All Switch gear components should be of same make to achieve the coordination. In order to meet total discrimination requirement, if any change in the rating / frame size of breakers needed to achieve total discrimination, the same shall be provided at no extra cost to Client.
- Switchgear selection shall be generally suitable for discrimination and co-ordination for over-current, Short circuit and earth fault. Vendor while selecting the switchgear shall ensure the switchgear discrimination is achieved and shall check with fabricators / switchgear suppliers. Vendor shall furnish discrimination charts before taking up fabrication of switchboards.
- Vendors shall share the complete technical specifications with recommended switchboard fabricators to ensure the fabricator understands the technical requirement of the project precise.
- Earthing system shall be conforming to IS 3043 & TN-S system.
- End connection shall be carried out using single core aluminium / copper conductor cables and terminated with use of suitable type – aluminium / copper lugs. This is separately quantified in the BOM / Q.
- End connection for grounding cable length shall be limited to 1 meter, to be hooked from the nearest earthing bus or earth bar / rigid GI / Aluminium / Copper bus.
- The earth chamber shall be made out of RCC and shall be heavy duty to take the load of vehicle movement.
- Unless specified or not, wherever specified, vendor / contractor shall consider microprocessor-based release for switchgears > 250A breaker.
- All switchgears shall be suitable for basic and selective protection.
- All cable trays whether specifically mentioned or not shall be of Hot dip GI only with minimum 2mm thick.
- Perforated type cable trays shall be of double bended at sides whether mentioned or not.
- Unless specifically mentioned all cable trays shall be prefabricated and weld less bolted rung system suitable for ready installation.
- Unless otherwise specified perforated cable tray systems shall include the following.

- Anchor fasteners – m _ to address the cable load.
- Down rods – m _ max length 600 mm – fully threaded galvanized.
- Slotted bottom channel – to suit width of cable tray.
- Cable tray shall be C / U shaped galvanized slotted arrangement.
- Rungs shall be as per standards.
- LV cables shall be rated for 1100 V.
- Cables shall be XLPE/PVC insulated, PVC sheathed, strip/wire armoured, and aluminium / copper conductors vide BOM / Q.
- On completion of works contractor shall carry out all necessary tests such as insulation resistance test, continuity of conductors and earth resistance and functional tests along with commissioning checks to the satisfaction of Client/Consultant.
- Power socket outlets

Note: Wherever industrial type sockets are offered the prices shall include plug top also.

 - 6 A – 3 pin
 - 16 A – 6 Pin
 - 6/16 A – 5 Pin
 - All metal clad sockets shall have min IP55 protection for Indoor and IP67 for outdoor application with MCB/RCCB control
 - All the power sockets will be universal type
- Power wiring
 - Light Normal & Emergency Point wiring – with use of 3 Runs of 1.5 Sqmm FRLS wires in 20 mm dia, 2 mm thick, FRLS PVC/MS conduits or as mentioned in BOM/Q.
 - Light Normal & Emergency Circuit main – with use of 2 Runs x 2.5Sqmm and 1 Run x 1.5Sqmm FRLS wires in 25 mm dia, 2 mm thick, FRLS PVC/MS conduits or as mentioned in BOM/Q.
 - General Power circuit wiring shall be of 2 Runs x 4Sqmm and 1 Run of 2.5Sqmm FRLS wires in 25mm Dia, 2mm thick, FRLS PVC/MS conduits or as mentioned in BOM/Q.

- MCB DBs
 - MCB DB's shall be Phase segregated, Phase isolated and vertical type with double door arrangement.
 - VTPN DB's shall be suitable to mount TP or SP ways.
 - Wherever Horizontal ways DBs are used – combined copper bus shall be installed for connectivity of supply side. Wiring between Incomer and supply side outgoing MCBs is not acceptable.
 - Wherever lighting control (programmable lighting controllers are part of DB) – if the component cannot be fitted in standard DBs, vendor/contractor can opt for fabrication DB's suitable for wall mounting.
 - All Lighting control MCB's shall be 6A or 10A max – “C” Curve
 - All General power control MCB's shall be 10A / 16A / 25A max – “C” curve
 - All UPS control MCB's shall be 10A / 16A max – “D” curve.
 - ELCB / RCCB's shall be with 100mA sensitivity for Lighting circuits
 - ELCB / RCCB's shall be with 30mA sensitivity for Power circuits.
 - ELCB / RCCB's shall be with 300mA sensitivity for HVAC equipments based on vendor's requirement.
- Light fixtures
 - Vendor/contractor to confirm the light fixtures brand envisaged.
 - Vendor / Contractor shall simulate with light fixtures to arrive the lux levels for different areas with the chosen brand.
 - Light fixtures shall be vide BOM/Q.
 - Light fixture installation – shall include
 - Necessary anchor fasteners
 - Down rods/Wires/chains (galvanized)
 - Ceiling rose/Junction Box
 - Assembling of light fixtures
 - Connectivity between ceiling rose and Light fixture using PVC insulated ZHFR multistarand copper wires in PVC flexible of suitable size.
 - Connectivity between ceiling rose to suspended light fixtures shall be with 3Core multistarand copper flexible braided silk cable.
 - Unless specified the light fixtures shall be provided with electronic ballasts.
 - Unless specified the all LED light fixtures shall be provided with drivers.
 - The light fixtures for office areas shall be with anti glare louvers.
 - The common areas and rest rooms / conference rooms / meeting rooms shall be provided with occupancy sensors to conserve energy (refer drawing)
 - All CFL / LED down lights shall be provided with frosted glass for diffusers unless specifically mentioned.
 - Earthing system shall be conforming to IS 3043 TNS system & IEEE regulations.

Abbreviations		
Rs or RS	:	Indian Rupees
LS or L.S or SUM	:	Lump Sum
No. / Nos.	:	Number(s)
M or Mtr or rmt	:	Metre
cum. Km. / cum km	:	Cubic Meter Kilometre
KG / kg / Kg	:	Kilogram
HP	:	Horse Power
IS	:	Indian Standard
KVA	:	Kilo volt ampere
KW	:	Kilo watts
KV	:	Kilo volt
KA	:	Kilo ampere
HT	:	High tension
LT	:	Low tension
PF	:	Power factor
DF	:	Diversity factor
AC	:	Alternating current
DC	:	Direct current
VCB	:	Vacuum circuit breaker
RMU	:	Ring main unit
CB	:	Circuit breaker
ATS	:	Auto transfer switch
Appx.	:	Approximate
Amp	:	Ampere
BOQ	:	Bill of quantity
BOM	:	Bill of material
CD	:	Compact disk
DB	:	Distribution board
Govt	:	Government
HSD	:	High speed diesel
HDPE	:	High density poly ethylene
LCD	:	Liquid crystal display
GI	:	Galvanized Iron
SLD	:	Single line diagram
MS	:	Mild steel
PVC	:	Poly vinyl chloride
FRLS	:	Fire Retardant Low Smoke
XLPE	:	Cross linked poly ethylene
AYFY	:	PVC Insulated PVC Sheathed Flat Strip Armored Aluminium conductor Cable
AYWY	:	PVC Insulated PVC Sheathed round wire Armored Aluminium conductor Cable
YFY	:	PVC Insulated PVC Sheathed Flat Strip Armored Copper conductor Cable
YWY	:	PVC Insulated PVC Sheathed round wire Armored Copper conductor Cable
YYY	:	PVC Insulated PVC Sheathed Unarmored Aluminium conductor Cable
YY	:	PVC Insulated PVC Sheathed Unarmored Copper conductor Cable
A2XFY	:	XLPE Insulated PVC Sheathed Flat Strip Armored Aluminium conductor Cable
A2XWY	:	XLPE Insulated PVC Sheathed Round wire Armored Aluminium conductor Cable
UPS	:	Uninterrupted power supply

-----END OF SECTION-----

CODES AND STANDARDS

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The work shall conform to the following Acts, Rules and codes,

- Indian Electricity Rules 1956
- Chief Electrical Inspector to Government rules (CEIG)
- National Building Code (NBC 2016)
- State Electricity Board Regulations
- Institute of Electrical and Electronics Engineers Standards (IEEE)
- Chartered Institution of Building services engineer (CIBSE)

FOLLOWING ARE SOME OF THE IS CODES FOR REFERENCE

IS code	Description
116	: Circuit Breakers for AC system
159	: Bus bars & bus bars connections
371	: Ceiling Roses
374	: electrical Ceiling Type Fan & Regulators
694	: PVC Insulated cables for working voltages Up To & Including 1100 Volts
732	: electrical Wiring installations
900	: Installation & Maintenance of Induction motors
996	: Single Phase Small AC & Universal electrical motors
1255	: Installation & Maintenance of Power cables Up to & Including 33 kV Rating
1293	: Plugs & Socket-Outlets Of 250 Volts & Rated Current Up to 16 Ampere
1534-1	: Ballast for Fluorescent Lamps
1554-1	: PVC Insulated (Heavy Duty) electrical cables (Switch Start Circuit)
1554-2	: PVC Insulated (Heavy Duty) electrical cables (for Working Voltage from 3.3 kV up to & including 11 KV)
1651	: Stationary Cells & Batteries, Lead Acid Type (With Tubular Positive Plates)
1766	: Time Switches for Metering & Load Control
1777	: Industrial Luminaries With Metal Reflectors
1818	: Isolator & Earthing switches
1885-1	: Electrotechnical Vocabulary (Fundamental Definitions)
1901	: Visual Indicator Lamps
1913-1	: General & Safety Requirement for Luminaries (Tubular Florescent Lamps)
1180	: Transformer (General)
1180	: Transformer (Temperature-Rise)
1180	: Transformer (Insulation Levels & Dielectric Tests)
1180	: Transformer (Terminal Markings, Tapping's & Connections)
2071-1	: High Voltage Test Techniques (General Definition & Test Requirement)
2071-2	: Methods Of High Voltage Testing's (Test Procedure)
2071-3	: Methods Of High Voltage Testing's (Measuring Devices)
2099	: Specification for Bushings for Alternating Voltages above 1000 Volts
2147	: Degree of protection provided for enclosure for switchgear
2206-1	: Flameproof electrical Lighting Fittings (Well-Glass & Bulkhead types)
2418-1	: Tubular Fluorescent Lamps for General Lighting Services (Requirement & Test)
2418-2	: Tubular Fluorescent Lamps for General Lighting Services (Standard Lamp Data Sheets)
2419	: Dimension for Panel Mounted Indicating & Recording electrical Instruments
2440	: guide for day lighting of buildings
2448-1	: Adhesive Insulating Tapes for electrical Purposes
2551	: Danger Notice Plates
2667	: Fitting for Rigid Steel Conduit for electrical Wiring
2705-1	: Current Transformer (General Requirement)
2705-2	: Current Transformer (Measuring Current Transformer)

2705-3	:	Current Transformer (Protective Current Transformer)
2705-4	:	Current Transformer (Protective Current Transformer for Specific Purpose Applications)
3043	:	Code Of Practice for Earthing
3072	:	Installation & maintenance of Switch gear
3106	:	Code of practice for installation & maintenance of switchgear.
3156-1	:	Voltage Transformers (General Requirements)
3156-2	:	Voltage Transformers (Measuring Voltage Transformers)
3156-3	:	Voltage Transformers (Protective Voltage Transformers)
3156-4	:	Voltage Transformers (Capacitor Voltage Transformers)
3231-0	:	electrical relays for Power System Protections (General Introduction & List Of Parts)
3480	:	Flexible Conduit for electrical Wiring
3528	:	Waterproof electrical Lighting Fittings
3646- 1	:	Code Of Practice for Interior Illumination (General Requirements & Recommendations for Working Interiors)
3646- 2	:	Code Of Practice for Interior Illumination (Schedules for Values Of Illuminations & Glare Index)
3837	:	Accessories for Rigid Steel conduits for electrical Wiring
3854	:	Switches for Domestic & Similar Purposes
3961- 1	:	Recommended Current Ratings for cables (Paper Insulated Lead Sheathed cables)
3961- 2	:	Recommended Current Ratings for cables (PVC Insulated & PVC Sheathed heavy Duty cables)
3961- 3	:	Recommended Current Ratings for cables (Rubber Insulated cables)
3961- 5	:	Recommended Current Ratings for cables (PVC Insulated Light Duty cables)
4012	:	Dust Proof electrical Light Fittings
4013	:	Dust-Tight electrical Light Fittings
4146	:	Application guide for Voltage Transformers
4201	:	Application guide for Current Transformer
4237	:	General requirements for switchgears not exceeding 1000 Volts
4289- 1	:	Flexible Cable for Lift & other Flexible Connections (Elastomer Insulated Connections)
4289- 2	:	Flexible Cable for Lift & other Flexible Connections (PVC Insulated Connections)
4615	:	Switch Socket Outlets (Non Interlocking Type)
5216- 1	:	Recommendation on Safety Procedure & Practices In electrical Work (General)
5216- 2	:	Recommendation on Safety Procedure & Practices In electrical Work (Life Saving Techniques)
5424	:	Rubber Mats for electrical Purposes
5831	:	PVC Insulation & Sheath Of Electric cables
6381	:	Construction & Testing Of electrical Apparatus With Type Of Protection
6665	:	Code Of Practice for Industrial Lighting
7098- 1	:	Cross linked Polyethylene Insulated PVC Sheathed cables (for Working Voltages Up to & Including 1100 Volts)
7098- 2	:	Cross linked Polyethylene Insulated PVC Sheathed cables (for Working Voltages 3.3 kV Up to & Including 33 kV)
7118	:	Recommendation for Direction Of Movement for Control Devices Operating electrical Apparatus
7752- 1	:	guide for Improvement Of Power in Consumer Installation (Low & Medium Supply Voltages)
8130	:	Specification for Conductors for Insulated Electric cables & Flexible Cords
8143	:	Specification for Plugs & Keys for Resistance Boxes
8804	:	Plugs, Socket, Terminal Arrangements & Welding Cable Connectors for Manual Welding Equipment Specification
8923	:	Warning Symbol for Dangerous Voltage
8935	:	Specification for Electric Solenoid Operated Actuators
9537- 1	:	Specification for conduits for electrical installations (General Requirements)
9537- 2	:	Specification for conduits for electrical wiring (Rigid Steel conduits)
9537- 3	:	Specification for conduits for electrical wiring (Rigid Plane conduits Of Insulating Materials)
9835	:	Specification for Series Capacitors for Power systems
9878	:	Specification for Safety Gears and Governors for Electric Passenger and Goods Lifts

10118- 1	:	Code of practice for selection, installation and Maintenance of Switchgear and Control gear (general)
10118- 2	:	Code of practice for selection, installation and Maintenance of Switchgear and Control gear (selection)
10118- 3	:	Code of practice for selection, installation and Maintenance of Switchgear and Control gear (installation)
10118- 4	:	Code of practice for selection, installation and Maintenance of Switchgear and Control gear (maintenance)
10322- 1	:	Specification for Luminaries (General requirements)
10322- 2	:	Specification for Luminaries (Constructional requirements)
10322- 3	:	Specification for Luminaries (Screw and Screw less terminals)
10322- 4	:	Specification for Luminaries (Methods of tests)
10580	:	Service Conditions for electrical equipments
10810- 0	:	Methods of tests for cables (general)
11448	:	Application guide for ac electricity meters
12640	:	Residual current-operated circuit breakers-Specifications
12640- 1	:	Residual current-operated circuit breakers for household and similar uses (circuit breakers without integral over current protection)
12640- 2	:	Residual current-operated circuit breakers for household and similar uses(circuit breakers with integral over current protection)
13032	:	AC miniature circuit breakers boards for voltages not exceeding 1000 V-Specification
13772	:	Hand tools for live working upto 1000 V ac 1500 V dc
13774	:	Gloves and mitts of insulating material for live working
13947- 1	:	Specification for low voltage switchgear and controlgear (general)
13947- 2	:	Specification for low voltage switchgear and controlgear (circuit breakers)
13947- 3	:	Specification for low voltage switchgear and controlgear (switches and disconnectors)
14768	:	Conduit fittings for electrical installations
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14927- 2	:	Cable trunking and ducting systems for electrical installations (cable trucking and ducting systems)
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14981	:	Earthing and short circuiting equipment using lances as short circuiting devices
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BASIC ELECTRICAL REQUIREMENTS

1.1 SCOPE

The scope of work covers design, fabrication, manufacture, supply, installation, testing and commissioning of below mentioned items.

The scope of work covers complete electrical installation system including but not limited to

- Design, fabrication, supply, installation, testing & commissioning of RMU.
- Design, fabrication, supply, installation, testing & commissioning of HT Panel.
- Design, fabrication, supply, installation, testing & commissioning of HT Cable.
- Design, fabrication, supply, installation, testing & commissioning of Distribution Transformer.
- Design, fabrication, supply, installation, testing & commissioning of LT Switch boards
- Design, supply, installation, testing & commissioning of LT ATS
- Design, supply, installation, testing & commissioning of Bus ducts, rising mains & Tap off box.
- Supply, installation, testing & commissioning of MCB DB's.
- Supply, laying, testing & commissioning of LV cables & end terminations.
- Supply, laying, testing & commissioning of Control cables & end terminations.
- Supply, installation, testing & commissioning of Cable trays & supports.
- Supply, installation, testing & commissioning of Light fixtures with Drivers/Ballasts
- Supply, installation, testing & commissioning of UPS/Inverter.
- Supply, installation, testing & commissioning of Power receptacles.
- Supply, installation, testing & commissioning of Point wiring and circuit wiring.
- Supply, installation, testing & commissioning of Floor and Ceiling Wire ways.
- Supply, installation, testing & commissioning of Conduits & Junction boxes.
- Supply, installation, testing & commissioning of Earth pits, earth bus and earth strips.
- Installation, testing and commissioning of all equipment, components, accessories, labour, tools and tackles required for the operation of the buildings to the extent specified and detailed on the drawings and specifications.
- All Civil works in connection with the Electrical Installation including supply, laying and fixing of necessary inserts, hooks, brackets and sleeves etc.
- Any work which can be reasonably inferred as necessary for the safe, satisfactory operation whether such work is specified or shown on the drawings or not.
- Necessary submissions of drawings as required to the supply authorities and arranging inspections and obtaining necessary approvals of all the concerned authorities.

1.2 LICENSED ELECTRICAL CONTRACTOR

All work shall be carried out by a licensed Electrical Contractor who is approved by the Consultant / Client and who possesses a valid local Electrical Contractor's license employing licensed Supervisors and licensed Electricians, Helpers, as required.

REQUIRED 5 YEARS OF DOCUMENTED EXPERIENCE AT LEAST.

1.3 REGULATIONS AND STANDARDS

The design, supply, installation and commissioning of the above stated items shall conform with the current Indian Electricity Rules, Bureau of Indian Standards, IEC and the Regulations and requirements of the local Electrical Supply Authority applicable to the design. Wherever this specification calls for a higher standard of materials than those required by any of the above Regulations, this Specification shall take precedence over the said Regulations and Standards.

In general, the materials, equipment not covered by the above shall conform to the latest Indian Standards.

1.4 MATERIALS AND EQUIPMENTS

All materials and equipment shall be of the one of the approved make listed in approved make list of this document elsewhere and design catered by use of best quality materials and equipment's. The Contractor shall be fully responsible for the safe custody of all materials at site at good conditions. The materials shall be insured against theft or damage in handling or storage etc. A list of items of materials and equipments, together with a sample of each and all-relevant certificates shall be submitted to the Client/Project Manager in charge within 15 days of the award of the contract.

All changes and substitutions shall be requested in writing and approvals obtained in writing from the Client /Project Manager in charge.

1.5 QUALITY OF MATERIALS

- All the materials and equipments supplied & Installed by the contractor shall be new. They shall be of such design, size and materials as to satisfactorily function under the rated condition of operation and to withstand the environmental conditions at site.
- All the components shall conform to relevant IS specification wherever existing. Materials with ISI certification marked shall be preferred if not otherwise mentioned the tender.
- For items of materials for which makes are approved by the Client/Consultants, Only such approve makes shall be permitted in the work in accordance to the preference of the Project manager / Engineer in Charge of the Client.

1.6 MANUFACTURER'S INSTRUCTION

Where manufacturers have furnished any specific instructions relating to the material used in the job and points that are not specifically mentioned in this document, then the manufacturer's instructions shall prevail and to be followed.

1.7 GUARANTEE

On completion of the supply, installation, testing and commissioning of materials at site, checking and inspection of the materials shall be conducted by the Project Manager/Engineer in charge and snags if any shall be recorded handed over to the Contractors for the attendance and replacement.

The functionality of the materials supplied & Installed shall be the responsibility of the Contractor for the entire defect's liability period.

The contractor shall stand guarantee that all the equipments and the supply works executed under this contract shall be free from all defects and faults in materials, design and manufacture and shall be acceptable standards for the contracted works and in full conformity to the technical specifications, drawings and other contract stipulations for a period of 18 months from the date of supply of materials or 12 months from the date of commissioning.

The Contractor shall be holding himself fully responsible for any reinstallation or replacement of work free of cost to the Client including the following:

- Any defective works or materials supplied.
- Any materials or equipments damaged or destroyed as a result of defective workmanship.

1.8 DOCUMENTATION

The indication and/or description of and item on the drawings or in the Specifications, unless otherwise specifically stated, implies an instruction to supply and fix such items.

Notes on drawings referring to individual items of work generally take precedence over specifications; however, all discrepancies shall be referred to the Consultant / Client before ordering materials or commencing work.

Drawings show general run of cables, approximate locations of outlets and equipment, utility symbols and schematic diagrams of no dimensional significance. Refer to the Architectural drawings for locations and also obtain approval from the Consultant / Client wherever dimensions are not shown, or locations cannot be determined from the drawings. Do not scale drawings to obtain locations.

1.9 DESIGN CRITERIA

Electrical materials and equipment shall comply in all respects, as a minimum to the latest Indian Standards Institution's recommendations.

Should any difference arise between IS and the specification, the requirement of the Specification shall prevail.

The components of sub main switchboards, distribution boards and other electrical equipment shall be clearly labeled in English.

Distribution boards shall have circuit schedules fastened to the inside cover of the board showing rating of the circuit breakers, type and number of points and their connected loads.

2.0 SUBMISSIONS

2.1 SHOP DRAWINGS

Shop drawings shall be provided of the Main and Sub-Main Switchboards, Distribution Boards, Cable Trays, Reactive Power Compensation Panel, Motor control center and any other switchboards and panels, wherever applicable and approval shall be obtained from the Consultant / Client before commencing fabrication or procurement.

Any equipment, material or switchboard manufactured without the written consent of the Consultant / Client prior to the approval drawings shall be liable for rejection.

2.2 AS BUILT DRAWINGS

As built drawings as specified in the contract shall be submitted to the Consultant / Client on completion of work.

As built drawings in AutoCAD R2000 format to a scale not smaller than the corresponding layout drawings shall be provided showing as a minimum the following,

- a. Exact runs and sizes of all wiring equipment such as, but not limited to, conduits, cables, Wire ways and cable trays.
- b. Layout drawings for lighting and power showing the actual locations of all electrical equipment including but not limited to, power points locations of switchboards, distribution boards. And details of types of fittings and other components.
- c. Details of schematic diagram, connected loads of distribution board, sub- main switchboard, and other boards and panels.
- d. Underground cable routes.

Drawings shall be of standard size. Submit both electronic and paper copies. The drawings shall carry the Electrical Contractor's title block giving his Company's name, address, telephone number and shall be signed by the Client or Partner.

Note: Failing to comply with the above, may result in withholding the release of the final payments.

3.0 FOREMAN/SUPERVISOR

3.1 QUALIFICATIONS

The Electrical Contractor shall employ a competent, licensed qualified full time electrical foreman/supervisor to direct the work of electrical installations in accordance with the Drawings and Specifications. **Required 5 years of documented experience at least.**

Good workmanship is an essential requirement to be complied with. The entire work of supply, installation, testing and commissioning shall conform to sound engineering practice involving highly skilled workers.

3.2 RESPONSIBILITY

The foreman/supervisor shall be available at all times on the site to receive instructions from the Consultant / Client in the day to day activities throughout the duration of the work.

The foreman/supervisor shall correlate the progress of the work in conjunction with all the relevant requirements of the Supply Authority. The skilled workers employed for the work shall have the

requisite qualifications and shall possess competency certificates from the Electrical Inspectorate of Local Administration.

4.0 APPLICATION FOR POWER SUPPLY, FEES, PERMITS AND TESTS

4.1 RESPONSIBILITY

The Contractor shall be responsible for filing and follow up of application for getting the drawings / scheme approved by the Electrical Inspector and finally the approval by the Electrical Inspector of the whole installation.

4.2 POWER SUPPLY TO SITE

The Contractor shall be responsible for negotiating with the authority for obtaining additional power sanctions wherever applicable.

4.3 STATUTORY APPROVALS

The Contractor shall be responsible for payment of all fees involved with obtaining Statutory Approvals (reimbursed by client on produce of receipt). On completion of the work, the Contractor shall obtain and deliver to the Consultant / Client the relevant final inspector, and approval certificates issued by the Local Electricity Supply Authority.

4.4 TESTS

The Consultant / Client shall have full powers to require the materials or works to be tested by an independent agency at the Contractor's expense in order to establish their soundness and adequacy.

The Contractor shall notify the Consultant / Client at least 7 working days before testing of each system. The Consultant / Client reserves the right to be present when such tests are being made.

If the Electrical Inspectorate requires manufacturer's test reports for cables, switch gear, transformers or any other equipment used in the project, the Contractor shall obtain such approvals at no extra cost to the Client. Such approved reports shall be handed over to the Consultant / Client.

Calibration certificates shall be obtained from the Meter and Relay Testing Department of the Electricity Board for all relays and meters used in the project at no extra cost to the Client.

4.5 QUALITY ASSURANCE REQUIREMENTS

General

Quality Assurance requirements form an integral part of the contract and all contractors & sub contractors are required to comply.

Scope:

The scope of Quality Assurance requirements is as follows:

Preparation of Quality Assurance Plan by the contractor, which is referred to as "Contractors Quality Plan" or "CQP".

- Performance of Quality Assurance
- Performance of Quality Control activities at site
- Documentation of the above.

4.6 MINIMUM SERVICE REQUIREMENTS

- In order to establish the minimum service requirements, a manufacturer's representative for the equipment specified herein shall be present at the job site for:
 - i) Functional testing of equipment viz., LT Switchboards including installation assistance, inspection, and certification of the installation.
 - ii) Training the Client's personnel with operation and maintenance instruction on system.
- The contractor shall notify at least 7 days in advance to the Consultant / Client regarding the readiness of equipment at manufacturers place before dispatch for Consultant / Client to witness the tests.

----- **END OF SECTION** -----

**TECHNICAL SPECIFICATIONS
FOR
LT CABLES AND CABLE TRAYS**

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LT CABLE

1.0 GENERAL

1.1 TYPE

Medium voltage cables shall be aluminium/Copper conductor, PVC/XLPE insulated, PVC sheathed and steel wire armored or steel tape armoured construction. The cables shall conform to IS 7098/1554 Part I in all respects. Cables shall be laid in tray / hume pipe/in readymade trenches etc., as required.

1.2 RATING

The cable shall be rated for a voltage of 1100 Volts.

1.3 CORE IDENTIFICATIONS

Cores shall be provided with the following color scheme of PVC insulation:

1 Core	:	Red/Black/Yellow/Blue
2 Core	:	Red and Black
3 Core	:	Red, Yellow and Blue
3 1/2 / Core	:	Red, Yellow, Blue & Black
4 Core	:	Red, Yellow, Blue & Black
5 Core	:	Red, Yellow, Blue, Black & Green

1.4 XLPE ARMoured / UNARMoured ALUMINIUM AND COPPER CONDUCTOR CABLES

This specification covers design, manufacture, shop testing, supply and delivery of LT (1.1 KV Grade) XLPE UG Armoured Aluminium Power Cables for use with effectively earthed distribution system

1.4.1 STANDARDS

Unless otherwise specified the cable shall conform in all respects to IS:7098 (Part-I/1988) Viz., "Cross linked Polyethylene insulated PVC sheathed cables for working voltages up to and including 1100 V" with upto date amendments. Cables meeting any other authoritative standards which ensure an equal or better quality shall also be acceptable.

1.4.2 MAIN FEATURES

The Power cable shall be LT 1100 V Grade, stranded, compacted shaped high conductivity H4 grade aluminium conductor of flexibility class 2 Three and half cores laid up together in right hand lay, each core XLPE insulated, extruded PVC sheathed galvanized steel strip armoured cable conforming in all respects to IS-7089 (Part-I/1988) with up to date amendments suitable for LT AC3 Phase 50c/s effectively earthed urban distribution systems.

Outer sheathing shall be designed to afford high degree of mechanical protection and shall be heat, oils, chemicals, abrasion and weather resistant. Common acids, alkalies, saline solutions etc., shall not have adverse effects on the PVC sheathing material used.

The cable shall be suitable for laying in air or covered trenches or buried underground to meet the outdoor application purpose.

1.4.3. MATERIAL AND CONSTRUCTION

Conductor: The cable conductor composed of electrically pure H4 grade flexibility class-2 plain aluminium wires, shall standard together and compacted. Conductor construction and testing shall be as per IS:8130/1984 including latest amendments thereto. The core shall be laid up together with a suitable right hand lay.

Insulation: The XLPE insulation shall be suitable for the specified system voltage. The manufacturing process shall ensure that the insulation is free from voids. The insulation shall withstand mechanical and thermal stresses under steady state as well as transient operation conditions.

The extrusion method shall give very smooth surface. The insulation shall be so applied that it fits closely on the conductor and it shall be easily possible to remove it without damaging the conductor. The XLPE shall be of high standard and quality conforming to the requirement specified in Table-1 of IS-7098 Part-I/1988. The thickness of insulation and tolerance thereof shall be as specified vide clauses 9.2 IS: 7098 Part-I/1988.

Inner sheath: The laid up cores shall be provided with the filler and inner sheath (common covering) shall be vulcanized or unvulcanized rubber or thermo plastic material and withstand site conditions and a continuous conductor temperature of 90 Deg.C It shall be ensured that it is as circular as possible and have adequate thickness, consistently applied that it fits closely on the laid up cores and it shall be possible to remove it without damage to the insulation. The sheath thickness shall be as given in table 4 of the IS-7098/Part. I/1988. When one or more layers of proofed or plastic taps are applied over the laid up cores as a binder, the thickness of such tapes shall not be construed as part of the inner sheath. The inner sheath material shall be so chosen as to be compatible with the temperature ratings of the cable and shall have no deleterious effect on any other component of the cable.

Armour: Armouring shall be applied over the inner sheath with single galvanized steel strip complying with the requirements of IS-3975 (1979). The dimensions of the galvanized strip shall be as specified in Table-6 of the IS-7098 (Part-I) 1988. The armour strips shall be applied as closely as practicable. The direction of the lay of the armour shall be left hand. The joints in armour strip shall be made by brazing or welding and the surface irregularities shall be removed. A joint in any strip shall be atleast 300mm

Outer sheath : The outer sheath shall be applied over the armouring by extension with polyvinyl chloride (PVC) compound conforming to the requirements of the ST2 of IS: 5831/1984. Colour of the outer sheath shall be black. Suitable additives to prevent attack by rodents and termites shall be added to the sheath material. The minimum sheath thickness shall not fall below the nominal value (ts) specified in Table-8 of IS-7098 (Part-I) / 1988 by more than $0.2\text{mm} + 0.2 \text{ ts}$.

Core and Cable Identification: By using colour red, yellow and blue on the cores throughout the length to identify the phase conductors and black, to identify the reduced neutral conductor. And year of Manufacture, company name/trademark shall be embossed throughout the length of the cable and also as per clause 17.1 of the IS-7098/ Part-I/1988.

Current Rating: The cables shall have current ratings and derating factors as per relevant IS. The 1 Sec. Short circuit current ratings values shall be subject to the purchaser's approval. The current rating shall be based on the maximum conductor temperature of 900C with stated ambient conditions specified for continuous operation at the rated current.

Operation: Cables shall be capable of giving satisfactory operation, under a power supply system frequency variation of ± 3 cycles/Sec, voltage variation of $\pm 10\%$ and combined frequency voltage variation of 10% (absolute sum). Cable shall have heat and moisture resistant properties. Their type and design shall have proven record on distribution network service.

General: All materials used in the manufacture of cable shall be new, unused and of finest quality.

All materials shall comply with the applicable provisions of the tests of the specifications, IS, Indian Electricity Rules, Indian Electricity Act and any other such applicable statutory provisions, rules and regulations etc. The purchaser reserves the right to call for documentary proof of purchase of various input materials to be used in the manufacture of cable and to check that the supplier is complying with quality control.

Note - The PVC material used in the manufacture of cable shall be of reputed make.
RECYCLED PVC IS NOT PERMISSIBLE.

1.5 PACKING & DRUM MARKING

The cable shall be wound on drums and packed. The ends of the cables shall be sealed by means of non hygroscopic sealing material. The cable shall be supplied strictly in single continuous lengths.

The cable shall carry the following information either stencilled on the drum as per clause 18.2 of IS:7098 (Part-I), 1988.

- a) Reference IS with IS certification mark.
- b) Manufacturer's name, brand name or trade mark
- c) Type of cable, voltage grade.
- d) No. of cores/nominal area of cross section of conductor.
- e) Cable code.
- f) Length of cable on drum (Kgs).
- g) Direction of rotation of drum (by arrow).
- h) Gross weight of drum (Kgs).

Tests: All type tests, acceptance tests, routine tests and optional test on cable shall be as per IS-7089/Part-I/1988 as the case may be.

Type Tests: All the cable offered shall fully type tested as per the relevant standards. In case the cables of the type and design offered have already been type tested in an independent and Govt. recognized test laboratory, the Bidder shall furnish four sets of type test reports along with the offer. These tests must not have been conducted earlier than five years from the date of opening of bid. The purchaser reserves the right to demand repetition of some or all the type tests in the presence of purchaser's representative at Bidders cost. For any change in the design type already type tested and the design/type offered against this specification the purchaser reserves the right to demand repetition of tests without any extra cost.

Acceptance and Routine tests:

Immediately after finalization of the program of type/acceptance/routine testing, the supplier shall given fifteen days advance intimation to the purchaser, to enable him to depute his representative of witnessing the tests.

All acceptance and routine tests as stipulated in the relevant standards shall be carried out by the supplier in presence of purchaser's representative.

Inspection: All acceptance tests shall be conducted at the time of inspection and inspection shall be made at the place of manufacture unless and otherwise specifically agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities, without charges to satisfy him that the material is being purchased in accordance with the specification.

The purchaser has the right to have the test carried out at his own cost by an independent agency whenever there is dispute regarding the quality of supply.

Guaranteed Technical particulars: The full guaranteed technical particulars as specified in IS shall be guaranteed and shall be given in the technical Data sheet enclosed along with this document. It shall be filled up for each size and necessary enclosures shall be submitted along with Bid document. Any deviations from the specifications referred to above shall be supported by adequate justification.

1.6 STORING, LAYING, JOINTING AND TERMINATIONS**1.6.1 STORING**

On receipt of cables at site the cables shall be inspected and stored in a safe place.

1.6.2 LAYING

Cables shall be laid as per the specifications given below:

1.7 CABLES IN OUTDOOR TRENCHES

Cables shall be laid in outdoor trenches wherever called for. The depth of the trenches shall not be less than 75 cm from the final ground level. The width of the trenches shall suit easy laying of cable. Where more than one cable has to be laid in the same trench, all attempts shall be made to keep the axial distance between successive cables to be at least 1d where 'd' is the diameter of the bigger cable. The trenches shall be cut square with vertical side walls and with uniform depth. Wherever cables are bent, the minimum bending radius shall not be less than 12 times the diameter of the cable. After the cable is laid and straightened, it shall be covered with sand cushion. Over this a course of cable protection tiles or burnt brick shall be provided on either sides and above. Trench shall be back filled with earth and consolidated. Cables shall be laid in hume pipes/stoneware pipes at all road crossings & wall entries. Approved cable markers made of CI indicating the voltage, no. of cables and the direction of run of the cables shall be installed at regular intervals.

1.8 CABLE IN INDOOR TRENCHES

Cables shall be laid in indoor trenches wherever specified. Suitable angle iron brackets, clamps, hoods and saddles shall be used for securing the cable in position.

1.9 CABLE ON TRAYS/RACKS

Cables shall be laid on cable trays/racks wherever specified. Cable racks / trays shall be of perforated steel section slotted angles for suitable purpose. The trays/racks shall be complete with plates, tees, elbows, risers and all necessary hardware. The steel trays shall be painted. Cable trays shall be erected properly to present a neat and clean appearance. Suitable cleats or saddles shall be used for securing the cables to the cable trays. The cable trays shall comply with the following requirements :

- a) The trays are ladder type and shall have suitable strength and rigidity to provide adequate support for all contained cables.
- b) It shall not present sharp edges, burrs or projections injurious to the insulation of the wiring/cables.
- c) If made of Sheet metal, it shall be adequately strength protected against corrosion or shall be made of corrosion resistant material.
- d) It shall have side rails or equivalent structural members.
- e) It shall include fittings such as horizontal, vertical bends, tie rods, hooks etc., or other suitable means for changes in direction and elevation of runs, fish plates and hardware.

2.0 INSTALLATION

- a) Cable trays shall be installed as a complete system. Trays shall be supported properly from the building structure. The entire cable tray system shall be rigid.
- b) Each run of the cable tray shall be completed before the installation of cables.
- c) In-ports where additional protection is required, non-combustible covers/enclosure shall be used.
- d) Cable trays shall be exposed and accessible.
- e) Where cables of different system are installed on the same cable tray, non-combustible solid barriers shall be used for segregating the cables.
- f) Cable trays shall be grounded by two nos. earth continuity wires. Cable trays shall not be used as equipment grounding conductors.

3.0 JOINTING AND TERMINATIONS

- 3.1 Cable jointing shall be done as per the recommendations of the cable manufacturer. Jointing shall be done by qualified cable jointers.
- 3.2 Each terminations shall be carried out using brass compression glands and cable sockets. Hydraulic crimping tool shall be used for making the end terminations. Cable gland shall be bonded to the earth by using suitable size copper wire/tape/clips.
- 3.3 Suitable identification tags with the feeder designation inscribed on an aluminium/G.I. sheet shall be tied to either ends of each cable.

4.0 ALUMINIUM CABLE TERMINATION METHODS

4.1 GENERALLY

The general requirements for all joints and terminations of aluminium cables shall be:

- a. To remove oxide from the conductor and prevent the oxide re-forming.
- b. To prevent corrosion resulting from contact between dissimilar metals.
- c. To retain contact pressure under cyclic loading conditions.

For all aluminium cables, the oxide shall be removed by thoroughly wire-brushing the bare end of the cable. After brushing, a liberal coating of an approved oxide-inhibiting, moisture-excluding thermally stable grease shall be applied, and the cable shall be wire-brushed again through the grease. Cable strands shall not be separated before brushing.

Bare aluminium lugs, ferrules and other connectors, unless factory-tinned or factory pre-filled with inhibiting grease, shall be wire-brushed and grease coated in the same way as cables.

Before making any joints or terminations in aluminium cables, the Contractor shall submit the proposed method for the Consultant / Client approval. Notice of at least three working days shall be given before making any joints or terminations, to enable the Consultant / Client to witness the work.

4.2 ACCEPTABLE TERMINATION METHODS

- a. Aluminium to aluminium connections shall be made by one of the following methods:

- Aluminium crimp lugs or tinned copper ferrules.
- Fusion welding with aluminium lugs.

Tinned copper ferrules shall be terminated using the compression method. For compression connections on stranded cables, a hexagonal die shall be used, on solid conductor cables, indent type dies shall be used, with at least two indentations per cable connection. Lugs or ferrules shall be selected to suit the size and shape of the conductor. Compression dies shall be selected to suit the particular lug or ferrule. Aluminium crimp lugs shall be filled with oxide inhibiting grease.

Joints by the fusion welding method shall be made by jointers experienced in this method. Particular care shall be taken to protect the cable insulation from heat by fixing substantial heat sinks to the cable near the joint. After completion of the weld the joint shall be wire brushed and all sharp projections filed smooth.

- b. Aluminium to copper connections shall be made by one of the following methods:

- Bi-metal connectors, or
- Tinned copper ferrules. or
- Electro-tinned cast aluminium lugs.

Bi-metal connections shall consist of lugs or pin type connectors having a cast copper palm or pin, friction-welded to an aluminium barrel section which is subsequently factory filled with oxide-inhibiting grease. The aluminium cable shall be inserted in the barrel section and fixed using the compression method as detailed above. The copper pin or palm section shall be fixed to copper or brass connectors or bus-bars in the conventional manner.

Tinned copper ferrules shall be terminated using the compression method.

Where electro-tinned aluminium lugs are used, they shall be fixed to the cable using the compression method. The palm of the lug shall be bolted to the copper bus-bar or terminal using

a stainless steel bolt and nut, with one large diameter stainless steel flat washer and two "Belleville" spring cup washers.

All nuts shall be adequately torque tightened to manufacturer's recommended levels.

Identification tags for feeder designation shall be by using 'Phoenix' plastic cable markers, tied to either end of each cable.

4.3 TESTING

Cables shall be tested at the factory as per the requirements of 1S 1554 Part 1. The tests shall incorporate routine tests, type tests and acceptance tests. A copy of such test certificates shall be furnished to the Consultant / Client prior to dispatch.

SCOPE OF WORK

- Cable laying
- Cable end terminations
- Tags to cables
- Cable route markers.

5.0 TECHNICAL DATA SHEET

Vendor shall fill this data sheet for each size or furnish data sheet

CABLE TRAYS

1.1 GENERAL

The contractor shall supply all labor, material and accessories for the completion of this installation strictly in accordance with the specification laid as under, illustrated in drawings and shown in the schedule / bills of quantities.

1.2 DESIGN, MATERIAL & CONSTRUCTION

Standard perforation shall be provided in cable trays at both axis i.e. : horizontal & vertical. The cable tray system shall be designed in the standardized modular system and comprise of basic modules of trays, fittings and accessories. Each modular shall be fabricated from prime quality Galvanized Iron sheet and then hot dip galvanized of 80 microns as per IS 2629.. Modular of 90 degree elbows, t-joints and double, T joints shall be used for horizontal changes in the direction of cable runs while hinged connectors shall be used for vertical branch off. The branch off joints should be such as to allow for angle connection to be easily bolted to them by means of button head screws. End plates shall be used to closed off unevenly cut faces of the cable trays and protect the cables from damage.

The cable tray shall have standard lengths of 2500 to 3000 mm.

BOLTED RUNG LADDER TYPE:

- A) The ladder tray should be weld less construction.
- B) The ladder type cable trays shall be made out of galvanized iron & shall be complete with associated accessories such as coupler plates, tees, elbows etc., the trays shall be fabricated from 2mm sheet steel conforming to IS 1079 Grade O.
- C) Cable trays, accessories shall be galvanized.
- D) The spacing of rungs for ladder type of trays shall be 250 mm unless otherwise specified.
- E) All finished cable trays and accessories shall be free from sharp edges, corners, burrs and unevenness.
- F) The thickness of galvanizing shall be 610 gm / Sq. mtr. (87 Microns) in line with IS: 4759.
- G) Hot dip galvanization as per IS 2629.

PERFORATED TYPE:

The Perforated type cable trays shall be made out of galvanized iron & shall be complete with associated accessories such as coupler plates, tees, elbows etc., the trays shall be fabricated from 2mm sheet steel conforming to IS 1079 Grade O. Perforation not more than 17.5%.

All finished cable trays and accessories shall be free from sharp edges, corners, burrs and unevenness.

The thickness of galvanizing shall be 610 gm / Sq. mtr. (87 Microns) in line with IS: 4759.

Hot dip galvanization as per IS 2629.

CABLE TRAYS AND ACCESSORIES:

The cable trays shall be complete with all necessary coupler plates, elbows, tees, bends, reducers, stiffeners, suspenders and other accessories and hardware. All hardware (i.e. bolts, nuts, screws, washers, etc.) shall be hot dip galvanized.

1.3 SERVICE CONDITIONS

The cable tray system supplied shall be suitable for installation and use under given combination of

Environmental conditions. Due and liberal consideration shall be given to the climatic conditions with respect to temperature, humidity, dust, etc.
 Manufacturing of the cable trays shall be based on the following services
 Extreme maximum air temperature = 45°C
 High relative humidity = 85 %
 Elevation above mean sea level = 50m

1.4 CABLE TRAY CONSTRUCTION

The interiors of all types of cable shall be smooth and free of any projection that might injure cable sheaths and jackets (NEC 318-4). All splice plates should be installed on the outside surface of the supports. Round head bolts, screws or other fasteners (head inside) are to be used exclusively.

The anchoring of cable trays through bottom sections with bolts or screws upon which cables may rest is prohibited. Sheaths or outer covers of cables are subject to damage where the cables are lying on bolt or screw heads. Bolting is satisfactory where the heads of bolts or screws are below the cable supporting surfaces.

Bends in cable trays shall be made with manufacturer's fittings or equivalent. Mitered vertical bends are permitted on ladder cable supports only. The effective radius must be not less than that allowable for the cables involved. Mitered cuts must be positioned midway between rungs and shall permit not over a 22 ½ degree directional change per meter or rung. Bends, ells tees and other fittings elbows are available with several radii. The radii of fittings both vertical and horizontal should be suitable to accommodate cables so that they will never be bent, either during installation or in the final arrangement, to lesser radii.

All the components of the supply, without exception, from one system and during the erection all the components will match each other without interference.

Cable trays used in the work shall be of Medium duty type. The minimum thickness of the sheet shall be 2 mm for ladder type cable trays. The tray shall be of perforated steel galvanized or PVC coated, with a flange height not less than 12 mm on each side. In a continuous long run of cable trays, standard couplers shall be used and fixed with the help of bolts and nuts to secure each joint.

All accessories like tees, intersection units, bends, turns and rise shall be factory built ones and shall be of matching design to the main section of cable tray. The appropriate joint shall be secured as applicable. On installations where 'Purpose-made' accessories are not available or otherwise impracticable, these shall be fabricated at site with written approval of the Client/Engineer in-charge.

The trays and accessories shall be hot dip galvanized conforming to IS: 2629 and 4759 and the zinc coating shall be not less than 335 G/m² and uniformity of zinc coating shall be in conformity with IS: 2633. Earth bonding shall be done either with PVC insulated copper wire or GI strips. Earth bonding shall be provided at each adjacent lengths/cut pieces to maintain earth continuity.

The size of the tray shall be such that the cables occupy not more than 60% of the available space.

Where proprietary channel section cable supports, racks, ladders are used in the works the same shall be galvanized ones in conformity with relevant Bureau of Indian Standards and specification. Preferably the tray and cable ladder shall be from single manufacturer. Unless otherwise approved by Project Manager /Engineer in charge.

Cable tray supports and accessories fabricated at site shall be applied with a protective finish of Zinc rich cold galvanizing paint or aerosol sprayed with PVC as applicable.

1.5 MATERIAL

All material in the scope of supply shall be of prime quality Galvanized iron sheet and then hot dip galvanized of 80 microns after fabrication, including all accessories.

It is manufacturer's responsibility that the materials quoted are fully resistant to the influence of the chemical product and environment For that reason manufacturer is requested give alternatives, in case the material mentioned on this document is technically and or / economically not the best solution. This is of course subject to approval from the Client.

1.6 TESTING & INSPECTION

The inspection & testing shall be carried out at the manufacturer's works in accordance with the relevant sections of the specification and witnessed by the purchaser prior to the shipment. Or a sample of the required specimen should be submitted for the approvals prior to manufacturing.

1.7 INSTALLATION OF CABLE TRAYS

Wherever possible, cable trays shall be installed in full lengths without cutting. Should it be necessary to cut or drill a length of tray then the barred ends or damaged section of the trays shall immediately be given a coat of zinc rich cold galvanizing approved paint or aerosol sprayed with PVC as explained above. Accessories fabricated at site, supports and metal fittings etc. required to ensure correct installation of the cable trays and shall be similarly treated to maintain the galvanizing properties.

All cables shall be firmly secured to the tray and retained in position by using purpose made saddles, or with proprietary nylon fasteners (cable ties) or cleats or straps as approved by the Project Manger /Engineer in charge.

Cable trays shall be fitted with close fitting lid or cover plate wherever specified and directed. Such covers shall be secured with metal screws and fixed nuts. Covers held by spring tension or self-tapping screws shall not be permitted. The cover plate shall be drip-proof wherever necessary.

Due allowance/provision shall be made for expansion, in case of long runs of trays. Flexible couplings shall be provided wherever the trays cross building expansion joints. At locations where cable tray crosses a fire barrier, no gaps shall be left between the trays and the surroundings. In case the cable tray with cable crosses fire zones, a proper opening shall be prepared in the wall/partition and close the opening with proprietary fire resistant materials in an approved manner. The fire resistant material shall be of fire rated for 2 hours. Proprietary fire proof coating shall be applied on the cables and trays.

Ceiling / wall mounted cable trays shall be supported along the length with the help of MS rods, flats, channels, angles suspended at not less than 1.2 m. However, for higher rating cables, suitable additional supports to be used if required to ensure that the vertical deflection of any one section shall not exceed 15 mm at mid span and additional supports shall be provided at points where the tray changes its direction and terminates at walls or equipments. The support shall be grouted to the ceiling / wall through an effective means, as approved by the Project manger / Engineer in charge. To take the height of the cable tray with the cables. On completion of the cable installation work, the measurements shall be recorded and handed over to the Client/Engineer in-charge for record.

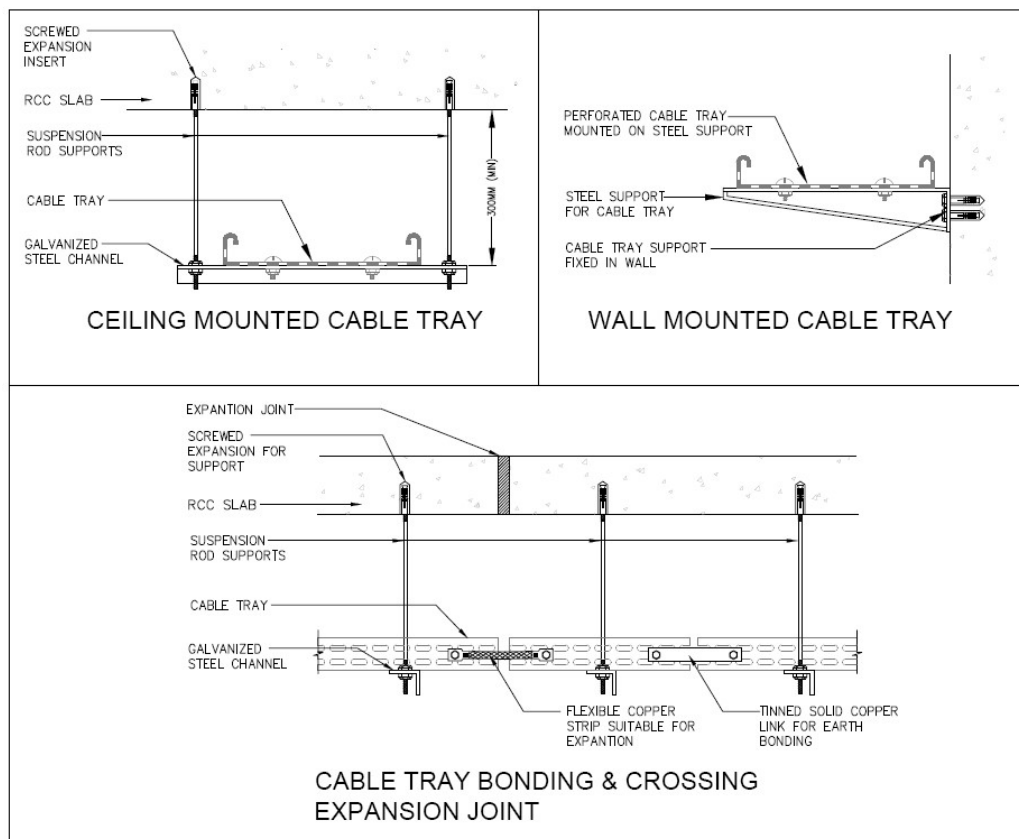
Cable trays shall be site fabricated from steel sections in line with drawings enclosed with this specification.

Fabricated trays and supports shall be free from all burrs and sharp cutting edges.

Trays and supports shall be made free of scale, grease, rust and welding slags.

Trays and supports shall be provided with two coats high quality primer and two coats of epoxy based paint.

1.8 TYPICAL CABLE TRAY INSTALLATION METHODS



Type of installation will be decided based on site condition and type of cable trays

----- END OF SECTION -----

**TECHNICAL SPECIFICATIONS
FOR
LT SWITCHBOARDS**

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LT SWITCHBOARDS

1.0 DISTRIBUTION BOARDS

1.1 GENERAL

Distribution boards shall be suitable for 415 volts, 3 phase AC supply and 240 volts single phase AC supply & Frequency 50 Hz as required. Distribution boards shall generally conform to IS:2675 or BS:214 or IEC 439.

1.2 TYPE AND CONSTRUCTION

All the distribution boards shall be of Class IP 54 as per IS 8623 III with approved type of components of recommended make of MCB. The sheet steel MCB DB shall be flush mounting type unless otherwise specified and shall consist of MCB/ELCB as incomer and MCB as outgoing. The short circuit rating of MCB shall be 10kA as a minimum, unless otherwise specified.

1.3 BUS BARS

Suitable bus bars of high conductivity combed Copper bus and mounted on non- hygroscopic insulating supports shall be provided.

1.4 CIRCUIT BREAKERS

Miniature circuit breakers shall be of approved make and of specified short circuit rating. Curve 'C' & 'B' for lighting and utility power requirement and Curve 'D' for UPS loads.

All RCCB/RCBO used for sub incomer in Distribution board shall be of 30mA for Power circuits and 100mA for Lighting circuits.

The Miniature circuit breakers and residual current circuit breakers shall be of same make of the Moulded case circuit breakers and Air circuit breakers to achieve the Discrimination and coordination up to final circuit level.

1.4.1 MINIATURE CIRCUIT BREAKERS (MCB)

The Miniature circuit breakers shall conform to IEC 60898-95/ IS 8828-96.

The Miniature circuit breakers shall have a breaking capacity of **10kA** or **15kA** (for Industrial applications) and shall conform to Class 3 Energy Limitation. The Miniature circuit breakers shall be suitable for Isolation function and have positive contact indication.

The Miniature circuit breakers shall be line load reversible, and power loss value as per IS 8828-96.

MCB shall be in 1,2,3 or 4, pole versions. MCB casing shall be made of self extinguishing, tropicalised material. MCB shall comply with IS 8828-1996/IEC 898-1995. It shall be suitable for use in frequency range 40Hz to 60Hz and shall accommodate AC/DC supply according to requirements. It shall have a trip-free mechanism and toggle shall give a positive contact indication. It shall be suitable for mounting on 35mm DIN rail/surface mounting.

Line supply may be connected to either top or bottom terminals i.e. there shall be no line-load restriction. Degree of protection, when the MCB is flush mounted, shall be IP40. MCB shall be supplied with clamping terminals fully open. Contact closing shall be independent of the speed of the operator. The MCB shall be capable of being used as Incomer Circuit Breaker and shall be suitable for use as an isolator. In case of multiple MCBs in a single location (DB), it shall be possible to remove any MCB without having to disturb other MCB's in the vicinity.

1.4.2 RESIDUAL CURRENT CIRCUIT BREAKERS (RCCB)

Residual Current Circuit Breakers shall conform to IEC 61008.

The RCCBs shall have sensitivities of **30 mA / 100 mA / 300 mA** as per the requirement.

The RCCBs shall have disconnection facility with suitability for Isolation, and shall be immune towards nuisance tripping due to Transient over voltages.

The RCCBs shall have trip indication facility on the front face and shall have provision for remote trip indication too.

RCCB shall be available in 2 pole and 4 pole versions and threshold sensitivities of 30mA, 100mA, 300mA and current ratings from 25 to 80A. Rating and sensitivities shall be as specified.

RCCB shall comply with IS 12640-1988/IEC 1008. The short circuit withstand of the RCCB without the associated short circuit/overhead protection shall not be less than **3kA**. It shall be operationally independent of line voltage. The sensitivity thresholds (30mA, 100mA, 300mA) shall be of non-user adjustable type by construction.

NOTE: RCCB for lighting applications shall be of 100mA Sensitivity and RCCB for power socket applications shall be of 30mA sensitivity.

1.4.3 RESIDUAL CURRENT CIRCUIT BREAKERS (RCCB) – TIME SELECTIVE

Residual Current Circuit Breakers shall conform to IEC 61008.

The RCCBs shall have sensitivities of **30 mA / 100 mA / 300 mA** as per the requirement.

The RCCBs shall have an inbuilt time delay mechanism to ensure Vertical discrimination in networks.

The RCCBs shall have disconnection facility with suitability for Isolation, and shall be immune towards nuisance tripping due to Transient over voltages.

The RCCBs shall have trip indication facility on the front face and shall have provision for remote trip indication too.

1.4.4 RESIDUAL CURRENT CIRCUIT BREAKERS (RCCB) - SUPER IMMUNIZED TYPE

Residual Current Circuit Breakers shall conform to IEC 61008.

The RCCBs shall have sensitivities of **30 mA / 100 mA / 300 mA** as per the requirement.

The RCCBs shall be immune to nuisance tripping due to Transient over voltages, Loads generating HF leakage current. Also, it shall be suitable to operate in networks with pulsated DC components, ensuring tripping on genuine earth fault.

The RCCBs shall have disconnection facility with suitability for Isolation.

The RCCBs shall have trip indication facility on the front face and shall have provision for remote trip indication too.

1.5 H.R.C. FUSES

Rating of the fuses and carriers shall be as per drawings. Fuses carriers and bases conform to IS:1300. They shall be non-flammable and non-hygroscopic, with hard finish.

HRC fuses are unacceptable for power circuits.

1.6 SAFETY AND INTERLOCKS

All the live parts shall be shrouded such that accidental contacts with live parts are totally avoided. Distribution boards shall be provided with a front hinged door. Distribution boards interior assembly shall be dead front with the front cover removed. Incoming lugs shall be shrouded. Suitable insulating barrier made of are resistant material shall be provided for phase separation. The ends of the bus structures shall also be shrouded.

1.7 CABINET DESIGN

The Distribution Board cabinet shall be totally enclosed type with dust and vermin proof construction. The cabinet shall be Powder coated. The interior surface shall be finished to an off-white shade. The interior components shall be mounted on separate sheet steel which is mounted and locked onto the studs provided inside the cabinet. Over this, a cover made of FRP Sheet or Powder coated sheet shall be provided with slots for operating handle of breakers. The cabinet shall be equipped with a front door having a spring latch and a vault lock. Cabinets shall have detachable glands plates at both top and bottom with knock out holes of suitable numbers. And diameter for the required number, of cables.

1.8 TERMINALS

Distribution boards shall be provided with a approved make terminal block of adequate size to receive Mains and outgoing circuits. The location of the terminal box shall be so located that crowding of wires in the proximity of live parts is avoided. A neutral link having a rating equal to that of phase bus shall also be provided.

1.9 DIRECTORY

Distribution boards shall be provided with a directory/legend plates indicating the area or loads served by each circuit breaker, the rating of breakers, size of conductors and other components as determined necessary for clear identification of the function and operation of the distribution board.

Indication labels shall be machine engraved on laminated plastic and attached with approved adhesive or mechanical fasteners. The font shall be ARIAL and sized to suit the application. The minimum font size shall be 3.5mm. Hand painted directory or text is not acceptable. Bolted connections should be torqued and marked with paint.

1.10 APPROVALS AND SUBMISSIONS

Distribution boards shall be deemed to be approved when a sample has been inspected and when the sample workshop drawings have been approved, by the Client / Consultant.

2.0 LT SWITCHBOARDS

2.1 GENERAL

The switchboard shall be metal clad, totally enclosed, rigid, compartmentalized design, floor mounting, air insulated, extensible cubicle type for use on medium voltage power, 3 phase 4 wire 50 cycles system.

The equipment shall be designed for operation in high ambient temperature and high humidity tropical atmospheric conditions. Means shall be provided to facilitate ease of inspection, cleaning and repairs for use in installations where continuity of operation is of prime importance.

2.2 BREAKER CO-ORDINATION.

The contractor shall submit breaker co-ordination details along with selection of breakers during bidding.

Selection of all switchgear components - it is intended to achieve total discrimination and coordination, as such vendor shall justify selection of switchgear from upstream to final circuit components. The Vendor/Fabricator shall understand this from switchgear manufacturer before concluding selection.

2.2 STANDARDS

The equipment listed below shall conform to the requirements shown:

IS 13937 - 1.2 - Air Circuit Breaker (ACB)
 IEC 60947 - 1 & 2. Certificate for Test Sequence 1 is mandatory - Air Circuit Breaker (ACB)
 IS 13937 - 1.2 - Moulded Case Circuit Breaker (MCCB)
 IEC 60947 - 1 & 2. Certificate for Test Sequence 1 is mandatory - Moulded Case Circuit Breaker (MCCB)
 IS 13947-1,4 - Contactors
 IS 8828 - 1996/ IEC 898 – 1995 energy limiting class 3 - Miniature Circuit Breaker (MCB)
 IS 12640 - 1988 / IEC 1008 - Residual Current Circuit Breaker (RCCB)
 IS 9224 & IS 2208 - HRC fuse link
 IS 2705 and IEC 185 - Current Transformer
 IS 3156 - Potential Transformer
 IS 3231 and IS 8686 - Static Relays
 IS 1248 - Indicating Instrument
 IS 13947 - AC Circuit Breakers
 IS 4047 - Specification for air break switches and combination fuse
 IS 6875 - Control switches for voltages up to and including 1000V AC and 1200V DC.
 IS 1822 - Motor duty Switches
 IS 12021 - Specification for control transformer.
 IS 8623 - Factory built assembly of switchgear & control gear for voltage not exceeding 1000V
 IS 13947 (Part I) - Degree of protection for enclosure
 IS 3842 - Specification for electrical relays for AC system
 IS 4237 - General requirement for switchgear & control gear for voltage not exceeding 1000V.
 IS 3231 - Electrical relays for power system protection
 IS 375 - Marking and arrangement for switchgear bus bars, main connection and control aux wiring.
 IS 5578 - Guide for marking of insulated conductors.
 IS 3618 - Pre-treatment of MS sheets for phosphatising.

2.3 TYPES AND CONSTRUCTION

Construction of the switchboard shall consists of

- a) Sheet steel enclosed, indoor floor free standing or wall mounted cubicle type, suitable provision shall be made for the method of fixing. Ingress protection of the panel boards shall be IP40.
- b) Made up of the requisite vertical sections modular type which when coupled together shall form continuous dead front switchboards.
- c) Shall be constructed from minimum 14 SWG sheet steel folded and braced as necessary to form right enclosures and be complete with removable top and bottom gland plates. Front panels shall also be removable for ease of wiring and lockable hinged doors are fitted to each panel.
- d) The main panel board shall be compartmentalized from IV construction and shall be dust and vermin proof. The board completes with bus bar and bus bar supports shall be in conformity with IS 13947 Part- 3 and shall be suitable for an interrupting capacity as specified elsewhere. The bus bars shall be shrouded with PVC heat shrinkable sleeves and colour coded for phase identification. Vertical and horizontal bus bar chambers shall be provided as needed. All inter connection between main and sub-bus bars and out going switchgears shall be done with solid copper conductors of appropriate current rating. Main panel board shall be extensible type.
- e) The sub-main boards shall be free standing or wall mounting as the case may be and the interrupting capacity as specified elsewhere. Bus bars shall consist of high conductivity Copper conductors of equal cross section, mounted on insulated pillars and rated in accordance with the details given on the drawings. Subpanel board shall be extensible type.
- f) Each feeder/instrument compartment shall be provided with a hinged door interlocked with MCCB inside the compartment such that door can only be opened when MCCB in off position.
- g) Readily extendable as required by the addition of vertical sections after removal of the end covers.
- h) The ACBs and MCCBs shall be lockable.

EACH VERTICAL SECTION SHALL COMPRISE:

- a) A front framed structure of rolled/folded CRCA sheet steel angle section of minimum 3 mm thickness rigidly bolted together. This structure shall house the components contributing to the major weight of the equipment such as circuit breaker cassettes, main horizontal bus bars, vertical risers and other front mounted accessories.
- b) The structure shall be mounted on a rigid base frame of folded CRCA sheet steel of minimum 6 mm thickness and 75 mm height. The design shall ensure that the weight of the components is adequately supported without deformation or loss of alignment during transit or during operation.
- c) A cable chamber housing the cable end connections and power or control cable terminations. The design shall ensure generous availability of space for ease of installation

and maintenance of cabling and adequate safety for working in one vertical or horizontal section without coming into accidental contact with live parts of the adjacent section.

- d) A cover plate at the top of the vertical section, provided with a ventilating hood where necessary. Any aperture for ventilation shall be covered with a perforated sheet having less than 1mm diameter perforations to prevent entry of vermin.
- e) Front and rear doors fitted with dust excluding neoprene gaskets with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors generous overlap shall be ensured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.

The height of the panel shall not be more than 2200 mm unless otherwise specified and maximum height of switch operating handle shall not be more than 1800mm from FFL. The total depth of the panel shall be adequate to cater for proper cabling space.

Doors shall be of minimum 14 gauge sheet steel and covers and partitions of 160 sheet steel. All sheet steel work forming the exterior of switchboards shall be smoothly finished, levelled and free from flaws. The corners shall be rounded.

The Components in the switchboards shall be so arranged as to facilitate ease of operation and maintenance and at the same time to ensure necessary degree of safety.

Components forming part of the switchboards shall have the following minimum clearances:

- Between phases 25 mm
- Between phases and neutral 25 mm
- Between phases and earth 25 mm
- Between neutral and earth 19 mm

Creepage distances shall comply to those specified in relevant standards.

All insulating material used in the construction of the equipment shall be of non-hygroscopic material treated to withstand the effects of high humidity, high temperature and tropical ambient service conditions.

Functional units such as circuit breakers, MCCBs, etc. shall be arranged in multi-tier formation except that not more than two air circuit breakers shall be housed in a single vertical section.

Metallic and/or insulated shrouding shall be provided within vertical sections and between adjacent sections to ensure prevention of accidental contact with:

- a. Main bus-bars and vertical risers during operation, inspection or maintenance of functional units and front mounted accessories.
- b. Cable terminations of one functional unit, when working on those of adjacent units.

All covers providing access to live power equipment or circuits shall be provided with tool operated fasteners to prevent unauthorized access.

Provision shall be made for permanently earthing the frames and other metal parts of the switch gear by two independent distinct connections.

Only CRCA steel sheets shall be used for fabricating the cubicle.
Thickness tolerance for sheets shall be as applicable in relevant IS.

2.4 METAL TREATMENT AND FINISH

Generally the treatment and finish of the metal surface shall be as per detailed specifications, Metal Treatment and Finish.

2.5 BUS BARS

The bus bars shall be made of high conductivity High grade Aluminium or copper suitable for 440 volts, 3 Phase, 4 wire, 50Hz unless otherwise specified.

The bus bar shall be suitably supported with non-hygroscopic supports to provide a fault withstand capacity as specified.

High tensile bolts and spring washers shall be provided at all bus bar joints.

Fish plates of equal type and size shall be used at all joints.

The bus bars shall have uniform cross section throughout and shall be capable of carrying the rated current at 415V continuously. The bus bars shall be designed to withstand a temperature rise of 45 Deg C above the ambient.

A current density of **1.20 Amp/Sqmm** shall not be exceeded for copper bus bars.

A current density of **0.80 Amp/Sqmm** shall not be exceeded for Aluminium bus bars.

Bus bars shall be fully sleeved using heat shrunk PVC sleeves appropriately colour coded to identify different phases and neutral bar.

Neutral bus of size not less than 100% of Phase bus current rating, An earth bus of size not less than 50% of Phase bus current rating, aluminium strips shall be run throughout the length of switchboard at top or bottom as required.

3.0 AIR CIRCUIT BREAKERS

3.1 GENERAL

The ACBs shall conform to IS 13947-1 & 2 / IEC 60947-1 & 2. Certificate for sequence 1 is mandatory The ACBs shall be suitable for 3 phase 4 wire or 3 phase 3 wire - 415 Volts.

4 Pole breakers shall have adjustable neutral. All the breakers shall have tropicalisation 2 as a standard feature. The Generator power incomers shall have built in earth leakage protection adjustable upto 25 A. All breakers shall have LCD front display module to show the parameter like Amphere, voltage, power etc. and also have Ammeter and O/C + S / C + E/F or E/Leakage.

ACB shall conform to the tests defined by the following standards for extreme atmospheric conditions:

IEC 60068-2-1: Dry Cold at -55 deg C

IEC 60068-2-2: Dry Heat at +85 deg C

IEC 60068-2-30: Damp Heat (temperature +55 deg C, relative humidity 95 %)

IEC 60068-2-52 LEVEL 2: salt mist

ACB shall confirm to IEC60947-II / IS 13947 (Part I & III), The Circuit Breaker shall comply with the isolation function requirements of IEC60947-2 Section 7.1.2 to facilitate safety of personnel in use. Possible to upgrade the degree of protection of ACB to IP54. Minimum degree of protection of the ACB shall be IP40. Suitable for front and rear access.

All ACB's shall comprise the following

- Microprocessor based micro logic release
- Front display module-Optional
- ZSI (Zone selective interlocking)
- Safety shutter lock
- RS 485 communication port
- Door interlock
- Ready to close contact
- Arch chute cover

3.2 CONSTRUCTION

The Breaker shall be suitable for rear and vertical mounting and line load reversibility without deration.

The operating mechanism shall be designed such that the handle can only be in the OFF position if the Main contacts are actually separated and vice versa.

3.3 CONTROL UNITS

The control units shall be housed in a separate enclosure and there shall be total insulation of the control unit with respect to the power unit.

The control unit shall have true RMS sensing, EMC, thermal memory and shall be free from the influence of harmonics.

PROTECTIONS

OVER LOAD: Adjustable from 40 – 100% of nominal current (I_n) with time delay.

SHORT CIRCUIT: Adjustable from 2-10 times of set current (I_r) with time delay.

INSTANTANEOUS: Adjustable up to 15 times of Nominal current (I_n)

EARTH FAULT: Adjustable up to 1200 A with time delay (Wherever specified in SLD or BOQ)

EARTH LEAKAGE: Adjustable upto 25 A with time delay (Wherever specified in SLD or BOQ)

Note: If earth leakage wherever asked for – earth fault shall not be provided in the Breaker. Non integral relay shall be provided wherever ACB s or MCCBs are not built in with ELR.

ACCESSORIES

ACB shall be provided with following accessories, in addition to the items specified elsewhere. Further these devices shall be fittable at site from the FRONT and TOP for all ratings.

- Under voltage trip with time delay wherever specified.
- Shunt trip
- Closing coil
- Auxiliary switches
- 4 NO + 4 NC potential free contacts shall be provided in all breakers.

Remote operation using motor mechanism with facility of using the same in **Auto/ Manual** mode wherever specified.

3.4 INTERLOCKING

ACBs shall be provided with the following interlocking devices for interlocking the door of a switchboard.

- Handle interlock to prevent unnecessary manipulations of the breaker.
- Door interlock to prevent door being opened when breaker is ON position.
- Defeat interlocking device to open the door even if the breaker is in ON position.

3.5 BREAKING CAPACITY

The ACB shall have **Ics = Icw** for 1 sec. as under.

Ratings [Amps]	Ics [kA] & Icw [kA]
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As Specified in SLD or Short circuit current calculation Sheet.

Original test certificate for breaking capacity for the ACB as per the IEC/IS shall be provided.

3.6 PROTECTION

- All ACB shall be protected against Over voltages caused by devices that generate Electromagnetic disturbances, Over voltages caused by atmospheric disturbances or by distribution-system outage. Devices emitting Radio waves (Radio, walkie-talkies, Radar etc.), Electrostatic discharges produced by users.
- There shall be facility for selecting various type of E/F protection if required.
- Neutral protection of 50 to 100% should be available
- The trip unit shall have thermal memory.
- Facility should be there to monitor the load and intimate a pre-trip alarm or have load shedding feature. Three phase Bar Graph indication should be provided for each ACB
- Fault indication by means of LED should be available for Overload, Short Circuit and Earth Fault and also LCD display for indication of menu's, settings, recorded information and current measurement as minimum.
- Trip reset facility should be Manual / Automatic
- It shall be possible to TRIP or CLOSE the Breaker through RS 232C / RS 485 communication interface.
- ACBs shall have the "MAKING CURRENT RELEASE"
- ACBs should provide the feature of Zonal Selective Interlocking (ZSI)
- ACBs should have the facility of changing the orientation of Termination at site without extra cost.
- ACBs should have the communication upgradability without changing the trip unit at site.
- ACBs should have a continuous rated Shunt Trip Coils
- ACBs should have short circuit pick up at multiples of rated set current Ir.
- All 4Pole ACBs shall have full rated Neutral.
- ACB shall be convertible from manual to Electrical Breaker at Site.

4.0 MCCB - MOULDED CASE CIRCUIT BREAKER

4.1 GENERAL

The Moulded Case Circuit Breaker shall be incorporated in the switchboard wherever specified and shall be of the current limiting type upto 630 A. Ratings of 800 and above shall be Cat B with Icw 0.5 Sec of 20 KA. MCCB shall conform to IS 13947-1 & 2 / IEC 60947 (part I and II / section 1) . It shall be suitable for Horizontal and Vertical mounting and line load reversibility without any de-rating. MCCB shall be suitable for 3 Phase 415V. The MCCB shall be available in 4 pole versions with 100% neutral. It shall have tropicalisation as a standard feature.

The MCCB cover and case shall be made of high strength heat-resistant and flame-retardant thermosetting insulating material. The operating handle shall be quick make, quick break, trip - free type. The operating handle shall have suitable 'ON' 'OFF TRIPPED' indicators and in order to ensure suitability for isolation complying as per annexure 7.1.2 IS 13947-2/IEC 60947-2, the operating mechanism shall be designed such that the toggle or the handle can only be in 'OFF' position : if the main contacts are actually separated.

PROTECTIONS.

OVER LOAD: Adjustable from 40 – 100% of nominal current (I_n) with time delay.

SHORT CIRCUIT: Adjustable from 2-10 times of set current (I_r) with time delay.

EARTH FAULT: Adjustable - $0.1 - 1(I_n)$ with time delay (Wherever specified in SLD or BOQ)

EARTH LEAKAGE: - Adjustable upto 25 A with time delay (Wherever specified in SLD or BOQ)

Note: If earth leakage wherever asked for – earth fault shall not be provided in the Breaker. Non integral relay shall be provided wherever ACB s or MCCBs are not built in with ELR.

4.2 ACCESSORIES

MCCB shall be designed to have following accessories and it shall be fittable at site.

- Under voltage trip with time delay wherever specified.
- Shunt trip wherever specified.
- Alarm switch and Aux switches wherever specified.
- Remote operation using motor mechanism with facility of using the same in Auto / Manual mode wherever specified.

4.3 INTERLOCKING

MCCB shall be provided with following interlocking devices for interlocking the door of a switchboard.

- Handle interlock to prevent unnecessary manipulations of the breaker.
- Door interlock to prevent door being opened when breaker is in ON position.

In addition to the above, and other features indicated elsewhere shall also be provided.

4.4 BREAKING CAPACITY

Short time with standing capacities different ratings of MCCB's shall be as per Short circuit current calculation chart:

Ratings [Amps]	Ics [kA] & Icw [kA]
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As Specified in SLD or Short circuit current calculation chart.

5 OTHER EQUIPMENTS

5.1 CONTACTORS

Contactors shall comply with IS 13947-1 for general rules and IS 13947 - 4.1 for Standards pertaining to Contactor and Motor Starter.

The Contactors shall be capable of withstanding breaking and making capacities per following:

AC3 Category	AC4 category
Making Current 10 x Rated Current	12 x Rated Current
Breaking Current 08 x Rated Current	10 x Rated Current

Contactors shall be capable of withstanding an impulse voltage of 8kV and have an insulation voltage of 1000V.

Contactors shall be suitable for copper termination with a maximum permissible temperature rise of 65 Deg; C at the terminals with an ambient temperature of 50 Deg; C.

The coils shall have three terminals and the insulation shall be of class H type.

The auxiliary contact block shall have a switching capacity of 240V at 2A. Contactors shall have one auxiliary in built and it shall be possible to have additional normally opened, normally closed contacts in steps of two.

5.2 CURRENT TRANSFORMERS

Current transformers shall comply with the requirements of IS 2705. They shall have ratios, outputs and accuracy as specified/required. All CT's shall be of resin cast type unless otherwise specifically called for.

All CT's shall be of bar type primary or suitable for the cable given type and size.

For all the CT's suitable type and size clamps are to be supplied for mounting in the switchboards.

All CT's shall be of 0.5 accuracy class.

Polarities and terminal markings of primary and secondary shall be clearly marked on all CT's.

5.3 SPECIFICATIONS FOR CT'S (RESIN CAST TYPE)

a)	Current Ratio - Primary	:	As per feeder ratings
b)	Current Ratio - Secondary	:	5A (Specification in SLD is final)
c)	Type	:	Resin Cast
d)	Class for Protection	:	PS-Differential Protection
e)	Class for Protection	:	5P10-O/C, E/F, RPR
f)	Class for Metering	:	Class 0.5
g)	System Voltage	:	415V, 3Ph, 50Hz

5.4 POTENTIAL TRANSFORMERS (RESIN CAST TYPE)

All the Potential transformers shall comply with the requirements of IS 3156 latest edition. All PT's shall be resin cast type and shall have voltage ratios, output and accuracy class as Specified in Data Sheer.

All PT's shall be single phase, dry type suitable for mounting inside the panel or cubicles. Clamps, brackets and supports required for the mounting shall be supplied along with PT.

Polarities and terminal markings shall be clearly marked in all PT's. Name plate indicating, voltage ratio, burden, accuracy class, type, serial number, make and model plus other related data, shall be provided.

A common earth terminal for earthing of core, bolts, clamps (non current carrying metal parts) etc., shall be provided.

Specification of the PT's shall be as follows:

a)	Voltage ratio	:	415 $\sqrt{3}$ /110 $\sqrt{3}$
b)	Type	:	Resin cast
c)	Burden	:	100VA
d)	Class (Metering)	:	1
e)	Class (Protection)	:	3P

5.5 INSTRUMENTS AND METERS

All instruments and meters shall be enclosed in dust proof, moisture resistant black finished cases and shall be suitable for tropical use. They shall be calibrated to read directly the primary quantities. They shall be accurately adjusted and calibrated at Works and shall have means of calibration, check and adjustment at site.

5.6 INDICATING INSTRUMENTS

Indicating instruments shall be flush mounted with digital displays. The indicating instruments shall conform to IS: 1248 and shall have an accuracy class of 1.5 or better.

The Ammeter and Wattmeter current coils shall withstand 200% of rated current continuously and 10 times the rated current for 0.5 seconds without loss of accuracy. Voltmeter and Wattmeter potential coils shall withstand 120% of rated voltage continuously and twice the rated voltage for 0.5 sec. without loss of accuracy.

5.7 VOLTMETER

Voltmeter shall be suitable for operating directly on LT supply voltage 415V, 50Hz or with a PT on HT circuits as per the requirements.

All the Voltmeters used for HT circuits shall be rated for operating Voltage of 110V, 50Hz, AC. with a scale indicating directly HT Voltages where as for LT metering. 0-500V Voltmeter shall be used.

All Voltmeters are 96mm x 96mm, suitable for mounting on the panel. Type, Serial Number, accuracy class and borders of the Voltmeter shall be indicated on the dial.

5.8 AMMETER

All the ammeters shall be CT operated (5A) with a dial marked for line currents.

Type, serial number, accuracy class, operating current, burden etc., shall be indicated on the dial.

All Ammeters shall be digital, panel mounting type and shall be provided with zero adjustment.

All ammeters shall be 96mm x 96mm, suitable for mounting on the panel.

5.9 ENERGY METERS

WATT HOUR AND VAR HOUR METERS shall be of the three phase two element type suitable for measurement of unbalanced loads in three phase four wire circuits. They shall be of draw out type and suitable for flush mounting with back connecting terminals. All meters shall be with RS485 port to record energy consumption through BMS. The meter shall have glass covers removable from the front of the panel, without dismantling the meter from the panel. All permanent magnets shall be of the non-ageing type. The meter shall be fitted with a separate test block for testing of the reverse direction. They shall be provided with a separate test block for testing of the meters without disturbing the CT and PT secondary connections. They shall have cyclometer type of register. At least two sealing studs for sealing purposes shall be provided.

The Energy Meter shall be connected to the secondaries of potential transformers and current transformers rated for 110 V and 5 Amp respectively. These meters shall conform to IS: 13010 and have an accuracy of class 0.5 or better for KWH meter and 3.0 or better for LVARH meters.

Meters shall be compensated for temperature errors and factory calibrated to directly read the primary quantities without the use of additional multiplying factor. Multiplying factor, if unavoidable shall be a multiple of 10. Number of digits provided shall be adequate to cover at least 1000hrs. of operations.

The current coil of the meters shall have a continuous overload capacity of 200% for both accuracy and thermal limits. Also the current coils shall withstand at least 10 times the rated current for 0.5 seconds without loss of accuracy.

5.10 PUSH BUTTONS

Push buttons shall be of momentary contact type with rear terminal connection. These shall be suitably shrouded to prevent inadvertent operation. Integral inscription plates engraved with their functions shall be provided. All push buttons shall have two Normally Closed and two Normally Open contacts comprising rivets of pure silver. The contacts shall be able to make and carry 5A and break up one amp inductive loads at 250V DC.

5.11 CABLE TERMINATIONS

Cable entries and terminals shall be provided in the switchboard to suit the number, type and size of Aluminum or copper conductor power cables and copper conductor control cable specified in the detailed specifications.

Provision shall be made for top or bottom entry of cables as required. Generous size of cabling chambers shall be provided with the position of cable gland and terminals such that cables can be easily and safely terminated.

Barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

Cable sockets shall be of tinned copper and of the crimping type.

5.12 CONTROL WIRING

All control wiring shall be carried out with 660/1100V grade single core FRLS PVC cable having stranded copper conductors with minimum cross section of 1.5 Sqmm for potential circuits and 2.5 Sqmm for current transformer circuits.

Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance.

Wires shall be identified by numbered ferrules at each end. The ferrules shall be of ring type and of non-deteriorating material. They shall be firmly located on each termination so as to prevent free movement.

All control circuit fuses shall be mounted for easy accessibility.

5.13 TERMINAL BLOCKS

Terminal blocks shall be of 500Volts grade and of stud/screw less type.

Terminal blocks shall have a minimum current rating of 10Amps and shall be shrouded. Provisions shall be made for label inscriptions. At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.

Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. Also, current transformer secondary leads shall be provided with short circuiting and earthing facilities.

There shall be a minimum clearance of 250mm between the first row of terminal blocks and the associated cable gland plate. Also, the clearance between two rows of terminal blocks shall be a minimum of 150mm.

5.14 RELAYS

All Relays shall conform to the requirement of IS : 3231/IS 8686 or other applicable approved standards Relays shall be suitable for flush and Semi- flush mounting on front At with connections from the rear.

All protective relays shall be of draw out or plug in type. They shall have modular cases with proper built in test facilities. Test blocks and switches shall be located immediately below each relay for testing. The auxiliary relays shall be self reset type.

All AC relays shall be suitable for operation at 50Hz. AC Voltage operated relays shall be suitable for 110/ $\sqrt{3}$ Volts PT secondary and Current operated relays for 5Amp CT secondary, as

specified in this specification. Voltage operated relays shall have adequate thermal capacity for continuous operation.

Auxiliary relays and timers shall have pairs of contacts as required to complete the scheme. Contacts shall be silver faced with spring action.

All protective relays, auxiliary relays and timers except the lockout relays and Interlocking relays specified, shall be provided with self reset type contacts. All Trip relays and Timers shall be provided with externally hand reset positive action provided with inscription subject to consultant / Client approval. Timers shall be of the electromagnetic or solid state type.

Wherever solid state relays are used the following requirement shall be met:

- a. All Relays shall be designed for operating under an ambient temperature 55 Deg; C and 100% relative humidity.
- b. All accessories required for correct operation of each relay shall be supported by the Contractor without any extra cost.
- c. The solid state relays shall be stable and suitably protected against transient or induced over voltages. The Bidder shall state clearly in his list special requirements if any, for DC input arrangement or cabling considered necessary for satisfactory operation of solid state relays quoted by him.

6.0 LABELING

6.1 GENERAL

Every switchboard, switchboard control contactor, time switch, relay, indicator lamp, meter, motor starter, link and any control or protection equipment within or on a switchboard shall be clearly and accurately labeled. Labels shall be engraved laminated plastic or photo anodized rigid aluminium and shall comply with the following requirements.

Except wherever required, labels shall be fixed adjacent to but not on any item of equipment.

Engraved lettering shall be black on a white background, except that the label for a main switch shall have red lettering on a white background, and warning and caution labels shall have white lettering on a red background.

The minimum height of lettering shall be 3mm and of sufficient definition to allow easy reading.

6.2 FIXING OF LABELS

Labels shall be securely fixed by Screws and adhesive, or Fixed in an extruded aluminium section which shall be countersunk screw fixed or countersunk riveted to the panel.

Screws shall be tightened with nuts or into tapped holes in the switchboard. Mechanically expanded plastic rivets of minimum 6mm head diameter are acceptable instead of screws. Aluminium rivets may be used to fix aluminium labels only. Self-tapping screws, thread-cutting screws or other fixings are not acceptable.

6.3 LABELS ON EXTERIOR OF SWITCHBOARDS AND SCHEDULES

All switchboards shall be labeled with the manufacturer's name.

A switchboard designation label shall be provided. For other than main switchboards, the designation label shall also state the source of electrical supply. Separate sections of enclosures shall be identified. The label for any section or enclosure containing Supply Authority equipment shall be to the satisfaction of the consultant / Client and the Supply Authority.

Every switchboard control shall be labeled and shall include:

- a) Circuit designation for all main switches, main controls and sub main controls.
- b) Details of the consumer's mains and all sub mains.
- c) Incoming bus bar or cable rating to the first tee-off.

The minimum height of lettering shall be 6 mm.

For identification of final sub circuits, a typed schedule, cross-referenced to the lighting and power layout plans shall be provided. The schedule shall be protected by a plastic sheet and fixed in a suitable frame mounted on the inside of the relevant switchboard door or, if the switchboard has no door, on the wall immediately adjacent to the switchboard.

6.4 LABELS ON INTERIOR OF SWITCHBOARDS

Labels identifying equipment within a switchboard shall be located such that the item referred to is obvious and the lettering is not substantially obscured by the temporary or permanent position of any equipment or wiring.

For plug-in equipment where items are physically but not functionally interchangeable, the label wording shall be expanded to clearly identify the removable section (e.g. to identify the contact configuration or timing range). Where this is not possible, a second identifying label shall be glue fixed to the removable section.

The function and coding shown on the circuit diagram shall be used.

The MEN link shall be labeled, or stamped and in filled, 'MEN LINK' on the link.

6.5 WARNING LABELS

Where copolymer membrane coating is used anywhere on live conductors without further insulation, a warning label shall be provided on the front cover near the main switch or local main switch and in a prominent position within each section of the switchboard. The label shall have the following wording in 6mm high lettering.

WARNING

PAINTED COATING ON BUS BARS OR TERMINATIONS IS NOT INSULATION

If a stand-by power supply is installed, an appropriate warning label shall be fixed at the main switch or local main switch. An example of a typical label is:

WARNING

IN THE EVENT OF LOSS OF NORMAL SUPPLY GENERATOR SET WILL AUTOMATICALLY START AND BE CONNECTED TO THIS SWITCHBOARD

When anti-condensation heaters are fitted, a label shall be provided at each heater reading:

WARNING

THERMOSTATICALLY CONTROLLED ANTI-CONDENSATION HEATER-DO NOT SWITCH OFF

7 TESTS

7.1 GENERAL

The routine tests shall be conducted as per IS standards on each Power Control Center and shall comprise: Inspection of the Switchboards including inspection of wiring and electrical operational and functional tests where necessary. Checking of protective measures and electrical continuity of the protective circuits.

7.2 DIELECTRIC TESTS

Insulation resistance of the power circuit between each pole and the earth and that between the poles shall be measured.

Insulation resistance of all secondary wiring between phase and earth shall be measured. Insulation test shall be carried out both before and after high voltage test.

7.3 HIGH VOLTAGE TEST

A high voltage test with **2.5kV** for power circuit and **1.5kV** for Control Circuit, Duration one minute shall be applied between each pole and earth and between poles. Test certificate shall be submitted along with panel.

8 STORING, ERECTION AND COMMISSIONING

8.1 STORING

The panels shall be stored in a well ventilated dry place.

Suitable polythene covers shall be pro-aided for necessary protection against moisture, dust, and vermin.

8.2 ERECTION

Switchboards shall be installed over trench/floor as required. Suitable grouping holes shall be provided in the flooring. Suitable MS base channel shall be embedded in the flooring on which the panel can directly be installed. The switchboards shall be properly aligned and bolted to the flooring by at least four bolts. Cables shall be terminated on the bottom plate or top plate as the case may be, by using brass compression glands. The individual cables as shall then be led through the panel to the required feeder compartments for necessary terminations. The cables shall be clamped to the supporting arrangement. Either side, the switchboard earth bus shall be connected to the local earth grid.

The base channel used for erection of panels shall form part of the cost of the panel and shall not be measured or paid separately.

8.3 PRE-COMMISSIONING TESTS

The panels shall be commissioned only after successful completion of the following tests. The tests shall be carried out in the presence of the Client / consultant.

- a) All main and auxiliary bus bar connections shall be checked and tightened.
- b) All wiring terminations and bus bar joints shall be checked and tightened.
- c) Wiring shall be checked to ensure that it is according to the approved drawing.
- d) All wiring shall be tested for insulation resistance by a 500 volt megger
- e) Phase Sequence tests shall be conducted.
- f) Suitable injection tests shall be applied to all the measuring instruments to establish the correctness and accuracy of calibration and working Order if required by the Client.
- g) All relays and protective devices shall be tested for correctness of settings and operation by introducing a current generator and an ammeter in the circuit or shall produce calibration or test certificate as required by the inspectorate or Client / Consultant.
- h) Functional tests on all feeders.
- i) Make, type and ratings of all components shall be checked and verified as per the approved drawings.

8.4 METAL TREATMENT AND FINISH

All steel work used in this Contract shall in general, undergo the following process of treatment and finish.

- a) Degreasing: by hot alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution.
- b) Phosphating : by a recognized Phosphating process to facilitate durable coating of the paint on the metal surfaces and also to prevent the spread of rust in the event of the paint film being mechanically damaged. This again shall be followed by hot water rinsing to remove traces of phosphate solution.
- c) Drying in dust-free atmosphere.
- d) Primer: Primer coating with a coat of corrosion resistant primer applied on wet surface.
- e) Finish coat: Two finishing coats of stoving synthetic enamel paint to the specified shade of IS 5. Both the finish coats shall be only spray painted.
- f) For outdoor units the finishing coat shall be of weather resistant stoving epoxy paint of specified shade of IS 5.

9.0 DIGITAL METERS, DIGITAL LOAD MONITOR & POWER MONITOR

All Energy meters shall be Digital type and shall be of 4 Wire for 3 Phase Application and 2 Wire For Single Phase Application.

All meters shall comply to IEC 61036 or IS 13799 shall be of following parameters

Parameters to be displayed	:	Current Power factor Voltage Frequency Per phase RMS voltage Per phase RMS Current Per phase sequence kW, kVA, kVA _r , kWh, kVA _h
Accuracy Class for power	:	Class 0.5
Accuracy Class for Voltage reading	:	0.5% of reading (+/- 2Digits)
Accuracy Class for Current reading	:	0.5% of reading (+/- 2Digits)
Voltage input – 3 Phase 4 Wire	:	415VAC (-40% to +20%)
Voltage input – 1 Phase 2 Wire	:	240VAC (-40% to +20%)
Current Input	:	5A or 1A
Starting current	:	0.2% of 5A or 1A
Frequency	:	50Hz +/- 10%
Load characteristics – Potential circuit	:	< 5VA
Load characteristics – Current circuit	:	< 0.5VA
Display	:	Backlit LCD / LED
Communication	:	RS 485
Measurement category	:	3
Operating temperature	:	-10°C to +60°C

9.2 POWER MONITOR

Multi Function meter with LCD backlit that will Display Volt Amps Power, Energy, Demand, P.F, Frequency, Power Volt Amps

Individual and THD of Voltage and Current and Power with Harmonic Direction to distinguish if there is Import or Export

Neutral current

Optional 2 Potential free contacts for tripping on any field selectable electrical parameter

Field Configurable of VT/CT ratio and 3 Phase 3 W 3 Ph 4 W, based on 3 or 2 Wattmeter of current measurement for Power computation

RTU Modbus standards with Data transfer speeds up to 38000bps
Accuracy as per IEC class 1036 or better

10.0 TRANSIENT VOLTAGE SURGE SUPPRESSORS (TVSS)

10.1 GENERAL

3-phase, 4-wire transient voltage surge suppression (TVSS) or surge Protection devices (SPD) as indicated in SLD.

10.2 DESCRIPTION

Transient voltage surge suppression (TVSS) or surge protection device (SPD) is the description and equipment required for the protection of all AC Electrical circuits and electronic equipment from the effects of lightning induced Voltages, external switching transients and internally generated switching Transients.

10.3 STANDARDS AND PUBLICATIONS

ANSI/IEEE C62.41-1991, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

ANSI/IEEE C62.45-1992, IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits

Underwriters Laboratories UL 1449 Second Edition, Standard for Safety -Transient Voltage Surge Suppressors

Underwriters Laboratories, UL 1283, Standard for Safety – Electromagnetic Interference Filters

National Fire Protection Association, NFPA 780 - National Electrical Code IEEE Standard 142-1991, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book)

ANSI/IEEE Standard 141-1999, IEEE Recommended Practice for Electric Power Distribution for Industrial Plants (IEEE Red Book)

IEEE Standard 1100-1999, IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (IEEE Emerald Book)

10.4 MANUFACTURER QUALIFICATIONS

The Manufacturer must be regularly engaged in the manufacture of surge suppression products for the specified categories for not less than ten (10) years.

All surge protective devices for service entrance, distribution, and branch circuit Protection within a facility shall be provided by a single manufacturer.

10.5 WARRANTY

The TVSS and supporting components shall be guaranteed by the manufacturer to be free of defects in material and workmanship for a period of 12 Months from the date of substantial completion of service and activation of the system to which the suppressor is attached.

Any TVSS that shows evidence of failure or incorrect operation during the Warranty period shall be replaced free of charge. Since "Acts of Nature" or similar statements typically include the threat of lightning to which the SPDs shall be exposed, any such clause limiting warranty responsibility in the general conditions of this specification shall not apply to this section.

TVSS shall have a response time of equal or less than 1 nanosecond, and be of non-deteriorating design.

Repetitive surge withstanding capabilities for ANSI/IEEE Category 3 shall be not less than 18,000 pulse life for main switchgear and for distribution and sub panels.

10.6 SUBMITTALS

Submit product data and shop drawings with complete description of material components. Manufacturer's certified test report indicating the ability of the product to meet or exceed requirements of this specification.

10.7 MATERIALS

The TVSS shall protect all modes and there shall be seven discrete suppression Circuits; 3 modes connected Line to Ground, 3 modes connected Line to Neutral, and 1 mode connected Neutral to Ground for 3-phase, 4-wire, plus ground voltage system. Line to Neutral ground is not an acceptable substitute for Line to Ground.

Line to Neutral to Line and Line to Ground to Line (in combination) will be acceptable for Line to Line protection.

The installing contractor shall install the parallel TVSS with short and straight conductors as practically possible.

The contractor shall follow the TVSS manufacturer's recommended installation practice as found in the equipment installation instructions (to be included in package with each unit).

The installation shall apply to all applicable codes.

11.0 POWER FACTOR CORRECTION CAPACITORS & HARMONIC FILTERS

11.1 STANDARDS

The Capacitors shall conform to IS 2834-1986 and 13585 (Part I) : 1994

11.2 CONSTRUCTION

- a) The capacitors shall be suitable for operation on 415V, 3 phase, 3 wire, 50Hz solidly earthed AC supply system.
- b) The capacitors shall be of internally connected in delta using to form a bank unit of KVAR as mentioned in Schematic distribution diagram / bill of quantities.
- c) The capacitor shall be suitable for a rated voltage of 415V and shall be of continuously operating at a maximum over-voltage up to 500V.
- d) The rated frequency is 50Hz. The capacitor shall however be suitable for continuous operation with a frequency variation of +/- 3% from the rated frequency.
- e) The capacitor shall be suitable for operation in maximum ambient temperature of 50Deg C as per IS: 2834-1986 & IS: 13585-1994.
- f) The capacitor shall also be capable of carrying without injury an increase in current loading up to 70% of the rated current which may arise due to increase in voltage, increase in frequency, presence of non-sinusoidal voltage supply or other causes. The maximum continuous reactive output of the capacitor shall not exceed 70% over the rated reactive output.
- g) All capacitors shall be suitably tropicalised and rated for the service conditions on site. The capacitors shall be liberally designed and manufactured from the best materials for satisfactory operation under generous service conditions without causing any permanent injury or shortening of the life.

Sl.No	Rating (Voltage 440V)	MH Value	Capacitor rating with Voltage
1.	10 kVAR	4.64	11.2kVAR 480 V
2.	12.5 kVAR	3.71	14kVAR 480 V
3.	20 kVAR	2.32	22.4kVAR 480 V
4.	25 kVAR	1.86	28.1kVAR 480 V
5.	50 kVAR	0.93	28.1X2kVAR 480 V

11.3 DISCHARGE DEVICES

Each capacitor bank shall be fitted with a low loss continuously rated effective discharge device. It shall be designed to discharge the entire capacitor from the peak A.C voltage to a voltage not exceeding 50V measured at the terminals of the capacitor within a maximum period of 1 minute of disconnection from supply.

Data - Gas filled capacitors.

Type of Dielectric	:	MPP
Impregnation	:	Inert Gas.
Nominal Voltage	:	440
Permissible over voltage	:	10% of the rated voltage
Permissible over current	:	30% of the rated current.
Temperature class.	:	- 25 to +55 degree C.

Inrush with stand capacity	:	200 In.
Watt losses	:	0.25 watts per kvar
Protection	:	Over pressure disconnecter.
Connection	:	Delta.
Useful life	:	_____ to be filled by vendor.
Cooling	:	natural.
Enclosure	:	IP 20
Case/ shape	:	Aluminium/ Cylindrical.
Terminals	:	Sigut type.IP 20 protection.
Standard	:	IEC 831.
Application	:	PFC/ detuned system.

11.4 TECHNICAL SPECIFICATION FOR AUTOMATIC POWER FACTOR CORRECTION (APFC)

The capacitor control panel shall be fabricated out of 16G sheet suitably rust inhibited and stove enameled. The panel shall have adequate space for mounting the capacitors and series reactors.

The panel shall be of conductors with minimum cross section of 1.5Sqmm for potential circuits and 2.5Sqmm for current. The panel shall be of dust and vermin proof construction with suitable ventilation arrangement for capacitors and series reactors. Panels shall be of dead front pattern and floor mounting type.

The capacitor control panel shall generally comprise of following

- a) Power factor correction relay.
- b) Step controller with reversing mechanism.
- c) Time delay and no-volt relays.
- d) Protection fuses.
- e) Contactor and switch fuses for individual capacitor banks.
- f) Change over switch for manual and automatic operation
- g) Power factor meter with protection fuses.
- h) Indicator lamp for each bank.

DATA – POWER FACTOR CORRECTION RELAY

System Voltage
 Reactive power
 Active power
 Apparent power
 Apparent current
 Temperature
 Real time cos phi
 Target cos phi
 Alaram out put (over compensation, harmonics exceeded)
 Transistor out put (optional)

Frequency	:	50/60 Hz
No relay out put	:	12
Switching current	:	50 mA

HARMONIC FILTERS & ANTI RESONANCE REACTORS

11.5 STANDARDS

The reactor shall confirm to IS 5553, IEC 60076-6.

The objective of connecting a reactor in series with the capacitor is to avoid resonance between the inductive impedance of the supply transformer plus the line cabling and the capacitors installed for power factor improvement in networks polluted with harmonics. In order to avoid resonance to the 5th harmonic and the above reactor should have a reactance of 7% i.e., resonance frequency of 189 Hz for 50Hz network.

11.6 CONSTRUCTION

The reactors could be built with a core made of oriented grain iron sheet with split air gaps so to give excellent anti saturation characteristics and very low losses. The coils can be made either with insulated copper bars or with aluminium sheet insulated.

The input / output connections should be made through tinned copper bars. The coil windings should be provided with ventilation space for allowing adequate heat evacuation even in hot ambience. The reactor should be vacuum impregnated with a varnish having high insulation properties.

DATA - FILTERS

Insulation level	:	3kV for 1min
Tolerance	:	+/- 5%
Type	:	Iron core type
Material	:	Aluminium foils wound
Voltage	:	440
Cooling	:	Natural
Ambient temp	:	45 Degrees
Class of protection	:	1
Enclosure	:	IP 00
Frequency	:	50Hz
Temperature protection	:	Thermal switch to be provided.
Loss	:	Below 6 watts per kvar
Filtering factor	:	5.67% or 7%
Detuning Factor	:	7
Internal Insulation	:	Class H

The voltage of the capacitor to be 480 for 400Volts system and 525Volts for 415Volts system. Also higher kVAR with respect to voltage (approximately 10% extra with higher voltage).

The Voltage Distortion subjected on the Transformer Incomer/Feeder should be less than 3 % and Current distortion to be less than 5%

12.0 MOTOR CONTROL CENTRE (MCC)

12.1 SCOPE

These Specifications cover design, manufacture, testing and supply of Motor Control Centers for voltages up to 1000 volts.

Specific requirements shall be in accordance with purchase data sheets or single line diagram.

In case of conflicting requirement between the 'Data Sheets' and 'Standard Specification' the former shall prevail.

12.2 STANDARDS

All materials, equipments and accessories used in the manufacture shall conform to the latest editions of relevant Indian Standards including amendments and addendums.

The electrical arrangement of the motor control centre, number of feeders, protection, metering, control, interlocking, trip logic etc. shall be in accordance with the Single Line Diagram.

12.3 SYSTEM

The electrical system voltage, frequency, faults level and circuit current ratings shall be as stated in SLD.

Motor Control Centers shall be capable of operation continuously and without adverse effects or injurious overheating under all specified conditions of operation.

Motor Control Centers shall be capable of withstanding without damage or danger to operating personnel, fault currents equal to the system fault level.

12.4 CONSTRUCTION

Motor Control Centre (MCC) shall be sheet steel enclosed, dead front, fully compartmentalized / non-compartmentalized as mentioned SLD

MCC shall be floor mounting, free standing, totally enclosed and dust, damp and vermin proof.

Non-deteriorating gaskets to be used between all adjacent units and beneath all covers and doors for dust proofing.

For indoor location, MCC enclosure shall have minimum degree of protection - IP 52 (as per IS 2147) and for outdoor location, the MCC enclosure shall have minimum degree of protection - IP 54 (as per IS 2147).

All MCC panels shall be of same height. The height of panel shall not exceed 2300 mm. Panels shall be bolted together to form a continuous flush front switchboard suitable for front of board operation. All switch operating handles, meters shall be between 300mm to 1800mm from the bottom of base frame of MCC panel.

MCC shall be suitable for extension at both ends. Ends of bus bars shall be drilled for extension.

MCC shall be fixed type or draw out type, as specified in the Data Sheets.

All circuit breaker feeders of the MCC shall be draw out type irrespective of whether MCC is fixed type or draw out type.

In case of draw out type MCC, all feeders, circuit breakers as well as switch fuse feeders shall be draw out type.

MCC shall be single or double front as specified in the Data Sheets.

Sheet steel used for fabrication shall be cold rolled, cold annealed. Minimum thickness of various members shall be as follows

Base frame / Channel / Gland plate	:	3 mm
Load Bearing Members / Doors	:	2 mm
Internal Partitions	:	1.6 mm

Construction shall be rigid and robust. All steel work shall be flawless and have a smooth finish. Stiffener shall be provided where required for sufficient rigidity.

Hinges provided for doors shall not be visible from front.

Instruments / relays, indicating lamps, etc. of MCC incomer shall be mounted in a separate compartment adjacent to the incomer compartment.

Motor Control Centre shall be self-ventilated. Ventilation louvers (without cooling fans) in bus bar chamber may be accepted in specific cases and if provided shall be backed up with fine wire mesh of brass for vermin proofing.

Clearance between phases and between phase and earthing as well as the insulation levels shall be in accordance with relevant standard. Sufficient Clearance shall be maintained between the door mounted devices and the top of components mounted inside the compartment.

MCC construction, mounting of various equipment viz. circuit breakers, instruments, relays, bus bars & secondary wiring and number of feeders per vertical panel shall be done with due consideration to the following

- a) Facility for ease of operation, inspection, maintenance and repairs.
- b) Minimum vibration and noise.
- c) Risk of accidental short circuits and open circuits.
- d) Interchangeability of components.
- e) Risk of accidental contact and danger to personnel due to live parts.
- f) Secure and vibration-proof connections for power and control circuits.
- g) When rear door is opened, only cable connections shall be accessible.
- h) Rating of vertical bus bars.
- i) Conformity to latest Indian Electricity Rules and other statutory regulation (in the state in which the installation is located) as regards safety, earthing and other essential provisions specified therein for insulation and operation of electrical plants.

Hooks shall be provided for lifting the MCC. Hooks shall not leave any openings in the MCC, when the same are removed.

All equipment and materials used in construction of MCC shall be new and of best quality and of approved make

12.5 COMPARTMENTAL TYPE

All feeders to be housed in separate compartments. All compartments to be fully segregated from one another, as well as from bus bar chambers, with sheet steel barriers. Terminal chambers for incoming feeders to be segregated from those for outgoing feeders. This type of construction may be

Single Front or Double Front as specified in data sheet. Each feeder compartment shall have a separate door.

Separate compartments shall be provided specifically for circuit breakers, horizontal and vertical bus bar / cable chambers, which will be fully and effectively segregated from one another. This is to confine internal equipment in any other compartments. It shall be possible to maintain

equipment in individual compartments / terminals whilst the remainder of MCC is energized. faults to faulted compartment and to prevent damage

12.6 TYPE OF FEEDERS

Feeders shall be fully draw out type.

The circuit breaker including its operating mechanism, starter / switch fuse feeders or MCCB with equipment shall be mounted on wheeled trolley / carriage moving on guides designed to align correctly and allow smooth movement.

Incoming and outgoing power connections for each draw out cubicle between fixed portion of the panel and trolley shall be by means of self aligning plug-in contacts. Both male and female contacts shall be of silver plated copper. Contact design shall ensure adequate pressure normally and increase in contact pressure during short circuits.

Control wiring connections between trolley and fixed part of panel shall be made by sliding type terminals, which will make and / or break in test and service positions, depending on control scheme.

The draw out design shall have three positions - 'SERVICE', 'TEST' and 'ISOLATE' for circuit breaker and motor starter feeders. For switch fuse feeders, only 'SERVICE' and 'ISOLATE' positions shall be provided. The selection of position shall be possible with the door of the circuit breaker / starter feeder closed for safety purpose.

Position indicator shall be provided on the panel to indicate the position of the feeder trolley viz. 'ISOLATE', 'TEST' and 'SERVICE'.

In the 'TEST' position it shall be possible to check the feeder operation including control logic without energizing the power circuit.

It shall be possible to withdraw the circuit breaker trolley up to the 'TEST' and 'ISOLATE' position without opening the front door.

Automatic safety shutter shall be provided in all C.B. Panels for all openings which will provide access to the live parts of the switchgear upon withdrawal of any portion of the switchgear components parts. This feature may also be provided for other feeders, if feasible.

There shall be provision for pad locking the trolley in all the three positions for complete safety.

Feeder compartments shall be totally closed from all sides, with a door on the front side.

The draw out portion of the cubicles shall be effectively connected to the earth bus through scraping contacts. It must be ensured that the draw out portion gets earthed both in service and test positions.

FIXED TYPE / NON DRAW OUT TYPE

All power as well as control connections of the feeder are fixed type i.e. by bolts or screws.

All feeder equipment to be mounted on a plate which in turn is fixed within the compartment by screws.

Metal sheets shall be provided between two adjacent vertical panels running to the full width of the wider panel and up to full useful height of the panel.

All hardware shall be corrosion resistant. All joints and connections of panel members shall be made by galvanized, zinc passivated or cadmium plated high quality steel bolts, nuts and washers, secured against loosening.

12.7 BUS BARS & INSULATING MATERIALS

The MCC shall have main horizontal and riser bus bars, air insulated / sleeved, (as specified in data sheet), housed in a separate compartment, segregated from all other compartments, with sheet steel barriers. Bus bars shall be of high conductivity Aluminum/electrolytic copper, suitable for carrying the rated and short time current without overheating. Bus bars shall be adequately supported on insulators to withstand dynamic stresses due to short circuits. Bus bar support design should ensure free thermal expansion. Maximum bus bar temperature shall not exceed 850 C under normal operating condition and 2000 C under short- circuit condition.

For double front MCC separate set of vertical bus bars shall be provided for front and rear section of MCC.

All bus bar connections and bus taps to individual feeders shall be either by means of 1100 / 650 V grade multi-strand annealed copper conductor PVC insulated wires or links insulated with shrunk PVC sleeves. Bus bars shall be colour coded for easy identification of three phases. Feeders rated above or equal to 63A shall have link connection with bus bar / bus bar dropper.

All insulating materials used in manufacture shall be non-hygroscopic and shall be treated for preventing fungus growth. Surface of insulators shall be highly glazed and treated with silicone compound to minimize accumulation of dust, condensation of moisture and tracking. The insulating materials shall preferably be non-carbonizing type.

Bus bars for risers shall be rated to carry 125% of the rated current of all feeders connected to the risers.

Bus bars for main horizontal and risers shall be of uniform section throughout.

The minimum cross section of neutral bus bars shall be more than half the size of bus bars for phase.

Bus bars of different voltage level shall be fully segregated from each other.

Only zinc passivated or cadmium plated high tensile strength steel bolts, nuts and washers shall be used for all bus bar joints and supports.

8.0 EQUIPMENT / COMPONENTS

8.1 GENERAL

All feeders to be provided with appropriate components and protective devices as called for in Purchase Data Sheet, Single Line Diagram, Control Schematic and Data Sheet enclosed with enquiry specifications.

Indicating meters and instruments and protective relays of the incoming feeder shall be mounted in a separate compartment adjacent to the incoming feeder compartment. For outgoing feeders these may be mounted in the same compartment.

8.2 CIRCUIT BREAKER & SAFETY INTERLOCKS

The circuit breakers shall be of air break and of horizontal draw out construction, with 3 poles and isolable bolted neutral link or 4 poles as specified in data sheet.

Circuit breakers may be hand operated or power operated, as called for in the Data Sheets.

The closing mechanism of the circuit breakers shall be of one of the following types :-

- 1) Hand operated, spring charged, independent manual type.
- 2) Motor wound, spring charged with a provision of manual charging.

The operating mechanism shall be mechanically and electrically trip-free and non-pumping. Anti-pumping feature may be built in or a separate anti-pumping relay may be provided. A mechanical closing device may be provided, if feasible.

A mechanical trip device suitable for front of board operation and a mechanical 'ON-OFF' indicator shall be provided. Trip device should be shrouded to prevent inadvertent mal operation.

A series or shunt trip coil, as called for in the Data Sheets shall be provided for tripping the circuit breakers. Wattage of shunt trip coils will be sufficiently high to prevent it from picking up or holding on with specified number of indicating lights wired in series with the same.

Provision shall be made for remote closing and tripping of the circuit breakers, with electrically operated mechanism. A 'local/remote' selector switch shall also be provided wherever called for in the Data Sheets.

In case of spring charged mechanism, 'Spring Charged' and 'Spring Discharged' indication (mechanical) shall be provided.

Interlock shall be provided to prevent plugging in or withdrawal of circuit breaker trolley unless it is open. Any attempt to do so shall trip the circuit breaker.

Interlock to prevent closing of circuit breaker, unless it is in 'SERVICE' or 'TEST' position and correctly locked in that position shall be provided.

The circuit breaker compartment door shall be interlocked to prevent access to a breaker which is in SERVICE or TEST position

Main contacts shall have ample area and adequate contact pressure to carry the rated and short time current without excessive temperature rise. The contacts shall be adjustable for wear and easily replaceable. Main contacts shall open before and close after the arcing contacts, when these are provided. Arcing contacts shall be easily accessible for inspection and replacement.

The tips of main and arcing contacts shall be silver plated or shall be of suitable material, to minimize erosion of contacts due to arcing.

Auxiliary switches directly operated by the breaker mechanism shall be provided for control and interlocks. A minimum of six normally open and six normally closed contacts shall be provided. The contacts shall be rated for 10Amp. at 240V A. C. / D.C. All spare contacts shall be wired upto terminal block. Auxiliary contacts in the "trip" circuit shall close before the breaker main contacts close and shall open after the main contacts have opened. All other contacts shall operate simultaneously with the main contacts.

8.3 SWITCH - DISCONNECTORS

Switch disconnectors shall be two position (ON / OFF) type, heavy duty load break, quick make and break type complying with the requirements of IS 13947 Part-3 and suitable for front of board operation. Switch disconnector for switch disconnector fuse shall be of minimum AC 22 category and switch disconnector for motor starter feeder shall be of AC 23 category.

Switch disconnectors shall be interlocked with compartment door to prevent opening or closing of the door in the closed (ON) position of the switch disconnector, in case of compartmentalized switchboard. Provision for padlocking the switch disconnector in open or closed position also to be made.

All live terminals on the Switch disconnector shall be adequately shrouded to prevent accidental contact and danger to the personnel.

Switch disconnectors shall be rated for 125% of circuit full load current with minimum rating of 25Amps.

Height of operating handle of switch disconnectors in MCC shall be between 300mm and 1800mm from the bottom of base frame of MCC.

Switch disconnector shall be provided with 1NO+1NC auxiliary contacts.

8.4 MOULDED CASE CIRCUIT BREAKER (MCCB)

MCCB's shall be 3 pole or 4 pole conforming to as IS-13947 (Part 2) specified in data sheet and Single Line Diagram

MCCB's shall have thermal over current and magnetic short-circuit adjustable releases.

In case of motor loads, the overload and short circuit characteristic shall be selected to avoid minimum tripping during starting.

8.5 MOTOR PROTECTION CIRCUIT BREAKER (MPCB)

MPCB's shall conform to IS-13947(Part 1,2 & 4) and shall have the short circuit breaking capacity as called for.

MPCB's shall provide overload, short circuit & single phasing protection.

MPCB's shall have 1NO + 1NC integral auxiliary contacts and 1NO + 1NC short circuit signaling contacts.

8.6 FUSES

All fuses shall be non-deteriorating high rupturing capacity, link type mounted in suitable fuse carriers or fuse bases, conforming to IS 13703.

Fuses for motor feeders shall be properly coordinated with overload relay so that they do not operate-during starting of the respective motors and shall provide adequate protection for all feeder components.

For switch fuse feeders, the rating of the fuse, if not specified, shall be same as that of the switch rating.

Fuses shall be provided with operation indicators and it shall be possible to change fuses with the circuit live.

All fuses in control, indication and metering circuit shall be HRC, link type.

Insulated fuse pulling handles shall be supplied for each size of fuse with the MCC.

8.7 CONTACTORS

Contactors shall be magnetic, air break type generally as per IS 13947 Part-4 suitable for

Type 2 co-ordination.

All power contactors shall be rated for 125% of feeder full load current. Minimum rating shall be not less than 9 Amps.

Coil voltage shall be as specified in Data Sheets. Contactor coils shall operate satisfactorily and drop OFF at voltages as given in IS 13947 Part-4.

Power contactor's making and breaking capacities shall be suitable for AC3 / AC4 categories of duty as per IS 13947 (Part- 4), unless the contactors are required for special duty, in which case, they will be suitably derated. For AC3 duty making capacity shall be minimum 10 times rated current and breaking capacity shall be minimum 8 times rated current. For AC4 duty making capacity shall be minimum 12 times rated current and breaking capacity shall be minimum 10 times rated current.

All power contactors shall be provided with 2 Normally Open (NO) and 2 Normally Closed (NC) auxiliary contacts; preferably, convertible from NO to NC and vice versa. The auxiliary contacts shall be rated for minimum 5 amps at 240V AC and 1.3 Amps at 110V DC (Inductive load).

All contactor coils to be suitable for tropical climatic conditions specified in Data Sheets. Insulation Class for Coils - Class 'H'.

Reversible contactors shall be electrically and mechanically interlocked.

All the terminal shall be shrouded such that they offer protection against finger contact as under IP 20 degree of protection.

9.0 BIMETAL RELAYS

All bimetal overload relays shall be of hand reset type with at least one NO and one NC contact with reset type push buttons, mounted on door such that it shall be possible to reset the O / L relay with door closed. Overload relay for application involving heavy duty starting with long acceleration time shall be adjustable saturable type of CT operated relay.

All bimetal relays shall have built-in single phasing prevention feature and ambient temperature compensation.

Range of bimetal relays shall be generally 70% to 110% of circuit full load current.

10.0 INDICATING LAMPS

Indicating lamps shall be low burden type with series resistor. Lamps shall be Led or filament type except where neon lamps are specifically called for. Lamp covers shall be provided with interchangeable coloured lenses of perspex or equivalent unbreakable material. It should be noted that lenses should not get discoloured in course of time, due to the heat generated by the lamps. Requirement of indicating lamps will be indicated in Data Sheets. Lamp holder provided shall be suitable for easy removal / insertion of lamps.

When neon lamps are used on D.C. circuits, they shall be tested for operation at specified D.C. voltage without any ripple content. Generally following colour code shall be followed for indicating lamps.

The colour of indicating lamps shall normally be the following unless otherwise specified :-

Red	-	Feeder 'ON'
Green	-	Feeder 'OFF'
White	-	'Trip Circuit Supervision'
Amber	-	Auto Trip
White	-	'Spring Charged'
RYB	-	Potential Indication for 3Ph A.C. supply

11.0 CURRENT TRANSFORMERS

Current Transformers shall conform to latest edition / amendment of IS-2705.

The design and construction shall be sufficiently robust to withstand thermal and dynamic stresses due to maximum short circuit current, available at the point of installation of current transformer.

Secondary terminals of the C.T. shall be brought out suitably to a disconnecting / shorting link type terminal block which will easily be accessible for testing and external connections. Terminals shall be marked in accordance with IS 2705. A name / rating plate as per IS 2705 shall be provided on each current transformer which shall be easily readable after opening the door.

Current transformers shall preferably be capable of being left open on the secondary side with the primary circuit carrying rated full load current without overheating or damage.

12.0 CONTROL TRANSFORMER

Normally Common Control transformer with 100% Standby shall be provided in all motor control centres unless specified otherwise.

Control transformer shall be double wound, air cooled type with one leg of secondary earthed unless otherwise specified.

Control transformers to be capable of withstanding secondary short circuit for not less than 15 seconds.

VA rating of the Control transformer to be adequate to supply about 150% of the control loads of the MCC. Voltage regulation of the Control transformer shall be limited to 4%.

The control transformer shall be provided with easy changeover arrangement for feeding the complete bus from either transformer or independently.

The control transformers shall have $\pm 2.5\%$ and $\pm 5\%$ tapping on primary side.

13.0 CONTROL AND SELECTOR SWITCHES

Control and selector switches shall be of rotary type, provided with suitable nameplate engraved with switch operating positions.

Breaker control switch shall be of pistol grip type spring return, with position indicator, sequence interlock and normal after closing (NAC) contact (when specifically called for).

Selector switches shall have stay put positions with oval handle. The number of contacts and their operation in each switch shall be as per the requirement specified in Data Sheets of Contact Development Diagram.

14.0 INSTRUMENTS AND RELAYS

All relays and instruments shall be flush mounting type. The instruments shall preferably be of the rectangular shape and shall have adequate scale length. Protective relays shall be in accordance with the protective scheme specified. All relays and instruments shall be mounted in a dust-tight, damp-proof, tropicalised cases. Instruments and relays shall be able to withstand a high voltage test of 2000 volts(rms) for one minute. Wherever possible, metering instruments and relays shall be drawout type. Minimum size of indicating instruments will be 96 mm sq. for incoming feeders. Indicating instruments for outgoing feeders, may be 72 mm sq.

Relays shall be micro-processor based numerical type or electromechanical type as specified.

Electro-Mechanical type relays shall be provided with hand reset type mechanical operation indicator of direct acting type or fitted with an auxiliary unit, where required. The auxiliary unit shall be shunt reinforcing, shunt seal-in or series seal-in type, as specified. It shall also be provided with minimum two pairs of self, hand or combined self and hand reset type contacts, as specified.

C.T. secondary rating and current setting range of relays shall be as specified in the drawing.

15.0 ANNUNCIATORS

Annunciators when specified in Data Sheet shall have audible alarm and visual display through translucent plastic window of preferably 50 mm x 65 mm size engraved with appropriate function in block letters on each window. "ACKNOWLEDGE", "RESET" and "LAMP TEST" push buttons shall be provided common for the annunciation system on the MCC.

On receipt of an alarm impulse, audible alarm shall be sounded and lamp inside appropriate window shall start flickering. On pressing of "ACKNOWLEDGE" button the audible alarm shall stop sounding and lamp shall become steady. By pressing "RESET" button the trouble lamps shall not reset unless the alarm condition has disappeared. Annunciator shall provide seal-in lamp indication and audible alarm shall be ready to operate for any new alarm condition immediately after audible alarm is reset for a previous alarm condition.

16.0 INDICATING/RECORDING INSTRUMENTS

All indicating instruments shall be of industrial grade 'A' accuracy, suitable for flush mounting and in accordance with IS1248. Selector switches to be provided for ammeters and voltmeters as called for in Data Sheets. Kilo-watt hour meters shall be in accordance with IS 722, suitable for flush mounting. Ammeters for motor feeders shall have an extended suppressed scale upto six times the rated current (e.g. 0-5/30). Where specified, these can be a part of combined metering and protection module.

17.0 PUSH BUTTONS

Push buttons shall be provided on front door.

Stop Push Button - with stay put feature, (preferably lockable) with mushroom head. Reset Push Button - for hand-resetting of BMR.

Start Push Button - Shrouded type spring return (to be provided only if called for). Colours of the push buttons :

Stop	-	red
Start	-	green
Reset	-	black or yellow

The switches and push buttons shall conform to utilization category AC 11 / DC 11 as per IS: 6875. The contacts shall be rated to make, break and carry inductive current of 5 amps. at 415 V AC and 1 Amp. At 220 V DC.

18.0 MINIATURE CIRCUIT BREAKERS (MCB)

- (1) MCB shall conform to IS: 8828 and shall be duty category M-9.
- (2) It shall be provided with overload and short circuit protective devices in heat resistance housing.
- (3) Type test certificate for short circuit rating and current time tripping curve shall be furnished along with the offer.

19.0 VOLTAGE TRANSFORMER

- (1) The voltage transformers shall generally conform to IS: 3156. The voltage transformer shall be of drawout type, and shall be provided with fuses on primary side and miniature circuit breakers with auxiliary contacts on the secondary side.

(2) The V.T. shall be mounted on a withdrawable carriage. Shutters with padlocking facility, provided on high voltage sides, shall be so arranged that the live orifices are automatically closed when the V.T. is withdrawn.

(3) Neutral point of the star connected VT, both on the primary and secondary sides shall be earthed.

(4) Mechanical interlocking arrangement shall be provided so that the access to the high voltage fuses is possible, only when the V.T. is fully withdrawn.

(5) The VTs shall have an over voltage factor of 1.9 for 30 Seconds, and an accuracy class of 1.0 from 10% to 120% of normal voltage

20.0 EARTHING

The MCC shall be provided with a continuous earth bus having sufficient cross section to carry the specified fault current for specified duration without exceeding the safe temperature throughout its entire length.

All non-current carrying metal work of the MCC shall be effectively bonded to this earth bus. Bonding washers (star washers) shall be used when sections of MCC are bolted together to ensure earth continuity.

21.0 INTERNAL WIRING

MCC shall be complete with all internal wiring and ready for Purchaser's external cable connections at the outgoing terminals. All inter-modular wiring within the MCC for control and interlock loopings shall be carried out by the MCC-manufacturer.

All control wiring inside the MCC shall be carried out with 1100 / 650 V Grade PVC insulated wires of grey colour.

Minimum size of conductor for power circuits shall be 2.5 sq. mm copper or 6 sq. mm aluminium. Conductor material will be specified in Data Sheets.

All control wiring except CT secondary wiring shall be carried out with minimum 1.5 sq. mm copper conductor. CT secondary wiring shall be carried out with 2.5 sq. mm copper conductor.

All wiring shall be securely fixed and neatly arranged to enable easy tracing of wires.

All terminal blocks and wires shall be tagged for identification in accordance with IS 5578 and IS 11353.

All wiring for external connections shall be brought out to the individual terminals on a readily accessible terminal block. All terminal blocks shall be shrouded or provided with transparent covers. All unused contacts shall be wired to terminal block.

Clamp type control terminal blocks shall be provided for outgoing control cables. Minimum 20% or 4 nos. spare terminals shall be provided for future use. Control terminal block of different voltages shall be separated by means of an insulating barrier.

Power terminals, if of bus bars, shall have terminal holes and fitted with cable lugs and bolts suitable for the cables specified.

22.0 MARSHALLING CABINET

Marshalling cabinet shall be provided in each shipping section of MCC for DCS interface.

Terminals for DCS input and DCS output contacts shall be segregated and separate terminal blocks shall be provided.

Screened control cable shall be used for wiring of potential-free contacts from the modules to the marshalling cabinet.

Unless otherwise specified, 8 nos. terminals shall be considered for each module to be prewired in marshalling cabinet (from each module of each shipping section of each MCC)

23.0 SPACE HEATERS

Adequately rated anti-condensation space heaters shall be provided in each breaker panel and in cable alleys of the MCC to maintain MCC inside temperature, 5°C above outside ambient temperature.

Space heater shall be strip type, rated for operation on 240V, single phase, 50 Hz. A.C. supply unless otherwise specified.

Each space heater shall be complete with a rotary type ON/OFF switch, HRC fuse in the phase, neutral link in neutral and a control thermostat.

A separate DP isolator and link type HRC fuses shall be provided in motor feeders for control of space heaters of motors. These shall be wired through a 'NC' contact of the contactor / circuit breaker for motor control.

24.0 AUXILIARY SUPPLY

Auxiliary AC supply for control, indication, space heater etc. shall be derived within the MCC. Vendor shall provide auxiliary control/supply bus in the MCC throughout its length for further distribution inside the MCC. Vendors shall also provide suitable switch and fuse or MCB in each sub-circuit as per requirement. These control / auxiliary supply bus bars shall be fully and effectively segregated from main power bus bars.

DC supply, if specified in data sheet, shall be made available to each MCC through external duplicate DC feeders. Vendor shall provide change - over switch for the same.

25.0 CABLE TERMINATIONS

Cable entry to MCC shall be either from top or bottom of the MCC as specified in the Data Sheets.

Ample space shall be provided in the cable compartment to accommodate PVC insulated Copper conductor cables as specified in the Data Sheets.

Removable undrilled gland plate shall be provided for termination of cables.

Access for cabling shall be from the rear / front. The cubicle width shall be adequate for a cable jointer to enter and work within the cubicle during cable jointing.

Power / control termination shall be properly shrouded so that there is no accidental touch to other line terminals while working on any terminal block. For this, Power terminations shall be properly shrouded and segregated from terminal blocks of other feeders.

All power and control terminals from fixed portion of the panel shall be wired upto power and control terminals in respective cable alley for external cable termination.

Each vertical panel shall have a separate cable alley. The width of this cable alley shall be sufficient to accommodate power & control cables of all feeders and shall have free access for cable terminations. It shall not be less than 300mm wide. Cable alley shall be provided with a suitable door. Sheet steel barriers shall be provided between individual compartment and cable alley. This barrier shall be provided with opening for power and control connections and it shall be possible to safely carryout maintenance work on cable connections to anyone circuit in the alley with the adjacent circuits live.

26.0 PAINTING AND FINISHING

All metal works and metal parts of the MCC shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphatising, passivating and then sprayed with a high corrosion resistant primer. The primer shall be baked in an oven. The finishing treatment shall be by application of synthetic enamel or epoxy or chlorinated rubber of colour shade, as specified. One liter of paint shall be supplied along with each switchboard for touch up at site. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint etc.

27.0 NAMEPLATES AND LABELS

One nameplate giving designation of the MCC shall be affixed prominently on top of the MCC.

Details of designation will be specified.

Labels giving following details shall be affixed on each feeder compartment.

- i) Feeder No.
- ii) Equipment Reference Number and Description
- iii) Rating (KW / KVA / AMP)

All components whether mounted inside the MCC or on the door shall be permanently and clearly labeled with reference number and/or letter of their function. (Rating of fuse shall form a part of the fuse designation.)

All labels shall be non-corrodible, preferably laminated plastic, with white letters on black background.

Labels for feeder designation shall be fixed on the front side of respective feeder with chrome plated, self tapping, countersunk head screws. These labels shall be identical size to permit interchange. Spare feeders shall have blank labels to enable engraving in later stage, if necessary.

28.0 DRAWINGS, INFORMATION AND CERTIFICATES

The Vendor shall furnish drawings in accordance with "Vendor Document Requirements" enclosed with the specification.

Generally following drawings shall be furnished:-

- i) General Arrangement Drawing showing front view, plan, foundation plan, floor cutouts and trenches for external cables, elevations, transport sections with weights ;
- ii) Sectional drawings of various types of feeder, 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 diagrams for each type of feeder and protection including indicating devices, metering instruments, alarms, space heaters, etc. Vendor drawings to be based on Purchaser's control wiring diagrams if furnished;
- iv) Terminal plans showing terminal numbers, ferrules markings, device terminal numbers, function etc.;
- v) Relay wiring diagrams

Vendor shall furnish required number of copies of above drawings as per Vendor Document Requirements for Purchaser's review. After final review, required number of copies and Reproducibles shall be furnished as final certified drawings. As built drawings shall be submitted after installation and commissioning.

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 for relays, etc.
- iii) An equipment list with detailed specifications.

The vendor shall submit CPRI test certificates for short time rating and temperature rise test for the duly specified in data sheet.

29.0 TESTING AND INSPECTION

After completion of all work at the manufacturer's works, MCC shall be inspected and tests witnessed by the Purchaser's Representative. However, stage inspection may be carried out from time to time to check progress of work and workmanship.

The following tests shall be carried out :-

- i) All routine tests specified in relevant Indian Standards shall be carried out on all circuit breakers.
- ii) Test for protective relay operation by primary or secondary injection method. iii) Operation of all meters.
- iv) Secondary wiring continuity test with a low voltage (6 volts) tester. v) Insulation test with 500 volts megger, before and after H.V. test
- vi) H.V. test on power and control circuits / components (2 KV for one minute).
- vii) Earth continuity test with a low voltage (6 volts)tester.
- viii) Simulating external circuits for remote operation of breaker, remote indicating lights and other remote operations, if any, for operational test.
- ix) Pick-up and drop-out voltages for shunt-trip and closing coils. x) C.T. Polarity Test
- xi) Heat run test on bus bar (if specified)

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 type test certificates and certificates from sub-vendor for the components procured from them are to be submitted before despatch of the MCC.

30.0 TOOLS

One complete set of all special or non-standard tools per MCC required for installation, operation and maintenance of MCC shall be supplied.

A suitable universal type circuit breaker handling truck shall be provided with each switchboard. The truck shall have platform of adequate mechanical strength for bearing the weight of the largest circuit breaker and shall be provided with necessary guide rails and stops. The height of the platform shall be adjustable to suit the levels at which the different circuit breakers are mounted in the switchboard.

One complete set of all special or non-standard tools per switchboard required for installation, operation and maintenance of switchboard shall be supplied.

31.0 SPARES

The manufacturer shall provide with his quotation separate priced list of recommended commissioning and Two (2) years operation and maintenance spares. Commissioning spares (list of which shall be approved) shall be purchased with the MCC

32.0 QUALITY ASSURANCE

Quality Assurance shall follow the requirements of Jacobs Engineering Q.A. Documents as applicable.

Q.A. involvement will commence at enquiry and follow through to completion and acceptance, thus ensuring total conformity to Purchaser's requirements.

33.0 DEVIATIONS

Deviations from the Specifications must be stated in writing at the quotation stage.

In the absence of such a statement, it will be assumed that the requirements of the Specifications are met without exception.

34.0 PACKING & DISPATCH

The switchboard shall be divided into several shipping sections for protection and ease of handling during transportation and also it should be moisture proof the equipment package shall be suitable for transportation by ship / rail or road. All out feeders shall be packed as separate shipping sections. The panel shall be covered in polythene sheets before being placed in crates to prevent damage to finish. Crates shall have skid bottom for handling. Special notations such as 'This side up', 'Fragile', 'Center of gravity', 'Weight' etc. shall be clearly marked on the package together with Tag nos., P.O. nos. etc.

The equipment may be stored outdoors for long periods before installation. The packing should also be suitable for outdoor storage areas with heavy rains/ high ambient temperature unless other wise agreed.

----- END OF SECTION -----

**TECHNICAL SPECIFICATIONS
FOR
LUMINAIRES**

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LUMINAIRES

1.1 GENERAL

Luminaires shall be installed in an approved manner and shall be complete with LED lights, incandescent lamps, fluorescent tubes, discharge lamps and accessories necessary for their proper functioning and shall be in accordance with the provisions indicated herein.

All discharge luminaires shall be power factor corrected to a minimum of 0.8 lagging. Lead lag circuits or blocking Inductors shall be incorporated where indicated and or where required by power Supply Company.

1.2 SCOPE

The scope includes the following:

- Interior lighting fixtures, lamps, ballasts, Drivers & Occupancy Sensors except office area's.
- Lighting fixture supports.
- External lights and poles – Not applicable.

The light fixture Installation shall include below accessories wherever necessary.

- Anchor fasteners
- Galvanized full threaded down rods
- Chains
- Extension of wiring using 3 core flexible wires.
- Assembling light fixtures.
- Flexible PVC or MS reinforced conduits for excess wires.

1.3 SUBMITTALS

Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following

- Physical description of lighting fixture including dimensions.
- Ballast / Drivers for LED lights
- Energy-efficiency data.
- Life, output, and energy-efficiency data for lamps.
- Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.

1.4 SHOP DRAWINGS

Show details of standard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.

- Wiring Diagrams: Power wiring.
- Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.
- Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, Operation and maintenance manuals.
- Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- Luminaires Photometric Data Testing Laboratory Qualifications Provided by manufacturer's laboratories that are accredited for Energy Efficient Lighting Products.
- Electrical Components, Devices, and Accessories, Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- Comply with NFPA 70.

1.6 WARRANTY

- Special Warranty for Ballasts/Drivers: Manufacturer's standard form in which ballast/ Drivers manufacturer agrees to repair or replace ballasts/Drivers that fail in materials or workmanship within specified warranty period.
- Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.
- Special Warranty for T5 Fluorescent Lamps: Manufacturer's standard form, made out to Client and signed by lamp manufacturer agreeing to replace lamps that fail in materials or Workmanship the nearest shipping point to Project site, within specified warranty period Indicated as below

1.7 EXTRA MATERIALS

- Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
- Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
- Ballasts/drivers: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

1.8 LIGHT FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- Metal Parts: Free of burrs and sharp corners and edges.
- Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 1. White Surfaces: 85 percent.
 2. Specular Surfaces: 83 percent.
 3. Diffusing Specular Surfaces: 75 percent.
 4. Laminated Silver Metallized Film: 90 percent.
- Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
- UV stabilized.
- Glass: Annealed crystal glass, unless otherwise indicated.

1.9 LED LIGHT FIXTURES

High power and high lumen efficient LEDs suitable for following features shall be used:

- The efficiency of the LED lamps at 85 Deg C junction temperature shall be more than 85%.
- The working life of the lamp at junction temperature of 85 Deg C at rated current shall be more than 50,000 working hours of accumulative operation and shall be suitable for continuous operation of 24 hours per day. These features shall be supported with datasheets.
- Adequate heat sink with proper thermal management shall be provided.
- Colour temperature of the proposed LED shall be 4000k.
- The output of LED shall be more than 100 lumen per watt at minimal operating current and shall ensure guaranteed operation life of 50,000 burning hours with controlled junction temperature of 85 Deg C.
- Lumen maintenance report as per LM 80 guidelines shall be produced for the power LEDs used.
- Power factor of complete fitting shall be more than 0.95 at full load 240V.
- Thermal management shall be in such a way that LED soldering point temperature shall not go beyond 75 degree centigrade.
- The LED luminaires shall be free of glare.

LED DRIVER SPECIFICATION

- Input voltage Range within 180Vrms to 270Vrms
- Operating input voltage 240Vrms
- No load power consumption $\leq 500\text{mW}$
- Output voltage 105VDC $\pm 3\%$
- Output voltage ripple should be within 3%
- Output over voltage protection 125VDC
- Power factor 0.95
- Full Load Efficiency $\geq 90\%$
- **THD $\leq 5\%$**
- Maximum Temperature rise $\leq 30^\circ\text{C}$ @ 45°C Temp with safety margin of 10°C
- The driver should comply to CISPR 15 for limits and methods of measurement of Radio Disturbance characteristics
- The equipment should comply to IEC 61547 for EMC immunity requirements
- The control gear should be compliant to IEC 61347-2-13, IEC 62031 and IEC 62384 as per the requirements
- The equipment should be compliant to IEC 60598-1, IEC 62031 and IEC/PAS 62612 depending on the type of luminary.

The conformal coating used on PCBs must be cleared and transparent and shall not affect colour code of electronic components or the product code of the company.

The LED must be mounted on MCPCB, which should be made up of Metal core (Aluminum metal core) and should have the alumina coating with aerosol spray process of manufacturing to have the better heat conduction or dissipation.

MCPCB shall be made with OPA dielectric thickness of 0.1mm and Al 5052H34.

MCPCB must comply with IPC-A-600G and IPC-6012A class 2. UL approved solder mask and silkscreen must be used.

The heat sink compound used should be of silicon with high thermal conductivity with 3W/mk . The heavy components shall be properly fixed. The solder connection shall be with good finish. The electronics covered for this equipment shall pass all the tests called for in the specification.

Note:

1. Variation in illumination level shall be $\pm 2\%$ is allowed in input voltage range from 180VAC to 270VAC.
2. The illumination shall not have infra-red and ultra-violet emission. The test certificate from the NABL approved laboratory shall be submitted.

2.0 SUPPLY OF LUMINAIRES

Luminaires shall be purchased from a reputable supplier and shall be manufactured in accordance with relevant standards.

The catalogue numbers or trade designations for luminaires used in the schedule of equipment are intended to indicate the required quality, style and performance of the luminaires. Where alternative luminaires are offered all performance data shall be submitted to the Consultant / Client for approval. If requested, by the Consultant / Client, a sample shall be submitted for approval.

3.0 INSTALLATION OF LUMINAIRES

3.1 GENERAL

All screws, battens, roses, trims, packing, etc., necessary for the proper fixing of luminaires shall be provided by the Contractor as part of the works. Packing pieces of approved material shall be fitted where required to level the luminaires and to prevent distortion.

Where painted surfaces are damaged, they shall be made good by painting to the same standard as the original paintwork.

Fittings are to be installed subject to the approval of the Consultant / Client.

All luminaires shall be effectively earthed.

Where rod suspensions are indicated, rods shall be steel water pipe. Rods shall be gimbal mounted from ceiling and lengths shall be adjusted so that the luminaires hang true.

3.2 SUSPENDED LUMINAIRES

Luminaires shall be supported by two fixings at each end. One fixing at each end of a narrow fitting will be accepted where a 1.6 mm thick back plate reinforces each fixing screw.

End to end luminaires shall be correctly aligned using packing strips where necessary.

Luminaires shall not be supported or suspended from plastic boxes or fittings.

Plastic boxes attached to luminaires or cable protection shall not be used as part of the fixing method.

Where a PVC conduit enters a luminary, a screwed PVC adaptor with circular lock nuts shall be used to secure the conduit to the luminary. Lock nuts are not required for luminaires with screwed conduit entries.

Where indicated, luminaires shall be suspended level with electroplated welded link chains at each end.

3.3 SURFACE MOUNTED LUMINAIRES

Luminaires shall be securely fixed to structural members of the ceilings or walls, or fixed by hangers or brackets, which are securely fixed to structural members.

The minimum size of fixing for luminaires, hangers, or brackets for various surfaces shall be as follows:

- (a) Fixing to timber: steel wood screw No.10 x 25, round head, cadmium plated.
- (b) Fixing to concrete: approved screw expanding bolts M5 x 40.
- (c) Fixing to hollow blocks: M5 electro-galvanized, round head screws with spring loaded butterfly toggles. Where a deep cast iron junction box is provided in the centre, M5 metal screws shall be used with approved expanding fixings at each end.
- (d) Fixing to suspended ceilings shall be as indicated.

All fixings shall be fitted with large diameter (minimum 3 mm screw dia.) cadmium plated washers under the heads of each screw.

3.4 RECESSED LUMINARIES

Recessed luminaries shall be fitted with flexible cords and 3 pin plugs. The flexible cord shall be PVC insulated, 3 core with 1.5 mm 2 conductors, and shall comply with the relevant IS. It shall be of suitable length not greater than 1500 mm.

A plug socket shall be located within 500 mm from the edge of the access aperture to allow the luminary to be plugged-in prior to fixing.

Recessed luminaries installed in timber-framed ceiling shall be fixed to the ceiling members and noggins using the proprietary fixings supplied by the luminary manufacturer, subject to the approval of the Consultant / Client.

Recessed luminaries using incandescent or discharge, lamps and installed in a confined space (e.g. covered way, counter canopy, integrated ceiling or roof) shall be wired to a near-by junction box using cable having insulation at least rated to 200 deg. C maximum operating temperature.

Recessed luminaries for suspended or modular ceilings shall be attached to suspended ceilings with proprietary mounting brackets supplied by the luminary manufacturer.

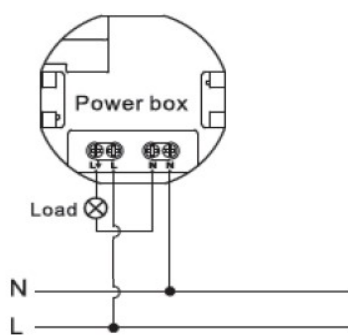
3.5 PROTECTION

All equipments shall be suitably protected to ensure preservation during transportation to the site and any subsequent storage within the site or outside. All vulnerable finished parts liable to scratching or other abrasion during handling shall have further protection by removable film. Any reflector seen installed in site without this protective film shall be rejected and any damage with respect to scratches, fingerprints etc to the reflector shall be made good or a new reflector shall be procured by the contractor. This protective film shall come as a standard with the manufacturer and no site adhesiveness of this film is acceptable.

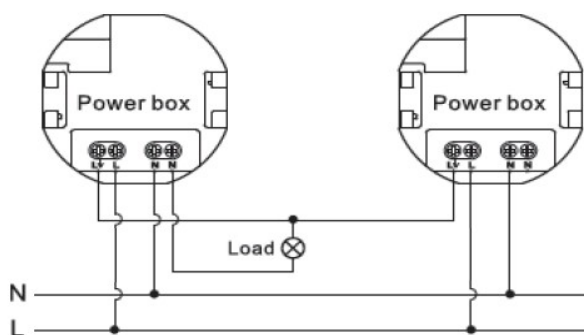
3.6 OCCUPANCY SENSOR SPECIFICATIONS AND REQUIREMENTS

Minimum Service requirements	
Product Specification	Surface / Flush Mounted
Loads	Single load
Technology	Dual Tech
Sensor Type	PIR and Ultrasonic
Angle of detection	360 Degree
Detection range	Min 8m(Dia) @ 2.5M height
Suitable for	Incandescent
	HV Halogen
	LV Halogen
	Fluorescent
	CFL
	T5
	LED
Rated Voltage	220 to 240VAC, 50/60Hz
Type of Installation	Ceiling (Flush/Surface)
Auto Off Time adjustment	5s to 30min
LUX adjustment	10LUX to 1000LUX

3.7 TYPICAL WIRING DIAGRAM FOR SENSORS IN ONE CIRCUIT

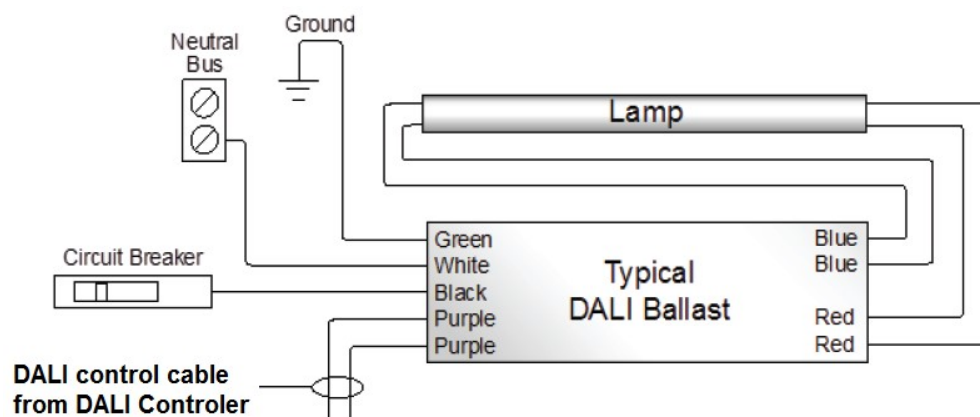


ONE LOAD IS CONTROLLED
BY ONE DETECTOR



ONE LOAD IS CONTROLLED
BY TWO DETECTORS

3.8 TYPICAL WIRING DIAGRAM FOR DALI CONTROL CIRCUIT



----- END OF SECTION -----

**TECHNICAL SPECIFICATIONS
FOR
WIRING DEVICES**

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WIRING DEVICES

1.0 SWITCHES, SOCKETS AND ACCESSORIES

1.1 GENERAL REQUIREMENTS

Light control switches shall be of a 240V, 6A/10A rating for controlling light points as specified. Light control switches shall be of plate type design with metal or PVC boxes suitable for flush mounting for general lighting. Light control switch boxes shall be of metal or PVC as specified.

All sockets 6A, 13A, 16A and 6/16A ratings shall be of flush mounting type unless otherwise indicated with control switches of plate type design of the same rating as that of the sockets. All socket outlets shall be 3/5 pin universal type with metal or PVC boxes as specified.

1.2 MODULAR POWER SOCKETS AND WIRING

Power circuits shall not be mixed with lighting circuits in any case. All Power Sockets shall be installed at heights specified in tender drawings or as per architect proposals.

The power sockets shall be modular in nature. The wiring for power circuits shall be labeled using ferruled for easy access and maintenance.

Scope

- Modular sockets
- SSO – Switched socket outlet – sockets with switch control
- SO – Socket outlet – sockets without switch control
- PVC / MS conduits – 20mm dia 2 mm thick rigid conduit for lighting circuits
- PVC / MS conduits – 25mm dia 2 mm thick rigid conduit for Power circuits
- PVC Conduits – Heavy duty with 2mm thick FRLS type
- Wires: 3Runs of 1.5 sq.mm FRLS multi strand copper flexible for point wiring
- Wires: 2Runs of 2.5 sq.mm + 1Run 1.5 sq.mm FRLS multi strand copper for lighting circuit mains.
- Wires: 2Runs of 1.5 sq.mm + 1Run 1.5 sq.mm FRLS multi strand copper for lighting circuit looping.
- Wires: 2Runs of 4 sq.mm + 1Run 2.5 sq.mm FRLS multi strand copper for power circuit mains.
- Wires: 2Runs of 2.5 sq.mm + 1Run 1.5 sq.mm FRLS multi strand copper for power circuit looping.
- Termination on DB side using tinned copper lugs.
- Neutral and earth wires: shall be distinct for each circuit.

1.3 INDUSTRIAL TYPE SOCKETS

Industrial type sockets shall be provided wherever specifically called for on the drawings. Industrial sockets shall be rated as specified. Plugs and sockets shall have 3 pins for single phase applications and 5 pins for 3 phase applications. The sockets shall be provided with suitable plug top and cable entry device and shall be controlled by a suitably rated MCB. The sockets shall be housed in suitable PVC housings of IP 54 OR IP 66 protection class as mentioned in Bill of quantities.

These Industrial type sockets shall be suitable for mount on Wire ways with proper arrangements.

1.4 LIGHT OUTLET ACCESSORIES

Accessories for light outlets such as lamp holders, 3 plate ceiling rose, etc. shall be in conformity with requirements of relevant IS specification. Only approved make of accessories shall be supplied.

1.5 INSTALLATION

All switch connections shall be made only after ensuring the continuity of wires and terminations. Tapping of wires shall be done only at the terminals of switches, sockets and ceiling roses and terminal blocks. Under joining and extension of wires in pipes and conduits shall not be carried out under any circumstances.

The arrangement of switches and sockets shall be neat, systematic, and aesthetic. The Contractor shall obtain approval from the Consultant / Client with regard to the proper location of switches and all outlets.

The enclosures of sockets and 3rd pin of the sockets shall be connected to the ground through a proper size insulated earth continuity wire. Metal or hylam phase barriers shall be interposed between switches located in a common enclosure, when wired on different phases.

1.6 SUB-MAINS AND CIRCUIT MAINS

Wiring of sub-mains and circuit mains in concealed or surface conduit systems shall be with 2mm thick rigid FRLS PVC / MS conduits and conduit accessories with 660/1100V grade PVC insulated copper flexible wires for phase neutral and earth.

Sub-main shall include MS or MS draw-boxes, sized as required to be located at every floor for easy drawing of wires.

Scope:

Circuit Wiring: using 2 runs of 2.5 sq.mm and 1 run 1.5 sq.mm for each circuit.

Conduits: 20 mm dia, 2mm thick FRLS PVC / 2mm thick MS conduit, on ceiling will be MS conduits and concealed inside wall or wall partition will be FRLS PVC conduit.

Chasing: On wall for wall drops and on MCB DB side.

Termination – Termination at both ends. At MCB end using pin type, tinned copper lugs.

2.0 POINT WIRING

Point wiring shall commence from the first point control box for the points connected to the same circuit. Point wiring for lights, sockets etc, shall be carried out with PVC insulated copper conductor wires of 660/1100V grade. The point wiring shall be inclusive of suitably sized conduits of standard and approved make (as specified before) along with approved quality of conduit accessories and shall be provided with PVC insulated copper earth continuity wire for earthing 3rd pin of sockets at all points as specified.

Point wiring shall include all works necessary to complete wiring of a switch circuit of any length from the Light point to the following via the switch.

- Back plate (in case of fluorescent fitting with down rods, etc.)
- Socket outlet (in the case of socket outlet points.)
- Lamp holder (in case of wall brackets, bulk head and similar fittings).

The following shall be needed to be included in the point wiring.

- Switch Modular Version, Plate, and Surface / Concealed Box etc.
- Ceiling rose or connector as required.
- Any special or suitable round block for neatly housing the connector and covering the fan hook in case of fan point.
- Wires for phase, Neutral, Earth from switch board to light point.
- Wooden box, bushed conduit, porcelain tubing where cables pass through wall.
- Earth wire from three pin socket outlet point
- PVC / MS Conduit / Casing Capping from Switch board to Point.
- All fixing accessories such as clips, rails, screws, phil plugs, wooden plug, etc. as required. Connections to ceiling rose, connector socket outlet, lamp holder, switch and fan regulator etc.

- Wires looping the same switch board and inter connections between points on the same circuit.
- Providing fish wire in conduits while recessed conducting work is undertaken.

Where one / two / three lighting fixture are controlled from one switch, wiring will be from switch to fixture.

Each lighting circuit shall not have more than fifteen outlets or 800 watts whichever is lower. Each Conduit shall not hold more than two branch circuits.

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

2.1 CONCEALED CONDUITS IN WALL

Conduits concealed in the wall should be installed in the rectangular fashion, i.e. horizontal or vertical placement from the switch board, drop point, etc. In no case it should be installed diagonally. The chasing of wall should be done by a machine which makes an exact slot in the wall to accommodate the conduit. The conduit should be properly secured in the slot by necessary hardware. Reinstatement should be done with plastering to the original surface of the wall. The conduit entry in a switch box must be through a bush adaptor.

2.2 SURFACE MS CONDUIT WIRING

All conduits shall be rigid MS conduits. All conduits accessories shall be MS grip type. No MS conduit less than 19 mm dia shall be used.

Conduit pipe shall be jointed by means of couplers and accessories only. In long distance straight runs of conduit, inspection type couplers at adequately supported. The under surface of the conduit pipes including all bends, unions, tees, junction boxes etc. forming part of the conduit system shall be adequately supported. Conduit pipes shall be fixed by heavy gauge galvanized MS saddles and spacers. The conduit pipes shall be individually fixed using galvanized screws at supported.

All necessary bends in the system including diversion shall be done by inspection type normal bends or by fixing inspection boxes whichever is more suitable. Conduit fittings shall not be used on conduit system exposed to weather. The conduit of each circuit or section shall be completed before conductors are drawn in. The entire system of conduit after erection shall be tested for mechanical and electrical continuity throughout and permanently connected to earth. Separate earth wire of appropriate size shall run in each conduit for earthing. If conduit pipes are liable to mechanical damage they shall be adequately protected.

2.3 GENERAL

Prior to laying and fixing of conduits / casing capping the contractor shall carefully examine the drawings indicating the layout of conduits / casing capping, satisfy himself about the sufficiency of the number and size of conduit, location of junction boxes, sizes and location of switch boxes and other relevant details. The consultant / Architects shall approve the layout any modification suggested by the consultant / Architects should be carried by the contractor. Any discrepancy found in the drawing shall be brought to the notice of the consultant.

2.4 MATERIAL

MS Conduit: MS shall be of minimum wall thickness of 2 mm for conduit up to 25 mm diameter and 2.7 mm for conduit above 25 mm diameter.

The tubing must be perfectly circular, without any burrs or kinks. All junction boxes shall be of high dome type and 2 mm thick. The conduit shall be delivered to site of construction in original bundles and each length of conduit shall bear the label mark of manufacture. The contractor shall submit to the consultant detail layout plan of conduit network containing particulars regarding size and routes of conduits, no. of wires carrying in each conduits, inspection and junction boxes provided.

The size of conduit shall be selected in accordance with the number of wires permitted under table given below.

2.5 CONNECTIONS

All conduit joints shall be fully weather tight. Junction boxes and running joints shall be provided at suitable places to allow for subsequent extension if any. As far as possible diagonal run of conduit and adaptable boxes, back outlet boxes, switch boxes and the like must be provided with entry spout and smooth bushes. Conduit system shall be erect and straight as far as possible.

2.6 BEND IN CONDUIT

Where necessary, bend or diversion may be required then the circular inspection boxes with adequate and suitable inlet and outlet shall be provided. In case of recessed system, each junction box shall be provided with a cover properly secured and flush with the finished wall/ ceiling surface, so that the conductors inside the conduit are accessible. No bend shall have radius less than 2.5 times the outside the diameter of the conduit.

2.7 FIXING OF CONDUIT

Conduit and junction boxes shall be kept in position while the wall / floor are under construction for which proper holdfasts shall be provided. Conduits shall be arranged so as to facilitate easy drawing of wires through them. Adequate junction boxes of approved make and size shall be provided. Where conduits cross expansion joint in the buildings adequate expansion fitting or other approved devices shall be used. Conduit stubs in floor slabs shall be kept as short as possible above the finished floor level in order to avoid any damage to them. After the conduit, junction boxes, outlet boxes and switch boxes are installed in position their outlets shall be properly plugged or covered so that water, mortar, insects or any other foreign matter does not enter into the conduit system. Where called for, surface conduits shall be fixed by means of spacer bar saddle at intervals not more than 500 mm from both sides of fittings or accessories. The saddles shall be of 3 mm x 19 mm galvanized mild steel flat, properly treated, primed and painted, securely fixed to support by means of nuts and bolts / plugs and GI machine screw.

2.8 SWITCH OUTLET AND JUNCTION BOXES

All outlets for switch and other receptacles shall be equipped with rust proof outlet boxes of MS / polycarbonate as called for, having external and internal surface true to finish. Where called for outlet boxes for receiving switches and fan regulators shall be of same make of switch and sockets with white polycarbonate modular cover plate

2.9 BUNCHING OF WIRE

Wire carrying current shall be so bunched in the conduit that the outgoing and return cables are drawn into the same conduit. Cables originating from two different phases shall not run in same conduit.

3.0 DRAWING OF CONDUCTOR

The drawing and jointing of copper conductor wires and cables shall be executed with due regard to the following precautions. While drawing insulated wires into the conduit care shall be taken to avoid scratches and kinks, which cause breakage of conductor. There shall be no sharp bends. Insulation shall be stripped off like sharpening of a pencil and it shall not be removed by cutting it square of wiring. Strands of wires shall not be cut for connecting at terminal. The terminals shall have sufficient cross sectional area to take all strands and shall have flat ends. The pressure applied to tighten terminal screws shall be just adequate neither too much nor too less. Only certified wiremen and cable jointer shall be employed to do jointing work. All wires and cables shall bear the manufacturer's label and shall be brought to site in new and original packages. For all internal wiring PVC, insulated wires of 1100 volt grade shall be used. The sub-circuit wiring for point shall be carried out in looping in system and no joint shall be allowed in the length of conductor. No wire shall be drawn into any conduit until all work of any nature that may cause injury to wire is completed. Care shall be taken in pulling the wires so that no damage occurs to the insulation of the wire. Before

the wires are drawn into the conduit, the conduit shall be thoroughly cleaned of moisture, dust, dirt, or any other obstruction by forcing compressed air through the conduits.

3.1 JOINTS

All joints shall be made at main switches, distribution boards, socket outlets, lighting outlets, and switch box only. No joint shall be made in conduits and junction boxes. Conductors shall be continuous from outlet to outlet. Joint where unavoidable shall be made to conform to approved standards.

3.2 MAINS AND SUB MAINS

Mains and sub-mains cable where called for, shall be of the rated capacity and approved make. Every sub main shall be drawn into an independent adequately sized conduit. Adequate size of draw boxes shall be provided at convenient location to facilitate easy drawing of the sub-main and mains cables. An independent earth wire of proper rating shall be provided for every single sub-main. Where mains and sub-mains cables are connected to the switchgear, sufficient extra length of mains and sub-mains cable shall be provided to facilitate easy connection and maintenance.

3.3 LOAD BALANCING

Balancing of circuit in three-phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

3.4 COLOR CODE OF CONDUCTORS

All wires shall be colour coded as follows:

Phase Color of wire

R--- Red ----- Phases

Y--- Yellow --- Phases

B--- Blue ----- Phases

N--- Black ----- Neutral

E----Green -----Earth

3.5 SWITCHES

All 6 Amp switches shall be enclosed type flush mounted switches of 250-volt grade. All switches shall be fixed inside the switch box on approved white polycarbonate modular cover plate, secured to the box with countersunk brass screws. leveling ample space at the back and side for accommodating wires. The switch board controlling the light or fan shall be located at 1200 mm above finished floor level, unless otherwise indicated.

3.6 FLUSH PLATES

All switch receptacles and telephone outlet in walls shall be provided with approved white polycarbonate modular cover plate, secured to the box with countersunk brass screws.

3.7 WALL SOCKET OUTLETS

All 6 Amp wall sockets outlets where called for on the drawing shall be switched and 3 pin type. All 16 amp sockets outlets where called for shall be switched and 3 pin type. The sockets shall be erected at 600 mm above finished floor level, unless otherwise indicated. The switch controlling the point outlet and sockets outlet shall be on the phase wire of the circuit. The earth terminal of the socket shall be connected to the earth terminal provided inside the box by means of green pvc insulated copper earth wire.

Scope

Modular switches – Two way switches, Single pole Switches, Switch Plates

Mounting boxes – Metal boxes

Light Point wiring: using 3Runs of 1.5 sq.mm for each point.

Light Circuit wiring: using 3Core of 2.5Sqmm Cable or 3Runs of 2.5 sq.mm for each point

Power Circuit wiring: using 3Core of 2.5Sqmm Cable or 3Runs of 2.5 sq.mm for each point

Conduits: 19 mm dia, 2mm thick PVC/MS conduit for lighting conduits
Conduits: 25 mm dia, 2mm thick PVC/MS conduit for Power conduits
Point Termination – Ceiling Rose with wire terminating wall / ceiling mounted arrangement.
Inter-connecting wiring inside mounting boxes for circuit connectivity.
Chasing: On wall for wall drops and switches.

3.8 LABELING

The Contractor shall provide labeling for all light control switches, industrial-type sockets, socket outlets, permanently connected devices, etc, identifying the distribution board and circuit breaker number, in an approved manner, acceptable to the Consultant / Client, to provide ready identification.

Hand painted labels are not acceptable.

4.0 WIRE WAYS (CABLE MANAGEMENT SYSTEMS)

4.1 SCOPE

This specification covers NEMA/EEMAC Type 1 Wire way used to house and protect power and/or communications cables for commercial, institutional, industrial and utility needs. The wire way system shall consist of wire way and appropriate fittings to complete the installation per the electrical drawings.

wire management system shall comply to relevant standards and specification, i.e., BS 4678, and IEC 61084.

The cable management system shall be made of ABS or Galvanized steel.

The floor junction boxes and out let boxes shall be capable of resisting minor accidental.

4.2 CODES

- NEMA
- National Electrical Code
- American National Standards Institute
- Underwriters Laboratories Inc.

4.3 MANUFACTURER

Manufacturer shall meet the specification and codes mentioned above.

4.4 MATERIALS

The wire way and all system components must be UL Listed and/or CSA certified. Material thickness shall be determined based on wire way dimensions according to the applicable UL or CSA requirements. The system shall be finished with a powder coat paint and made available with a factory installed divider to separate power and low voltage wiring housed in the same wire way sections.

The base and cover shall be factory assembled and fitted with wing nuts and screws for positive latching. Straight lengths of wire way shall have 1/2" [12.7mm] and 3/4" [19.1mm] concentric knockouts on 24" [61cm] centers to facilitate the entry and exit of various types of conduit. Other electrical knockouts may be provided in the wire way base as required.

4.5 FITTINGS

A full compliment of fittings for the wire way shall be available including, but not limited to, 45° and 90° flat, vertical inside and outside elbows, tee and cross fittings, couplings for joining sections of wire way, reducers, hangers, end blanks, a field installed divider and all other components necessary to make the system workable. The fittings shall have a powder coat paint finish to match the wire way.

4.6 INSTALLATION

Prior to and during installation, refer to system layout drawing containing all elements of the system. Installer shall comply with detailed manufacturer's instruction sheets which accompany system components, as well as complete system instruction sheets, whichever is applicable.

4.7 MECHANICAL SECURITY

All wire way systems shall be mechanically continuous and connected to all electrical boxes and cabinets, in accordance with manufacturer's installation sheets.

4.8 ELECTRICAL SECURITY

All connections shall be checked to make sure they are correctly tightened and to insure that all wire way shall be electrically continuous and bonded, in accordance with the National Electrical Code or other applicable electrical codes for proper grounding.

4.9 COMPLETENESS

All CSA approved wire way must be supported on 5' [1.524m] centers or closer. UL approved wire way of square cross-section, measuring 2 1/2", 4" and 6" [63.5mm, 101.6mm and 152.4mm] may be supported on 10' [3.5m] centers or closer. All other UL approved wire way must be supported on 5' [1.53m] centers or closer.

4.10 COMPLETENESS

All wire way systems shall be installed complete. Work shall include fastening all wire way and appropriate fittings to install a complete wire way system as indicated on the electrical and/or communication drawings and in the applicable specifications.

----- **END OF SECTION** -----

TECHNICAL SPECIFICATIONS FOR EARTHING

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EARTHING FOR ELECTRICAL WORKS

1.1 GENERAL

All non-current carrying metal parts of the electrical installation shall be earthed as per IS:3043. All metal conduits, trunking, cable sheathes, switch gear, distribution boards, meters, light fixtures, fans and all other metal parts forming part of the work shall be bonded together and connected by two separate and distinct conductors to earth electrodes. Earthing shall conform with the provisions of Rules 32, 61,67 and 68 of IER 1956.

Metallic pipes used for other services, such as gas and water shall be considered as unavoidably in contact with metallic enclosures of electrical equipment and shall be effectively bonded to the earthing system.

1.2 EARTHING CONDUCTORS

All earthing conductors shall be of high conductivity copper/GI required/specified and shall be protected against mechanical damage and corrosive. The connection of earth continuity conductors to earth bus and earth electrodes shall be strong and sound and shall be easily accessible. The earth conductors shall be rigidly fixed to the walls, cable trenches, cable trays or conduits and cables by using suitable clamps.

The main earth bus shall have a connection taken from the main medium voltage panel to the earth electrodes. The number of electrodes required shall be arrived at taking into consideration the anticipated fault on the medium voltage network.

All the sub-mains and sub-circuits shall be provided with earth continuity conductors as specified and connected to the main earth bus. Earthing conductors for equipment shall be run from the exposed metal surface of the equipment and connected to a suitable point on the sub-main or main earthing bus. All switchboards, distribution boards and isolators, disconnect switches shall be connected to the earth bus. Earthing conductors shall be terminated at the equipment using suitable lugs, bolts, washers and nuts.

All conduits, cable armoring, raceways, rising mains, metal boxes, panel boards etc., shall be connected to the earth all along their run by earthing conductors of suitable cross sectional area. Sprinkler pipes, LPG pipes, water pipes, steel structural elements, lighting conductors shall not be used as a means of earthing an installation. The electrical resistance of earthing conductors shall not exceed one Ohm.

1.3 EARTHING ELECTRODES

Earthing electrodes shall be designed as per the requirements of clause 17.2 of IS:3043. The number and size of earth electrodes shall be calculated so that under fault conditions no electrode is loaded above its maximum permissible current density. The resistance of earth electrodes shall not exceed one Ohm.

Earthing electrodes of plate type shall be used. The choice of pipe or plate electrode shall be decided according to the anticipated fault level of the network and local soil conditions.

1.4 PLATE ELECTRODE

Plate electrodes shall be made of copper plate of 3.15 mm thick and 60 x 60 cm size. The plate shall be buried vertically in ground at a depth of not less than 2 meters to the top of the plate, the plate being encased in salt and charcoal to a thickness of 15 cm all around. It is preferable to bury the electrode to a depth where subsoil water is present. Earth leads to the electrode shall be of copper and shall be laid in a GI pipe and connected to the plate electrode with brass, bolts, nuts and washers. A GI pipe of not less than 25 mm dia. shall be placed vertically over the plate and terminated in a funnel at 5 ems above the ground. The funnel shall be provided with a wire mesh. The funnel shall be enclosed in masonry chamber of 45 cm x 45 cm x 30 cm dimensions. The chamber shall be provided with GI frame and GI cover. The earth station shall also be provided with a suitable permanent identification using painting.

1.5 PRECAUTIONS

Earthing system shall be mechanically robust and the joints shall be capable of retaining low resistance, even after passage of fault currents.

Joints shall be welded, bolted or double-riveted. All welded joints are painted with cold zinc galvanizing paint. All the joints shall be mechanically and electrically, continuous and effective. Joints shall be protected against corrosion.

1.6 TESTING

On the completion of the entire installation, tests on the earth resistance of the electrodes shall be conducted using an earth-testing megger.

All meters, instruments and labour required for the tests shall be provided by the Contractor. The test results shall be submitted in triplicate to the Consultant / Client for approval. Tests shall be conducted in the presence of Consultant / Client.

1.7 MAINTENANCE FREE EARTH ELECTRODES

A. Characteristics

- Shall have good Electrical conductivity.
- Shall high Corrosion Resistance.
- Shall be mechanically robust and reliable.

B. Maintenance free Earthing System shall consist

- Copper bonded Earth Rod at a depth of minimum 3 meters (1 Rod per pit and 3 rod per pit)
- Ground Enhancing Material (GEM).
- Earth Rod Clamps.

C. Copper bonded Steel Earth Rods

Copper bonded Steel Earth Rods shall have the UL certification, which calls for a minimum molecular bonding of 250 microns. These Coppers bonded rods are provided with a Nickel bonding interface to avoid galvanic corrosion.

D. Ground Enhancing Material

Earth Enhancing Material shall be supplied in bags consists of Earth Enhancing chemical for good conductivity.

E. Method of Installation

One number or three numbers as per Bill of material, Copper bonded Earth Rod shall be placed in an Earth Pit of 10-inch diameter. The earth pit has to be connected by means of Copper Earth Rod Clamp. The whole setup is treated by Ground Enhancing Material (GEM).

The resistance of earth electrodes shall not exceed one Ohm.

1.8 PRECAUTIONS

Earthing system shall be mechanically robust and the joints shall be capable of retaining low resistance, even after passage of fault currents.

Joints shall be welded, bolted or double-riveted. All welded joints are painted with cold zinc galvanizing paint. All the joints shall be mechanically and electrically, continuous and effective. Joints shall be protected against corrosion.

1.9 TESTING

On the completion of the entire installation, tests on the earth resistance of the electrodes shall be conducted using an earth-testing megger.

All meters, instruments and labour required for the tests shall be provided by the Contractor. The test results shall be submitted in triplicate to the Client/consultant for approval. Tests shall be conducted in the presence of Client / Consultant.

2.0 SCOPE

- Installation of earth electrodes
- Grounding strips
- Measuring earth resistance

----- **END OF SECTION** -----

**TECHNICAL SPECIFICATIONS
FOR
LIGHTNING PROTECTION**

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- 1.1 GENERAL**
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- 1.3 INSTALLATION GUIDELIENS**

LIGHTNING PROTECTION

1.1 SCOPE

This specification covers the requirement of supply, installation, testing and commissioning of lightning protection system

- A. Work Included:
 - 1. Lightning Protection system
- B. Submittals:
 - 1. Product data.
 - 2. Shop drawings

1.2 TECHNICAL SPECIFICATIONS

Lightning Protection System (Faraday cage Type)

System shall be provided completely in accordance with

IS/IEC 62305 (I – IV) : 2010

INDIAN standard for Lightning Protection

IEC 62561(part 1-7)

Lightning Protection Components (LPC) Part 1-7 : Requirements for connection components, conductors & earth electrodes, earth pits, earth rods and seals.

UL 96 and UL 467

Testing of lightning protection and earthing components as per the Underwriters Laboratory requirements

The lightning protection installation shall consist of air termination network, down conductors, earthing and bonding to prevent side flashing.

Air terminals shall be mounted on spring enabling the air terminals to have flexibility as well as support base to be mounted to.

The first connection from the air terminal to the GI strip network shall be via aluminum braided conductor.

The Lightning Protection Contractor shall submit the Risk Evaluation and the achieved Lightning Protection Level (LPL) calculation based on IS/IEC 62305 – Part 2. In the absence of such an evaluation employment of LPL-I will be deemed mandatory. The Lightning Protection Contractor shall then submit the shop drawings based on the achieved LPL and shall employ the air termination network consisting of mesh of either 5m x 5m or less, in co-ordination with rolling sphere (size as per the protection level). All the service entries to the structure i.e. power line, telecom line, gas line, water line etc. shall be protected by installing current surge protectors (either 25KA or 18.75KA or 12.5 KA rating), depending on the Lightning Protection Level (LPL) to be used to bring down the risk (R) below the tolerable risk level (R_T).

The Lightning Protection Contractor shall use 25x3 mm GI tape of 99.99% purity complying with BS EN 13601 to form the air-termination mesh on the uppermost part of the structure (typically the roof) and ring conductor around the structure, the spacing between the ring conductors shall depend on the size of the rolling sphere to prevent from side flashes.

Air termination network shall be extended and it's determined by using rolling sphere method.

This method involves rolling an imaginary sphere of 20m or 30m or 45m or 60m radius (depending on the Lightning Protection Level to be used) over structure to require protection.

Typically, if LPL I is employed, then the first horizontal conductor shall be at 20m level (from ground). From 20m to 120m, horizontal conductors shall be installed at every 20 meters or every 5 floors. From 120m upto 400 meters, horizontal conductors shall be installed at every 10 meters or every 3 floors, from 400 meters and above, the horizontal conductors shall be installed at every 5 meters or every floor. However, if the structure is more than 120m in height then the top 20% of the building height is protected using ring conductors every floor and then follow the above rule.

Based on the above the Lightning Protection Contractor shall use 8mm aluminium round rod conductor as ring conductor and this ring shall be bonded to all down conductors around the periphery and a branch conductor to be taken horizontally and all these down conductors shall be bonded to the aluminium cladding wall using bi-metallic clamps.

Any roof (e.g. staircase) on top of the main roof shall have air termination network and it shall be connected to lower roof network.

All the fixing clips for the GI tape shall be metallic (complying with Class 'H' of the electrical testing based on IEC 62561) and shall be fixed at an interval of 500mm (1000 mm fixing distance for fixing conductors on vertical surface up to 20m from the ground level and on the horizontal surface i.e. roof).

The down conductors shall be placed around the periphery of the building. A minimum of two re-enforcing bars shall be used as down conductors in each column. The minimum overlap dimension to connect two re-bars shall be at least 20 times the diameter of the re-bar. If it not practical to arc-weld two re-bars then suitable clamps shall be used at a distance of each 10cm till the above dimension is achieved. Re-enforcement bars in the designated columns should be used as down conductors, with a suitable junction box to be recessed at approx. 500mm above the ground for the test link.

The electrical continuity of the reinforcing bars shall be determined by electrical testing between the uppermost part and the ground level. The overall electrical resistance shall not be greater than 0.2Ω , measured using test equipment suitable for this purpose. If this value is not achieved, or it is not practical to conduct such testing, the reinforcing bar shall not be used as a natural down conductor.

The composite glass panel shall be bonded to all the down conductors at the various slab levels as per the rolling sphere spacing by using bi-metallic clamps complying to IEC 62561.

The earthing shall be done as per local authority's requirements. A minimum of 2400 mm solid copper electrode shall be provided with each down conductor separately. However, the Lightning Protection Contractor shall submit the calculation for deciding the number of earth rods in each earth pit. Wherever the soil resistivity is low (typically below $<20 \Omega m$), the Lightning Protection Contractor must use either solid copper rods or stainless steel rods to ensure the longevity of the earth termination network or we can have interconnection all the down conductor with main strip/rod and buried by 0.5 Mtr below the ground level.

The complete Lightning Protection System measured at any point, shall not exceed 10 ohms. With the test clamp disconnected, the resistance of each individual earth should be

no more than ten times the number of down conductors in the complete system.

The LV and the IT earth shall in no case exceed 1 ohm.

The terminated head of each electrode shall be located in a light weight inspection pit.

The double flange earth seals should be designed for use in concrete slabs of nominal thickness from 300mm to 5000mm thick, the seal will withstand water pressure up to 80 psi equal to a 55 meter head of water. The earth seal flange shall be free from dust / debris, grease/paint before pouring of the concrete. A Contractor should be employed to do the installation or shall be done under the supervision of the manufacturer or the manufacturer's authorised representative.

Lightning Protection Contractor also has to ensure, based on IS/IEC 62305 – IV, that suitable coordinated over-voltage surge protection devices with an extra low let – through voltage are used for protecting any terminal devices i.e. DBs feeding critical services or even the local critical electrical gadget.

All metallic parts protruding outside the extended air termination network (e.g. balcony hand rails, building façade etc) shall be connected to the air termination using suitable clamps (material complying to IS/IEC 62305) at every floor wherever the horizontal conductor is applied. The equipments on the roof (i.e. Chiller units etc) shall be protected using vertical air terminals of suitable height so that it provides the zone of protection. This air terminal shall be installed at a suitable separation distance so that the partial lightning current doesn't flow through the equipment. The cable from the equipment shall be protected using an over – voltage protector. The equipment shall not be bonded to the air termination network. Lightning Protection Contractor shall give the calculation of the suitable separation distance.

The Lightning Protection Contractor shall install suitable surge protectors at local power distribution boards feeding vulnerable equipment, in order to protect these against transients generated downstream of the protectors in 1, above. (These transients may be the result of inductive coupling or electrical switching.)

Protectors shall be tested in accordance with the requirements of:

- IS/IEC 62305 – Electrical & Electronics Systems Protection within structures (Part 4),
- BS 2914:1972 'Specification for surge diverters for alternating current power circuits',
- IEEE C62.41-1991 'Recommended practice on surge voltages in low voltage AC power circuits'.

Protectors for a given Location Category shall be rated for a High Exposure Level (as defined by IS/IEC 62305), unless contrary information is available.

The protector must not interfere with or restrict the system's normal operation. It shall not:

- corrupt the normal mains power supply
- break or shutdown the power supply during operation
- have an excessive earth leakage current.

The protector shall be rated for a peak discharge current of no less than 10kA (8/20:s waveform) between any two conductors (phase to neutral, phase to earth and neutral to earth).

The protector shall limit the transient voltage to below equipment susceptibility levels. Unless otherwise stated, the peak transient let-through voltage shall not exceed 600 volts, for protectors with a nominal working voltage of 230 or 240 volts, when tested in accordance with IS/IEC 62305 (6kV 1.2/50 μ s open circuit voltage, 3kA 8/20 μ s short

circuit current).

This peak transient let-through voltage shall not be exceeded for all combinations of conductors:

- phase to neutral
- phase to earth
- neutral to earth.

Mains protectors (installed in shunt/parallel) shall have continuous indication of its protection status and the presence of power.

Status indication shall clearly show per phase:

- full protection present
- reduced protection - replacement required
- no protection - failure of protector.

Remove indication of status (including loss of phase/supply) shall also be possible via a volt free contact.

The status indication shall warn of protection failure between all combinations of conductors, including neutral to earth. (Otherwise a potentially dangerous short circuit between neutral and earth could go undetected for some time.) This shall include early warning of excessive neutral to earth voltages.

The protector shall be supplied with detailed installation instructions. The Contractor must comply with the installation practice detailed by the protector manufacturer.

The Lightning Protection Contractor shall also install transient overvoltage protectors on all data communication/signal/telephone lines in order to protect equipment connected to the line, against transient over-voltages. (Where data lines link equipment in separate buildings, transient overvoltage protectors shall be installed at both ends of the line in order to protect both pieces of equipment.)

Protectors shall be tested in accordance with the requirements of:

- IS/IEC 62305 – Electrical & Electronics Systems Protection within structures (Part 4),
- CCITT IX K17 'Tests on power fed repeaters using solid-state devices in order to check the arrangements for protection from external interference'.

Protectors shall be rated for Location Category - High Exposure Level (as defined by IS/IEC 62305), unless contrary information dictates a lower Exposure Level.

The protector must not impair the system's normal operation. It shall not:

- suppress the system's normal signal voltage
- restrict the system's bandwidth or signal frequency
- introduce excessive in-line resistance
- cause signal reflections or impedance mismatches (high frequency systems only).

The protector will have a low transient let-through voltage for tests conducted in accordance with IS/IEC 62305 (5kV 10/700µs test).

This let-through performance will be provided for all combinations of conductors:

- signal line to signal line
- signal line to screen/earth.

The protector shall be rated for a peak discharge current of 10kA.

The protector shall be supplied with detailed installation instructions. The Contractor must comply with the installation practice detailed by the protector manufacturer.

The protector manufacturer shall allow for the facility to mount and earth large numbers of protectors through an accessory combined mounting and earthing kit.

Materials

Materials shall comply in weight, size and composition with the requirements of IS/IEC 62305, UL96 and UL467.

All surge protection devices to be used shall be from the same manufacturer who supplies the structural lightning protection.

Surge protectors shall be manufactured for the specific type and voltage of the electrical service and shall provide clamping for both normal (L-N) and common (L-N-G) mode protection.

EQUIPOTENTIAL BONDING

Lightning Protection Contractor shall ensure proper co-ordination between the Structural , Civil , Electrical and the Cladding contractor

All installation details shall be agreed with the Engineer prior to commencement of work. The Lightning Protection Contractor shall obtain an inspection certificate from the manufacturer or its authorized representative towards the satisfactory installation of the system and that proper material in accordance to the above standard has been used.

Equipotential Bonding is the electrical interconnection of all the appropriate metallic installation / parts, such that in the event of the lightning current flowing, no metallic part is at a different voltage potential with respect to another. The metallic parts have to be essentially at the same potential so that the risk of sparking or flash over is nullified. This electrical interconnection shall be achieved by using specific bonding solid copper bar of atleast 50mm x 6mm cross section area. Bonding shall also incorporate the use of surge protection devices where direct connection to the bonding bar is not suitable or practical. The SPDs must be installed in such a way that they are readily accessible and visible for inspection purposes.

The lightning Protection Contractor shall install the equipotential bonding at the ground level and then every 20 meters floor thereafter. Wherever protection of internal systems against over-voltages caused by lightning discharge requires SPDs, these shall conform to IS/IEC 62305.

The gas, water and other metallic systems shall all be bonded directly to the equi-potential bar located inside but close to the outer wall near the ground floor or basement level. The power cable shall be bonded to the equi-potential bonding bar via a suitable SPD. The screen of the antenna cable or any shielded power supply shall also be bonded to the equipotential bar.

Service entry SPDs are for metallic electrical services only - gas and water do not fall under this category. Metallic gas and water need to be directly bonded. The service entry data and telecom lines can handle 2.5kA (10µs/350 µs) per line, so the lightning protection Contractor shall provide suitable SPDs in accordance to the above specification as per the IS/IEC 62305.

Since the service entrance SPDs are designed to protect against dangerous sparking only as per IS/IEC 62305. The lightning protection Contractor shall need to fit additional protection at the sub-distribution and near equipment to protect electronic equipment to IS/IEC 62305. Both types of SPD are a required in accordance with this BS EN standard if the risk assessment demands this.

The bonding bar shall be located close to the main distribution board and shall be connected to earth termination network at ≤ 1 ohm, with a very short length conductor not exceeding 10 meters in length.

Please refer to the details for further clarification.

All the bonding bars at different levels shall be connected to each other, which in-turn is earthed at 1 ohm.

INSTALLATION GUIDELIENS

TESTING

On completion of the installation or of any modification to it, the following isolated and combined measurement and and checks has to be made and the results recorded in a lightning protection system logbook.

The resistance to earth of each local earth electrode and in addition the resistance to earth of the complete earth termination system

Each local earth electrode has be measured in isolation and the test point between the down conductor and the earth electrode in the disconnected position (isolated measurement)

A further measurement has to be taken with the test point in the connected position (combined measurement)

The results of visual check of all conductors, bonds and joints and their measured electrical continuity

If the resistance to earth of a lightning protection system exceeds 10 ohms, the value must be reduced. Necessary remedial action needs to be taken to reduce the value below or equal to 10 ohms.

The shop drawings must be approved by the manufacturer or the manufacturer's authorized representative, which has to be used for installation afterwards to ensure total adherence to the standards and requirements. Also the manufacturer or the manufacturer-authorized representative will have to survey and certify the installation to ensure the standards.

The manufacturer or the manufacturer's authorized representative will certify the length and quantity, provided by the Lightning Protection Contractor for the project.

The Lightning Protection Contractor must submit the Test Certificates of the materials used as per IS/IEC 62305, which shall be attested in original by the manufacturer or the manufacturer's authorized representative.

Records

The contractor has to keep on site, the following records, and be responsible for the upkeep of the installation:

- a) Approved shop drawings, showing the nature, dimensions, materials and position of all component parts of the lightning protection system.
- b) The nature of the soil and any special earthing arrangements.
- c) The type and position of the earth electrodes, including reference electrodes.
- d) The test conditions and the result obtained.
- e) Any alteration, additions or repairs to the system.
- f) The name of the person responsible for the installation upkeep.
- g) A label shall be attached at the origin of the electrical installation, worded as follows
- h) "This structure is provided with a lightning protection system in accordance with IS / IEC 62305 and IEC 62561 and the bonding to the services and the main equipotential bonding shall be maintained accordingly"

----- **END OF SECTION** -----
